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Original Article

Spatial and Epidemiological Analyses of COVID-19 in the Older Population of the Brazilian Amazon Region During 2020

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Abstract

Background and aims: In December 2019, the disease associated with SARS-CoV-2 was identified as the new coronavirus (COVID-19). The older population is regarded as the greatest risk group. The objective of the present study was to investigate the epidemiological aspects of COVID-19 during 2020 in the older adults in the Brazilians Amazon region.

Methods: The present study is a longitudinal study based on a national database from the Website of the State Department of Health of Para from January to December 2020. Medical, socio-demographic, and geographical data were analyzed to assess the epidemiological data to verify whether there was an association between these variables using logistic regression.

Results: Official data published until December 31 indicated 293 802 confirmed cases and 7199 deaths from COVID-19 in the state of Para, as well as a 12.5% rate of fatality. Para has demonstrated a linear curve in relation to the number of deaths since August. More cases of COVID-19 were found among the older people, men, and people who declared themselves brown, and a greater chance of death was observed among indigenous and yellow people.

Conclusion: Brazil is among the five countries with the highest number of infected cases and deaths resulting from COVID19, possibly due to poor planning concerning social isolation and the lack of public health policies and guidance by government leaders, especially in this specific context.

Keywords: COVID-19, Older people, Brazil, Epidemiology

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Introduction

In December 2019, the disease associated with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was identified as the new coronavirus disease 2019 (COVID-19) in Wuhan, China.

COVID-19 is transmitted mainly by respiratory droplets (sneezing and coughing), causing an acute infectious respiratory disease. The virus is transmitted from one human to another, and symptomatic people are the most frequent source of COVID-19 spread who are capable of transmitting the virus.[1]

The first case of coronavirus in Brazil was confirmed on February 26, 2020. According to data presented by the Ministry of Health, the patient was a 61-year-old man in São Paulo.[2] Furthermore, according to government sources, the first coronavirus death was confirmed on March 12, when there were 291 confirmed cases and 8819 suspected cases. The victim was a hypertensive 62-year-old man with diabetes who was admitted to a hospital in São Paulo, as informed by the Health Department of the Municipality of Sao Paulo.[3]

On March 18, a 37-year-old man resident in Belem-Para who traveled to Rio de Janeiro was confirmed as the first case of the new coronavirus in Para. The patient had moderate symptoms and was isolated for 14 days.

In Brazil, official data published on December 31 indicated 56 773 new cases and 1074 new deaths, totaling 7 675 973 and 194 949 cases and deaths, respectively.[4] As informed by the Health Department of the Municipality of Para, there were 293 802 confirmed cases and ,199 deaths from COVID-19 in the state of Para, located in the Brazilian Oriental Amazon.[5] Based on data from the World Health Organization (WHO), Brazil is placed in the third position in the world ranking regarding the number of cases and deaths after the USA and India.

Adults aged 65 and older are at the greatest risk of contaminating with the coronavirus and becoming severely ill or dying from the virus. Symptoms such as confusion, fall, or diarrhea are serious symptoms among these populations.[6,7]

The fatality rate is higher in the older people population and among adults with chronic diseases and prolonged use of medications.[8-11] In the USA, the majority of deaths occurred in patients aged 65 and over, with greater severity among those aged 85 and over.[12]

A retrospective study suggested that there is the

possibility of a worse prognosis depending on the age and poor clinical examinations.[13] A Chinese study compiled several case series that demonstrated increasing rates of serious illness and mortality with aging.[14] A study conducted on the older people in Brazil investigated the incidence of COVID-19 in the elderly population across the country. It was found that the cumulative incidence and mortality in the elderly population was associated with socio-demographic aspects and that older and poorer individuals had adverse disease outcomes.[15]

The present study has aimed to discuss the epidemiology of the coronavirus in the older population of Para since the beginning of the pandemic in the country.

Materials and Methods

The present study was conducted based on public data regarding cases and deaths accumulated by COVID-19 in Para-Brazil until December 31, 2020. Thus, it presented an overview of the evolution of the disease in the Brazilian Amazon region throughout 2020. A consultation was carried out on the website of the State Department of Health of Para (https://www.covid-19.pa.gov.br/#/). The aim has been to discuss the epidemiology of coronavirus in the older population of Para since the beginning of the pandemic in the country.

The variables analyzed in this study were the city, age, gender (male and female), ethnicity (white, brown, black, Asian, and indigenous), and death (yes and no). For this study, the age variable was categorized into two groups based on the median years of the life of the population (i.e., 60-69 years and 70 years or above). Further, the case fatality rate was calculated by the division between deaths and cases multiplied by 100.

In Brazil, there are often problems in official records due to delays in publishing data or even the lack of performed tests. Thus, to minimize the variation of these data by municipalities, we used the average of confirmed cases and deaths registered in a one-week period. In addition, the distribution of this historical series of cases and deaths from COVID-19 was analyzed graphically.

The chi-square test and multivariate logistic regression were performed to compare the number of deaths with age and gender on different dates in the year 2020. The analyses were performed by the Statistical Package for the Social Sciences (version 18) considering the statistical relevance of $P \leq 0.05$.

Spatial analysis was performed using the free software QGis. The data were inserted in an attribute table and later classified by "natural breaks" with representations in the gradation of colors. Darker colors and lighter colors indicate higher fatality and lower fatality, respectively.

Results

To better understand the infection speed of the older people by COVID-19 in Para, it is important to note that the number of cases and deaths increased considerably in all age groups. Figure 1 presents the distribution of the number of new cases and deaths per day since the beginning of the pandemic in Para. As demonstrated, lethality was high in May, with a peak in the record of more than 100 deaths per day. On July 31, there was an increase in the number of cases and a reduction in the number of deaths.

The 5-day moving average of the number of accumulated cases and deaths (Figure 2A) illustrates that the number of cases tripled between May and July and doubled again until December 31. These data continue to present a sharp curve even when analyzed at 3 and 7 days moving average for the incidence of cases and deaths (Figure 2B).

By the end of 2020, the lethality rate was 12.5%. We observed more cases of COVID-19 among the older people, men, and people who declared themselves brown. The results revealed statistically significant differences among deaths by age, gender, and ethnicity ($P \leq 0.001$). The percentage differences in lethality in the older people aged

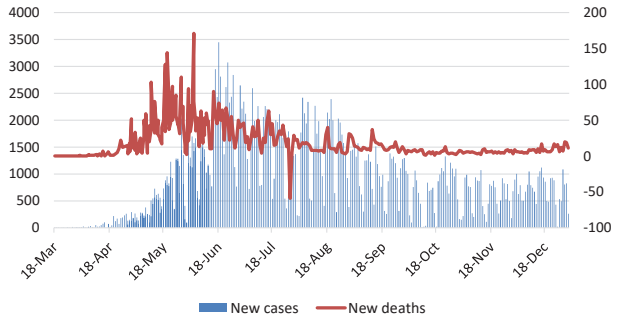
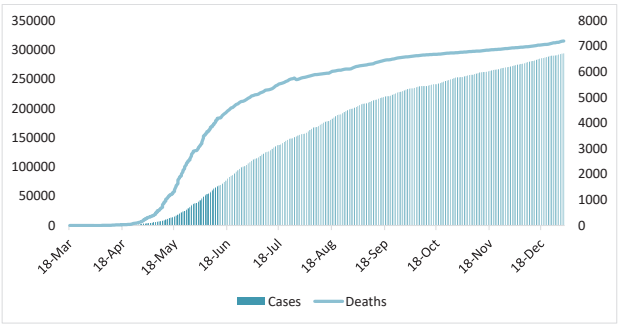
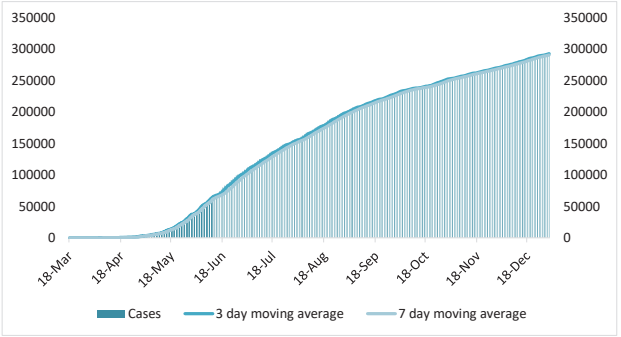


Figure 1. Distribution of the Number of New Cases and Deaths per Day Since the Beginning of the Pandemic in Para.



(A)



(B)

Figure 2. (A) The 5-day Moving Average for the Number of Cases and Accumulated Deaths Since the Beginning of the Pandemic in Para. **(B)** The 3- and 7-day Moving Average for the Number of Cases and Accumulated Deaths Since the Beginning of the Pandemic in Para.

60 to 69 and above was 2.2% (Table 1).

In the logistic regression model, there was a higher probability of death among older people with more years (OR = 3.4, 95% CI = 3.1-3.6) and men (OR = 1.8, 95% CI = 1.7-2.0) at the end of 2020 (Table 2).

Only three municipalities (2.0%) did not report deaths from COVID-19 among the older adults (i.e., Água Azul do Norte, Bannach, and Chaves). The evolution of the fatality rate of COVID-19 in Para during July indicates that there was an increase in the number of municipalities with the registered deaths of older people.

The vast majority of municipalities (95.0%) registered a case fatality rate above that of Brazil (2.5%) and the global rate (2.1%). São João do Araguaia is the municipality of Para that indicated the highest lethality from COVID-19 in 2020 among the older population (45.4%), 18 times higher than the world values (Figure 3).

Discussion

The findings of the present study are extremely relevant because it is the first scientific publication that has aimed to demonstrate data on the number of cases, deaths, and fatality rates among the older people in the northern region of the country, more specifically in the state of Para since the beginning of the pandemic.

The findings confirmed what already was described in previous studies, that is, the older adults represent a group at higher risk for complications of the disease and consequently a higher fatality rate when compared to the younger population.[16-20] One possible explanation for this phenomenon could be that older adults are more fragile than younger individuals with an already deficient immune system and an inefficient anti-inflammatory response. It is also quite common for the elderly to present comorbidities that favor complications due to the virus infection.[21]

Para is one of the poorest regions in the country with

Table 1. Univariate Analysis and Logistic Regression Model Between COVID-19 Deaths by Demographic Profile and Variables

Variables	Deaths		Total	OR (95% CI)	*P* Value*
	Yes	No			
	No. (%)	No. (%)	No. (%)		
Age					
60-69	1633 (30.8)	22086 (59.2)	23719 (55.7)	1.0	≤0.001
70 and more	3677 (69.2)	15207 (40.8)	18884 (44.3)	3.4 (3.1-3.6)	
Gender					
Female	2034 (38.3)	17534 (47.0)	20810 (48.8)	1.0	0.001
Male	3276 (61.7)	19759 (53.0)	21793 (51.2)	1.8 (1.7-2.0)	
Ethnicity					
White	441 (13.8)	3363 (13.3)	3804 (13.4)	1.0	
Black	141 (4.4)	1331 (5.3)	1472 (5.2)	1.2 (0.9-1.5)	
Brown	2520 (78.8)	19347 (76.5)	21867 (76.8)	1.0 (0.9-1.1)	≤0.001
Asian	47 (1.5)	622 (2.5)	669 (2.3)	1.8 (1.3-2.4)	
Indigenous	48 (1.5)	613 (2.4)	661 (2.3)	2.0 (1.4-2.7)	

Note. COVID-19: Coronavirus disease 19; OR: Odds ratio; CI: Confidence interval; *$P \leq 0.001$ for test χ^2.

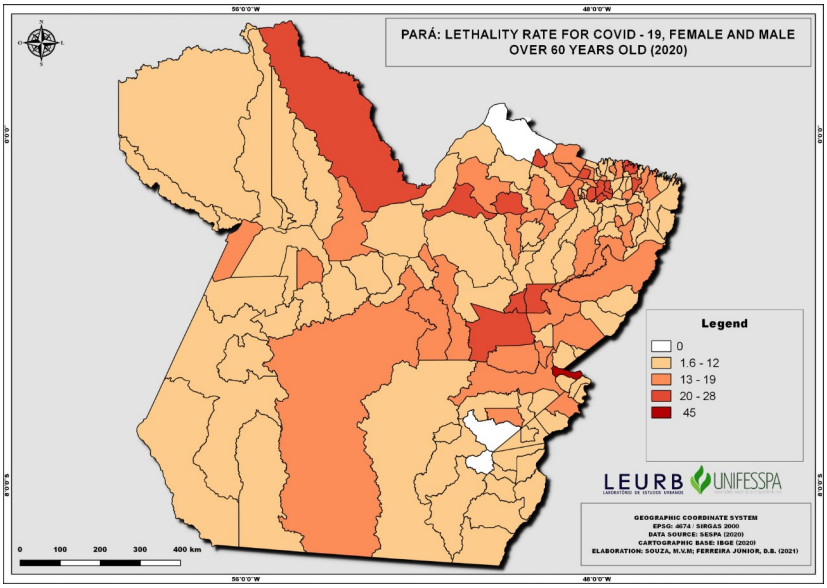


Figure 3. Case Fatality Rates of Older People With COVID-19 in Para, 2020. *Note*. COVID-19: Coronavirus disease 19.

Table 2. Logistic Regression Model between COVID-19 deaths and variables.

Variables	OR	95%CI	*P* Value
Age			
60-69	1.0		0.000
70 and more	3.4	3.1-3.6	
Gender			
Female	1.0		0.000
Male	1.8	1.7-2.0	
Ethnicity			
White	1.0		0.000
Black	1.2	0.9-1.5	
Brown	1.0	0.9-1.1	
Asian	1.8	1.3-2.4	
Indigenous	2.0	1.4-2.7	

*$P<0.001$

an important precariousness in the infrastructure of cities and health systems. The state of Para has a Human Development Index of 0.65, which is considerably low, indicating a medium-developed country.[22,23] According to data from the last (2010) Census of the Brazilian Institute of Geography and Statistics, the state of Para has 795 677 older people in an estimated universe of 8 705 436 of the total population of the state. Therefore, 9% of the total population of the state is older adults.[24]

The results presented in this paper with regard to the high fatality rate in the older people due to COVID-19 corroborated with the results demonstrated both in other countries of the world[25-30] and in Brazil.[15,22,31-35]

Under a capitalistic perspective in which the older people are perceived as being less productive than the younger individuals and in a state where the majority of the population is young, a context of public health calamity is installed without the investment of specific public policies for this population, resulting in high fatality rate in this population. The fatality rate in Brazil, especially the state of Para, exceeds that observed in several other countries such as China (2.9%), Italy (7.2%), and even the USA (4.8%).[36]

Para presented a linear curve for the number of deaths since August. Throughout the year 2020, a high number of new cases and daily deaths were observed. In Para, the months with the lowest numbers were March (at the beginning of the pandemic, approximately an average of 10 new cases per day with no death) and October with a mean of 688±401 new cases and 5.45±2.7 deaths per day.

Such facts may be associated with the adverse living conditions of the population in the northern region of the country. Most people were not authorized or could not stop their work routines, which exposed them to the risk of contamination. Many of these people also depended on public transport, which increases the crowding of people in a restricted environment with insufficient ventilation. As a population with low economic income, many of these people also live in small houses with several people living under the same roof in regions without access to basic sanitation and hygiene.[15]

The observed low level of social isolation was found to be one of the best measures to prevent contamination by the coronavirus. This index varied throughout 2020 but maintained an average of only 35%, which would also explain the high number of new cases throughout the year.

An important reason for the high rate of lethality among the older population was that many of them were responsible for the financial support of the family who enjoys the social benefits of the retiree. Thus, many deprived families also had to deal with the risk of becoming even poorer.

This study revealed ethnic differences in the number of cases of older people with COVID-19 and the greater probability of death among indigenous and Asian people who deserve special attention from managers and the academic community. Social and regional inequalities in the country can also be emphasized. In Para, the route between cities is quite difficult because of the poorly maintained roads, which makes it difficult for smaller villages to have access to health centers. A Brazilian observational study[37] showed a higher number of cases registered among younger people and whites. Comparing the center and south to the north of Brazil, the majority of deaths were on average 1.5 times higher among black, brown, and indigenous people.

One of the limitations of the current study was the possible underreporting of new cases since the federal government has imposed a restriction to only carry out tests on people with severe symptoms, thus excluding people with mild symptoms or even asymptomatic ones from the account. Hence, the differences observed in fatality rates among Brazilian states compared to other countries can be explained by socioeconomic and environmental factors along with the population profile. This rate is an indicator that depends on the ability to identify cases and deaths. This high fatality observed among older people in Para is likely to increase by the inability to detect transmitted cases, that is, an underreporting of mild and asymptomatic cases, which highlights the importance of improving the epidemiological surveillance process.[38,39]

Another important limitation of the present study was the difficulty in accessing complete data and information released by the government. The health departments did not release additional data on these individuals such as the presence of previous illnesses or data on lifestyle (e.g., smoking, sedentary lifestyle). Finally, we also did not have access to data on health services probably following this population. Without these data, it was not possible to carry out a more in-depth analysis of lethality. Greater transparency and dissemination of Brazilian data will be useful for future epidemiological analyses that better elucidate the social vulnerability of older people to COVID-19.

In addition, in concert with recent studies, Brazil is among the five countries with the highest number of cases

and deaths due to COVID19. This can be attributed to poor planning in relation to social isolation that has been considered till now; hence, the best strategy can be taken into account for preventing the increase of contagious cases based on the experiences of other countries. There is also the lack of public health policies and guidance by government leaders focusing on this specific context.[40-43]

This lack of responsible leadership has led to a situation in which several countries in the world have already been in an immunization phase while the Brazilian government does not still have an appropriate vaccination plan and nor a date prediction for the entire population's immunization at least for a small risk group (i.e., health professionals, older, and indigenous people).

Conclusion

In sum, there are important differences in the epidemiological profile of COVID-19 among the older population in Para, with a higher probability of death among men, indigenous people, and individuals over 70. Comparing the beginning of the pandemic to December 31, 2020, there was an increase in the fatality of COVID-19 among the older population in the state of Para for both genders. In addition, it was observed that there were regional differences in maintaining the highest lethality with a prevalence of more deaths in specific municipalities. More detailed epidemiological and clinical information should be measured in further studies.

Authors' Contribution

NS: Conception and design, analysis, and interpretation of data, drafting of the article, critical revisions for important intellectual content, and final approval of the version for publication. MVMS and ACVC: Conception and design, acquisition of data, analysis and interpretation of data, drafting of the article, and final approval of the version for publication.

Conflict of Interest Disclosures

The authors have no conflicts of interest for this study.

Ethical Approval

The present study was based on data from a public database of the State Department of Health of Para. For this reason, there was no need for evaluation by an ethics committee or signing the informed consent forms.

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References

1. Cascella M, Rajnik M, Aleem A, Dulebohn SC, Di Napoli R. Features, Evaluation, and Treatment of Coronavirus (COVID-19). In: StatPearls. Treasure Island (FL): StatPearls Publishing; January 5, 2022.
2. Ministério da Saúde (BR). Ministério da Saúde confirma primeiro caso de coronavírus no Brasil [Internet]. Brasília: Ministério da Saúde; 2020. [citado 2021 ago 30]. Available in: https://agenciabrasil.ebc.com.br/saude/noticia/2020-02/ministerio-da-saude-confirma-primeiro-caso-de-coronavirus-no-brasil.
3. Ministério da Saúde (BR). Primeira morte por Covid-19 no Brasil aconteceu em 12 de março. [Internet]. Brasília: Ministério da Saúde; 2020. [citado 2021 ago 21]. Available in: https://agenciabrasil.ebc.com.br/saude/noticia/2020-06/primeira-morte-por-covid-19-no-brasil-aconteceu-em-12-de-marco.
4. Ministério da Saúde (BR). Coronavírus Brasil: Painel Coronavírus [Internet]. Brasília: Ministério da Saúde; 2020. [citado 2020 dez 31]. Available in: https://covid.saude.gov.br/.
5. Governo do Pará (BR). Secretaria de Saúde Pública. Coronavírus no Pará. Bol Epidemiol [Internet]. 2020. [citado 2020 dez 31]. Available in: http://www.saude.pa.gov.br/coronavirus/.
6. Godaert L, Proye E, Demoustier-Tampere D, Coulibaly PS, Hequet F, Dramé M. Clinical characteristics of older patients: the experience of a geriatric short-stay unit dedicated to patients with COVID-19 in France. J Infect. 2020;81(1):e93-e4. doi: 10.1016/j.jinf.2020.04.009.
7. Centers for Disease Control and Prevention (CDC). Older adults 2020. Available from: https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/older-adults.html.
8. Shahid Z, Kalayanamitra R, McClafferty B, Kepko D, Ramgobin D, Patel R, et al. COVID-19 and older adults: what we know. J Am Geriatr Soc. 2020;68(5):926-9. doi: 10.1111/jgs.16472.
9. Grasselli G, Zangrillo A, Zanella A, Antonelli M, Cabrini L, Castelli A, et al. Baseline characteristics and outcomes of 1591 patients infected with SARS-CoV-2 admitted to ICUs of the Lombardy region, Italy. JAMA. 2020;323(16):1574-81. doi: 10.1001/jama.2020.5394.
10. Li X, Xu S, Yu M, Wang K, Tao Y, Zhou Y, et al. Risk factors for severity and mortality in adult COVID-19 inpatients in Wuhan. J Allergy Clin Immunol. 2020;146(1):110-8. doi: 10.1016/j.jaci.2020.04.006.
11. Niu S, Tian S, Lou J, Kang X, Zhang L, Lian H, et al. Clinical characteristics of older patients infected with COVID-19: a descriptive study. Arch Gerontol Geriatr. 2020;89:104058. doi: 10.1016/j.archger.2020.104058.
12. Nikolich-Zugich J, Knox KS, Rios CT, Natt B, Bhattacharya D, Fain MJ. SARS-CoV-2 and COVID-19 in older adults: what we may expect regarding pathogenesis, immune responses, and outcomes. Geroscience. 2020;42(2):505-14. doi: 10.1007/s11357-020-00186-0.
13. Sun H, Ning R, Tao Y, Yu C, Deng X, Zhao C, et al. Risk factors for mortality in 244 older adults with COVID-19 in Wuhan, China: a retrospective study. J Am Geriatr Soc. 2020;68(6):E19-E23. doi: 10.1111/jgs.16533.
14. Wu Z, McGoogan JM. Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72 314 cases from the Chinese Center for Disease Control and Prevention. JAMA. 2020;323(13):1239-42. doi: 10.1001/jama.2020.2648.
15. Barbosa IR, Galvão MH, de Souza TA, Gomes SM, de Almeida Medeiros A, de Lima KC. Incidence of and mortality from COVID-19 in the older Brazilian population and its relationship with contextual indicators: an ecological study. Rev Bras Geriatr Gerontol. 2020;23(1):e200171. doi: 10.1590/1981-22562020023.200171 .
16. Arsalan M, Mubin O, Alnajjar F, Alsinglawi B, Zaki N. Global and temporal COVID-19 risk evaluation. Front Public Health. 2020;8:440. doi: 10.3389/fpubh.2020.00440.
17. Rothan HA, Byrareddy SN. The epidemiology and pathogenesis of coronavirus disease (COVID-19) outbreak. J Autoimmun. 2020;109:102433. doi: 10.1016/j.jaut.2020.102433.
18. Wister A, Speechley M. COVID-19: pandemic risk, resilience and possibilities for aging research. Can J Aging. 2020;39(3):344-7. doi: 10.1017/s0714980820000215.
19. Preskorn SH. The 5% of the population at high risk for severe COVID-19 infection is identifiable and needs to be taken into account when reopening the economy. J Psychiatr Pract. 2020;26(3):219-27. doi: 10.1097/pra.0000000000000475.
20. Lim WS, Liang CK, Assantachai P, Auyeung TW, Kang L, Lee WJ, et al. COVID-19 and older people in Asia: Asian Working

Group for Sarcopenia calls to actions. Geriatr Gerontol Int. 2020;20(6):547-58. doi: 10.1111/ggi.13939.
21. Meftahi GH, Jangravi Z, Sahraei H, Bahari Z. The possible pathophysiology mechanism of cytokine storm in elderly adults with COVID-19 infection: the contribution of "inflame-aging". Inflamm Res. 2020;69(9):825-39. doi: 10.1007/s00011-020-01372-8.
22. da Silva AR, Xavier MB, de Moraes FC, de Almeida Santos E. Dynamics of pandemic evolution in the Amazon context: epidemiological configuration of the COVID-19 virus in the states of Pará and Amazonas. Rev Eletrônica Acervo Saúde. 2020;(46):e3863. doi: 10.25248/reas.e3863.2020.
23. Mendonça FD, Rocha SS, Pinheiro DL, de Oliveira SV. North region of Brazil and the COVID-19 pandemic: socioeconomic and epidemiologic analysis. J Health NPEPS. 2020;5(1):20-37.
24. Instituto Brasileiro de Geografia e Estatística (IBGE). Censo 2010. [Internet]. Brasília; 2010. Available in: https://censo2010.ibge.gov.br/sinopse/index.php?dados=26&uf=15.
25. Liu Y, Liu L, Wang Y, Du X, Ma H, Yao J. Clinical course and characteristics of patients with coronavirus disease 2019 in Wuhan, China: a single-centered, retrospective, observational study. Aging (Albany NY). 2020;12(16):15946-53. doi: 10.18632/aging.103745.
26. Bhatraju PK, Ghassemieh BJ, Nichols M, Kim R, Jerome KR, Nalla AK, et al. COVID-19 in critically ill patients in the Seattle region - case series. N Engl J Med. 2020;382(21):2012-22. doi: 10.1056/NEJMoa2004500.
27. Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. Lancet. 2020;395(10229):1054-62. doi: 10.1016/s0140-6736(20)30566-3.
28. Ruan Q, Yang K, Wang W, Jiang L, Song J. Clinical predictors of mortality due to COVID-19 based on an analysis of data of 150 patients from Wuhan, China. Intensive Care Med. 2020;46(5):846-8. doi: 10.1007/s00134-020-05991-x.
29. McMichael TM, Clark S, Pogosjans S, Kay M, Lewis J, Baer A, et al. COVID-19 in a long-term care facility - King County, Washington, February 27-March 9, 2020. MMWR Morb Mortal Wkly Rep. 2020;69(12):339-42. doi: 10.15585/mmwr.mm6912e1.
30. Hong KH, Choi JP, Hong SH, Lee J, Kwon JS, Kim SM, et al. Predictors of mortality in Middle East respiratory syndrome (MERS). Thorax. 2018;73(3):286-9. doi: 10.1136/thoraxjnl-2016-209313.
31. de Melo CML, Silva GAS, Melo ARS, de Freitas AC. COVID-19 pandemic outbreak: the Brazilian reality from the first case to the collapse of health services. An Acad Bras Cienc. 2020;92(4):e20200709. doi: 10.1590/0001-3765202020200709.
32. Dias FLT, Mendonça FD, Pinto GM, Borges ISC, de Oliveira SV. Respiratory diseases in the Triângulo Mineiro: epidemiological analysis and projective with the COVID-19 pandemic. 2020;8(1):1-6. doi: 10.12662/2317-3076jhbs.v8i1.3219.p1-6.2020 .
33. Niquini RP, Lana RM, Pacheco AG, Cruz OG, Coelho FC, Carvalho LM, et al. Description and comparison of demographic characteristics and comorbidities in SARI from COVID-19, SARI from influenza, and the Brazilian general population. Cad Saude Publica. 2020;36(7):e00149420. doi: 10.1590/0102-311x00149420.
34. Pacheco ES, da Silva VR, Soares LS. A brief epidemiological analysis of COVID-19 in Piauí, Brazil. Rev Prev Infecc Saúde. 2020;6:10690. doi: 10.26694/repis.v6i0.10690.
35. dos Santos Teixeira KK, de Carvalho KMG, de Almeida Medeiros A, Barbosa IR. Indicators of cases and deaths by COVID-19 and its relationship with contextual factors: an ecological study in the city of Natal-RN. Braz J Dev. 2020;6(6)40689. doi: 10.34117/bjdv6n6-562.
36. do Prado MFD, de Paula Antunes BB, Bastos L, Peres IT, da Silva A, Dantas LF, et al. Analysis of COVID-19 under-reporting in Brazil. Rev Bras Ter Intensiva. 2020;32(2):224-8. doi: 10.5935/0103-507x.20200030.
37. Baqui P, Bica I, Marra V, Ercole A, van der Schaar M. Ethnic and regional variations in hospital mortality from COVID-19 in Brazil: a cross-sectional observational study. Lancet Glob Health. 2020;8(8):e1018-e26. doi: 10.1016/s2214-109x(20)30285-0.
38. Medeiros de Figueiredo A, Daponte A, Moreira Marculino de Figueiredo DC, Gil-García E, Kalache A. [Case fatality rate of COVID-19: absence of epidemiological pattern]. Gac Sanit. 2021;35(4):355-7. doi: 10.1016/j.gaceta.2020.04.001.
39. Gianicolo E, Riccetti N, Blettner M, Karch A. Epidemiological measures in the context of the COVID-19 pandemic. Dtsch Arztebl Int. 2020;117(19):336-42. doi: 10.3238/arztebl.2020.0336.
40. Sahai AK, Rath N, Sood V, Singh MP. ARIMA modelling & forecasting of COVID-19 in top five affected countries. Diabetes Metab Syndr. 2020;14(5):1419-27. doi: 10.1016/j.dsx.2020.07.042.
41. Abu-Hammad O, Alnazzawi A, Borzangy SS, Abu-Hammad A, Fayad M, Saadaledin S, et al. Factors influencing global variations in COVID-19 cases and fatalities; a review. Healthcare (Basel). 2020;8(3):216. doi: 10.3390/healthcare8030216.
42. Sun Z, Yang B, Zhang R, Cheng X. Influencing factors of understanding COVID-19 risks and coping behaviors among the elderly population. Int J Environ Res Public Health. 2020;17(16):5889. doi: 10.3390/ijerph17165889.
43. Lee VJ, Chiew CJ, Khong WX. Interrupting transmission of COVID-19: lessons from containment efforts in Singapore. J Travel Med. 2020;27(3):taaa039. doi: 10.1093/jtm/taaa039.