

## Incidence and lethality by COVID-19 in the population of the Federal District: an ecological study

*Incidência e letalidade por COVID-19 na população do Distrito Federal: um estudo ecológico*

*Incidencia y letalidad por COVID-19 en la población del Distrito Federal: un estudio ecológico*

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### ABSTRACT

**Background and objectives:** understanding the social situation of COVID-19 in poor and less developed countries is still doubtful. Thus, this study aimed to estimate the incidence and lethality by COVID-19, according to the per capita income of the administrative regions of the Federal District (FD). **Methods:** this is a descriptive ecological study, based on secondary data. Thirty-one administrative regions of the FD were included, and the population consisted of 382,488 individuals. The variables considered were sex, incidence, mortality, lethality, age group, population estimate and education. **Results:** despite the greater contamination by women, in terms of total mortality, more men died, representing 57.3% of the total deaths in the period. Regarding the influence of the level of education and income on the incidence, it appears that the highest rates of confirmed cases occurred in groups with higher levels of education and income. Despite this higher incidence, it is the group that exhibits the lowest lethality and the third lowest mortality per 100,000 inhabitants. **Conclusion:** the highest incidence rates were observed in regions with higher per capita income. On the other hand, lethality occurred more incisively in regions with lower purchasing power. In view of this, it is necessary to apply long-term preventive measures in unequal regions.

**Keywords:** COVID-19. Incidence. Lethality. Per Capita Income.

### RESUMO

**Justificativa e objetivos:** o entendimento da situação social da COVID-19 em países pobres e menos desenvolvidos ainda é dubitável. Desse modo, o objetivo deste estudo é estimar a incidência e letalidade por COVID-19, de acordo com a renda *per capita* das regiões administrativas do Distrito Federal (DF). **Métodos:** trata-se de um estudo ecológico descritivo, baseado em dados secundários. Foram incluídas 31 regiões administrativas do DF, e a população foi composta por 382.488 indivíduos. Consideraram-se como variáveis sexo, incidência, mortalidade, letalidade, faixa etária, estimativa populacional e escolaridade. **Resultados:** apesar da contaminação maior por parte das mulheres,

em termos de mortalidade total, mais homens foram a óbito, representando 57,3% do total de mortos no período. A respeito da influência do grau de escolaridade e da renda na incidência, verifica-se que os maiores índices de casos confirmados aconteceram em grupos com maior nível de escolaridade e de renda. Apesar dessa maior incidência, é o grupo que exibe a menor letalidade e a terceira menor mortalidade por 100.000 habitantes. **Conclusão:** as mais altas taxas de incidência foram observadas nas regiões com maior renda *per capita*. Por outro lado, a letalidade ocorreu, de forma mais incisiva, nas regiões de menor poder aquisitivo. Diante disso, é necessário aplicar medidas preventivas de longo prazo em regiões desiguais.

**Descritores:** COVID-19. Incidência. Letalidade. Renda Per Capita.

## RESUMEN

**Justificación y objetivos:** la comprensión de la situación social del COVID-19 en los países pobres y menos desarrollados aún es dudosa. Así, el objetivo de este estudio es estimar la incidencia y letalidad por COVID-19, según el ingreso per cápita de las regiones administrativas del Distrito Federal (DF). **Métodos:** se trata de un estudio ecológico descriptivo, basado en datos secundarios. Se incluyeron 31 regiones administrativas del DF, la población estuvo conformada por 382,488 individuos. Se consideraron como variables el sexo, la incidencia, la mortalidad, la letalidad, el grupo de edad, la población estimada y la escolaridad. **Resultados:** a pesar de la mayor contaminación por mujeres, en términos de mortalidad total, fallecieron más hombres, representando el 57,3% del total de defunciones en el período. En cuanto a la influencia del nivel de educación e ingresos en la incidencia, parece que las tasas más altas de casos confirmados ocurrieron en grupos con mayores niveles de educación e ingresos. A pesar de esta mayor incidencia, es el grupo que presenta la menor letalidad y la tercera mortalidad más baja por 100.000 habitantes. **Conclusión:** las tasas de incidencia más altas se observaron en las regiones con mayor ingreso per cápita. Por otro lado, la letalidad se produjo de forma más incisiva en las regiones de menor poder adquisitivo. Ante esto, es necesario aplicar medidas preventivas a largo plazo en regiones desiguales.

**Palabras clave:** COVID-19. Incidencia. Letalidad. Renta Per Capita.

## INTRODUCTION

The COVID-19 pandemic called SARS-CoV-2 severe respiratory syndrome was identified in China at the end of 2019, taking on greater proportions that spread across the globe, being considered the greatest health challenge of this century. Due to the magnitude and dispersion of the virus, on March 11, 2020, the World Health Organization (WHO) declared a pandemic.<sup>1</sup> In view of this, social isolation has been applied as a way to reduce the spread of the virus.<sup>2</sup>

Therefore, there was an increase in research on coping strategies focused on discerning the disease in vulnerable groups. However, the understanding of the social situation of the disease in poor and less developed countries is still doubtful. Some studies have indicated a possible relationship between per capita income and disease incidence<sup>3</sup>, because in low-income countries, population groups have difficulty in adopting preventive measures, such as social isolation, and are more exposed in the context of vulnerability, which increases the risk of contamination and, if infection occurs, people have limited access to health services.<sup>1</sup>

In addition to affecting populations' health around the world, health crises involving viral agents tend to have even more harmful effects and their impact on population subgroups is uneven. Thus, regions in an unequal context the burden of morbidities tends to be higher.<sup>2</sup> Thus, this study aimed to estimate the incidence and lethality of COVID-19 according to the per capita income of the administrative regions (AR) of the Federal District (FD), Brazil.

## METHODS

This is a descriptive ecological study, based on secondary data obtained by the website "Painel COVID-19", from the epidemiological reports of the FD Department of Health. The study population consisted of 382,488 individuals, men and women, who tested positive for COVID-19 between March 2020 and August 2021.

The study included notified data of residents of the FD and who lived in some registered AR. This study was carried out in July 2021 in Brasília, FD, Brazil, with 31 AR as units of analysis.

In the data collection process, information was tabulated, organized and filtered in spreadsheets using Microsoft Excel® of cases of contamination and death by COVID-19 by sex and age group, per capita income, education by AR. All these data were obtained from the District Household Sample Survey (PDAD - *Pesquisa Distrital por Amostra de Domicílios*), which was carried out by the Federal District Planning Company (Codeplan - *Companhia de Planejamento do Distrito Federal*), whose latest version is from 2018.

The variables contained in this study are sex (female or male), notifications of people who tested positive for COVID-19, deaths, age group ( $\leq$  19 years old; 20-29 years old; 30-39 years old; 40-49 years old; 50-59 years old;  $\geq$  60 years old), population estimate, education (no education; complete elementary school; incomplete elementary school; incomplete high school; complete high school; incomplete higher education; complete higher education) and AR made up of 31 regions. Águas Claras/Arniqueira, Ceilândia/Pôr do Sul were grouped

in the analyses, because when the Codeplan research took place there were only Águas Claras and Ceilândia, totaling 31 regions. Subsequently, there was a subdivision creating the Arniqueira and Pôr do Sol region, which today comprises 33 AR.

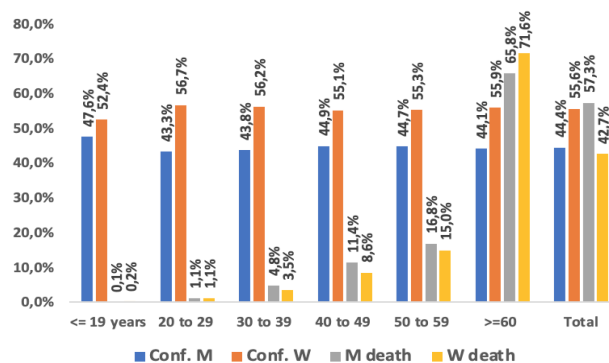
To analyze the number of infected people and deaths by sex, the percentage by age group was calculated. The analysis of the population affected by COVID-19 was carried out as follows: incidence of contamination (number of cases/population estimate) and mortality rate (number of deaths/population estimate \*100,000).

With regard to income, the calculation was made taking into account the per capita income range by AR in relation to the number of infected people and deaths. Education by group was also analyzed in relation to the incidence of contaminated and mortality by percentage. Analysis was presented by groups of regions, as the education data presented by Codeplan were grouped. Finally, the case fatality rate was calculated: the number of deaths in relation to the number of confirmed cases per AR (death/confirmed cases).

The research used secondary data in the public domain, and no approval from the Research Ethics Committee was required.

## RESULTS

The total number of confirmed cases of COVID-19, in all AR in the FD, in the period defined for the present research, was 382,488 individuals. A total of 169,961 (44.4%) people were male and 212,527 (55.6%) were female. Despite the greater contamination by women, in terms of total mortality, more men died, representing 57.3% of the total deaths in the period (Figure 1).



**Figure 1.** Cases and deaths confirmed by sex and age group in the Federal District. **Note:** Conf. M: confirmed men; M - man; Conf. W - confirmed women; W - woman.

**Table 1.** Population, confirmed cases, deaths, incidence and mortality of COVID-19 in the administrative regions of the Federal District. Brazil, 2021.

Administrative region	Populational estimate	Confirmed cases	Deaths	Incidence	Mortality per 100.000 Inhabitants
SIA	1.549	96	0	6,2%	0,0
Fercal	8.583	519	6	6,0%	69,9
Itapoã	62.208	3.411	60	5,5%	96,5
Sobradinho II	85.574	3.163	92	3,7%	107,5
Riacho Fundo II	85.658	4.555	108	5,3%	126,1
SCIA	35.520	2.272	48	6,4%	135,1
São Sebastião	115.256	11.243	206	9,8%	178,7
Sudoeste/Octogonal	53.770	10.006	97	18,6%	180,4
Águas Claras/ Amiqueiras	161.184	25.277	308	15,7%	191,1
Jardim Botânico	26.449	4.540	58	17,2%	219,3
Recanto Das Emas	130.043	11.337	337	8,7%	259,1
Varião	8.802	963	25	10,9%	284,0
Cruzeiro	31.079	5.189	90	16,7%	289,6
Lago Norte	33.103	6.051	96	18,3%	290,0
Planaltina	177.492	16.988	518	9,6%	291,8
Paranoá	65.533	7.290	193	11,1%	294,5
Plano Piloto	221.326	44.905	658	20,3%	297,3
Lago Sul	29.754	7.307	93	24,6%	312,6
Samambaia	232.893	25.327	734	10,9%	315,2
Santa Maria	128.882	13.379	414	10,4%	321,2
Park Way	20.511	3.517	67	17,1%	326,7
Vicente Pires	66.491	8.694	222	13,1%	333,9
Guará	134.002	22.210	449	16,6%	335,1
Ceilândia/ Pôr do sol	432.927	50.216	1520	11,6%	351,1
Candangolândia	16.489	2.415	62	14,6%	376,0
Brazlândia	53.534	6.910	204	12,9%	381,1
Riacho Fundo	41.410	6.636	170	16,0%	410,5
Núcleo Bandeirante	23.619	3.877	100	16,4%	423,4
Gama	132.466	20.193	573	15,2%	432,6
Taguatinga	205.670	36.018	949	17,5%	461,4
Sobradinho	60.077	17.984	462	29,9%	769,0

Regarding the age group, contamination was predominant in individuals aged  $\leq 19$  years (47.6%) among men and 20 to 29 years (56.7%) among women. On the other hand, mortality increased with aging, becoming the majority in the age group  $\geq 60$  years, 65.8% male and 71.6% female.

The largest number of confirmed cases and deaths was from Ceilândia/Pôr do Sol, with 50,166 cases and 1,520 deaths, followed by Plano Piloto, with 44,905 cases and 658 deaths, and Taguatinga, with 36,018 cases and 949 deaths. The region with the lowest number of cases of the disease was SIA, with 96 cases and no reported deaths, followed by Fercal, with 519 cases and 6 deaths, and Varjão, with 963 cases and 25 deaths (Table 1).

Regarding incidence, the highest rate occurred in Sobradinho (29.9%), followed by Taguatinga (17.5%) and Gama (15.2%). The lowest occurred in Sobradinho II (3.7%), Itapoã (5.5%) and Fercal (6.0%), respectively. Regarding mortality per 100,000 inhabitants, the highest rates were also in Sobradinho (769.0), Taguatinga (461.4) and Gama (432.6). The smallest, with the exception of SIA, with no record of deaths, are repeated in Fercal (69.9) and Itapoã (96.4).

To analyze the possible relationship between purchasing power and COVID-19 in the FD, AR were segre-

gated by per capita income and by lethality in relation to the number of confirmed cases, as can be seen in Table 2. With this approach, it appears that the lethality of confirmed cases was higher in those AR with lower purchasing power.

The mortality rate in the FD was 2.3% and, of the 31 AR, 17 had a result higher than this rate. Of these, only one, Vicente Pires, had a per capita income above the FD average. On the other hand, of the 14 regions that had a lethality rate lower than the average for the federal capital, ten have the highest per capita incomes in the FD. The four that are not part of this group are São Fercal, Itapoã, São Sebastião and SCIA.

Regarding the influence of the level of education and income on the incidence, it appears that the highest incidence rates occurred in those groups with the highest level of education and income (Table 3). Group 1 had an incidence of 19.8%, the highest among the four groups, and a higher level of education, with 76.6% of individuals having completed higher education and with an average per capita income of R\$ 6,739.00 (about US\$1,225.27), i.e., also the highest income of the FD. Despite this higher incidence, it is the group with the lowest lethality and the third lowest mortality per 100,000 inhabitants.

**Table 2.** Population, confirmed cases, deaths from COVID-19, per capita income and lethality in the administrative regions of the Federal District. Brazil, 2021.

Administrative region	Populational estimate	Confirmed cases	Deaths	Per capita income	Lethality
SIA	1.549	96	0	3.800	0,00%
Sudoeste/Octogonal	53.770	10.006	97	7.131	0,97%
Fercal	8.583	519	6	816	1,16%
Águas Claras/ Ariqueiras	161.184	25.277	308	6.505	1,22%
Lago Sul	29.754	7.307	93	8.323	1,27%
Jardim Botânico	26.449	4.540	58	5.846	1,28%
Plano Piloto	221.326	44.905	658	6.750	1,47%
Lago Norte	33.103	6.051	96	6.440	1,59%
Cruzeiro	31.079	5.189	90	3.749	1,73%
Itapoã	62.208	3.411	60	932	1,76%
São Sebastião	115.256	11.243	206	1.375	1,83%
Park Way	20.511	3.517	67	5.946	1,91%
Guará	134.002	22.210	449	3.689	2,02%
SCIA	35.520	2.272	48	573	2,11%
FEDERAL DISTRICT	2.881.854	382.488	8.919	2.827	2,33%
Riacho Fundo II	85.658	4.555	108	803	2,37%
Vicente Pires	66.491	8.694	222	2.979	2,55%
Riacho Fundo	41.410	6.636	170	1.321	2,56%
Candangolândia	16.489	2.415	62	1.435	2,57%
Sobradinho	60.077	17.984	462	2.128	2,57%
Núcleo Bandeirante	23.619	3.877	100	2.377	2,58%
Varjão	8.802	963	25	841	2,60%
Taguatinga	205.670	36.018	949	2.212	2,63%
Paranoá	65.533	7.290	193	830	2,65%
Gama	132.466	20.193	573	1.604	2,84%
Samambaia	232.893	25.327	734	997	2,90%
Sobradinho II	85.574	3.163	92	2.354	2,91%
Brazlândia	53.534	6.910	204	1.129	2,95%
Recanto Das Emas	130.043	11.337	337	860	2,97%
Ceilândia/ Pôr do sol	432.927	50.216	1520	1.767	3,03%
Planaltina	177.492	16.988	518	1.139	3,05%
Santa Maria	128.882	13.379	414	991	3,09%



**Table 3.** Education, income, incidence, mortality, and case fatality of proven COVID-19 cases by Federal District administrative region groups.

Cathergorization	Group 1	Group 2	Group 3	Group 4	Federal District
<b>Education</b>					
Up to incomplete high school	6,0%	20,3%	41,6%	53,4%	29,9%
Complete high school and incomplete higher education	17,3%	36,8%	42,4%	36,9%	36,0%
Complete higher education	76,6%	42,8%	16,0%	9,7%	33,9%
<b>Mean per capita income</b>	6.739	2.903	1.480	809	2.827
<b>Incidence</b>	19,8%	15,8%	10,7%	8,3%	13,3%
<b>Mortality per 100,000 inhabitants</b>	277,7	360,8	305,1	215,3	309,5
<b>Lethality of confirmed cases</b>	1,4%	2,3%	2,9%	2,6%	2,3%

Source: PDAD 2018/Codeplan - Own elaboration.

Note: Group 1 - Plano Piloto, Jardim Botânico, Lago Norte, Lago Sul, Park Way and Sudoeste/Octogonal; Group 2 - Águas Claras, Candangolândia, Cruzeiro, Gama, Guarã, Núcleo Bandeirante, Sobradinho, Sobradinho II, Taguatinga, Vicente Pires; Group 3 - Brazlândia, Ceilândia, Planaltina, Riacho Fundo, Riacho Fundo II, SIA, Samambaia, Santa Maria and São Sebastião; Group 4 - Fercal, Itapoã, Paranoá, Recanto das Emas, SCIA/Estrutural and Varjão.

In contrast, Group 4 exhibits the lowest incidence (8.3%), the lowest per capita income (R\$809.00 or US\$147.09), the lowest mortality per 100,000 inhabitants and the lowest education, with 53.4% of individuals with education to incomplete high school. On the other hand, despite the low incidence and mortality per 100,000 inhabitants, this group has the second highest fatality rate among confirmed cases, second only to Group 3, which has the second worst income and education.

## DISCUSSION

The results of this study indicate greater contamination by women and in the age groups formed by young adults  $\leq 19$  years, for men, and 20 to 29 years, for women. Nevertheless, the highest mortality rate occurred in males, with 57.3% of all deaths. With advancing age, the mortality rate increased for both sexes, with the most affected age group being  $\geq 60$  years, for both men (65.8%) and women (71.6%).

Supporting these findings, a cross-sectional study carried out with the population of Rondônia showed that contamination of women by COVID-19 was also higher.<sup>4</sup> In another observational study, females again had a higher percentage of contamination.<sup>5</sup> This evidence suggest that this is because women are more at risk, as they are health professionals and are on the front lines of COVID-19 mitigation efforts in communities. Moreover, many women are part of the labor market, even if informally, and need to move because they are responsible for family income.<sup>4</sup>

About women representing the majority of those infected and still having lower mortality rates than men, the literature indicates that they are more resistant than men in extreme situations such as epidemics, hunger and slavery. This may be due to the relevance of X chromosome and female hormones, which induce them to have a stronger immune response to viral infections. Despite this, there are also cases in which men were more infected than women.<sup>16</sup> However, what really became evident, through a series of cases, was that 75% of deaths were among men.<sup>17</sup> These results were revalidated in a cohort

study, which showed a significant association between male sex and mortality from COVID-19.<sup>18</sup>

In addition to this, in the male context, other factors can influence higher mortality, such as excessive consumption of alcoholic beverages, violence, abuse of toxic substances, pre-existing diseases, such as hypertension, diabetes, cardiovascular and chronic lung diseases.<sup>19</sup> Moreover, men comply less with hand hygiene practices, delay in seeking health care<sup>20</sup> and wear less face mask.<sup>21</sup> In other words, science shows a disadvantage for men, whether for genetic, immunological or lifestyle reasons.<sup>22</sup>

In general, the sex issue is still little discussed and there is a neutral positioning regarding public policies, as if men and women were equally infected and affected<sup>7</sup> and, therefore, more robust studies are necessary to assess the differences pointed out.

The finding of the predominance of mortality in patients aged  $\geq 60$  years is also attested by similar studies in countries such as China, Mexico and Peru, which also had a higher number of deaths in people  $\geq 60$  years.<sup>8,9</sup> In the United States, Similar data indicated that 80% of COVID-19 deaths also corresponded to older ages.<sup>10</sup> Mortality among older adults tends to be nine times higher than in other age groups, as at this stage of life they are more likely to have comorbidities and structural health determinants that increase morbidity and mortality.<sup>9,11</sup> In addition, factors related to health and care systems, public policies and programs that integrate older adults into society are still few, making them even more vulnerable to epidemics.<sup>4</sup>

However, although older adults were the most affected by COVID-19,<sup>12,9</sup> young adults are also dying from the disease<sup>12</sup> as well as a large percentage of younger people are being hospitalized.<sup>13</sup> In other words, this is not just an older adult disease, since individuals of any age can be infected with COVID-19.<sup>14</sup> Despite this, the disease affected more older adults, males and who had some type of comorbidity.<sup>15</sup>

The present study also demonstrates that the highest incidence rates were observed in regions with higher education and per capita income. On the other hand, lethality occurred more incisively in regions with lower purchasing power and lower education. Education

has been exposed as a risk factor in the dissipation of the disease and evolution to death in previous pandemics. The seriousness of the disease and schooling may be associated with social class, income, lifestyle, understanding of the disease and seeking medical care.<sup>23,24</sup>

There are studies that show that people from lower social classes complied less with COVID-19 restrictions.<sup>19,25</sup> Furthermore, individuals with low education are more likely to contract the disease, as they use public transport, live in overcrowded places, have less purchasing power, which reduces preventive measures such as the purchase of gel alcohol, predisposing the individual to death from the disease.<sup>19,23</sup>

In Brazil, more specifically, a higher incidence rate was observed in municipalities with greater social vulnerability. Additionally, mortality caused by the disease mainly affected the family provider, increasing poverty.<sup>1</sup> Otherwise, when relating the economic inequality in different Brazilian regions and the impacts of COVID-19, it is not possible to assert that the most economically vulnerable are the most affected, but in areas of greater inequality, the pandemic is more likely to cause more severe impacts to the population.<sup>2</sup>

The occurrence of higher incidence in higher income regions<sup>1</sup> evidenced in another study carried out in the Metropolitan Region of the city of Rio de Janeiro,<sup>3</sup> initially, because, due to the higher population density in peripheral and poor areas, the most obvious assumption would be that there would be a higher incidence in these places, in the same way that it occurs with other infectious diseases of a respiratory nature.

However, there may be greater underreporting in these regions, as the testing of the population has not been homogeneous and those with greater purchasing power are more likely to carry out tests in specialized laboratories, clinics and hospitals. Moreover, the proportion of asymptomatic infections and people with mild and even moderate disease are unlikely to go to health units to undergo tests.<sup>1,3</sup>

The greater lethality in less favored regions is related to worse public health, safety, sanitation and urbanism structures, aspects that deteriorate everyone's quality of life, but that have a more serious impact on the less economically well off. In these locations, the greater the number of people with impaired health, including chronic diseases currently recognized as risk conditions for COVID-19. Another aggravating factor is the scarcity of beds in Intensive Care Units (ICU) for patients in the Unified Health System (SUS - *Sistema Único de Saúde*), which is up to five times smaller than those available in the private network. As a result, it is assumed that the risk of death from COVID-19 is up to 10 times higher among the most vulnerable.<sup>2</sup>

It is important to highlight the limitations arising from the study design, whose generalization, as it is an ecological study, applies to the population and not to the individual. Additionally, by using data collected from the state, given that Brazil does not carry out mass testing, underreporting for confirmation of cases and deaths by

COVID-19 may have influenced the results. However, the findings of this research can help governments in the creation of public policies and long-term measures in regions with greater social vulnerability aimed at reducing economic inequality.

In conclusion, the present study observed that the highest incidence rates were observed in the regions with the highest per capita income. On the other hand, lethality occurred more incisively in regions with lower purchasing power. Therefore, studies with other metrics are necessary to assess the influence of income associated with infection and death from COVID-19. It is also necessary to apply long-term preventive measures in unequal regions. In addition, well-structured public policies need to be created to reduce economic vulnerability to combat future health crises in Brazil.

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