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Characteristics, comparisons and outcomes of COVID-19 hospitalization and mortality in the obstetric and non-obstetric population: Cohort study

Características, comparações e desfechos de hospitalização e mortalidade por COVID-19 na população obstétrica e não obstétrica: Estudo de coorte

Características, comparaciones y resultados de la hospitalización y mortalidad por COVID-19 en la población obstétrica y no obstétrica: Estudio de cohortes

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Abstract
Objective: To explore the impact of COVID-19 on morbidity and mortality among pregnant, postpartum and non-pregnant women hospitalized in Brazil. Method: This is a retrospective cohort study using data from the Brazilian Epidemiological Surveillance Information System (SIVEP-Gripe), covering epidemiological weeks from December 29, 2019 to January 2, 2021.Data were collected through the Brazilian SIVEP-Gripe; these data include sociodemographic aspects, comorbidities and other outcomes derived from hospitalization. Results: 40,640 hospitalized women aged between 10 and 49 years were categorized as pregnant (n=3,372), puerperal (n=794) and non-pregnant (n=36,474). The 19.3% of non-pregnant and non-postpartum women had no associated comorbidities, compared to 57.7% of pregnant women and 73.3% of postpartum women. There was an increased risk of oxygen saturation below 95% in postpartum women compared to pregnant women. Conclusion: Similarly, a higher risk of mortality was observed in postpartum women compared to pregnant women. There were no differences in the risk of morbidity and mortality associated with COVID-19 between non-pregnant and pregnant women.
Keywords: COVID-19; Pregnancy; Postpartum period; Hospitalization; Maternal mortality.

Resumo
Objetivo: Explorar o impacto da COVID-19 na morbidade e mortalidade entre mulheres grávidas, puérperas e não grávidas hospitalizadas no Brasil. Método: Trata-se de um estudo de coorte retrospectivo utilizando dados do Sistema de Informações sobre Vigilância Epidemiológica (SIVEP-Gripe) do Brasil, abrangendo semanas epidemiológicas de 29 de dezembro de 2019 a 02 de janeiro de 2021.Os dados foram coletados através do SIVEP-Gripe do Brasil; esses dados incluem aspectos sociodemográficos, comorbidades e outros desfechos derivados da hospitalização. Resultados: 40.640 mulheres hospitalizadas com idade entre 10 e 49 anos, categorizadas nos grupos de gestantes (n=3.372), puérperas (n=794) e não gestantes (n=36.474). As 19,3% das mulheres não grávidas e não pós-parto não apresentavam comorbidades associadas, em comparação com 57,7% das gestantes e 73,3% das mulheres pós-parto. Verificou-se um risco acrescido de saturação de oxigénio inferior a 95% nas mulheres no pós-parto em comparação com as mulheres grávidas. Conclusão: Da mesma forma, foi observado um maior risco de mortalidade nas mulheres no pós-parto em comparação com as mulheres grávidas. Não foram evidenciadas diferenças no risco de morbidade e mortalidade associadas à COVID-19 entre mulheres não grávidas e grávidas.
Palavras-chave: COVID-19; Gravidez; Período pós-parto; Hospitalização; Mortalidade materna.

Resumen
Objetivo: Explorar el impacto del COVID-19 en la morbilidad y mortalidad entre las mujeres embarazadas, puérperas y no embarazadas hospitalizadas en Brasil. Método: Se trata de un estudio de cohortes retrospectivo que utiliza datos del Sistema de Información de Vigilancia Epidemiológica de Brasil (SIVEP-Gripe), abarcando las semanas epidemiológicas del 29 de diciembre de 2019 al 02 de enero de 2021.Los datos se recopilaron a través del SIVEP-Gripe brasileño; estos datos incluyen aspectos sociodemográficos, comorbilidades y otros resultados derivados de la hospitalización. Resultados: 40.640 mujeres hospitalizadas entre 10 y 49 años, categorizadas en gestantes (n=3.372), puérperas (n=794) y no gestantes (n=36.474). El 19,3% de las mujeres no embarazadas y no puérperas no tenían comorbilidades asociadas, en comparación con el 57,7% de las embarazadas y el 73,3% de las puérperas. Hubo un mayor riesgo de saturación de oxígeno inferior al 95% en las puérperas en comparación con las embarazadas. Conclusión: Del mismo modo, se observó un mayor riesgo de mortalidad en las puérperas en comparación con las embarazadas. No hubo diferencias en el riesgo de morbilidad y mortalidad asociado a la COVID-19 entre las mujeres no embarazadas y las embarazadas.
Palabras-clave: COVID-19; Embarazo; Periodo posparto; Hospitalización; Mortalidad materna.

1. Introduction

On March 11, 2020, the World Health Organization (WHO) declared COVID-19 a pandemic (World Health Organization, 2020a). One month later, 1,521,252 cases and 92,798 deaths were confirmed globally (World Health Organization, 2020b). In Brazil, on the same date, there were 19,638 confirmed cases and 1,056 deaths, with a fatality rate of 5.4% (Brazil, 2022). Regarding the evolution of the pandemic, it became important to define vulnerable groups with severe disease progression and, among these, the obstetric population was included, since it is understood that the pregnancy-puerperal cycle is a period with physiological changes (Brazil, 2022).

The first studies originated in China. A Chinese review study described the clinical picture and pointed out that pneumonia caused by the new coronavirus was a highly contagious and rapidly spreading disease; that the specific mechanism of action of the virus was unknown and that specific drugs for treatment or vaccines had not yet been developed (Wang; Ye &

Liu, 2020). Five other studies conducted in China, one of them with nine pregnant women, described a clinical picture similar to that of non-pregnant women and four (44.4%) that evolved to premature birth (Chen et al., 2020). Two other studies, with seven pregnant women infected at the end of pregnancy (Yu et al., 2020) and 15 pregnant women infected in the three trimesters of pregnancy (Liu et al., 2020a), found good maternal and neonatal outcomes; with only one case reported, of a pregnant woman at 30 weeks of gestational age who underwent a cesarean section, and the baby was born healthy, with no evidence of infection (Wang et al., 2020b). Finally, a study of 13 pregnant women concluded that they were susceptible to infection and that when this occurred there could be an increased risk to perinatal health (Liu et al., 2020b).

In the Latin American scenario, Brazilian researchers reported that in Brazil, Iran, and Mexico, there was a possibility of an increased risk of maternal death (MM) due to COVID-19; in Brazil at the time, there were five MM out of a total of 1,947 deaths due to COVID-19, in Iran two out of 3,800, and in Mexico 4 2/486. Thus, it was possible to identify that in developing countries, limited resources for health care corroborate the risk of MM due to COVID-19 (Amorim; Soligo & Fonseca, 2020). When analyzing cases of pregnant and postpartum women hospitalized for COVID-19, the study in question showed that patients with cardiovascular diseases are more likely to be admitted to the Intensive Care Unit (ICU), orotracheal intubation, and mortality (Testa et al., 2023).

A review study showed that COVID-19 had a negative impact on the MM rate (Alves et al., 2022). The increase in MM due to COVID-19 in Brazil and worldwide suggests an emergency in containment measures and worsening of infection in physiologically vulnerable people (Gonzalez et al., 2021).

It is worth mentioning that black women are hospitalized in worse conditions, such as a higher prevalence of dyspnea and lower oxygen saturation, in addition to a higher rate of ICU admission and need for mechanical ventilation, and a risk of death almost twice as high in black women when compared to white women (Santos et al., 2020). Social, racial, and gender inequality has also been described in the United States of America (USA). Social and monetary conditions influence the increased prevalence of maternal deaths, with black women presenting more severe clinical conditions due to the higher prevalence of comorbidities in this group (Alves et al., 2022). As in the global context, a review study found black skin color as a risk factor for severe COVID-19 (Santos et al., 2021).

Therefore, we seek to recognize the high rate of hospitalization and maternal and non-obstetric mortality observed in Brazil, as well as to reflect on completely preventable deaths, given the deterioration in timely access to health services and the quality of services provided to pregnant and postpartum women, suggesting the deepening of social and regional inequalities. It should also be considered that the general pattern of excess maternal deaths reinforces the dramatic development of the pandemic in Brazil. This undermines the country's efforts in previous years to achieve the Sustainable Development Goals (SDGs), which aimed to further reduce maternal mortality and ensure universal and quality access to health and reproductive health for women by 2030.

Understanding the disease and assessing why the prognosis of pregnant and postpartum women has been worse during this pandemic is relevant. We found no studies comparing demographic and clinical characteristics and disease progression among pregnant and postpartum women, and neither pregnant nor postpartum women hospitalized with COVID-19. Considering the gaps in knowledge, this study is justified in trying to answer the question: What was the trend in hospitalization and mortality among the obstetric population (pregnant and postpartum women) compared to the non-obstetric Brazilian population? The aim of the present study is to explore the impact of COVID-19 on morbidity and mortality among hospitalized pregnant, postpartum, and non-pregnant women in Brazil.

2. Methodology

Study design

This is a population-based, retrospective, descriptive, exploratory and documentary cohort study, following the recommendations of Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) (Vandenbroucke, Von, Altman, Gotzsche, Mulrow & Pocock, 2007), carried out throughout Brazil, using secondary data from SIVEP-Gripe. This is the official system for recording cases and deaths from COVID-19 and contains variables for monitoring the pandemic in several aspects, such as sociodemographic trends of cases and deaths and vaccination effectiveness.

Population and sample

The data search covered epidemiological weeks 1 to 53 (December 29, 2019 to January 2, 2021) conducted throughout Brazil. The study included all data from female patients aged 10 to 49 years hospitalized with COVID-19. Cases that were not hospitalized or not confirmed with COVID-19, or whose sex or gestational status was not recorded, were excluded. The study collected 40,640 women hospitalized with COVID-19 and aged 10 to 49 years, who were divided into two groups: pregnant women (n=3,372) and non-pregnant women (n=37,268), the latter separated into postpartum women (n=794) and non-obstetric population (n=36,474).

Study variables

Notification data include demographic and clinical information, characteristics of pregnancy and puerperium (considering the period from birth to the 45th day after delivery). SIVEP-Gripe records include demographic data (sex, age, skin color, education, place of residence); clinical data (signs and symptoms, risk factors/comorbidities); epidemiological data (previous vaccination against influenza, community infection or hospital infection); laboratory and etiological diagnoses. There is also information on hospital admission, ICU admission, use of ventilatory support (invasive and non-invasive) and disease progression (cure or death).

The variables used were age, gestational period, comorbidities, education, skin color, signs and symptoms, SARS without fever, ICU admission, respiratory support, and outcome (cure or death). The comorbidities reported were chronic cardiovascular, renal, neurological, hematological, and hepatic diseases, asthma, obesity, diabetes, and immunosuppression, fever, cough, sore throat, dyspnea, respiratory distress, oxygen saturation less than 95%, diarrhea, vomiting, abdominal pain, fatigue, anosmia, and ageusia. Cases that were not hospitalized or not confirmed with COVID-19, or if sex or gestational status were not recorded, were excluded.

Statistical analysis

Quantitative variables were summarized as mean and standard deviation. Qualitative variables were presented as absolute frequencies (n) and percentages of categories (%). The nonparametric Kruskal-Wallis test was applied to compare the three study groups in terms of quantitative variables, and pairwise comparisons were considered using the Wilcoxon rank-sum test with continuity correction. The chi-square test was used to assess the association between groups and qualitative variables. The Odds Ratio (OR) was used as a measure of association to compare the relative odds of the outcome of interest occurring, considering alpha adjustment for multiple comparisons using the Bonferroni method. Since the significance level adopted was 5% (alpha = 0.05), the adjusted alpha was 0.05/3 = 0.016.

Analyses were performed using R statistical software (R Foundation for Statistical Computing Platform, version 4.0.3) and Process Safety Management (PSM) was performed using the R Weightlt package.

Ethical aspects

Ethical aspects were preserved in accordance with Resolution No. 510 of April 7, 2016 of the National Health Council. As this is a study with a public database, there is no need for submission to the Research Ethics Committee.

3. Results

We identified (n=40,640) hospitalized women of reproductive age 10–49 years who tested positive for SARS-CoV-2. Of these, (n=3,372) were pregnant and (n=37,268) were nonpregnant. Nonpregnant women comprised (n=794) postpartum women and (n=36,474) women who were neither pregnant nor postpartum. The groups differed significantly regarding demographics and comorbidities (Table 1). The three groups differed in terms of age (neither pregnant nor postpartum vs. pregnant: p-value <0.0001, neither pregnant nor postpartum vs. postpartum: p-value <0.0001, and pregnant vs. postpartum: p-value = 0.034). The group without pregnant or postpartum women had a higher rate of comorbidities.

Table 1 –Demographic and clinical characteristics of the obstetric and non-obstetric population with COVID-19, Brazil 2020/2021

Features	Pregnant	Puerperal	Non-obstetric population	P-value
Age (years) Average	29.64 ± 6.93	30.24 ± 7.34	38.22 ± 8.25	<0.0001
Age (years)				
<20	250 (7.4%)	61 (7.7%)	1,009 (2.8%)	<0.0001
20-34	2,244 (66.5%)	494 (62.2%)	9,629 (26.4%)	-
>34	878 (26%)	239 (30.1%)	2,5836 (70.8%)	-
Total	3,372	794	36,474	-
Skin color				
White	1,102 (40.5%)	238 (37.2%)	15,418 (54%)	<0.0001
Black	192 (7.1%)	46 (7.2%)	1,679 (5.9%)	-
Yellow	33 (1.2%)	4 (0.6%)	359 (1.3%)	-
Brown	1,382 (50.8%)	348 (54.4%)	10,976 (38.5%)	-
Indigenous	13 (0.5%)	4 (0.6%)	97 (0.3%)	-
Total	2,722 (100%)	640 (100%)	28,529 (100%)	-
Education				
No schooling	7 (0.5%)	2 (0.6%)	219 (1.4%)	-
Until high school	360 (25.1%)	81 (24.5%)	3,661 (23.7%)	<0.0001
High school	790 (55.1%)	179 (54.2%)	7,532 (48.7%)	-
Faculty	277 (19.3%)	68 (20.6%)	4,058 (26.2%)	-
Total	1,434 (100%)	330 (100%)	15,470 (100%)	-
Risk factors and comorbidities				
Chronic cardiovascular disease (n=14,976)	214/1,141 (18.8%)	77/505 (15.2%)	5780/13,330 (43.4%)	<0.0001
Chronic hematologic disease (n=12,901)	16/1,081 (1.5%)	11/480 (2.3%)	356/11,340 (3.1%)	0.006
Chronic liver disease (n=12,769)	8/1,066 (0.8%)	4/477 (0.8%)	189/11,226 (1.7%)	0.0273
Asthma (n=13,426)	139/1,119 (12.4%)	33/486 (6.8%)	1883/11,821 (15.9%)	<0.0001
Diabetes (n=14,575)	241/1,151 (20.9%)	61/490 (12.4%)	4825/12,934 (37.3%)	<0.0001
Chronic neurological disease (n=12,933)	25/1,078 (2.3%)	5/478 (1%)	568/11,377 (5%)	<0.0001
Chronic lung disease (n=12,945)	23/1,075 (2.1%)	5/480 (1%)	579/11,390 (5.1%)	<0.0001

Immunodepression (n=13,137)	40/1,078 (3.7%)	18/481 (3.7%)	1,289/11,578 (11.1%)	<0.0001
Chronic kidney disease (n=13,047)	24/1,073 (2.2%)	12/479 (2.5%)	1,080/11,495 (9.4%)	<0.0001
Obesity (n=13,713)	143/1,097 (13%)	53/481 (11%)	3,741/12,135 (30.8%)	<0.0001
Metabolic syndrome (n=12,509)	7/1,044 (0.7%)	7/467 (1.5%)	422/10,998 (3.8%)	<0.0001
Number of comorbidities (n=11,958)				
0	576/999 (57.7%)	335/457 (73.3%)	2,022/10,502 (19.3%)	-
1-2	408/999 (40.8%)	106/457 (23.2%)	7,681/10,502 (73.1%)	-
>2	15/999 (1.5%)	16/457 (3.5%)	799/10,502 (7.6%)	-

Source: Prepared by the authors with data extracted from SIVEP-Gripe, Brazil 2020/2021.

The main results from Table 2 can be: fever and cough are more common in the non-obstetric group, while respiratory distress shows notable differences between the groups. Results of the comparison of COVID-19 symptoms before and after PSM in the three study groups.

Table 2 – Characteristics of COVID-19 signs and symptoms in the obstetric and non-obstetric population with COVID-19, Brazil 2020/2021.

Signs and symptoms	Pregnant	Puerperal	Non-obstetric population
Fever (n=36,371)	2.038/2.983 (68.3%)	424/686 (61.8%)	24,297/32,702 (74.3%)
Cough (n=37,101)	2,408/3,085 (78.1%)	475/692 (68.6%)	27.305/33.324 (81.9%)
Sore throat (n=31,474)	724/2.629 (27.5%)	156/603 (25.9%)	8,854/28,242 (31.4%)
Dyspnea (n=36,272)	1,761/2,940 (59.9%)	381/668 (57%)	25,134/32,664 (76.9%)
Respiratory discomfort (n = 34,023)	1,374/2,771 (49.6%)	341/652 (52.3%)	20,158/30,600 (65.9%)
SpO2<95% (n = 33,482)	860/2.708 (31.8%)	291/637 (45.7%)	17.109/30.137 (56.8%)
At least 1 respiratory Symptom (n=37,726)	2,177/3,021 (72.1%)	490/703 (69.7%)	30.208/34.002 (88.8%)
Diarrhea (n=30,907)	335/2,574 (13%)	65/575 (11.3%)	6,387/27,758 (23%)
Vomiting (n=30,342)	342/2,566 (13.3%)	45/570 (7.9%)	4,148/27,206 (15.2%)
Abdominal pain (n=15,775)	117/1,175 (10%)	20/240 (8.3%)	1,347/14,360 (9.4%)
Fatigue (n=16,216)	263/1,191 (22.1%)	47/245 (19.2%)	4,383/14,780 (29.7%)
Anosmia (n=16,202)	335/1,224 (27.4%)	51/260 (19.6%)	3,216/14,718 (21.9%)

Ageusia (n=16,103)	297/1.212 (24.5%)	45/257 (17.5%)	3,121/14,634 (21.3%)
SARS (n=34,118)	1,308/2,795 (46.8%)	242/634 (38.2%)	18,089/30,689 (58.9%)
SARS without fever (n=35,939)	1,816/2,925 (62.1%)	351/661 (53.1%)	24,504/32,353 (75.7%)
Hospital acquired Infection (n=30,722)	37/2.617 (1.4%)	34/597 (5.7%)	760/27,508 (2.8%)

Source: Prepared by the authors with data extracted from SIVEP-Gripe, Brazil 2020/2021

In Table 3, both pregnant and postpartum women were less likely to have fever, cough, sore throat, dyspnea, respiratory distress, lower oxygen saturation, diarrhea, vomiting, fatigue, SARS, and SARS without fever than were pregnant or postpartum women. Pregnant women had anosmia and ageusia more frequently than the others. Postpartum women were less likely to have fever, cough, vomiting, SARS, and SARS without fever than were pregnant women; however, their oxygen saturation level was more frequently below 95% at hospital admission.

Table 3 – Characteristics of COVID-19 signs and symptoms of the obstetric and non-obstetric population with COVID-19 before and after propensity score matching, Brazil 2020/2021.

Signs and symptoms	**Group comparison**			**Group comparison after PSM**		
	Pregnant vs. NPrNPu	**Puerperal vs. NPrNPu**	**Puerperal vs. Pregnant**	**Pregnant vs. NPrNPu**	**Puerperal vs. NPrNPu**	**Puerperal vs. Pregnant**
	OR (98.33% CI)	**OR (98.33% CI)**	**OR (98.33% CI)**	**OR (98.33% CI)**	**OR (98.33% CI)**	**OR (98.33% CI)**
Fever (n=36,371)	0.75 (0.68 – 0.82)	0.56 (0.46 – 0.68)	0.75 (0.61 – 0.93)	0.78 (0.67 – 0.90)	0.63 (0.51 – 0.77)	0.81 (0.65 – 1.00)
Cough (n=37,101)	0.78 (0.70 – 0.88)	0.48 (0.40 – 0.59)	0.62 (0.49 – 0.77)	1.19 (1.01 – 1.41)	0.81 (0.64 – 1.01)	0.68 (0.54 – 0.85)
Sore throat (n=31,474)	0.83 (0.75 – 0.93)	0.76 (0.61 – 0.95)	0.92 (0.72 – 1.17)	0.88 (0.75 – 1.03)	0.90 (0.71 – 1.15)	1.02 (0.79 – 1.32)
Dyspnea (n=36,272)	0.45 (0.41 – 0.49)	0.40 (0.33 – 0.48)	0.89 (0.72 – 1.09)	0.54 (0.46 – 0.63)	0.54 (0.44 – 0.67)	1.00 (0.81 – 1.24)
Respiratory discomfort (n = 34,023)	0.51 (0.46 – 0.56)	0.57 (0.47 – 0.69)	1.11 (0.90 – 1.37)	0.60 (0.52 – 0.69)	0.73 (0.59 – 0.90)	1.21 (0.98 – 1.51)
SpO2<95% (n=33,482)	0.35 (0.32 – 0.39)	0.64 (0.53 – 0.78)	1.81 (1.46 – 2.24)	0.40 (0.34 – 0.46)	0.79 (0.64 – 0.98)	1.99 (1.59 – 2.49)
At least 1 respiratory Symptom (n=37,726)	0.32 (0.29 – 0.36)	0.29 (0.24 – 0.35)	0.89 (0.72 – 1.11)	0.44 (0.37 - 0.53)	0.43 (0.34 - 0.55)	0.98 (0.78 – 1.23)
Diarrhea (n=30,907)	0.50 (0.43 – 0.58)	0.43 (0.31 – 0.58)	0.85 (0.60 – 1.19)	0.61 (0.50 – 0.74)	0.53 (0.38 – 0.74)	0.88 (0.61 – 1.25)
Vomiting (n=30,342)	0.86 (0.74 – 0.99)	0.48 (0.32 – 0.68)	0.56 (0.37 – 0.82)	0.75 (0.60 – 0.92)	0.47 (0.31 – 0.69)	0.63 (0.42 – 0.94)
Abdominal pain (n=15,775)	1.07 (0.83 – 1.36)	0.88 (0.48 – 1.50)	0.83 (0.43 – 1.47)	0.94 (0.65 – 1.36)	0.75 (0.41 – 1.39)	0.80 (0.43-1.49)
Fatigue (n=16,216)	0.67 (0.56 – 0.80)	0.56 (0.38 – 0.82)	0.84 (0.54 – 1.27)	0.95 (0.74 – 1.20)	0.86 (0.57 – 1.29)	0.90 (0.58 – 1.40)

Anosmia (n=16,202)	1.35 (1.15 – 1.58)	0.87 (0.59 – 1.26)	0.65 (0.43 – 0.96)	1.79 (1.42 – 2.26)	1.26 (0.85 – 1.88)	0.70 (0.46 – 1.07)
Ageusia (n=16,103)	1.20 (1.01 – 1.41)	0.79 (0.52 – 1.15)	0.66 (0.42 – 0.99)	1.70 (1.36 – 2.13)	1.17 (0.78 – 1.77)	0.69 (0.45 – 1.07)
ARDS (n=34,118)	0.61 (0.56 – 0.67)	0.43 (0.35 – 0.52)	0.70 (0.56 – 0.87)	0.78 (0.68 – 0.90)	0.58 (0.47 – 0.72)	0.74 (0.59 – 0.93)
SARS without fever (n=35,939)	0.52 (0.48 – 0.58)	0.36 (0.30 – 0.44)	0.69 (0.56 – 0.85)	0.75 (0.65 – 0.87)	0.57 (0.46 – 0.70)	0.75 (0.61 – 0.94)
Hospital acquired Infection (n=30,722)	0.51 (0.33 - 0.74)	2.13 (1.35 – 3.21)	4.21 (2.34 – 7.54)	0.38 (0.22 - 0.65)	1.28 (0.78 – 2.11)	3.38 (1.79 - 6.37)

PSM, Propensity Score Matching; NPrNPu, neither pregnant nor postpartum; OR, Odds Ratio; 98.33% CI, 98.33% confidence interval; SpO2, oxygen saturation in room air; SARI, temperature 38˚C, cough and onset within 10 days.
Source: Prepared by the authors with data extracted from SIVEP-Gripe, Brazil 2020/2021

Pregnant women, compared with pregnant and postpartum women, were less likely to experience any of the study outcomes (ICU admission, invasive and noninvasive respiratory support, and death). Conversely, postpartum women, compared with those who were neither pregnant nor postpartum, were more likely to be admitted to the ICU and less likely to require noninvasive support. Postpartum women had a higher risk of requiring ICU admission, invasive respiratory support, and death than pregnant women (Table 4).

Table 4 -Comparison of outcomes of obstetric and non-obstetric population with COVID-19, Brazil 2020/2021

Result		Pregnant	Puerperal	Non-obstetric population
ICU admission(n=32,769)		574/2.721 (21.1%)	244/680 (35.9%)	8014/29.368 (27.3%)
Ventilatory support (n=31,457)	No	1626/2.598 (62.6%)	11,450/28,199 (40.6%)	349/660 (52.9%)
	Yes, invasive	209/2,598 (8%)	3,536/28,199 (12.5%)	133/660 (20.2%)
	Yes, non-invasive	763/2,598 (29.4%)	13.213/ 28,199 (46.9%)	178/660 (27%)
Death (n=35,700)		181/2.904 (6.2%)	114/715 (15.9%)	4,534/32,081 (14.1%)

Source: Prepared by the authors with data extracted from SIVEP-Gripe, Brazil 2020/2021.

After the PSM (with the inclusion variables education, Brazilian Federation Unit and respiratory symptoms), the only difference between this analysis and the general analysis was that postpartum women were not more likely than pregnant or postpartum women to be admitted to the ICU, maintaining a worse prognosis than pregnant women in relation to ICU admission, invasive ventilatory support and death (Table 5).

Table 5 -Comparison of obstetric and non-obstetric population outcomes before and after propensity score matching with COVID-19, Brazil 2020/2021.

Result		Group comparison			Group comparison after PSM		
		Pregnant vs. NPrNPu OR (98.33% CI)	**Puerperal vs. NPrNPu OR (98.33% CI)**	**Puerperal vs. Pregnant OR (98.33% CI)**	**Pregnant vs. NPrNPu OR (98.33% CI)**	**Puerperal vs. NPrNPu OR (98.33% CI)**	**Puerperal vs. Pregnant OR (98.33% CI)**
ICU admission (n=32,769)		0.71 (0.63 – 0.80)	1.49 (1.23 – 1.81)	2.09 (1.67 – 2.61)	0.58 (0.46 – 0.74)	1.14 (0.87 – 1.51)	1.97 (1.55 – 2.50)
Ventilatory support (n= 31,457)	No	-	-	-	-	-	-
	Yes, invasive	0.42 (0.35 - 0.50)	1.23 (0.96 – 1.58)	2.96 (2.19 – 4.00)	0.48 (0.31 - 0.74)	1.29 (0.89 - 1.85)	2.71 (1.78 – 4.13)
	Yes, non-invasive	0.41 (0.36 – 0.45)	0.44 (0.35 – 0.55)	1.09 (0.85 – 1.39)	0.59 (0.44 - 0.79)	0.65 (0.49 - 0.87)	1.10 (0.81 - 1.50)
Death (n = 35,700)		0.40 (0.33 – 0.49)	1.15 (0.89 – 1.47)	2.85 (2.09 – 3.87)	0.43 (0.33 – 0.57)	1.09 (0.81 – 1.45)	2.51 (1.79 – 3.52)

PSM, Propensity Score Matching; NPrNPu, neither pregnant nor postpartum; OR, Odds Ratio; 98.33%CI, 98.33% confidence interval; FUB, Federative Unit of Brazil; UTI, Intensive Care Unit
Source: Prepared by the authors with data extracted from SIVEP-Gripe, Brazil 2020/2021

After PSM (with the inclusion variables education and respiratory symptoms), the only difference between this analysis and the general analysis was that postpartum women were no more likely than the obstetric population (pregnant and postpartum women) and the nonobstetric population (neither pregnant nor postpartum women) to be admitted to the ICU, maintaining a worse prognosis than pregnant women regarding ICU admission, invasive ventilatory support, and death. Pregnant women with cardiovascular or chronic kidney disease, asthma, or diabetes, and those admitted to the ICU or receiving ventilatory support were less likely to die than neither pregnant nor postpartum women with the same characteristics (Table 6). Postpartum women did not differ significantly from pregnant and postpartum women in terms of the study variables. Postpartum women were more likely to die than pregnant women when both had diabetes, or when they received noninvasive ventilatory support, or when they were admitted to the ICU. After PSM, among women with chronic cardiovascular disease or diabetes and those who received noninvasive support, pregnant women were less likely to die than postpartum women.

Table 6 -Comparison of outcome rates in the obstetric and non-obstetric population before and after propensity score matching with COVID-19, Brazil 2020/2021

Variable	Mortality rate			Group comparison			Group comparison after PSM		
	Non-obstetric population	Pregnant	Puerperal	Pregnant vs. NPrNPu OR (98.33% CI)	Puerperal vs. NPrNPu OR (98.33% CI)	Puerperal vs. Pregnant OR (98.33% CI)	Pregnant vs. NPrNPu OR (98.33% CI)	Puerperal vs. NPrNPu OR (98.33% CI)	Puerperal vs. Pregnant OR (98.33% CI)
Chronic cardiovascular disease disease (n = 5,349)	1,159/5,093 (22.8%)	24/186 (12.9%)	15/70 (21.4%)	0.51 (0.29 – 0.83)	0.93 (0.44 - 1.82)	1.84 (0.74 – 4.39)	0.47 (0.25 – 0.89)	0.96 (0.46 – 2.00)	2.02 (0.82 – 4.99)
Asthma (n = 1,804)	254/1,658 (15.3%)	8/119 (6.7%)	27/06 (22.2%)	0.41 (0.15 – 0.90)	1.61 (0.44 – 4.57)	3.93 (0.87 – 16.64)	0.56 (0.16 – 1.99)	2.68 (0.80 – 8.94)	4.79 (0.95 – 24.10)
Diabetes (n = 4,539)	1,143/4,268 (26.8%)	27/212 (12.7%)	19/59 (32.2%)	0.40 (0.24 – 0.64)	1.30 (0.64 – 2.51)	3.24 (1.39 – 7.46)	0.43 (0.23 - 0.81)	1.52 (0.75 – 3.06)	3.50 (1.45 – 8.47)
Immunodepression (n=1,213)	408/1,159 (35.2%)	6/36 (16.7%)	3/18 (16.7%)	0.38 (0.11 – 1.01)	0.38 (0.06 – 1.48)	1.02 (0.12 – 6.44)	0.54 (0.15 – 1.85)	0.55 (0.12 – 2.61)	1.03 (0.15 – 7.09)
Chronic kidney disease (n = 995)	385/963 (40%)	2/21 (9.5%)	4/11 (36.4%)	0.17 (0.01 – 0.75)	0.87 (0.15 – 3.93)	4.96 (0.49 – 87.60)	0.59 (0.09 – 3.97)	1.52 (0.30 – 7.54)	2.56 (0.24 – 26.90)
Obesity (n= 3,500)	762/3,327 (22.9%)	19/125 (15.2%)	15/48 (31.2%)	0.61 (0.32 – 1.07)	1.54 (0.69 – 3.19)	2.52 (0.95 – 6.62)	0.80 (0.37 – 1.76)	2.29 (1.06 – 4.93)	2.84 (0.98 – 8.21)
Invasive respiratory support (n = 3,878)	2,249/3,536 (63.6%)	104/209 (49.8%)	77/133 (57.9%)	0.57 (0.40 – 0.80)	0.79 (0.51 – 1.22)	1.39 (0.81 -2.38)	0.68 (0.33 – 1.37)	0.83 (0.41 – 1.68)	1.22 (0.67 – 2.22)
Non-invasive respiratory support (n = 14,154)	1246/13.213 (9.4%)	37/763 (4.8%)	18/178 (10.1%)	0.49 (0.32 – 0.72)	1.09 (0.57 – 1.90)	2.21 (1.04 – 4.48)	0.48 (0.27 – 0.86)	0.92 (0.47 – 1.80)	1.93 (0.89 – 4.17)
ICU admission (n = 8,832)	2.755/8.014 (34.4%)	127/574 (22.1%)	90/244 (36.9%)	0.54 (0.42 – 0.69)	1.12 (0.80 – 1.53)	2.06 (1.38 – 3.06)	0.69 (0.44 – 1.07)	1.27 (0.81 – 1.98)	1.84 (1.18 – 2.86)

PSM, Propensity Score Matching; NPrNPu, neither pregnant nor postpartum; OR, Odds Ratio; 98.33%CI, 98.33% confidence interval; FUB, Federative Unit of Brazil; UTI, Intensive Care Unit
Source: Prepared by the authors with data extracted from SIVEP-Gripe, Brazil 2020/2021.

4. Discussion

The results of this analysis show that, upon hospital admission, both pregnant and postpartum women, in general, had a lower rate of symptoms than both pregnant and postpartum women, except for cough, anosmia, and ageusia in pregnant women. On the other hand, the contrast between postpartum and pregnant women revealed that the former had a higher rate of respiratory distress and lower oxygen saturation, in addition to a higher probability of ICU admission, invasive ventilatory support, and death. Therefore, the data from our study suggest that postpartum women are at greater risk of severe outcomes than pregnant women and are at the same risk as pregnant or postpartum women.

At the beginning of the COVID-19 pandemic, the initial publications addressing infections in pregnant women were case reports, short case series, and systematic reviews. Given the low number of cases, the initial impression was that pregnant and postpartum women were not at higher risk of complications and death than the non-obstetric population (Chen et al., 2020; Mullins et al., 2020; Kasraeian et al., 2020; Zaigham & Anderson, 2020; Di Toro et al., 2021; Elshafeey et al., 2020). As the epidemiological weeks pass, new studies have reported a greater need for invasive ventilation and ICU and an increase in the number of deaths in the obstetric population (Sentilhes et al., 2020; Badr et al., 2020; Zambrano et al., 2020; Martinez-Portilla et al., 2021; Hantoushzadeh et al., 2020; Collin et al., 2020).

The US Centers for Disease Control and Prevention published data from January 22 to October 3, 2020, covering 1,300,938 women with COVID-19. Of these, 23,434 were symptomatic pregnant women. In this study, pregnant women, unlike non-pregnant women, had a higher risk of ICU admission, invasive ventilation, extracorporeal membrane oxygenation, and death (Zambrano et al., 2020). In a study of the Brazilian population involving 2,475 pregnant and postpartum women with SARS, 72% of whom had COVID-19, 590 had an unfavorable outcome (Menezes et al., 2020).

A review study showed that the presence of comorbidities was associated with greater complications of the disease and negative outcomes, increasing the chances of ICU admission and the need for mechanical ventilation, with the postpartum period being the period with the highest frequency of deaths in pregnant women (Silva et al., 2021).

Several hypotheses may explain the worse prognosis for postpartum women. The postpartum period is considered a high-risk period for the occurrence of thromboembolism, such as COVID-19, which may have an additive effect on these occurrences (Kamel et al., 2014; Helms et al., 2020). In Mexico, a study that included a cohort of 5,183 pregnant women and 175,905 non-pregnant women with COVID-19 compared the two groups in terms of death, pneumonia, invasive respiratory support, and ICU admissions. Data (comorbidities, age, language, and health insurance level) were analyzed with and without adjustment for propensity score matching. After matching, pregnant women were more likely to have death, pneumonia, and ICU admission than non-pregnant women, but both groups had a similar risk of invasive respiratory support (Martinez-Portilla et al., 2021).

The study, however, did not evaluate any of the groups separately. In contrast to the Mexican study, our data, after adjustments, revealed that pregnant women were less likely to die, require invasive respiratory support, and be admitted to the ICU than women who were neither pregnant nor postpartum. and postpartum women. It is worth mentioning that the two studies are not comparable, since the Mexican study, on the one hand, included women who were not hospitalized and, on the other, divided women of reproductive age into only two groups, pregnant and non-pregnant (Martinez-Portilla et al., 2021).

In a cohort study conducted in Brazil, the risks were higher among black women, due to three comorbidities: cardiovascular disease, diabetes mellitus, and obesity (Guimarães et al., 2023). Another study found that brown skin color, age, region of residence, and symptoms of fever, cough, dyspnea, respiratory distress, and oxygen saturation less than 95% were associated with ICU admission, and that black pregnant women were approximately five times more likely to die (Santos et al., 2022).

Diabetes, cardiovascular disease, and obesity are significant conditions associated with mortality in the obstetric population (Takemoto et al., 2020). Among the American study, the number of participants can be considered small: 34 mother-baby binomials, the study carried out in Detroit, with a predominantly African-American population, concluded that COVID-19 does not appear to increase morbidity and mortality among pregnant women and their newborns (Jani et al., 2020). Thus, the set of American studies is not conclusive regarding the greater risk of unfavorable outcomes for black/brown pregnant/postpartum women with COVID-19 compared to white women, nor regarding the greater risk of pregnant women and newborns from this disease.

A national health surveillance study in the United Kingdom found that the majority of pregnant women hospitalized for COVID-19 were black and from other minority ethnic groups (56%). There was an association between COVID-19 and race, with the odds of COVID-19 occurring being eight times higher among black women compared to white women. The authors considered that the findings may indicate a higher risk of infection and/or progression to severe disease among black women and other minority groups, such as Asian women in general, Chinese women, and mixed-race women, but pointed out that further studies are needed to explain this finding. They suggest that the result cannot be explained simply by the higher number of cases in metropolitan areas that include large proportions of women from minority ethnic groups, as the worse outcome remained even

when metropolitan areas were excluded from the analysis. To explain the more frequent occurrence of COVID-19 among pregnant black women and other minorities (Knight et al., 2020).

The risk of death is more prevalent in women over 35 years of age compared to women under 20 years of age, with black/brown skin color and living in the Southeast, Northeast and North regions compared to the South of Brazil, and pregnant women with black skin color were approximately five times more likely to die (dos Santos; de Andrade; de Sordi; Nunes & Parada, 2022). The ratio of white and black/brown pregnant and postpartum women was 3:1, respectively, with worse COVID-19 outcomes among black women, with a higher proportion of hospitalizations in more severe conditions; higher rates of ICU admission, use of mechanical ventilation and death. Thus, indicating that processes originating outside the hospital environment can affect pregnant/postpartum women disproportionately, impacting the evolution of the disease, due to the intersection between gender, race and social class (Santos et al., 2020).

Our study showed that postpartum women were at higher risk of the most severe outcomes (need for intensive care unit (ICU), use of invasive ventilatory support, and death), and that the fact that the pregnancy was terminated should not underestimate the risk of severity. As postpartum women have been shown to be a higher risk group than pregnant women among those hospitalized for COVID-19, further studies comparing these groups are needed.

A study of 978 cases highlights that 22.6% of women who died were not admitted to the ICU and that only 64.0% received invasive ventilation. No ventilatory support was offered to 14.6% of all fatal cases, while the remaining 21.4% received only noninvasive ventilation (Takemoto et al., 2020). It is also worth noting that postpartum women with COVID-19 had twice the risk of adverse effects, such as ICU admission, need for mechanical ventilation and death, than pregnant women, the proportion of deaths among postpartum women was high, and respiratory signs/symptoms, need for mechanical ventilation and intensive care were associated with death (Takemoto et al., 2020).

As pointed out by Guimarães et al., maternal deaths had a lower risk of occurring than deaths among women of childbearing age. Regarding social variables, the risk of maternal death was higher among black women, women living in rural areas, and women treated outside their cities of origin. Regarding hospitalization, women who died during pregnancy and childbirth were more likely to have been admitted to the ICU and to have undergone invasive ventilatory support (Guimarães et al., 2023).

Large-scale studies of this magnitude are important because they will provide a differentiated view of maternal and child health, especially for pregnant and postpartum women. Looking not only at individual factors: pregnant women in Brazil have different characteristics from those in other countries, with the presence of comorbidities such as obesity, preeclampsia and hypertension, which, by themselves, do not explain the high maternal mortality in Brazil. Therefore, a careful search is necessary considering the areas of greatest social vulnerability, and the areas most in need of financial and other resources related to health care and the most urgent measures for these most affected populations.

As a limitation, our study included notified cases (cases of hospitalization due to SARS-Cov-2 due to COVID-19), therefore, comparisons with COVID-19 patients in the general population (non-hospitalized cases) are not possible. In addition, although the notification of hospitalizations due to COVID-19 is mandatory in Brazil, it is not possible to guarantee that all hospitalized patients with COVID-19 are included and variables may be missing or entered incorrectly, which also does not eliminate bias. It should be considered that there will be other consequences of the crisis caused by the pandemic, this study contributes significantly to Obstetric Nursing and Public Health, considering that women should be prioritized in Brazilian public health policies.

5. Conclusion

In this study, the risk of death due to each comorbidity was identified separately for the three groups of women: pregnant women, postpartum women, and the non-obstetric population (neither pregnant women nor postpartum women). It was found that postpartum women had a higher risk of severe outcomes (need for ICU, need for invasive and noninvasive ventilatory support, and death) than pregnant women. Ideally, all women would be vaccinated to minimize the risk of SARS-CoV-2 infection and that they would adhere to protective measures to avoid contamination by the virus. Since postpartum women have been shown to be a higher risk group than pregnant women among those hospitalized for COVID-19, further studies comparing these groups are needed. In addition, it should be considered that childbirth can influence the progression of COVID-19.

There is a need for further studies in the obstetric population to provide in-depth knowledge of the impact of COVID-19 on the pregnancy-puerperal cycle, especially according to skin color, which is essential for planning and managing strategies. In short, there is a need for further studies before attesting to the independent effect of skin color on the negative evolution of COVID-19 globally. Finally, it is suggested that further studies be carried out to measure the questions that need to be answered about women's health during the COVID-19 pandemic.

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