Public Health 192 (2021) 15–20

Contents lists available at ScienceDirect

Public Health

journal homepage: www.elsevier.com/locate/puhe

Original Research

Sociodemographic factors associated with COVID-19 in-hospital mortality in Brazil

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ARTICLE INFO

Article history:
Received 26 September 2020
Received in revised form
15 December 2020
Accepted 8 January 2021
Available online 15 January 2021

Keywords:
In-hospital mortality
COVID-19
Sociodemographic factors

ABSTRACT

Objectives: The coronavirus disease 2019 (COVID-19) pandemic has highlighted inequalities in access to healthcare systems, increasing racial disparities and worsening health outcomes in these populations. This study analysed the association between sociodemographic characteristics and COVID-19 in-hospital mortality in Brazil.

Study design: A retrospective analysis was conducted on quantitative reverse transcription polymerase chain reaction–confirmed hospitalised adult patients with COVID-19 with a defined outcome (i.e. hospital discharge or death) in Brazil. Data were retrieved from the national surveillance system database (SIVEP-Gripe) between February 16 and August 8, 2020.

Methods: Clinical characteristics, sociodemographic variables, use of hospital resources and outcomes of hospitalised adult patients with COVID-19, stratified by self-reported race, were investigated. The primary outcome was in-hospital mortality. The association between self-reported race and in-hospital mortality, after adjusting for clinical characteristics and comorbidities, was evaluated using a logistic regression model.

Results: During the study period, Brazil had 3,018,397 confirmed COVID-19 cases and 100,648 deaths. The study population included 228,196 COVID-19–positive adult in-hospital patients with a defined outcome; the median age was 61 years, 57% were men, 35% (79,914) self-reported as Black/Brown and 35.4% (80,853) self-reported as White. The total in-hospital mortality was 37% (85,171/228,196). Black/Brown patients showed higher in-hospital mortality than White patients (42% vs 37%, respectively), were admitted less frequently to the intensive care unit (ICU) (32% vs 36%, respectively) and used more invasive mechanical ventilation (21% vs 19%, respectively), especially outside the ICU (17% vs 11%, respectively). Black/Brown race was independently associated with high in-hospital mortality after adjusting for sex, age, level of education, region of residence and comorbidities (odds ratio = 1.15; 95% confidence interval = 1.09–1.22).

Conclusions: Among hospitalised Brazilian adults with COVID-19, Black/Brown patients showed higher in-hospital mortality, less frequently used hospital resources and had potentially more severe conditions than White patients. Racial disparities in health outcomes and access to health care highlight the need to actively implement strategies to reduce inequities caused by the wider health determinants, ultimately leading to a sustainable change in the health system.

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https://doi.org/10.1016/j.puhe.2021.01.005
0033-3506/

Introduction

Although coronavirus disease 2019 (COVID-19) is a respiratory tract infection with contagion dynamics typical of an epidemic, the progression of cases of and deaths from COVID-19 is also influenced by socio-economic factors. Inequalities lead to pandemics having uneven impacts throughout the world.[1] Understanding the risk of death from COVID-19, both as an individual and within communities, is crucial for adopting new behaviours. Health authorities need to implement sustainable change in health systems to reduce health inequalities.[2]

In Brazil, where significant socio-economic differences exist (Gini coefficient in 2018 = 53.9, 9th highest in the world),[3] the evidence of an association between the socio-economic characteristics and COVID-19 mortality remains unclear. This study aimed to evaluate the association between sociodemographic factors and COVID-19 in-hospital mortality in Brazil. Data were obtained from the national surveillance system.

Methods

Data sources

This study is a retrospective analysis of hospitalised adult patients with COVID-19 in Brazil. Data were extracted from the Influenza Epidemiological Surveillance Information System (SIVEP-Gripe), the national surveillance system of severe acute respiratory infections (SARIs), which was established after the 2009 H1N1 pandemic by the Ministry of Health and is the main repository of notifications of COVID-19 hospitalisations (see Table S1 in the supplementary material).[4] Notification is mandatory, and each observation includes patients' demographic information, such as age, sex, self-reported race (or skin colour), self-reported level of education, region of residence, self-reported symptoms and comorbidities, use of respiratory support, date of the onset of symptoms, date of hospital admission, date of intensive care unit (ICU) admission and date of outcome (i.e. hospital discharge or death).[5,6] Information was obtained on confirmed COVID-19 cases and deaths in Brazil from Brasil.IO,[7] a consortium that compiles epidemiological forms from the health secretaries of each state.

Study population

We included all patients who (i) were admitted to the hospital between February 16 and August 8, 2020, (ii) were aged ≥20 years and (iii) had a positive quantitative reverse transcription polymerase chain reaction (RT-qPCR) test result for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Individuals with only serological or clinical-epidemiological diagnoses were excluded. The current analysis considered only adult COVID-19 hospitalisations with a defined outcome (i.e. hospital discharge or death).

Outcomes and variables

The primary outcome was in-hospital mortality. The results were also stratified by sociodemographic factors, with a focus on self-reported race (or skin colour), which was originally defined in the data dictionary as White (Branca), Black (Preta), Brown (Parda), Asian (Amarela) or Indigenous (Indígena).[6]

Statistical analyses

The associations between sociodemographic characteristics and in-hospital mortality of adult patients with COVID-19 were evaluated. A multivariable analysis was performed using a logistic regression model. The main aim of this study was to evaluate the impact of sociodemographic variables on in-hospital mortality, adjusting for clinically relevant characteristics, such as sex, age and comorbidities. The main analysis was based on complete case data, computing odds ratios (ORs) with the respective 95% confidence intervals (CIs) for each variable. In the SIVEP-Gripe system, although several variables are mandatory, others have the 'Ignored' option. Some variables present a considerable amount of missing information, such as comorbidities, self-reported race and level of education. We conducted a sensitivity analysis by considering missing or ignored values as a single 'not reported' category in the multivariable analysis.

All analyses were performed using version 4.0.2 of the R programming language, using the 'tidyverse' packages:[8] 'dplyr', 'tidyr' for data wrangling and 'broom' for model analysis. Data and code used in the analyses were made available in a github repository (https://github.com/noispuc/Peres_etal_PublicHealth_Socio_demographic_COVID19_mortality).

Results

Outcomes and characteristics of adult COVID-19 hospitalisations in Brazil

Between February 16 and August 8, 2020, there were 549,809 SARI hospitalisations registered in the SIVEP-Gripe system. Of these patients, 251,178 had positive RT-qPCR test result for SARS-CoV-2, and 228,196 were adults with a defined outcome (hospital discharge or death) (Fig. 1). During the same time period, Brazil reported 3,018,397 confirmed COVID-19 cases and 100,648 deaths; thus, the proportion of COVID-19 hospitalisations with a defined outcome was 7.5% of confirmed cases (228,196/3,018,397), and the proportion of in-hospital deaths was 85.6% of confirmed deaths (85,171/100,648).

The median age of in-hospital adult patients with COVID-19 was 61 years (interquartile range: 48, 73), with 54% aged >60 years, 57% were men and 85% (68,933/82,426) presented with at least one comorbidity (Table 1). Most patients were from the Southeast and Northeast regions of Brazil (57% and 20%, respectively), and almost half were educated up to high school (45%, 34,964/78,511).

White patients represented 35.4% (80,853/228,196) of hospitalisations, whereas Black/Brown individuals accounted for 35% (79,914/228,196) of hospitalisations, Asians accounted for 11.2% (2558/228,196) of hospitalisations and Indigenous was the smallest group (0.2%, 449/228,196) (data on missing values for race are available in Table S2). The median age of hospitalised patients was similar across races, except for Indigenous individuals, who had a younger median age. Black/Brown, White and Asian groups had a similar proportion of patients with at least one comorbidity (84%), which was higher than that in the Indigenous group (77%). Races were distributed differently across the regions: Black/Brown and Asian groups were mostly present in the Southeast, Northeast and North, the White population was concentrated in the Southeast and South regions and the Indigenous group was mainly from the North and Central-West of Brazil. This study observed that White (36%) and Asian (34%) patients were admitted more frequently to the ICU than Black/Brown (32%) and Indigenous (28%) patients. In addition, the proportions of Black/Brown patients (21%) and Indigenous patients (23%) who underwent invasive respiratory support were higher than the proportions of White (19%) and Asian (19%)

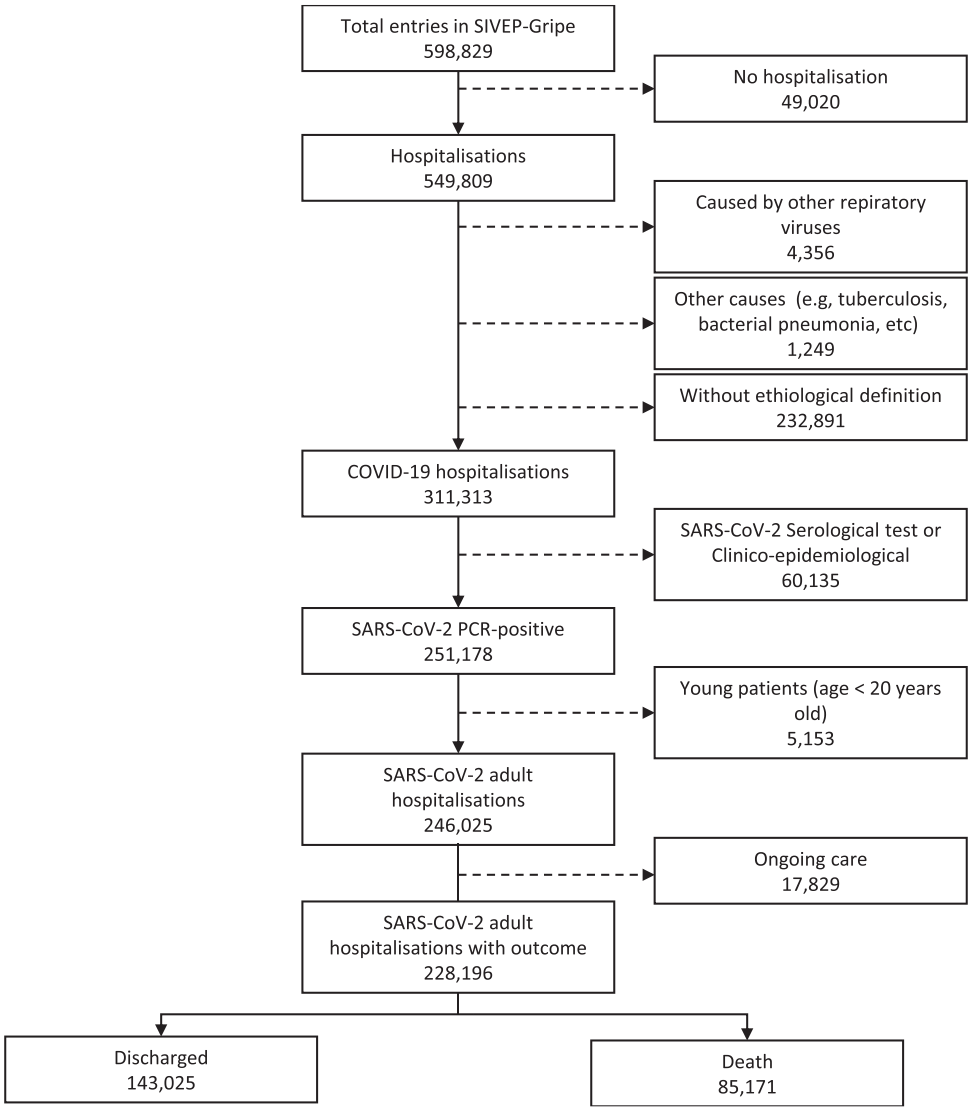

Fig. 1. Flowchart of the study population. COVID-19, coronavirus disease 2019; PCR, polymerase chain reaction; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

patients, especially outside the ICU (Black/Brown [17%], Indigenous [28%] vs White [11%], Asian [14%]).

The total in-hospital mortality was 37% (85,171/228,196) (Fig. 1, Table 1). In-hospital mortality peaked in weeks 18–20 (almost 40%) and then decreased until the end of the study period (Fig. S1). In-hospital mortality for Black/Brown patients was higher than that for White patients during all time periods (Fig. S1). Black/Brown and Indigenous patients had higher in-hospital mortality (42% and 43%, respectively) than White and Asian patients (37% and 39%, respectively) (Table 1, Fig. 2). In terms of age and number of comorbidities, Indigenous and Black/Brown patients showed higher in-hospital mortality, except for patients with more than three reported comorbidities, wherein the mortality in Asian patients was higher (Fig. 2, Table S3). Regarding the level of education, illiterate patients showed the highest in-hospital mortality (>50%); this was especially true for Black/Brown patients with low education levels (Fig. 2, Table S3).

Sociodemographic factors associated with COVID-19 mortality

The association between sociodemographic factors and COVID-19 in-hospital mortality was evaluated. In the complete case multivariable analysis (Table S4, Fig. 3), the sociodemographic variables remained associated with in-hospital mortality, even after adjusting for sex, age and comorbidities. The results were similar when considering missing or ignored values as a single 'not reported' category in the sensitivity analysis (Table S5).

Considering the results of complete cases, only Black/Brown race (OR = 1.15; 95% CI = 1.09–1.22) was associated with increased mortality. A higher risk of mortality was related to education levels lower than college/university, especially the illiterate (OR = 1.77; 95% CI = 1.58–1.98) and up to the high school level (OR = 1.52; 95% CI = 1.4–1.65) groups. Increased mortality was also seen in the residential regions in the North (OR = 2.76; 95% CI = 2.45–3.1) and Northeast (OR = 2.05; 95% CI = 1.86–2.26) of Brazil.

Table 1
Sociodemographic characteristics, use of resources and outcomes of hospitalised adult patients with COVID-19 in Brazil, stratified by self-reported race.[a]

Variables	Total,[b] $n = 228,196$	White, $n = 80,853$	Black/Brown, $n = 79,914$	Asian, $n = 2558$	Indigenous, $n = 449$
Sex, n (%)					
Male	129,003 (57%)	45,140 (56%)	45,918 (57%)	1533 (60%)	275 (61%)
Female	99,155 (43%)	35,707 (44%)	33,982 (43%)	1025 (40%)	174 (39%)
Not reported	38 (<0.1%)	6 (<0.1%)	14 (<0.1%)	0 (0%)	0 (0%)
Age in years, median (IQR)	61 (48, 73)	62 (48, 74)	61 (47, 73)	64 (50, 76)	59 (46, 73)
Age group, n (%)					
20–39 years	30,547 (13%)	10,315 (13%)	10,864 (14%)	306 (12%)	67 (15%)
40–49 years	33,606 (15%)	11,175 (14%)	11,948 (15%)	306 (12%)	74 (16%)
50–59 years	42,790 (19%)	14,723 (18%)	15,164 (19%)	415 (16%)	85 (19%)
60–69 years	47,296 (21%)	16,695 (21%)	16,898 (21%)	541 (21%)	80 (18%)
70–79 years	40,450 (18%)	14,792 (18%)	14,347 (18%)	552 (22%)	74 (16%)
80+ years	33,507 (15%)	13,153 (16%)	10,693 (13%)	438 (17%)	69 (15%)
Level of education, n (%)					
College/university	12,728 (5.6%)	7642 (9.5%)	3254 (4.1%)	193 (7.5%)	13 (2.9%)
High school	25,949 (11%)	12,812 (16%)	10,758 (13%)	338 (13%)	31 (6.9%)
Up to high school	34,964 (15%)	17,046 (21%)	15,935 (20%)	370 (14%)	100 (22%)
Illiterate	4870 (2.1%)	1692 (2.1%)	2842 (3.6%)	47 (1.8%)	46 (10%)
Not reported	149,685 (66%)	41,661 (52%)	47,125 (59%)	1610 (63%)	259 (58%)
Region of residence, n (%)					
South	22,942 (10%)	17,306 (21%)	2177 (2.7%)	135 (5.3%)	41 (9.1%)
Southeast	129,399 (57%)	54,350 (67%)	38,463 (48%)	1468 (57%)	77 (17%)
Central-West	16,227 (7.1%)	2890 (3.6%)	6503 (8.1%)	236 (9.2%)	135 (30%)
Northeast	45,907 (20%)	5023 (6.2%)	23,512 (29%)	521 (20%)	84 (19%)
North	13,702 (6.0%)	1278 (1.6%)	9250 (12%)	197 (7.7%)	112 (25%)
Not reported	19 (<0.1%)	6 (<0.1%)	9 (<0.1%)	1 (<0.1%)	0 (0%)
Number of comorbidities,[c] n (%)					
No comorbidities	13,493 (5.9%)	5382 (6.7%)	5122 (6.4%)	142 (5.6%)	30 (6.7%)
1–2	61,309 (27%)	25,072 (31%)	23,428 (29%)	739 (29%)	93 (21%)
≥3	7624 (3.3%)	3317 (4.1%)	2868 (3.6%)	92 (3.6%)	9 (2.0%)
Not reported	145,770 (64%)	47,082 (58%)	48,496 (61%)	1585 (62%)	317 (71%)
ICU admission, n (%)					
No	123,653 (54%)	45,709 (57%)	44,700 (56%)	1377 (54%)	271 (60%)
Yes	77,967 (34%)	29,214 (36%)	25,759 (32%)	864 (34%)	125 (28%)
Not reported	26,576 (12%)	5930 (7.3%)	9455 (12%)	317 (12%)	53 (12%)
Respiratory support, n (%)					
No	53,718 (24%)	20,092 (25%)	17,844 (22%)	561 (22%)	94 (21%)
Yes, non-invasive	94,430 (41%)	36,580 (45%)	32,942 (41%)	1047 (41%)	169 (38%)
Yes, invasive	44,164 (19%)	15,732 (19%)	16,631 (21%)	487 (19%)	105 (23%)
Place of invasive respiratory support,[d] n (%)					
In the ICU	37,164 (84%)	13,712 (87%)	13,381 (80%)	415 (85%)	75 (71%)
Outside the ICU	5870 (13%)	1725 (11%)	2779 (17%)	66 (14%)	29 (28%)
Not reported (place)	1130 (2.6%)	295 (1.9%)	471 (2.8%)	6 (1.2%)	1 (1.0%)
Not reported	35,884 (16%)	8449 (10%)	12,497 (16%)	463 (18%)	81 (18%)
Length of hospital stay in days, median (IQR)	8 (4, 15)	8 (4, 15)	8 (4, 15)	8 (4, 16)	8 (5, 15)
In-hospital deaths, n (%)	85,171 (37%)	29,033 (36%)	33,730 (42%)	999 (39%)	191 (43%)

COVID-19, coronavirus disease 2019; ICU, intensive care unit; IQR, interquartile range.
[a] Data were included as self-reported race or skin colour, originally defined in the data dictionary as White (Branca), Black/Brown (Parda), Asian (Amarela) or Indigenous (Indígena).
[b] Total includes the number of observations with not reported/missing values for self-reported races.
[c] The sum of comorbidities include complete cases for the following: cardiovascular, diabetes, renal, neurologic, haematologic, hepatic, chronic respiratory disorder, obesity and immunosuppression. 'Not reported' corresponds to missing values for all nine comorbidities.
[d] Place of invasive respiratory support is the combination of ICU admission and invasive respiratory support variables. 'Not reported' means patients who received invasive respiratory support, but ICU admission is missing.

Discussion

The relationship between sociodemographic characteristics and mortality of 228,196 hospitalised patients with COVID-19 in Brazil was evaluated. Racial differences in the use of health services and outcomes were observed. Black/Brown and Indigenous patients were admitted less frequently to the ICU and were more intubated, especially outside the ICU, than White and Asian patients. Furthermore, Black/Brown race was associated with high in-hospital mortality after adjusting for sex, age, comorbidities, level of education and residential region.

Race, education level and region of residence presented different risks of mortality. These variables highlight the wider social determinants of health, differences in access to health care and the quality of care throughout Brazil. Race and education level are strong predictors of mortality. Historically, many Black/Brown communities, with limited access to education, living in poor areas, especially in the North and Northeast regions of the country, also have the lowest access to healthcare services.[9] These populations are more likely to have chronic conditions, which increases their risk of COVID-19–associated mortality.[1] However, even when considering the underlying comorbidities, the effects of socio-demographic factors remained. Previous studies have not found a significant association between race and COVID-19 mortality in the US.[10–13] However, an ecological analysis in UK participants noted a robust association between non-white race and COVID-19 mortality.[14] The effect of race on COVID-19 mortality in Brazil may be related not only to the social inequity presented in the country[15] but also to the colonial heritage and the structural racism that is frequently not admitted by Brazilian elites or policymakers.

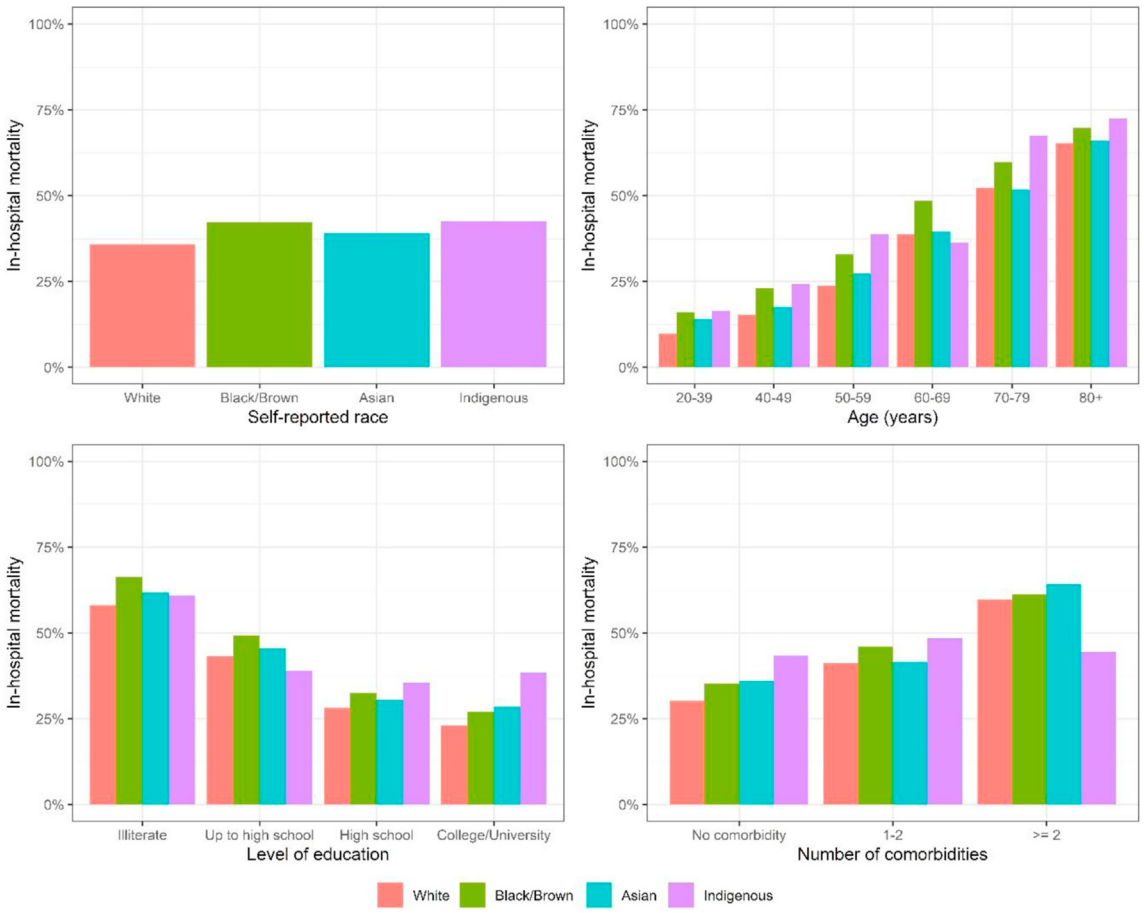

Fig. 2. In-hospital mortality for hospitalised adults with COVID-19 in Brazil, stratified by self-reported race, age, number of comorbidities and level of education (n = 228,196). Complete cases for in-hospital mortality and the sociodemographic variables are reported. COVID-19, coronavirus disease 2019.

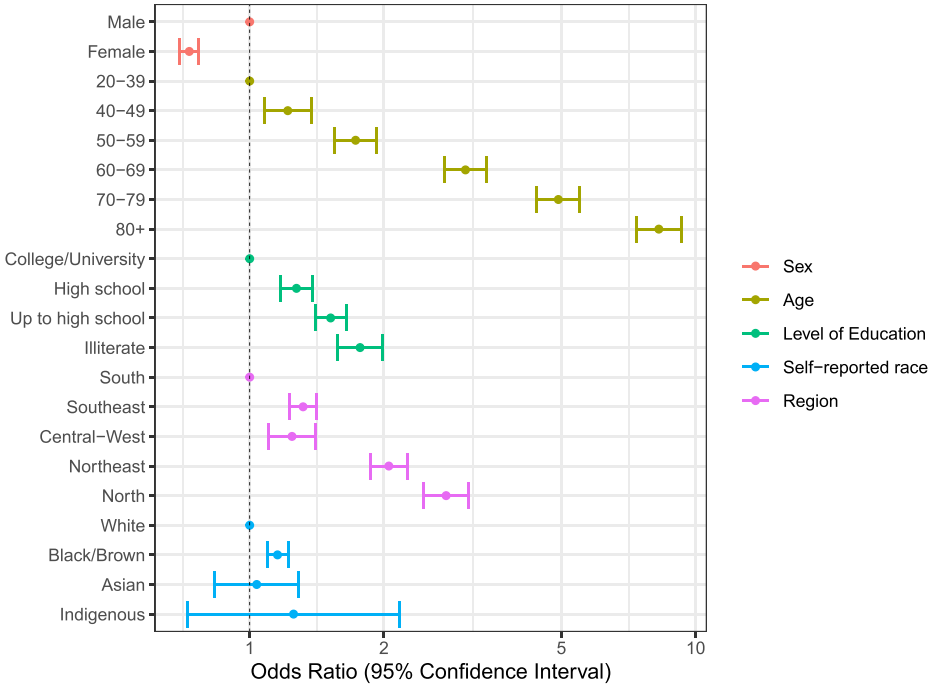

Fig. 3. Association of sex, age, comorbidities and sociodemographic characteristics with in-hospital mortality using a multivariable logistic regression model. Variables were adjusted for the presence of nine comorbidities: cardiovascular, diabetes, renal, neurologic, haematologic, hepatic, chronic respiratory disorder, obesity and immunosuppression. Selfreported race (or skin colour) is originally defined in the data dictionary as White (Branca), Black/Brown (Parda), Asian (Amarela) or Indigenous (Indígena). Complete cases for in-hospital mortality are reported.

In terms of Brazilian regions, the presence of higher mortality in the North and Northeast regions may be related to several aspects. First, there were a higher proportion of COVID-19 cases per 100,000 inhabitants in these regions.[16] Second, there are a lower number of ICU beds per 10,000 inhabitants in these regions than other Brazilian regions (North: 0.9; Northeast: 1.5; South: 2.2; Central-West: 2.5; Southeast: 2.7).[17] Third, these regions are the poorest in Brazil (gross regional product per capita, US$ [2016]: North, 5430; Northeast, 4495; Southeast, 11,294; South, 10,320; Central-West, 11,119),[18] where there is less access to care and poorer quality of care than in other regions.

As the global economy gets into an economic crisis, funding allocation must aim to reduce inequalities rather than exacerbate them. Public health decision makers must ensure that prevention activities prioritise communities and racial groups that are most impacted by COVID-19. Much of the racial inequalities are not related to biology, but are related to socio-economic disadvantages that ethnic minorities face (e.g. deprivation, lack of opportunities and societal oppression).[19] In Brazil, Black/Brown individuals with low education levels who live in the most impoverished regions are the most impacted by COVID-19 and require special attention. Regular income support to low-income households, access to testing, proactive contact tracing, emphasis on home diagnosis and care, providing shelter to the homeless and improving healthcare access to vulnerable communities have the potential to reduce the burden of short- and long-term morbidity and mortality.[20,21]

This study presents strengths and limitations. Although the notifications of COVID-19 hospitalisations in the SIVEP-Gripe system are mandatory, we cannot ensure that all of Brazil's hospitalised cases are covered in this study. However, data were retrieved from the national surveillance system, which is the principal repository of COVID-19 hospitalisations nationwide. Second, a significant amount of data were missing or 'not reported' owing to data collection and manual entry in the system, which may be aggravated by the increased volume of patient data requiring to be entered by physicians. However, a large amount of information was provided, and a sensitivity analysis was performed by categorising the missing values and adding them to the model. Third, only RT-qPCR–confirmed COVID-19 cases were evaluated, which is the main testing procedure for hospitalised patients with COVID-19; however, this likely led to a study sample with more severe cases enrolled in the SIVEP-Gripe system. It is important to note that serological/clinical-epidemiological tests are also used for diagnosis, especially in regions with low healthcare resource availability.

Conclusions

Among hospitalised Brazilian adults with COVID-19, Black/Brown patients showed higher in-hospital mortality, less frequently used hospital resources and had potentially more severe conditions than White patients. Therefore, public health decision makers should ensure that prevention activities prioritise these population groups, providing regular income support to low-income households, access to testing and shelter to the homeless, in addition to improving healthcare access in the most vulnerable communities.

Author statements

Ethical approval

Ethical approval was not required. This work used de-identified data available from the Influenza Epidemiological Surveillance Information System, a public database used to monitor severe acute respiratory syndromes in Brazil.

Funding

This work was supported by Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) – Finance Code 001, Fundação de Amparo à Pesquisa do Estado do Rio de Janeiro (FAPERJ) and Pontifícia Universidade Católica do Rio de Janeiro (PUC-Rio).

Competing interests

None declared.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.puhe.2021.01.005.

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