Severe acute respiratory syndrome by covid-19: epidemiological profile in pregnant and postpartum women in the state of Amazonas

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ABSTRACT

Objectives: To describe the epidemiological profile of pregnant and postpartum women with severe acute respiratory syndrome (SARS) caused by severe acute respiratory syndrome corona virus (SARS-CoV-2) in Amazonas. **Methods**: This quantitative, cross-sectional study extracted data from pregnant and postpartum women residing in the state of Amazonas who were notified in the Influenza Epidemiological Surveillance Information System (SIVEP-Gripe) and had a confirmed diagnosis of SARS during corona virus disease (COVID-19) from February 16, 2020, to December 31, 2021. Sociodemographic data and clinical characteristics, such as admission to the intensive care unit, use of ventilatory support, use of antiviral therapy, and outcomes were collected. Data were analyzed and presented with relative frequencies. **Results and Discussion:** During the study period, Amazonas recorded 828 cases of SARS caused by SARS-CoV-2 in pregnant and postpartum women. Of these, 58 patients remained in progress with no outcomes. Most women were aged between 20 and 34 years, educated to high school level, lived in urban areas, and were in the third trimester of pregnancy at the time of diagnosis. Predominant clinical manifestation was cough, respiratory distress, fever, and dyspnea. The most frequent comorbidities were asthma, chronic cardiovascular diseases, diabetes mellitus, and obesity. 19.7% of pregnant and postpartum women were admitted to the intensive care unit (ICU). Of these, 70.6% needed invasive mechanical ventilation, 80.2% antiviral therapy, and 79 patients (10.3%) died. **Conclusion:** This study characterized the epidemiological profile of pregnant and postpartum women with SARS caused by SARS-CoV-2 in Amazonas and showed a high death rate during the study period, especially in the capital.

Keywords: COVID-19, Severe acute respiratory syndrome, Pregnancy, Postpartum period.

INTRODUCTION

The COVID-19 pandemic was registered in Brazil in February 2020. By December 9, 2021, 22,184,824 cases and 616,691 deaths were recorded with a case fatality rate of 2.8% and mortality rate of 293.5 deaths per 100,000 inhabitants[1], making Brazil the country with the third highest number of cases in the world, behind only the United States and India[2].

COVID-19 has impacted places differently owing to economic, social, and political contexts. Amazonas, located in the northern region of Brazil, is one of the most affected regions by the COVID-19 pandemic[3]. Manaus, the capital, recorded the first confirmed case of COVID-19 in March 2020, and by December 27, 2021, 433,335 cases and 13,831 deaths from COVID-19 had been recorded. In January 2021, Amazonas recorded the highest daily average of cases (2,927), and on January 27, 2021, 157 deaths were recorded in a single day[4] as a consequence of the strong circulation of the Gamma variant (P1).[5] This led to depletion of the oxygen stock and total collapse of the public hospital network[3,6].

Initial studies carried out in highly developed countries did not report major complications in pregnant women with COVID-19. As the pandemic progressed, research in middle-and low-income countries showed consistent increases in severe morbidity and maternal mortality[7–9]. Pregnant and postpartum women are considered a high-risk group because they are more likely to

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have adverse outcomes, such as hospitalization in the intensive care unit (ICU), use of mechanical ventilation, and an increase in the percentage of preterm delivery. This is because physiological changes during the pregnancy-puerperal cycle increase susceptibility to developing the most severe form of COVID-19[10-12].

It is essential to monitor the occurrence of cases of severe acute respiratory syndrome (SARS) by COVID-19 in pregnant and postpartum women, and to continuously monitor the results and risk factors to better understand the impact of COVID-19 in obstetric populations. This study aimed to describe the epidemiological profile of pregnant and postpartum women diagnosed with SARS due to COVID-19 in the state of Amazonas, Brazil.

METHODS

This was a quantitative, cross-sectional study that analyzed the Severe Acute Respiratory Syndrome Database of the Flu Epidemiological Surveillance Information System (SIVEP-gripe). SIVEP-gripe is a national public domain database managed by the Brazilian Ministry of Health for surveillance of severe acute respiratory infections.

The SIVEP-gripe defines SARS in pregnant or postpartum women as an aggravation of the clinical picture characterized by a flu-like syndrome that meets one of the following criteria: (1) dyspnea or respiratory distress, (2) persistent chest pressure, (3) O_2 saturation <95%, and (3) lip or facial cyanosis. It is also important to note the presence of hypotension and oliguria[13].

Data for 2020 were obtained on December 1, 2021, at https://opendatasus.saude.gov.br/dataset/srag-2020-banco-de-dados-de-sindrome-respiratoria-aguda-grave-including-dados-da-covid-1914, and data for 2021 were obtained on January 15, 2022, from https://opendatasus.saude.gov.br/dataset/bd-srag-202115. The analysis included all pregnant women (in any gestational period) and postpartum women with a final diagnosis of SARS during COVID-19, living in Amazonas, reported in SIVEP-Gripe between February 16, 2020 and December 31, 2021.

Pregnant women in different gestational periods and postpartum women residing in Amazonas, with a final diagnosis of SARS caused by COVID-19, were included. The characterization variables evaluated included age group, schooling, race/color, geographic area of residence, and gestational period. The clinical and epidemiological variables (according to the Manual of Recommendations for Assistance to Pregnant and Postpartum Women in the face of the COVID-19[13] pandemic) were clinical manifestations (fever, cough, sore throat, dyspnea, respiratory distress, O_2 saturation <95%, loss of smell, loss of taste, abdominal pain, fatigue, diarrhea, and vomiting), presence of comorbidities (chronic cardiovascular disease, hematologic disease, asthma, diabetes mellitus, neuropathy, pneumopathy, immunosuppression, chronic kidney disease, liver disease, and obesity), and characteristics of hospitalization (ICU admission, need for invasive and/or non-invasive ventilatory support, use of antiviral therapy, and the dichotomous outcome of cure or death). All SARS cases in pregnant and postpartum women due to unconfirmed or other etiologic agents were excluded.

Data were stored in Microsoft Excel spreadsheets and later exported and analyzed using the IBM SPSS Statistics 23 software. For qualitative variables, absolute and relative frequencies were calculated. The distribution of finalized cases and deaths caused by COVID-19 among the municipalities of the state of Amazonas was presented through a choropleth map built using the QGIS program version 3.22, using the geographic coordinates provided by the Brazilian Institute of Geography and Statistics (IBGE).

Because these are secondary data of public access, unrestricted, and without identification of study participants, the research was exempt from evaluation by the Research Ethics Committee, according to resolution CNS nº 510 of April 7, 2016.

RESULTS

Between February 16, 2020 and December 31, 2021, Brazil recorded 35,106 SARS cases in pregnant and postpartum women. Of these, 19,207 had a confirmed diagnosis of COVID-19.

There were 1,877 ongoing cases in Brazil with no outcome of death or cure.

Over the same period, the state of Amazonas recorded 1,151 SARS cases in pregnant and postpartum women, and 828 (71.9%) were diagnosed with COVID-19. Of these, 58 were in progress in the state of Amazonas and were awaiting outcomes.

Table 1

Sociodemographic data of pregnant and postpartum women with severe acute respiratory syndrome (SARS) caused by COVID-19, in the State of Amazonas, between February 16, 2020 and December 31, 2021- Severe Acute Respiratory Syndrome Database of the Flu Epidemiological Surveillance Information System (SIVEP-gripe).

Variables	N	%
Age (Years)		
< 20 years	143	17.2
20- 34 years	529	64.0
≥ 35 years	156	18.8
Total	828	100.0
Race/Color		
Yellow	4	0.5
Black	10	1.2
Brown	717	88.2
White	32	3.9
Indigenous	50	6.2
Total	813	100.0
Schooling		
No schooling	6	1.2
Elementary school	171	35.2
High school	261	53.7
University	48	9.9
Total	486	100.0
Residence Zone		
Urban	677	85.3
Rural	116	14.6
Periurbana	1	0.1
Total	794	100.0
Gestational age		
1st trimester	84	10.1
2nd trimester	153	18.5
3rd trimester	345	41.7
Unknown gestacional age	73	8.8
Puerperal women	173	20.9
Total	828	100.0

The predominant clinical symptoms were cough, respiratory distress, fever, and dyspnea. The most frequent comorbidities were asthma, chronic cardiovascular diseases, diabetes mellitus, and obesity (Table 2).

Eighty-nine (70.6%) patients were hospitalized in the ICU with invasive ventilatory support. Of the 154 patients put on non-invasive ventilator support, (82.5%) were not hospitalized in the ICU while 27 (17.5%) were. Of the 664 patients who received antiviral therapy, 471 (70.9%) received zanamivir, and 193 (29.1%) received oseltamivir.

Table 2

Clinical data of pregnant and postpartum women with severe acute respiratory syndrome (SARS) caused by COVID-19, in the State of Amazonas, between February 16, 2020 and December 31, 2021- Severe Acute Respiratory Syndrome Database of the Flu Epidemiological Surveillance Information System (SIVEP-gripe).

Variables	N	%
Clinical manifestations		
Cough (n = 696)	534	76.7
Fever (n = 692)	485	70.1
Respiratory distress (n = 649)	470	72.4
O_2 Saturation < 95% (n = 576)	238	41.3
Loss of smell (n = 378)	86	22.8
Loss of taste (n = 376)	77	20.5
Dyspnea (n = 660)	461	69.8
Sore throat (n = 587)	287	48.9
Diarrhea (n = 531)	91	17.1
Vomit (n = 525)	89	17.0
Abdominal pain (n = 368)	55	14.9
Fatigue (n = 404)	194	48.0
Comorbidities		
Chronic cardiovascular disease (n = 235)	27	11.5
Diabetes mellitus (n = 237)	22	9.3
Obesity (n = 221)	15	6.8
Asthma (n = 234)	29	12.4
Imunodeficiency (n = 224)	4	1.8
Chronic kidney disease (n = 220)	4	1.8
Chronic hematological disease (n = 224)	6	2.7
Other chronic lung disease (n = 223)	3	1.3
Chronic neurological disease (n = 224)	4	1.8
Liver disease (n = 221)	1	0.5
Characteristic of Hospitalization		
Admission to the Intensive Care Unit (n = 675)	133	19.7
Use of ventilatory support		
Invasive (n = 631)	97	15.4
Non-invasive (n = 631)	158	25.0
Use of Antiviral Therapy		
Oseltamivir (n = 664)	193	29.1
Zanamivir (n = 664)	471	70.9
Evolution		
Death (n = 770)	79	10.3

Diagnosis was made by laboratory testing in 567 (68.5%) cases. The most frequently used diagnostic test, the serological test for SARS-CoV-2, was performed on 293 (35.4%) of the samples taken from pregnant and postpartum women. Diagnosis was made by reverse transcription followed by real-time polymerase chain reaction (RT-PCR) for 225 (27.2%) samples, and antigen tests were used for 49 (5.9%) samples. Diagnosis was made by other criteria (clinical, clinical-epidemiological, or clinical-imaging) for 261 (31.5%) samples.

Of the finalized cases--those with a cure or death outcome (n=770), 79 (10.3%) died. Of the finalized cases with information about the ICU, 131 (20.8%) pregnant and postpartum women were admitted to the ICU, and 55 (42%) of them died. 24.66% of the patients who died were not admitted to the ICU and 20.5% were not intubated.

The percentage of deaths was 6.3% (n=26 over 45 weeks surveyed) in 2020 and 14.8% (n=53 over 52 weeks surveyed) in 2021. The average number of deaths per week rose from 0.57 in 2020 to 1.01 in 2021 (88.6% increase).

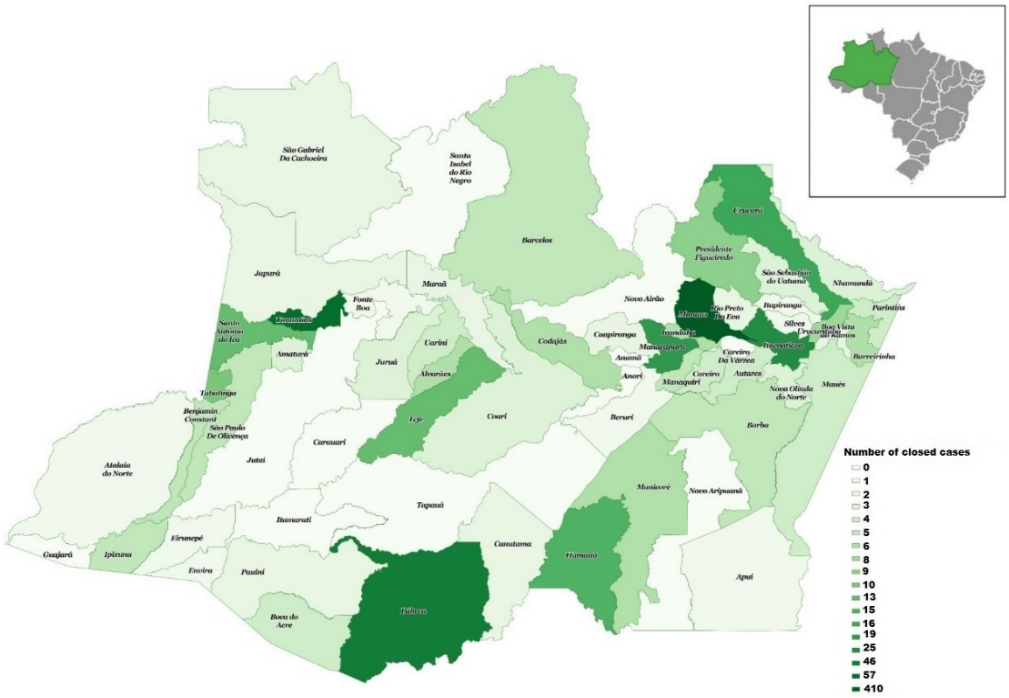

Figure 1: Distribution of finalized cases of severe acute respiratory syndrome caused by severe acute respiratory syndrome corona virus (SARS-CoV-2) in pregnant and postpartum women, in the state of Amazonas, by city of occurrence, between February 16, 2020 and December 31, 2021. n= 770.

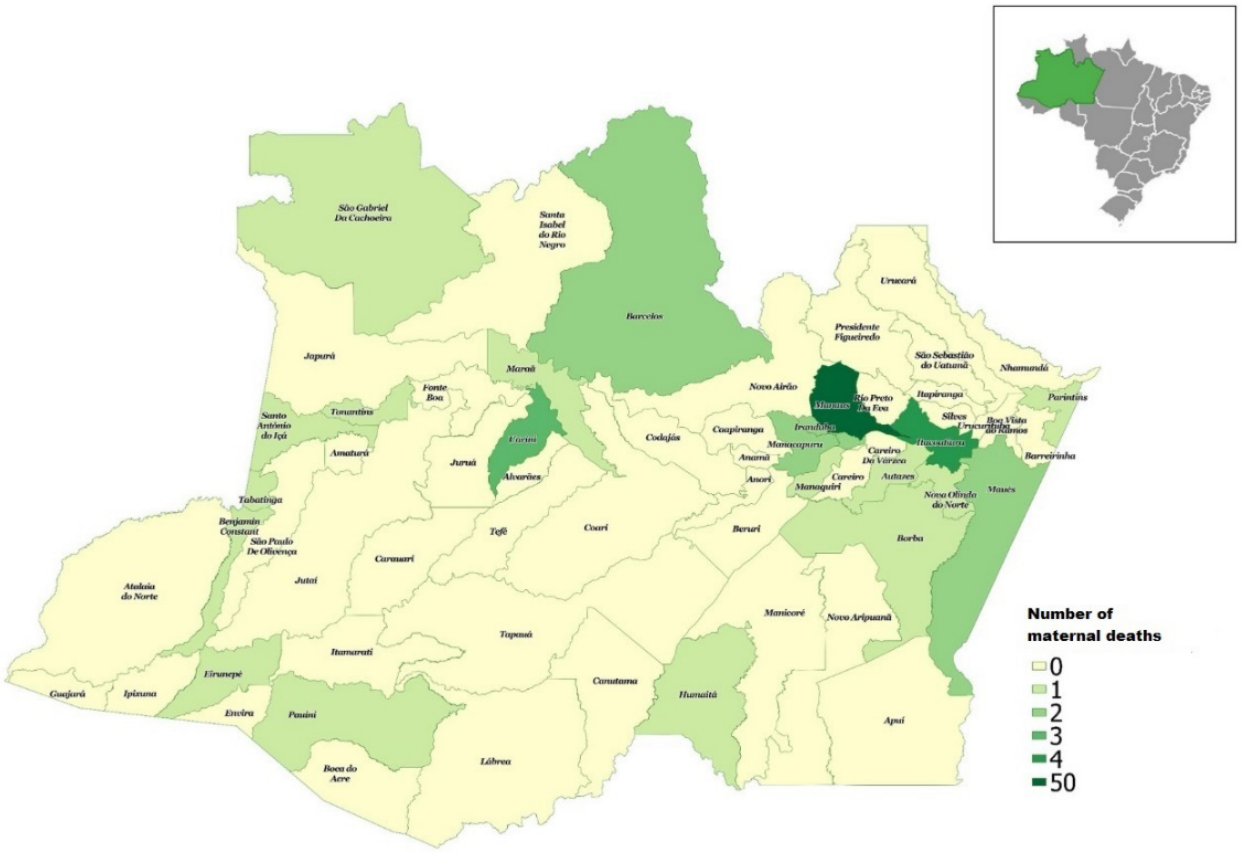

Figure 2: Distribution of deaths from severe acute respiratory syndrome caused by severe acute respiratory syndrome corona virus (SARS-CoV-2) in pregnant and postpartum women, in the state of Amazonas, by city of occurrence, between February 16, 2020 and December 31, 2021, n= 79.

The municipalities in the state of Amazonas with the highest number of finalized SARS cases during COVID-19 were Manaus (n=410, 53.2%) and Tonantins (n=57, 7.4%;Figure 1). Deaths occurred in 22 municipalities, and the cities that recorded the most deaths in pregnant and postpartum women were Manaus (n=50, 63.3%) and Itacoatiara (n=4, 5.0%;Figure 2).

DISCUSSION

A total of 828 obstetric cases of SARS caused by SARS-CoV-2 were identified, and 770 cases were finalized. Most women were between 20 to 34 years old, mixed-race, lived in urban areas, had high school education, and were in the third gestational trimester at the time of diagnosis. There were 79 deaths among pregnant and postpartum women, corresponding to a case fatality rate of 10.3%.

Mortality rates from COVID-19 in obstetric populations varies between countries and their regions as the pandemic progresses.[16] In 2020, Brazil recorded a maternal mortality rate of 7.8%[17] with disease progression in Brazil. From February 2020 to September 2021, Brazil recorded a 12.3% mortality rate in the obstetric population, and the Northern region recorded 15%, the highest maternal mortality rate in Brazil[16]. From February to June 2020, Amazonas recorded a 29% maternal mortality rate from COVID-19[18].

The devastating results of SARS by COVID-19 in the obstetric population are influenced by the physiological and anatomical changes in the cardiorespiratory, vascular, immune and coagulation systems caused by pregnancy (making them

more prone to viral pneumonia), as well as by social determinants of health[9,13,18,19].

The state of Amazonas has a weak the health care network, including limited availability of ICU beds, great social inequality, and limited access between municipalities separated by large geographical distances. These, along with low adherence of the population to non-pharmacological measures to control the spread of COVID-19, contribute to the severity of the pandemic in this state[3,5,6,20,21].

The most common symptoms presented were cough, respiratory distress, and fever. Physiological dyspnea caused by increased maternal metabolism, with increased oxygen consumption and aggravated by gestational anemia, must be properly evaluated to avoid confusion with pathological dyspnea. Other pulmonary alterations can also contribute to worse gestational prognosis[20,13].

The most frequent comorbidities in the obstetric population were asthma, chronic cardiovascular disease, diabetes mellitus, and obesity. A meta-analysis that evaluated 192 cohort studies revealed that pregnant women were more likely to have symptoms than non-pregnant women of reproductive age, and the most common symptoms were cough and fever[22]. Another study carried out in the state of Minas Gerais in pregnant and postpartum women with COVID-19 reported a high frequency of cough (76.1%), fever (63.9%), and dyspnea (58.4%)[23].

The most common comorbidities with SARS caused by COVID-19 found in the Brazilian population were diabetes (6.7%), obesity (6.4%), and cardiovascular diseases[16]. When comparing maternal death and survival outcomes, at least one pre-existing disease was present in 48.4% of COVID-19 deaths in pregnant and postpartum women, compared with 24.9% in survival outcomes[7]. Older age, non-white ethnicity, increased body mass index, presence of at least one comorbidity, chronic hypertension, diabetes mellitus, preeclampsia, ICU admission, use of invasive ventilation, and death was all associated with SARS in COVID -19 in pregnant women[22].

The manual of recommendations for assistance to pregnant and postpartum women in the face of the COVID-19 pandemic, provided by the Ministry of Health of Brazil since June 2020, recommends that RT-PCR be performed to detect the virus in pregnant or postpartum women, aiming to reduce mortality in this group[13]. However, the data revealed that serology for SARS-CoV-2 was the most frequently performed diagnostic test in the population studied, and RT-PCR was used in only 27.2% of women, different from the reality of most Brazilian pregnant women who were diagnosed through RT-PCR[16].

Manaus, the city with the largest population in the state of Amazonas, had the highest percentage of cases (53.2%), followed by Tonantins (7.4%). According to the last IBGE census, Tonantins had about 19,038 inhabitants in 2021, making it the 43rd most populous municipality in the state. 8.6% of households have adequate sanitation and 2.8% of urban households are on public roads with trees. Tonantins is the 5,510th of 5,570 Brazilian municipalities[24-25] for schooling rate of children aged 6 to 14 years. A spatial analysis of COVID-19 cases and deaths carried out in the Brazilian obstetric population showed that the highest rates of infection and mortality from COVID-19 occurred in municipalities with fewer health resources and greater socioeconomic inequality[26].

The emergence in Amazonas of the Gama variant, named by the P1 lineage, triggered an exponential growth in the number of new cases from December 2020[5] and the consequences were devastating. In January 2021, the health system in Manaus collapsed due the oxygen shortage in the hospital system, resulting in a 39.8% increase in deaths between 2020 and 2021 in the general population[20]. In the obstetric population of Amazonas, there was an 88.6% increase in the weekly average of maternal deaths from COVID-19 between 2020 and 2021. Therefore, it is essential to reinforce the vaccination coverage[27] and increase the diagnosis and surveillance of COVID-19 in pregnant and postpartum women. Despite being considered a high-risk group, obstetric women suffered enormous difficulties in accessing women's healthcare services (mainly prenatal care), which were strongly harmed by redirecting resources to the treatment of COVID-19[8].

It is important to consider that the data presented here refer only to pregnant and postpartum women in the Amazon who died from or were hospitalized by SARS due to COVID-19--representing the most serious cases of the disease. The data were extracted from the SIVEP-gripe database; therefore, such findings should be interpreted with caution, as they exclusively reflect the results of those pregnant and postpartum women who managed to access health services. There may be underreporting with undiagnosed cases, either due to lack of tests or because some women were unable to access obstetric hospital services. The clinical and epidemiological variables of the system were extracted from the manual of recommendations for assistance to pregnant and postpartum women in the face of the Covid-19[13] pandemic, from the Ministry of Health. Such limitations do not affect the validity of the results presented, as the SIVEP-gripe has been used since 2009 to report SARS cases caused by different etiological agents, and its wide use guarantees reliable data. This research can help define public policies specifically aimed at the obstetric population, as well as contribute to the direction of new studies aimed at evaluating the impact of the disease during the pregnancy-puerperal cycle. Given this scenario, studies that reveal the characteristics of the obstetric population affected by the disease should be encouraged, and perinatal results should always be associated with variables related to pregnancy, childbirth, and puerperium.

CONCLUSION

The epidemiological profile of pregnant and postpartum women with SARS due to SARS-CoV-2 in Amazonas, presented in this study, showed that most women were aged between 20 and 34 years, had non-white/mixed race ethnicity, lived in urban areas, had high school education, and were in the third trimester of gestation at diagnosis. There were 79 deaths among pregnant and postpartum women, corresponding to a case fatality rate of 10.3%. This profile may be related to social determinants of health, and difficulties in accessing health services may play a fundamental role in care.

REFERENCES

1. Brazil, Ministry of Health (2022) Coronavirus panel: summary of cases, deaths, incidence and mortality. In: OpenDATASUS. https://covid.saude.gov.br/. Accessed 9 Jan 2022
2. World Health Organization W (2022) WHO Coronavirus (COVID-19) Dashboard. In: 2022. https://covid19.who.int/. Accessed 9 Jan 2022
3. Orellana JDY, da Cunha GM, Marrero L, Horta BL, da Costa Leite I (2020) Explosion in mortality in the Amazonian epicenter of the COVID-19 epidemic. Cad Saude Publica 36:1–8
4. Amazonas F de V em S do (2021) Bulletin Epidemiological Situation of COVID-19 and Severe Acute Respiratory Syndrome. Amazonas Health Surveillance Foundation 12
5. Naveca FG, Nascimento V, de Souza VC, et al (2021) COVID-19 in Amazonas, Brazil, was driven by the persistence of endemic lineages and P.1 emergence. Nat Med 27:1230–1238
6. Ferrante L, Duczmal LH, Steinmetz WA, Almeida ACL, Leão J, Vassão RC, Tupinambás U, Fearnside PM (2021) Brazil's COVID-19 Epicenter in Manaus: How Much of the Population Has Already Been Exposed and Are Vulnerable to SARS-CoV-2? J Racial Ethn Heal Disparities. https://doi.org/10.1007/s40615-021-01148-8
7. Takemoto MLS, Menezes M de O, Andreucci CB, Nakamura-Pereira M, Amorim MMR, Katz L, Knobel R (2020) The tragedy of COVID-19 in Brazil: 124 maternal deaths and counting. Int J Gynecol Obstet 151:154–156
8. Souza ASR, Amorim MMR (2021) Maternal mortality by COVID-19 in Brazil. Rev Bras Saúde Matern Infant 21:s257–s261
9. Nakamura-Pereira M, Amorim MMR, Pacagnella R de C, Takemoto MLS, Penso FCC, Leal M do C, Rezende-Filho J de (2020) COVID-19 and Maternal Death in Brazil: An Invisible Tragedy. Rev Bras Ginecol Obs 42:445–447
10. Chmielewska B, Barratt I, Townsend R, et al (2021) Effects of the COVID-19 pandemic on maternal and perinatal outcomes: a systematic review and meta-analysis. Lancet Glob Heal 9:e759–e772
11. Villar J, Ariff S, Gunier RB, et al (2021) Maternal and Neonatal Morbidity and Mortality among Pregnant Women with and without COVID-19 Infection: The INTERCOVID Multinational Cohort Study. JAMA Pediatr 175:817–826
12. Marchand G, Patil AS, Masoud AT, et al (2022) Systematic Review and Meta-Analysis of COVID Maternal and

Neonatal Clinical Features and Pregnancy Outcomes to June 3rd 2021. AJOG Glob Reports 100049

13. Brasil, Saúde M da, Saúde S de AP à, Estratégicas D de AP e (2021) Manual of recommendations for assistance to pregnant and postpartum women in the face of the Covid-19 pandemic, 2ª. Brasília

14. Brasil, Saúde M da (2020) SARS 2020 - Severe Acute Respiratory Syndrome Database - including COVID-19 data. In: OpenDATASUS. https://opendatasus.saude.gov.br/dataset/srag-2020. Accessed 15 Jan 2022

15. Brasil, Saúde M da (2021) SARS 2021 - Severe Acute Respiratory Syndrome Database - including COVID-19 data. In: OpenDATASUS. https://opendatasus.saude.gov.br/dataset/bd-srag-2021. Accessed 15 Jan 2022

16. Siqueira TS, Souza EKG de, Martins-Filho PR, Silva JRS, Gurgel RQ, Cuevas LE, Santos VS (2022) Clinical characteristics and risk factors for maternal deaths due to COVID-19 in Brazil: a nationwide population-based cohort study. J Travel Med. taab199:

17. Scheler CA, Discacciati MG, Vale DB, Lajos GJ, Surita F, Teixeira JC (2021) Mortality in pregnancy and the postpartum period in women with severe acute respiratory distress syndrome related to. Int J Gynecol Obstet 475–482

18. Takemoto MLS, Menezes MO, Andreucci CB, et al (2020) Clinical characteristics and risk factors for mortality in obstetric patients with severe COVID-19 in Brazil: a surveillance database analysis. BJOG An Int J Obstet Gynaecol 127:1618–1626

19. Prasannan L, Rochelson B, Shan W, Nicholson K, Solmonovich R, Kulkarni A, Lewis D, Greenberg M, Nimaroff M, Blitz MJ (2021) Social determinants of health and coronavirus disease 2019 in pregnancy. Am J Obstet Gynecol MFM 3:1–11

20. Castro MC, Kim S, Barberia L, Ribeiro AF, Gurzenda S, Ribeiro KB, Abbott E, Blossom J, Rache B, Singer BH (2021) Spatiotemporal pattern of COVID-19 spread in Brazil. Science (80-) 372:821–826

21. Barreto IC de HC, Filho RVC, Ramos RF, Oliveira LG de, Martins NRAV, Cavalcante FV, Andrade LOM de, Santos LMP (2020) Health collapse in Manaus: the burden of not adhering to nonpharmacological measures to reduce the transmission of Covid-19. Health debate 45:1126–1139

22. Allotey J, Stallings E, Bonet M, et al (2020) Clinical manifestations, risk factors, and maternal and perinatal outcomes of coronavirus disease 2019 in pregnancy: Living systematic review and meta-analysis. BMJ. https://doi.org/10.1136/bmj.m3320

23. Godoi APN, Bernardes GCS, Almeida NA de, Melo SN de, Belo VS, Nogueira LS, Pinheiro M de B (2021) Severe Acute Respiratory Syndrome by COVID-19 in pregnant and postpartum women. Rev Bras Saúde Matern Infant 21:461–469

24. Dashraath P, Wong JLJ, Lim MXK, Lim LM, Li S, Biswas A, Choolani M, Mattar C, Su LL (2020) Coronavirus disease 2019 (COVID-19) pandemic and pregnancy. Am J Obs Gynecol 222:521–531

25. Brazilian Institute of Geography and Statistics (2022) IBGE-Cidades@. https://cidades.ibge.gov.br/brasil/am/tonantins/panorama. Accessed 17 Jan 2022

26. Siqueira TS, Silva JRS, Souza M do R, Leite DCF, Edwards T, Martins-Filho PR, Gurgel RQ, Santos VS (2021) Spatial clusters, social determinants of health and risk of maternal mortality by COVID-19 in Brazil: a national population-based ecological study. Lancet Reg Heal - Am 3:100076

27. Shimabukuro TT, Kim SY, Myers TR, et al (2021) Preliminary Findings of mRNA Covid-19 Vaccine Safety in Pregnant Persons. N Engl J Med 384:2273–2282

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Barbosa-Filho MC, Lopes FNB and Ferreira BO participated in the conceptualization, data curation, formal analysis, investigation, writing of the original draft and writing of the revision/editing of the manuscript. Viana JFS participated in the formal analysis, methodology, software and writing of the review/editing of the manuscript. All authors approved the final version of the article.

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