



# Incidence of and mortality from COVID-19 in the older Brazilian population and its relationship with contextual indicators: an ecological study

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## Abstract

**Objective:** to analyze the incidence of and mortality caused by COVID-19 in the older population in Brazil and its relationship with contextual variables. **Methods:** the 22 Brazilian states (including the Federal District) with 50 deaths or more due to COVID-19 by May 25<sup>th</sup>, 2020 were included. The rates of accumulated incidence, accumulated mortality and accumulated lethality among older adults were considered as dependent variables. Among the contextual variables, the provision of health services and professionals, and demographic, income and development indicators were included. The variables were analyzed in a descriptive and bivariate manner using Spearman's correlation. **Results:** the state of Pará had the highest incidence and mortality rate among older adults. The highest accumulated lethality rates among this population were observed in Bahia (56.46%), Rio de Janeiro (48.10%) and Pernambuco (40.76%). There was a significant negative moderate correlation between the accumulated incidence rate and the aging index ( $\rho=-0.662$ ;  $p=0.001$ ) and the proportion of older adults ( $\rho=-0.659$ ;  $p=0.002$ ); and between the mortality rate and the aging index ( $\rho=-0.520$ ;  $p=0.013$ ) and the proportion of older adults ( $\rho=-0.502$ ;  $p=0.017$ ). The accumulated incidence rate and mortality rate also revealed, respectively, a significant positive correlation with the proportion of black (Afro-Brazilian) and brown (mixed race) skinned people ( $\rho=0.524$ ;  $p=0.018$  and  $\rho=0.558$ ;  $p=0.007$ ) and with the income ratio ( $\rho=0.665$ ;  $p=0.0001$  and  $\rho=0.683$ ;  $p<0.001$ ). **Conclusions:** the Brazilian epidemiological situation shows that the mortality of older adults due to COVID-19 in Brazil is related to demographic and income distribution aspects.

**Keywords:** Coronavirus Infections. Coronavirus. Health of the Elderly. Incidence. Mortality. COVID-19.

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## INTRODUCTION

Since December 2019, public health authorities around the world have been on alert due to reports of cases of pneumonia with an unknown etiology in China. In January 2020, the illness was discovered to be Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), and the disease caused by this new zoonotic agent became known as Coronavirus Disease - 2019 (COVID-2019)<sup>1,2</sup>.

Since its discovery, the new coronavirus has had an extremely high transmission rate, and by January 30, 7,818 cases of infected people had been reported in 18 countries, with 170 people having already died in China due to COVID-19. As a result, the World Health Organization (WHO) declared a Public Health Emergency of International Concern<sup>3</sup>. COVID-19 cases were growing rapidly worldwide and on March 11, the WHO declared a pandemic, when more than 118,000 cases of the disease were registered in 113 countries, with more than 4,000 deaths<sup>4</sup>.

The first case of the disease was recorded in Brazil on February 26th, in an older man with a history of having travelled to Italy<sup>5</sup>. Since then, cases of the disease have shown significant daily growth in the country and, by May 25th, more than 374,000 cases and 23,473 deaths had been registered throughout the country<sup>6</sup>.

When analyzing the distribution of cases of the disease and deaths by age group, both in Brazil and around the world, a higher incidence of the disease in the adult population can be observed, with lethality higher still among the older population<sup>7</sup>. The presence of associated morbidities contributes significantly to the increase of this rate, with 69.3% of deaths in Brazil occurring in people over 60 years old, of whom 64% had at least one risk factor<sup>8</sup>. A similar situation had already been reported by patients infected with the Severe Acute Respiratory Syndrome coronavirus (SARS-CoV) and the Middle East Respiratory Syndrome coronavirus (MERS-CoV)<sup>9,10</sup>.

Data from COVID-19 show that among people aged 80 or over, 14.8% of those infected with the disease subsequently died, compared to 8.0% among older adults aged 70 to 79 years, and

8.8% among those aged 60 to 69 years old (a rate 3.82 times higher than the overall average), which should alert health authorities to the need to develop strategies to protect the health of older adults. This, however, has not occurred. The risk of dying from COVID-19 increases with age, as most deaths occur in older adults, especially those with chronic illnesses. Immunosence increases vulnerability to infectious diseases and the prognosis for those with chronic diseases is unfavorable<sup>11</sup>.

In addition, in developing countries, tackling the COVID-19 pandemic becomes even more challenging due to the high rates of poverty, conflict and political instability, violence, illiteracy, deficiencies in diagnostic laboratories and other infectious diseases that compete for scarce health resources<sup>12</sup>. Socioeconomic conditions, housing and precarious infrastructure contribute to increased socio-spatial vulnerability of contamination, demanding specific measures for different parts of the territory.

Looking at the territory allows us to identify the particularities of the dynamics of the evolution of the pandemic, favoring the design of specific strategies to tackle the different scales of the disease<sup>13</sup>. In Brazil, socioeconomic data have revealed that those most affected are older women, with low levels of education, who live on a per capita household income of up to half the minimum wage<sup>14</sup>. The identification of sociodemographic characteristics related to COVID-19 can contribute to the understanding of the dynamics of the disease in the country, in addition to being crucial for the development of measures to deal with the pandemic and minimize damage among this specific population.

In this context, the present study aimed to describe and analyze the indicators of incidence and mortality from COVID-19 in the older population in Brazil and its relationship with contextual variables.

## METHOD

This is an observational, ecological and analytical study. For analysis units, Brazilian states (including the Federal District) that had 50 or more deaths due

to COVID-19 up to May 25th, 2020, were included, namely: Amazonas, Alagoas, Bahia, Ceará, o Distrito Federal (the Federal District), Espírito Santo, Goiás, Maranhão, Minas Gerais, Pará, Paraíba, Paraná, Pernambuco, Piauí, Rio de Janeiro, Rio Grande do Norte, Rio Grande do Sul, Rondônia, Roraima, Santa Catarina, São Paulo and Sergipe.

For data collection, a survey was carried out of the epidemiological bulletins of the respective states, available from the websites of the state health departments. The collected information was entered into a matrix for analysis in Microsoft Excel 2016.

Dependent variables related to COVID-19 among older adults (over 60 years of age) were considered, namely: an accumulated incidence rate per 100,000 older adults (accumulated number of new cases /number of older adults in the state\*100,000), accumulated mortality rate per 100,000 older adults (accumulated number of deaths/number of older adults in the state \*100,000), and accumulated lethality rate (accumulated number of deaths/number of cases in the older adults\*100).

The independent variables applied were: number of hospital beds per 1000 inhabitants, number of doctors per 1000 inhabitants, percentage of coverage by the Family Health Strategy, percentage of Primary Health Care coverage, rates of aging and overaging<sup>15</sup>, proportion of older adults, human development index (HDI), percentage of black (Afro-Brazilian) and brown (mixed race) skinned people, income ratio and demographic density per km<sup>2</sup>. The information was obtained from the Brazilian Institute of Geography and Statistics (or IBGE) and from the Informatics Department of the National Health Service (or DATASUS), all of which are in the public domain.

The variables were analyzed in a descriptive and bivariate manner, through Spearman correlation

analysis, considering a significance level of 5%, using the R<sup>®</sup> software package.

## RESULTS

When observing the population characteristics and number of cases and deaths from COVID-19 in Brazil, the state of São Paulo has the highest number of cases and deaths from COVID-19, with 82,161 cases and 6,163 deaths. The state with the lowest number of cases due to the disease is Roraima with 2,514 cases, and this state also has the lowest number of deaths due to the disease, with 86 (Table 1).

The state of Ceará has the highest number of cases of COVID-19 among older adults with 6,896 cases, and the state of Roraima has the lowest number of cases in the older population, with 198. Although the state of São Paulo did not present case data by age group, the highest number of deaths among older adults was registered in the state, with 4,495. The lowest number of deaths in this age group was also observed in the state of Roraima, with 43 (Table 1).

The highest proportion of cases and deaths among older adults, respectively, were observed in the states of Pará (22.36%) and Rio Grande do Sul (84.44%), and the lowest proportions, respectively, were in the states of Bahia (3.90%) and Amazonas (37.66%) (Table 1).

Table 2 presents the socioeconomic and health resource and services characteristics and indicators of population aging in the states analyzed. About 12.47% of the population in the evaluated states is made up of older adults, with an average mean aging rate of 58.40. In contrast, Primary Health Care coverage is around 78.47% of the population, with an average rate of 1.65 doctors and 2.38 hospital beds for every 1000 inhabitants.

**Table 1.** Population characteristics and number of cases and deaths by COVID-19 in Brazilian states. Brazil, 2020.

State	Total Cases	Total Deaths	Older Adult Cases	Older Adult Deaths	Proportion of Cases	Proportion of Deaths	Total Population	Pop. Older adults
São Paulo	82161	6163	-	4495	-	72.94%	45,919,049	6,993,969
Rio de Janeiro	39298	4105	5823	2801	14.82%	68.23%	17,264,943	2,893,098
Ceará	35947	2330	6896	1602	19.18%	68.76%	9,132,078	1,148,430
Pernambuco	27759	2200	4546	1853	16.38%	84.23%	9,557,071	1,213,174
Amazonas	29867	1758	2091	662	7.00%	37.66%	4,144,597	311,473
Pará	26077	2375	5830	1673	22.36%	70.44%	8,602,865	763,716
Maranhão	22786	784	4063	560	17.83%	71.43%	7,075,181	722,295
Bahia	13899	460	542	306	3.90%	66.52%	14,873,064	1,919,264
Espírito Santo	10007	447	1678	327	16.77%	73.15%	4,018,650	566,931
Paraíba	7823	272	-	174	-	63.97%	4,018,127	546,557
Santa Catarina	6696	105	919	74	13.72%	70.48%	7,164,788	1,043,218
Minas Gerais	6668	226	1091	171	16.36%	75.66%	21,168,791	3,315,874
Rio Grande do Sul	6470	180	1151	152	17.79%	84.44%	11,377,239	2,069,569
Distrito Federal	5902	98	795	74	13.47%	75.51%	3,015,268	328,379
Alagoas	6214	316	1087	215	17.49%	68.04%	3,337,357	370,746
Sergipe	5314	93	507	59	9.54%	63.44%	2,298,696	253,134
Rio Grande do Norte	4709	184	779	118	16.54%	64.13%	3,506,853	445,618
Piauí	3550	110	644	77	18.14%	70.00%	3,273,227	411,268
Paraná	3212	153	595	106	18.52%	69.28%	11,433,957	1,712,479
Rondônia	3201	121	359	73	11.22%	60.33%	1,777,225	169,913
Goiás	2518	96	401	66	15.93%	68.75%	7,018,354	836,663
Roraima	2514	86	198	43	7.88%	50.00%	605,761	41,240

**Table 2.** Socioeconomic characteristics, health service provisions and aging indicators of analyzed states. Brazil, 2020.

Variable	n (%)	Minimum	Maximum	Median	Mean	SD
Hospital beds per 1000 inhabitants	22	1.59	3.61	2.34	2.38	0.435
Doctors per 1000 inhabitants	22	0.48	3.38	1.53	1.65	0.671
Percentage of FHS coverage	22	39.47	99.95	73.27	71.06	15.581
Percentage of primary care coverage	22	53.36	99.98	78.12	78.47	12.160
Overaging index	22	9.26	16.41	14.47	13.96	1.922
Ageing index	22	24.99	99.19	57.22	58.40	19.380
Proportion of older adults	20	6.81	18.19	12.63	12.47	2.876
Human Development Index	22	0.631	0.824	0.687	0.704	0.054
Percentage of black and brown skinned people	22	19.20	82.00	67.40	62.86	18.507
Income ratio	22	13.48	87.71	35.68	37.63	19.863
Demographic density per km <sup>2</sup>	22	2.00	444.00	54.58	82.46	112.665

n = number of states; SD = standard deviation; FHS = Family Health Strategy; km<sup>2</sup> = square kilometers

The highest rate of accumulated incidence and mortality due to COVID-19 was registered in the state of Pará, with 763.37 cases per 100,000 older adults and 219.06 deaths per 100,000 older adults. The lowest accumulated incidence was observed in Bahia with 28.24 cases per 100,000 older adults and the lowest mortality rate was in the state of Minas Gerais (5.16 deaths per 100,000 older adults). Regarding lethality, it was found that the highest rate was registered in Bahia (56.46%) and the lowest in Santa Catarina (8.05%) (Table 3).

When assessing the correlation between the indicators of cases and deaths in older adults and

independent sociodemographic variables, coverage by health services and population aging indicators, a significant negative moderate correlation was observed between the accumulated incidence and mortality rates, respectively, with the aging index ( $\rho = -0.662$ ;  $p=0.001$  and  $\rho = -0.520$ ;  $p=0.013$ ) and the proportion of older adults ( $\rho = -0.659$ ;  $p=0.002$  and  $\rho = -0.502$ ;  $p=0.017$ ). The accumulated incidence and mortality rates showed, respectively, a significant positive correlation with the proportion of black and brown skinned people ( $\rho=0.524$ ;  $p=0.018$  and  $\rho=0.558$ ;  $p=0.007$ ) and with the income ratio ( $\rho=0.665$ ;  $p=0.0001$  and  $\rho=0.683$ ;  $p<0.001$ ) (Table 4).

**Table 3.** Indicators of cases and deaths in older adults from COVID-19 in Brazilian states. Brazil, 2020.

State	Accumulated Incidence *	Accumulated Mortality*	Accumulated Lethality
São Paulo	-	64.27	-
Rio de Janeiro.	201.27	96.82	48.10%
Ceará	600.47	139.49	23.23%
Pernambuco	374.72	152.74	40.76%
Amazonas	671.33	212.54	31.66%
Pará	763.37	219.06	28.70%
Maranhão	562.51	77.53	13.78%
Bahia	28.24	15.94	56.46%
Espírito Santo	295.98	57.68	19.49%
Paraíba	-	31.84	-
Santa Catarina	88.09	7.09	8.05%
Minas Gerais	32.90	5.16	15.67%
Rio Grande do Sul	55.62	7.34	13.21%
Federal District	242.10	22.53	9.31%
Alagoas	293.19	57.99	19.78%
Sergipe	200.29	23.31	11.64%
Rio Grande do Norte	174.81	26.48	15.15%
Piauí	156.59	18.72	11.96%
Paraná	34.74	6.19	17.82%
Rondônia	211.28	42.96	20.33%
Goiás	47.93	7.89	16.46%
Roraima	480.12	104.27	21.72%

\* per 100,000 inhabitants

**Table 4.** Correlation between indicators of cases and deaths among older adults by COVID-19, and socioeconomic, health resource and services characteristics, and indicators of population aging in Brazilian states. Brazil, 2020.

Variable	Accumulated Incidence	Accumulated Mortality	Accumulated Lethality
Hospital beds per 1000 inhabitants	-0.183	-0.203	-0.086
Doctors per 1000 inhabitants	-0.355	-0.299	-0.155
Percentage of FHS coverage	-0.141	-0.202	-0.322
Percentage of primary care coverage	-0.331	-0.369	-0.408
Overaging Index	-0.247	-0.127	0.036
Ageing index	-0.662*	-0.520*	-0.141
Proportion of older adults	-0.659*	-0.502*	-0.104
Human Development Index	-0.353	-0.345	-0.258
Percentage of black and brown skinned people	0.524*	0.558*	0.390
Income ratio	0.665*	0.683*	0.385
Demographic density per km <sup>2</sup>	-0.134	-0.074	-0.215

ESF=Family Health Strategy; km<sup>2</sup>=square kilometers; \*correlation is statistically significant at the 5% level.

## DISCUSSION

The results show that among the Brazilian states included in the analysis there was a correlation between the incidence and mortality rate of older adults and race/skin color. In relation to this demographic factor, similar data have been observed in the population of the United States, where there is high prevalence and high mortality among the African American population, with more than 70% of deaths by COVID-19 occurring in this group in some states<sup>16,17</sup>.

Race/color as a social construct, in the context of a discriminatory and exploratory historical process, has become a socioeconomic determinant capable of defining inequalities in health, life and death conditions<sup>18</sup>. The COVID-19 pandemic has exposed the geography of inequalities and mercilessly reflected past historical processes.

In the racial composition of those vulnerable to COVID-19 in Brazil, residents of *favelas* and outlying urban regions, homeless people and the group with the highest prevalence of specific morbidities (diabetes and hypertension, for example) are expressively composed of black people<sup>19</sup>. The population with the lowest levels of education, which in Brazil is mostly

composed of black/Afro-Brazilian citizens, is also the population with the greatest difficulty in accessing health services and who are highly dependent exclusively on the National Health Service (or SUS); have a lower income, and live in areas of substandard housing and infrastructure of basic services, with worse social and health indicators<sup>20-23</sup>. A low level of education can increase access difficulties for individuals by reducing their understanding of the system, making it hard to recognize situations of risk and health problems, compromising their ability to make informed decisions about their health and, consequently, reducing the demand for and use of health services<sup>24</sup>.

These vulnerabilities are heightened among the older population. The findings of a study carried out with data from the 2008 National Household Sample Survey (or PNAD) indicate that social inequalities, in health and living conditions, exist among older adults in Brazil, with black and poor populations experiencing the aging process with overlapping risks<sup>23</sup>. The COVID-19 epidemic in Brazil has revealed how challenging these inequalities are for the organization of a health system based on the principles of integrality, universality and equity, in a scenario of intense demographic and epidemiological transition.

Despite the fact that higher incidence and mortality rates are inversely related to the proportion of older adults in the population and the aging rate, these findings corroborate the premise that the areas most affected by the COVID-19 pandemic in Brazil are the states of the north and northeast of the country, the regions with the youngest age structures. Similar to many developed countries, the demographic changes experienced in Brazil have converged towards a rapid and accentuated aging process and an increase in population longevity<sup>25</sup>.

However, this process has not occurred simultaneously throughout the country, where the gains in life expectancy observed throughout the second half of the twentieth century revealed marked regional disparities, especially with regard to the less developed regions of Brazil. This uneven process is reflected in the age pyramids and the age structure indicators of the regions of Brazil, with lower aging rates in the north and northeast<sup>26</sup>.

The idea that Brazil has “rejuvenated” the COVID-19 pandemic has arisen, as a result of the combination of the Brazilian age pyramid and low degrees of social distancing. Despite the number of deaths being higher among older age groups, a significant percentage of young people are being hospitalized. The percentage of deaths observed in Brazil for people under 50 years of age has been higher than that observed in other countries, such as Italy, Spain and the United States<sup>27</sup>.

Another important finding of the present study is the higher incidence and mortality due to COVID-19 among older adults in the poorest states in Brazil. There are several variables that make the low-income population more prone to infection from the new coronavirus, such as the use of public transport, higher numbers of residents per household, inadequate access to basic sanitation and health services, and the difficulty older adults and family members experience in maintaining social isolation without significant loss of income or work<sup>28</sup>.

The northern regions of the country are among the least developed in Brazil<sup>29</sup> and, in this current health emergency, have stood out due to their high COVID-19 burden. A possible explanation for the higher mortality rates due to COVID-19 among older

adults in these regions is related to the difficulty of access to and availability of health services. Data from the National Health Survey show that there are major differences in access to health services between the regions of Brazil, with higher proportions of medical appointments in the regions that have the best living conditions and the highest Human Development Indexes<sup>21</sup>. The higher mortality rates observed in the northern states of the country can be justified by the territorial size of the regions, the inadequate transport system, which is composed of few highways and is in poor condition, in addition to waterways with navigability problems, impairing the effective distribution and organization of health services, making accessibility difficult for users<sup>30</sup>. In addition, the north region of the country has, proportionally, the lowest number of ICU beds, doctors and respirators, which are widely needed in the treatment not only of these diseases, but also of complications triggered by COVID-19 infections<sup>28</sup>.

The low availability of specific diagnostic tests, particularly real time RT-PCR, is a crucial challenge for the detection of COVID-19. Brazil faces a shortage of kits for the detection of agents (primers, probes and controls, among others), and limited human resources trained to carry out testing, which generates a delay in the release of local results, generating not only a delay in notification, but overburdening reference laboratories, leading to under-notification<sup>31</sup>. This is one of the main limitations for population-based studies that intend to describe the scenario of the disease in the country, since a large portion of cases may not have been reported.

It is believed that the current scenario of COVID-19 in Brazil is also related to the low adherence of the population to guidelines of social distancing, since data from May 25 indicate that the index of social isolation in the country was 43.9%, below the recommended value of 70%, and among the states, the one with the highest index was Amapá with 52.6% and the lowest was registered in Goiás with 37.2%<sup>32</sup>. According to the Center for Disease Control and Prevention (CDC) in the United States, for the effectiveness of non-pharmacological interventions during the pandemic, such as social distancing, there must be acceptance and participation among the population, and for this to happen, it is

extremely important that communication between the authorities and the population is honest, transparent and coherent, leading to confidence on the part of the population, who, in turn, will adopt control measures to mitigate the disease<sup>33,34</sup>.

To impose these sanitary measures to control the pandemic in Brazil, it is crucial that special care for the older population is considered. The implementation of measures such as vertical social isolation may expose the part of the population that is already highly vulnerable, to greater vulnerability. In this sense, vertical isolation will not be effective in completely protecting older adults, who are at high risk of developing serious illness and death, since, even with restricted circulation, the older population will be susceptible to intra-household transmission, because they have contact with individuals who leave the home and, therefore, will be more exposed to the virus, as well as to collateral damage arising from the change in routine of this group, such as a greater risk of developing or worsening mental health problems and chronic non-communicable diseases, especially cardiovascular illnesses<sup>35</sup>.

It is important to highlight the limitations arising from the design of the present study. As it is an ecological study, its findings can be expanded to population groups, but not to an individual level. In addition, as it uses data collected by municipalities and states, the underreporting of cases should be considered due to the lack of resources for mass

testing, as previously discussed. However, the study can support decision making and the creation of safety nets for the population groups identified, as well as encouraging increased notifications and monitoring among the older population.

## CONCLUSION

The COVID-19 epidemic in Brazil has revealed that, in the states analyzed, the accumulated incidence and mortality in the older population are related to demographic issues - age, skin color/race and income, highlighting the need for specific care and monitoring of older adults. At the present moment, when social distancing is considered a priority strategy for disease control, Primary Health Care (PHC) becomes an essential pillar for the care of older adults, both for its principles and its territorial scope – especially in the areas of greatest vulnerability. This demonstrates the need for the structuring and strengthening of this level of health care, which plays an extremely important role in reducing health inequities.

In this sense, it is important to rethink the working processes of PHC professionals and to introduce information and communication technologies as a complementary strategy for monitoring the health of older adults, which have been shown to be an important tool for integrated healthcare at this level.

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