

COMORBIDITIES AND DEATHS BY COVID-19 IN BRAZIL

COMORBIDADES E ÓBITOS POR COVID-19 NO BRASIL

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ABSTRACT

The new coronavirus outbreak in November 2019 quickly became an international public health emergency. Some studies demonstrate that the poor prognosis of the disease is directly related to the presence of comorbidities, with a risk of death increased by 3.4 times. Thus, the present study aimed to describe the cases of patients with Covid-19 that progressed to death in Brazil, evidencing age, sex, and presence of comorbidities. A retrospective, descriptive study was carried out with secondary data from patients with Covid-19 who progressed to death in Brazil, available on the websites of the health departments of each of the 27 federative units that make up the country. Data were tabulated and frequencies calculated in Microsoft Office Excel® 2007. There were 13,900,091 confirmed cases of Covid-19 until the 59th National Epidemiological Bulletin of 2021, of which 371,678 evolved to death; of them, 61.3% had comorbidities. Among the main comorbidities reported, heart disease (40.1%), diabetes (28.4%), obesity (10.3%), neurological diseases (5.0%), kidney diseases (4.7%) and pneumopathies (4.5%) stand out. In 70% of the cases of patients who died, age equal to or greater than 60 years was observed in males in 55% of the cases. The data obtained corroborate the literature, which indicate a poor prognosis of Covid-19 in patients with one or more comorbidities. Among these, the one that stood out in Brazil during the study period was heart disease.

Keywords: Brazil. Comorbidities. Covid-19. Deaths. SARS-CoV-2.

RESUMO

O surto pelo novo coronavírus em novembro de 2019 tornou-se rapidamente uma emergência de saúde pública a nível internacional. Alguns estudos demonstram que o mau prognóstico da doença está diretamente relacionado à presença de comorbidades, com um risco de óbito aumentado em 3,4 vezes. Assim, o presente estudo teve por objetivo descrever os casos de pacientes com Covid-19 que evoluíram para óbito no Brasil, evidenciando a idade, sexo e presença de comorbidades. Foi realizado um estudo retrospectivo, descritivo, com dados secundários de pacientes com Covid-19 que evoluíram para óbito no Brasil, disponíveis nos sites das secretarias de saúde de cada uma das 27 unidades federativas que compõem o país. Os dados foram tabulados e as frequências calculadas no Microsoft Office Excel® 2007. Foram registrados 13.900.091 casos confirmados de Covid-19 até o 59º Boletim Epidemiológico Nacional de 2021, desses 371.678 evoluíram para o óbito, dos quais 61,3% apresentaram comorbidades. Dentre as principais comorbidades relatadas destacam-se cardiopatias (40,1%), diabetes (28,4%), obesidade (10,3%), doenças neurológicas (5,0%), doenças renais (4,7%) e pneumopatias (4,5%). Em 70% dos casos de pacientes que evoluíram ao óbito, observou-se idade igual ou superior a 60 anos em indivíduos do sexo masculino em 55% dos casos. Os dados obtidos corroboram com a literatura, os quais indicam mau prognóstico da Covid-19 em pacientes com uma ou mais comorbidades, entre estas, o que se destacou no Brasil no período estudado foram as cardiopatias.

Palavras-chave: Brasil. Comorbidades. Covid-19. Mortes. SARS-CoV-2.

INTRODUCTION

Covid-19 is a viral respiratory disease caused by the coronavirus, called SARS-CoV-2. The outbreak that erupted in November 2019 quickly became an international public health emergency. In this sense, in view of its rapid spread and high mortality rate, it is very important to assess the risk factors associated with the disease that affected its progression (GUAN *et al.*, 2020; WANG *et al.*, 2020a).

In Brazil, the first case of the new coronavirus was confirmed in the State of Sao Paulo on February 26th, 2020. However, social distancing measures were only adopted at the end of the following month, which favored contagion (NIQUINI *et al.*, 2020). From that date until April 17, 2021, 13,900,091 cases and 371,678 deaths from Covid-19 were confirmed in the country (BRASIL, 2021a).

Some studies demonstrate that the prognosis of Severe Acute Respiratory Syndrome (SARS) is associated with certain comorbidities, in which the presence of one or more would increase the risk by 3.4 times of developing the disease. This fact highlights the importance and need to identify patients from risk groups to guide decision-making and correct case management (GUAN *et al.*, 2020; WANG *et al.*, 2020a; WANG *et al.*, 2020b).

In this sense, Feitoza *et al.* (2020), after carrying out an integrative review covering studies from several countries, such as China, India, Spain, Switzerland and Brazil, identified the importance of knowing the profile of patients who died from Covid-19 and the need to develop measures and public policies, such as care protocols, in order to assist in the treatment and prevention of the disease in individuals considered at risk (FEITOZA *et al.*, 2020).

In addition, we have a very heterogeneous Brazilian scenario regarding access to health. There are different standards of sanitary conditions, income, and education inequalities. The pandemic has led to an overload of the health system and the gradual regional internalization of the disease, which can further affect the country's economy (NIQUINI *et al.*, 2020). In this context, the characterization of cases regarding the presence of comorbidities becomes of great importance, especially to better guide the management of patients with Covid-19 in view of the precariousness of the health service. In addition, knowledge of the cases will also provide a scientific basis for conducting further research.

Thus, the present study aimed to describe the cases of patients with Covid-19 that progressed to death in Brazil, evidencing age, sex and presence of comorbidities.

MATERIAL AND METHODS

A retrospective, descriptive study was carried out using secondary data from patients notified with Covid-19 and who progressed to death in the country, from the websites of the health secretariat of the 27 federative units that make up Brazil, as well as from the 59th epidemiological bulletin provided by the Ministry of Health.

Data were collected manually and observationally from the beginning of cases in the country (February 26, 2020, in the state of Sao Paulo) until April 17, 2021, date of the 59th epidemiological bulletin. Data were tabulated and frequencies calculated and analyzed using the software Excel® 2007.

The following variables were analyzed: number of confirmed cases by state, number of confirmed deaths by Covid-19, disease fatality rate, cases with and without comorbidities by state (when available), and national, age group defined by higher or lower than 60 years, sex, main comorbidities classified according to organ systems, as notified. All cases of deaths confirmed in the period defined above were entered in order to calculate the fatality rate. There was no need for approval by the ethics committee since we were using public data.

RESULTS AND DISCUSSION

During the study period, were registered and confirmed 13,900,091 cases of Covid-19, of which 371,678 evolved to death, the first being notified on March 17, 2020. The state of Sao Paulo, followed by Rio de Janeiro and Minas Gerais, were consecutively the states with the highest number of deaths from the disease (Table 1). Regarding the lethality rate, which is defined by proportion of deaths from a certain disease in relation to the total number of patients, the national rate was 2.7% and the state with the highest rate was Rio de Janeiro with 5.9%. Importantly, in some cases diagnostic laboratory tests were not performed, but, due to the symptoms, the patients were clinically diagnosed with Covid-19 (SOUZA *et al.*, 2020).

In relation to deaths with or without comorbidities, we have a limiting factor in this study. Since no pattern was observed in the epidemiological bulletins between states, the collection of these data was made impossible for the following states: Amapa, Amazonas, Para, Rondonia, Roraima, Tocantins, Pernambuco, Sergipe, Goias, Sao Paulo, Rio de Janeiro, Espirito Santo, Minas Gerais, and Santa Catarina. Even without this information by state, national data issued by the Ministry of Health indicated that 61.3% of deaths had comorbidities (Table 1).

Table 1 - Number of confirmed cases, deaths, fatality rate and percentage of deaths with and without comorbidities per federative unit in the period from February 26, 2020, to April 17, 2021.

	Number of confirmed cases	Number of deaths	Lethality rate	Deaths WITH comorbidity (ies)	Deaths WITHOUT comorbidity (ies)
North region					
Acre (AC)	75.334	1.405	1,86%	58,1%	41,9%
Amapa (AP)	103.002	1.464	1,42%	NI	NI
Amazonas (AM)	363.102	12.362	3,40%	NI	NI
Para (PA)	450.277	11.751	2,61%	NI	NI
Rondonia (RO)	203.728	4.788	2,35%	NI	NI
Roraima (RR)	93.574	1.445	1,54%	NI	NI
Tocantins (TO)	152.684	2.357	1,54%	NI	NI
Northeast region					
Alagoas (AL)	165.461	3.944	2,38%	85,8%	14,2%
Bahia (BA)	859.760	17.228	2,00%	65,7%	34,3%
Ceara (CE)	616.022	16.163	2,62%	68,8%	31,2%
Maranhao (MA)	255.281	6.824	2,67%	83%	17%
Paraiba (PB)	279.170	6.414	2,29%	72,4%	27,6%
Pernambuco (PE)	380.818	13.179	3,46%	NI	NI
Piaui (PI)	225.796	4.731	2,09%	94,83%	5,17%
Rio Grande do Norte (RN)	211.890	5.096	2,40%	43%	57%
Sergipe (SE)	189.573	3.929	2,07%	NI	NI
Midwest region					
Mato Grosso (MT)	340.220	8.880	2,61%	67,36%	32,64%
Mato Grosso do Sul (MS)	236.087	5.156	2,18%	83,7%	16,3%
Goias (GO)	523.287	13.647	2,60%	NI	NI
Distrito Federal (DF)	365.646	7.172	1,96%	83,2%	16,8%
Southeast region					
Sao Paulo (SP)	2.739.823	88.097	3,21%	NI	NI

To be continued...

Cont. **Table 1**

Rio de Janeiro (RJ)	699.422	41.162	5,88%	NI	NI
Espirito Santo (ES)	413.996	8.588	2,07%	NI	NI
Minas Gerais (MG)	1.275.234	29.940	2,34%	NI	NI
South region					
Parana (PR)	905.751	20.297	2,24%	78%	22%
Rio Grande do Sul (RS)	920.426	23.121	2,51%	73%	27%
Santa Catarina (SC)	854.727	12.541	1,46%	NI	NI
TOTAL	13.900.091	371.678	2,7%	227.839 (61,3%)	143.839 (38,7%)

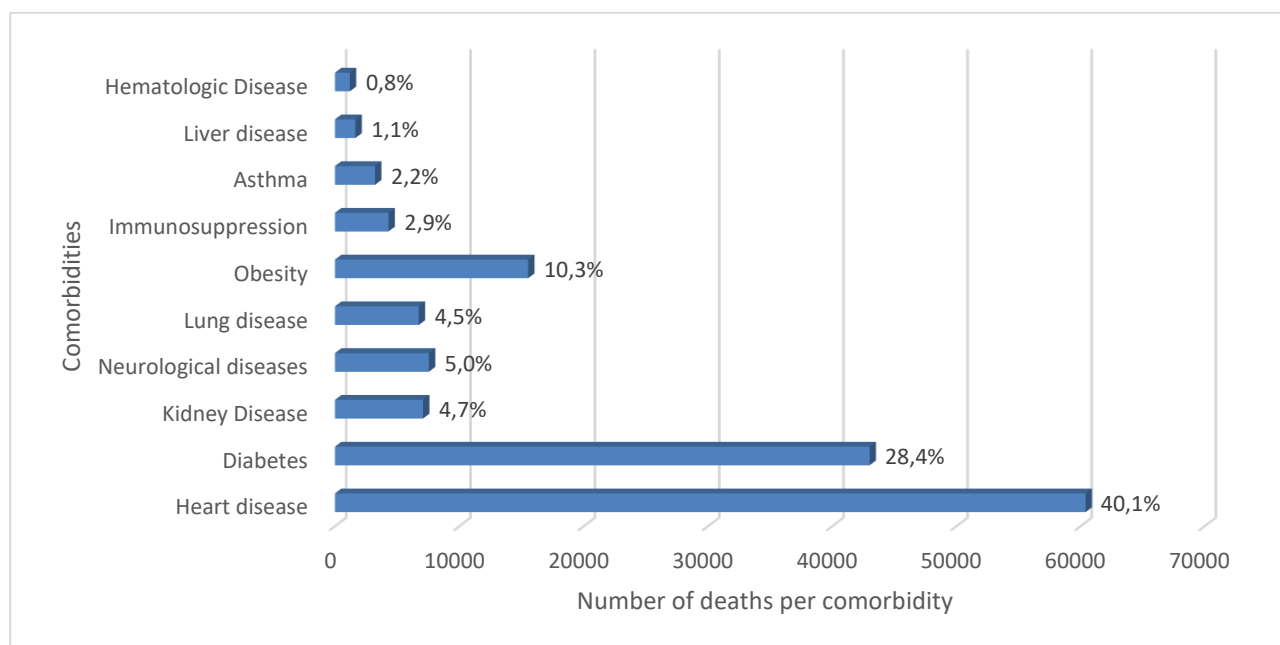
Notes: NI: Not informed

Source: Prepared by the authors using the 59th Epidemiological Bulletin of 2021 with complementary information from the state epidemiological bulletins (BRASIL, 2021a; ACRE, 2021; ALAGOAS, 2021; AMAPÁ, 2021; AMAZONAS, 2021; BAHIA, 2021; CEARÁ, 2021; DISTRITO FEDERAL, 2021; ESPÍRITO SANTO, 2021; GOIÁS, 2021; MARANHÃO, 2021; MATO GROSSO, 2021; MATO GROSSO DO SUL, 2021; MINAS GERAIS, 2021; PARÁ, 2021; PARAÍBA, 2021; PARANÁ, 2021; PERNAMBUCO, 2021; PIAUÍ, 2021; RIO DE JANEIRO, 2021; RIO GRANDE DO NORTE, 2021; RIO GRANDE DO SUL, 2021; RONDÔNIA, 2021; RORAIMA, 2021; SANTA CATARINA, 2021; SÃO PAULO, 2021; SERGIPE, 2021; TOCANTINS, 2021).

Among the cases of deaths from Covid-19 in Brazil during the study period, the main comorbidities were heart disease (40.1%), diabetes (28.4%), obesity (10.3%), neurological diseases (5.0%), kidney diseases (4.7%) and lung diseases (4.5%) (Figure 1).

Some researchers evidenced in their studies that patients with comorbidities, such as: cardiovascular and pulmonary diseases, hypertension, diabetes, and cancer, had greater severity and mortality associated with Covid-19. This result corroborates the data from the present study and emphasizes the need for adequate screening and assessment of patients before any decision is taken (SILVA, 2020; SINGH *et al.*, 2020; TIAN *et al.*, 2020; GUAN *et al.*, 2020).

Figure 1 - Deaths from Covid-19 in Brazil, up to the 59th Epidemiological Bulletin of 2021, according to the comorbidity reported.



Source: Adapted by the authors using the 59th Epidemiological Bulletin of 2021 (BRASIL, 2021a).

It is important to emphasize that the data presented in Figure 1 refer to individuals with one or more associated comorbidities. According to Chan *et al.* (2020) the risk is increased for a poor prognosis in patients who present: two or more comorbidities, use of mechanical ventilation, lack of glycemic control and severe acidosis in diabetics and non-diabetics (CHAN *et al.*, 2020).

Li *et al.* (2020) also studied the correlation between risk factors and the presence of comorbidities for the severity of the infection. However, the only comorbidity associated with severity that showed statistical significance was hypertension. In the present study, these findings are in agreement, since heart diseases, including hypertension, appear in the first places, representing 40.1% of the cases (Figure 1).

Table 2 presents the characterization of cases of death from Covid-19 according to sex and age. In 70% of cases, the age was equal to or greater than 60 years. It can be observed that with age there was an increase in the mortality rate, which was aggravated when associated with the presence of chronic diseases. This can occur since with immunosenescence people become more vulnerable, often contributing to an unfavorable outcome of the case (HAMMERSCHMIDT; SANTANA, 2020). Age was also a risk factor found by Li *et al.* (2020), in which more than 50% of severe cases were over 65 years of age. Based on an estimate where approximately 34 million people aged over 50 years have at least one comorbidity, it is possible to relate the age factor as an aggravating factor for health (NUNES *et al.*, 2020).

Table 2 – Percentage of deaths from Covid-19 notified in Brazil, by age group and sex in the period from February 26, 2020, to April 17, 2021.

Sex	%
Female	45
Male	55
Age Group	
>60 years old	70
<60 years old	30

Source: Prepared by the authors using the 59th Epidemiological Bulletin of 2021 (BRASIL, 2021a).

Regarding gender, males accounted for 55% of deaths from Covid-19. According to Chen *et al.* (2020), it is more likely that the virus affects older men with comorbidities, which corroborates the findings of the present study. Women generally have better health habits, regular medical appointments and continuous treatment compared to men, which can contribute to reducing the worsening of the disease in this population (SUSUKI; OLAK; URBANO, 2021).

In a pandemic context, data such as those observed in this study are very important because they help to characterize the population. Despite the limitations in data collection, where the states with the highest number of deaths did not have information about comorbidities, this study presents an overview of the correlation between Covid-19 and comorbidities and supports the definition of measures and contingency strategies for Covid-19. Another important aspect is that with the advance of vaccination it is necessary to continue studies in order to compare and define new profiles, which already seem to reflect in the 75th Epidemiological Bulletin of 2021 (until August 7, 2021), where deaths in patients older than 60 years old, the population that completed the vaccination scheme primarily, dropped to 61% compared to the finding of 70% in the present study (BRASIL, 2021b).

CONCLUSION

The data obtained in this study reinforce that the poor prognosis of Covid-19 is directly associated with the presence of one or more comorbidities, among which we highlight heart disease. Another important aspect to be considered is the age of the patients, since the vulnerability of elderly patients to Covid-19 is aggravated in the presence of comorbidities and that sex also seems to have a

relationship with the mortality of the disease. Continuing the study in the post-vaccine era may be interesting for comparison with the results obtained in the present study.

REFERENCES

ACRE. Secretaria de Saúde do Acre, Governo do Estado do Acre. **Boletim epidemiológico COVID-19**, Acre, 2021. Disponível em: <<https://agencia.ac.gov.br/agencia-de-informacoes-sobre-coronavirus/>>. Acesso em: 17 abr. 2021.

ALAGOAS. Secretaria de Saúde de Alagoas, Governo do Estado de Alagoas. **Boletim epidemiológico COVID-19**, Alagoas, 2021. Disponível em: <<http://cidadao.saude.al.gov.br/saude-para-voce/coronavirus/>>. Acesso em: 17 abr. 2021.

AMAPÁ. Secretaria de Saúde do Amapá, Governo do Estado do Amapá. **Boletim epidemiológico COVID-19**, Amapá, 2021. Disponível em: <<https://portal.ap.gov.br/coronavirus>>. Acesso em: 17 abr. 2021.

AMAZONAS. Secretaria de Saúde do Amazonas, Governo do Estado do Amazonas. **Boletim epidemiológico COVID-19**, Amazonas, 2021. Disponível em: <<http://www.saude.am.gov.br/painel/corona/>>. Acesso em: 17 abr. 2021.

BAHIA. Secretaria de Saúde da Bahia, Governo do Estado da Bahia. **Boletim epidemiológico COVID-19**, Bahia, 2021. Disponível em: <<http://www.saude.ba.gov.br/temasdesaude/coronavirus/boletins-diarios-covid-19/>>. Acesso em: 17 abr. 2021.

BRASIL. Ministério da Saúde (MS). **Boletim Epidemiológico Especial 59**: doença pelo coronavírus COVID-19, Brasília: MS; 2021a. Disponível em: <https://www.gov.br/saude/ptbr/media/pdf/2021/abril/22/boletim_epidemiologico_covid_59.pdf>. Acesso em: 17 abr. 2021.

BRASIL. Ministério da Saúde (MS). **Boletim Epidemiológico Especial 75**: doença pelo coronavírus COVID-19, Brasília: MS; 2021b. Disponível em: <https://www.gov.br/saude/ptbr/media/pdf/2021/agosto/13/boletim_epidemiologico_covid_75-final-13ago_15h40.pdf>. Acesso em: 7 ago. 2021.

CEARÁ. Secretaria de Saúde do Ceará, Governo do Estado do Ceará. **Boletim epidemiológico COVID-19**, Ceará, 2021. Disponível em: <<https://www.saude.ce.gov.br/download/covid-19/>>. Acesso em: 17 abr. 2021.

CHAN, K. H. *et al.* Clinical characteristics and outcome in patients with combined diabetic ketoacidosis and hyperosmolar hyperglycemic state associated with COVID-19: a retrospective, hospital-based observational case series. **Diabetes research and clinical practice**, v. 166, p. 108279, 2020.

CHEN, N. *et al.* Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. **The Lancet**, v. 395, n. 10223, p. 507-513, 2020.

HAMMERSCHMIDT, K. S. A.; SANTANA, R. F. Saúde do idoso em tempos de pandemia COVID-19. **Cogitare enfermagem**, v. 25, 2020.

DISTRITO FEDERAL. Secretaria de Saúde do Distrito Federal, Governo do Distrito Federal. **Boletim epidemiológico COVID-19**, Distrito Federal, 2021. Disponível em: <<https://www.saude.df.gov.br/boletinsinformativos-divep-cieves/>>. Acesso em: 17 abr. 2021.

ESPÍRITO SANTO. Secretaria de Saúde do Espírito Santo, Governo do Estado do Espírito Santo. **Boletim epidemiológico COVID-19**, Espírito Santo, 2021. Disponível em: <https://saude.es.gov.br/coronavirus_boletim_epidemiologico>. Acesso em: 17 abr. 2021.

FEITOZA, T. M. O. *et al.* Comorbidades e COVID-19. **Revista Interfaces: Saúde, Humanas e Tecnologia**, v. 8, n. 3, p. 711-723, 2020.

GOIÁS. Secretaria de Saúde de Goiás, Governo do Estado de Goiás. **Boletim epidemiológico COVID-19**, Goiás, 2021. Disponível em: <<https://www.saude.go.gov.br/noticias/764-coronavirus>>. Acesso em: 17 abr. 2021.

GUAN, W. *et al.* Comorbidity and its impact on 1590 patients with COVID-19 in China: a nationwide analysis. **European Respiratory Journal**, v. 55, n. 5, 2020.

LI, X. *et al.* Risk factors for severity and mortality in adult COVID-19 inpatients in Wuhan. **Journal of Allergy and Clinical Immunology**, v. 146, n. 1, p. 110-118, 2020.

MARANHÃO. Secretaria de Saúde do Maranhão, Governo do Estado do Maranhão. **Boletim epidemiológico COVID-19**, Maranhão, 2021. Disponível em: <<https://www.saude.ma.gov.br/boletins-covid-19/>>. Acesso em: 17 abr. 2021.

MATO GROSSO DO SUL. Secretaria de Saúde do Mato Grosso Do Sul, Governo do Estado do Mato Grosso Do Sul. **Boletim epidemiológico COVID-19**, Mato Grosso do Sul, 2021. Disponível em: <<https://www.coronavirus.ms.gov.br/>>. Acesso em: 17 abr. 2021.

MATO GROSSO. Secretaria de Saúde do Mato Grosso, Governo do Estado do Mato Grosso. **Boletim epidemiológico COVID-19**, Mato Grosso, 2021 Disponível em: <<http://www.saude.mt.gov.br/painelcovidmt2/>>. Acesso em: 17 abr. 2021.

MINAS GERAIS. Secretaria de Saúde de Minas Gerais, Governo do Estado de Minas Gerais. **Boletim epidemiológico COVID-19**, Minas Gerais, 2021. Disponível em: <<https://coronavirus.saude.mg.gov.br/boletim>>. Acesso em: 17 abr. 2021.

NIQUINI, R. P. *et al.* SRAG por COVID-19 no Brasil: descrição e comparação de características demográficas e comorbidades com SRAG por influenza e com a população geral. **Cadernos de Saúde Pública**, v. 36, p. e00149420, 2020.

NUNES, B. *et al.* Envelhecimento, multimorbidade e risco para COVID-19 grave: ELSI-Brasil. **CEP**, v. 96010, p. 610, 2020.

PARÁ. Secretaria de Saúde do Pará, Governo do Estado do Pará. **Boletim epidemiológico COVID-19**, Pará, 2021. Disponível em: <<http://www.saude.pa.gov.br/coronavirus/>>. Acesso em: 17 abr. 2021.

PARAÍBA. Secretaria de Saúde da Paraíba, Governo do Estado do Paraíba. **Boletim epidemiológico COVID-19**, Paraíba, 2021. Disponível em: <<https://paraiba.pb.gov.br/diretas/saude/consultas/vigilancia-em-saude-1/boletins-epidemiologicos>>. Acesso em: 17 abr. 2021.

PARANÁ. Secretaria de Saúde do Paraná, Governo do Estado do Paraná. **Boletim epidemiológico COVID-19**, Paraná, 2021. Disponível em: <<https://www.saude.pr.gov.br/Pagina/Coronavirus-COVID-19>>. Acesso em: 17 abr. 2021.

PERNAMBUCO. Secretaria de Saúde de Pernambuco, Governo do Estado de Pernambuco. **Boletim epidemiológico COVID-19**, Pernambuco, 2021. Disponível em: <<http://portal.saude.pe.gov.br/boletim-epidemiologico-covid-19>>. Acesso em: 17 abr. 2021.

PIAUÍ. Secretaria de Saúde do Piauí, Governo do Estado do Piauí. **Boletim epidemiológico COVID-19**, Piauí, 2021. Disponível em: <<http://coronavirus.pi.gov.br/>>. Acesso em: 17 abr. 2021.

RIO DE JANEIRO. Secretaria de Saúde do Rio De Janeiro, Governo do Estado do Rio De Janeiro. **Boletim epidemiológico COVID-19**, Rio de Janeiro, 2021. Disponível em: <<https://painel.saude.rj.gov.br/monitoramento/covid19.html>>. Acesso em: 17 abr. 2021.

RIO GRANDE DO NORTE. Secretaria de Saúde do Rio Grande Do Norte, Governo do Estado do Rio Grande Do Norte. **Boletim epidemiológico COVID-19**, Rio Grande do Norte, 2021. Disponível em: <<https://portalcovid19.saude.rn.gov.br/>>. Acesso em: 17 abr. 2021.

RIO GRANDE DO SUL. Secretaria de Saúde do Rio Grande Do Sul, Governo do Estado do Rio Grande Do Sul. **Boletim epidemiológico COVID-19**. Disponível em: <<https://ti.saude.rs.gov.br/covid19/>>. Acesso em: 17 abr. 2021.

SANTA CATARINA. Secretaria de Saúde de Santa Catarina, Governo do Estado de Santa Catarina. **Boletim epidemiológico COVID-19**, Santa Catarina, 2021. Disponível em: <<https://www.saude.sc.gov.br/coronavirus/boletins.html>>. Acesso em: 17 abr. 2021.

RONDÔNIA. Secretaria de Saúde de Rondônia, Governo do Estado de Rondônia. **Boletim epidemiológico COVID-19**, Rondônia, 2021. Disponível em: <<https://rondonia.ro.gov.br/covid-19/noticias/boletim-diario-de-casos/>>. Acesso em: 17 abr. 2021.

RORAIMA. Secretaria de Saúde de Roraima, Governo do Estado de Roraima. **Boletim epidemiológico COVID-19**, Roraima, 2021. Disponível em: <<https://www.saude.rr.gov.br/index.php/transparencia/transparencia-saude/coronavirus/informacoes-coronavirus>>. Acesso em: 17 abr. 2021.

SÃO PAULO. Secretaria de Saúde de São Paulo, Governo do Estado de São Paulo. **Boletim epidemiológico COVID-19**, São Paulo, 2021. Disponível em: <<http://saude.sp.gov.br/cve-centro-de-vigilancia-epidemiologica-prof.-alexandre-vranjac/areas-de-vigilancia/doencas-de-transmissao-respiratoria/coronavirus-covid-19/situacao-epidemiologica>>. Acesso em: 17 abr. 2021.

SERGIPE. Secretaria de Saúde de Sergipe, Governo do Estado de Sergipe. **Boletim epidemiológico COVID-19**, Sergipe, 2021. Disponível em: <<https://www.saude.se.gov.br/noticias/>>. Acesso em: 17 abr. 2021.

SILVA, A. I. D. Perspectivas históricas e econômicas sobre a saúde na China no século XXI. **História, Ciências, Saúde-Manguinhos**, v. 27, p. 375-389, 2020.

SINGH, A. K. *et al.* Prevalence of co-morbidities and their association with mortality in patients with COVID-19: a systematic review and meta-analysis. **Diabetes, Obesity and Metabolism**, v. 22, n. 10, p. 1915-1924, 2020.

SOUZA, C. D. F. D. *et al.* Evolução espaço temporal da letalidade por COVID-19 no Brasil, 2020. **Jornal Brasileiro de Pneumologia**, v. 46, n. 4, 2020.

SUSUKI, A. M.; OLAK, A. S.; URBANO, M. R. A pandemia da COVID-19: Gênero e idade. **Revista Políticas Públicas & Cidades**, v. 2359, p. 1552, 2021.

TIAN, W. *et al.* Predictors of mortality in hospitalized COVID-19 patients: a systematic review and meta-analysis. **Journal of medical virology**, v. 92, n. 10, p. 1875-1883, 2020.

TOCANTINS. Secretaria de Saúde de Tocantins, Governo do Estado de Tocantins. **Boletim epidemiológico COVID-19**, Tocantins, 2021. Disponível em: <<http://integra.saude.to.gov.br/covid19>>. Acesso em: 17 abr. 2021.

WANG, B. *et al.* Does comorbidity increase the risk of patients with COVID-19: evidence from meta-analysis. **Aging (Albany NY)**, v. 12, n. 7, p. 6049, 2020a.

WANG, D. *et al.* Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus–infected pneumonia in Wuhan, China. **Jama**, v. 323, n. 11, p. 1061-1069, 2020b.