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Factors associated with COVID-19 in hospitalized Brazilian patients

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ABSTRACT. To estimate the prevalence of confirmed cases of COVID-19 and their associated factors in hospitalized Brazilian patients. The study analyzed 757,657 reported cases between February 26th and October 9th, 2020. The chi-square test and a Poisson multivariate regression model with a robust variance estimator were used to identify the prevalence and confidence intervals, considering $p<0.05$ as significant. COVID-19 diagnosis increased by 0.34% with increasing age and was 5% lower in male patients. The diagnosis increased with increasing education, and the disease was 17% more frequent among participants with higher education.Nosological characteristics were associated with the diagnosis, increasing by 32% in patients with anosmia, 28% among those with fever, 26% in obese patients, 14% in patients with diabetes, 5% in patients with heart disease, and 2.7% in those with oxygen saturation below 95%. A high prevalence of COVID-19 cases and a statistical association with clinical and sociodemographic variables were detected.

Keywords: COVID-19; coronavirus infections; cross-sectional studies; hospitalization; prevalence.

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Introduction

The COVID-19 pandemic is one of the greatest global challenges of this century, which, despite efforts to contain it, has continued to grow globally, with serious health, social and economic consequences (Hillesheim, Tomasi, Figueiró, & Paiva, 2020; Silva, Jardim, & Santos, 2020). Since the new coronavirus (SARS-CoV-2) identification in December 2019, more than 274 million cases and 5 million deaths have been recorded by December 2021.

In this scenario, South America has become one of the main regions affected by outbreaks of the pandemic, with emphasis on Brazil, which had recorded 18,332,760 confirmed cases and 511,142 accumulated deaths until June 26, 2021, corresponding to a fatality rate of 2.8%, making the country lead the ranking of confirmed cases and deaths per day in the world (Brasil, 2021).

Suspected or confirmed cases represent a portion of the total number of COVID-19 cases in the country since the clinical spectrum of the disease ranges from asymptomatic infections to severe manifestations that lead to death (Pollán et al., 2020). Besides, underreporting, a common problem, reflects the country's socio-economic, health, and geographic disparities, corroborating the lack of control of COVID-19 cases (Hillesheim et al., 2020; Sousa, Estrela, & Bezerra, 2020).

In this regard, when considering the unfavorable evolution of the number of cases of the disease in Brazil, as well as the deformity of the characteristics of the infection along the planisphere, it is important to estimate the prevalence of confirmed cases of COVID-19 and associated factors in the hospitalized population of Brazil. It is expected that the study findings contribute to monitoring cases and the definition and implementation of preventive and disease control measures.

Given the above, the objective of this study was to estimate the prevalence of confirmed cases of COVID-19 and their associated factors in hospitalized Brazilian patients.

Material and methods

Ethical aspects

Concerning the ethical aspects, the study is exempt from approval from the Ethics Committee since the data was obtained from an information system (*SIVEP-Gripe*) that is freely accessible through the Internet. It is also important to highlight the impossibility of identifying patients since information such as name or address is unavailable. In this perspective, the ethical commitment of the researchers in handling, analyzing, and publishing the data is reiterated, as recommended by Resolution 466/2012 of the Brazilian National Health Council.

Study design, period, and location

A cross-sectional study was conducted, guided by the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines, using secondary data available in the Influenza Epidemiological Surveillance Information System (*SIVEP-Gripe*). This information system integrates notifications of suspected and confirmed cases of severe acute respiratory syndrome (SARS) in the country and laboratory test results in November 2020. The study was conducted in the city of Fortaleza, Ceará, Brazil.

Population, sample, inclusion, and exclusion criteria

The population consisted of reported, hospitalized, and positive COVID-19 cases between February 26 and October 9, 2020, in the Brazilian territory. Confirmation of COVID-19 was defined as a positive RT-PCR test for the new coronavirus (SARS-CoV-2), preferably performed between the 3rd and 4th day of infection, extending up to the 10th day. Cases without a confirmatory laboratory test result were excluded. The study analyzed 757,657 reported cases, some with incomplete data on the variables analyzed.

Study protocol

A positive test for SARS-CoV-2 was listed as the outcome, with a prediction of a dichotomous response (yes/no). Independent variables were also selected, such as age (continuous), sex (male/female), education (illiterate, elementary education – 1st cycle, elementary education – 2nd cycle, high school, and higher education), anosmia (yes/no), fever (yes/ no), obesity (yes/no), diabetes (yes/no), heart disease (yes/no), and saturation < 95% (yes/no).

Data analysis and statistics

The descriptive data analysis included the assessment of the median and interquartile range (IQR) of age and calculating simple and relative frequencies of the other categorical variables. The association between the independent variables and the outcome was tested using the Mann-Whitney test for age and the chi-square test for the other variables, considering the p-value <0.05 to be significant. The strength of these associations was verified utilizing bivariate regression, thus making it possible to identify the Prevalence Ratio (PR) and the 95% confidence interval (95%CI).

The variables that presented p<0.20 in the bivariate analysis were inserted into a Poisson multivariate regression model with a robust variance estimator. This type of regression analysis is an alternative to logistic regression as it provides more accurate point estimates and narrower confidence intervals, especially with medium and high prevalence outcomes (Coutinho, Sazufca, & Menezes, 2020).

Results

According to Table 1, the prevalence of COVID-19 in hospitalized patients in the present study was 53.5% (n=405,364). As for the sociodemographic characterization of the patients, more than half were female (54.6%; n=413,741), the median age was 57 years (IQR: 40-72), and 41.4% had completed the 2nd cycle of elementary school (n=303,926).

Of the COVID-19 positive cases, 60.1% (n=45,5045) had fever, 55.6% (n=421,198) had oxygen saturation < 95%, and 3% (n=22,579) had anosmia. COVID-19 was present mainly in women (55.1%; n = 228,159) and people with higher education (62.8%; n = 21,012).

Regarding comorbidities, 31.9% had heart disease (n=241,593), 22.7% had diabetes (172,380), and 8.6% had obesity (30,243). It is noteworthy that 66.7% (n=20,164) of the obese and 60.4% (n=104,058) of the diabetic patients tested positive for Covid-19.

Table 1. Diagnosis of COVID-19 according to the clinical and sociodemographic characteristics of the sample. Fortaleza, CE, Brazil, 2021 (n=757,657)

Variables	COVID-19					p-value
	Total	Yes (%)	No (%)	PR	95% CI	
Age (median)	57	58 (44 - 72)	54 (31 - 72)	1.006	1.005 - 1.007	<0.001
Sex						<0.001
Female	413,741 (54.6)	228,159 (55.1)	185,582 (44.9)	1	-	
Male	343,656 (45.4)	177048 (51.5)	166,608 (48.5)	0.934	0.930 - 0.938	
Education						<0.001
Illiterate	244,672 (33.4)	131,577 (53.8)	113,094 (46.2)	1	-	
Elementary – 1st cycle	76,862 (10.5)	388.66 (50.6)	37,996 (49.6)	0.94	0.93 - 0.95	
Elementary – 2nd cycle	303,926 (41.4)	166,680 (54.8)	137,246 (45.2)	1.02	1.01 - 1.03	
High school	74,316 (10.1)	43,923 (59.1)	30,393 (40.9)	1.10	1.09 - 1.11	
Higher education	33,459 (4.6)	21,012 (62.8)	12,447 (37.2)	1.17	1.16 - 1.18	
Oxygen saturation <95%						<0.001
Yes	421,198 (55.6)	233,758 (55.5)	187,440 (44.5)	1.09	1.08 - 1.10	
No	336,460 (44.4)	171,535 (51.0)	164,924 (49.0)	1	-	
Anosmia						<0.001
Yes	22,579 (3.0)	16,128 (71.4)	6,451 (28.6)	1.35	1.34 - 1.36	
No	735079 (97.0)	389,165 (52.9)	345,913 (47.1)	1	-	
Fever						<0.001
Yes	455,045 (60.1)	263,193 (57.8)	191,852 (42.2)	1.23	1.22 - 1.24	
No	302613 (39.9)	142,100 (47.0)	160,512 (53.0)	1	-	
Obesity						<0.001
Yes	30,243 (8.6)	20,164 (66.7)	10,079 (33.3)	1.29	1.28 - 1.30	
No	321,878 (91.4)	166,125 (51.6)	155753 (48.4)	1	-	
Diabetes						<0.001
Yes	172,380 (22.7)	104,058 (60.4)	68,322 (39.6)	1.17	1.16 - 1.18	
No	585277 (77.3)	301,235 (51.5)	284,042 (48.5)	1	-	
Heart disease						<0.001
Yes	241,593 (31.9)	137,654 (57.0)	103,939 (43.0)	1.10	1.09 - 1.11	
No	516,965 (68.1)	267,639 (51.9)	248,425 (48.1)	1	-	

% = percentage; PR: prevalence ratio; CI: confidence interval.

All the variables investigated achieved statistical significance in the bivariate analysis, being therefore submitted to the regression model. In this model, there was an increase in the prevalence of COVID-19 by 0.34% for each year of increase in age (95% CI: 1.0033 – 1.0036). Regarding gender, the frequency of COVID-19 was 5% lower in male patients than in female patients (95% CI: 0.94 – 0.96). The increase in the level of education was related to an increase in the proportion of infected subjects, especially among participants with higher education, in which the disease was 17% more frequent (95% CI: 1.15 – 1.19) compared to illiterate participants.

Finally, nosological characteristics were associated with the diagnosis of COVID-19, since the prevalence increased by 32% (95% CI: 1.31 – 1.34) in patients with anosmia, compared to 28% (95% CI: 1.27 – 1.29) in patients with fever, 26% (95% CI: 1.25 – 1.27) in obese patients, 14% (95% CI: 1.13 – 1.15) in diabetic patients, 5% (95% CI: 1.04 – 1.06) in patients with heart disease, and 3% (95% CI: 1.02 – 1.04) in those with O_2 saturation < 95% (Table 2).

Table 2. COVID-19 prevalence ratio according to clinical and sociodemographic characteristics. Fortaleza, CE, Brazil, 2021(n=757,657)

Variable	PR	95% CI	p-value
Age (continuous)	1.0034	1.0033 - 1.0036	<0.001
Gender (male)	0.95	0.94 - 0.96	<0.001
Education			
Illiterate	1	-	
Elementary – 1st cycle	0.94	0.93 - 0.95	<0.001
Elementary – 2nd cycle	1.02	1.01 - 1.03	<0.001
High school	1.12	1.10 - 1.13	<0.001
Higher education	1.17	1.15 - 1.19	<0.001
Not applicable	0.40	0.37 - 0.42	<0.001
Anosmia	1.32	1.31 - 1.34	<0.001
Fever	1.28	1.27 - 1.29	<0.001
Obesity	1.26	1.25 - 1.27	<0.001
Diabetes	1.14	1.13 - 1.15	<0.001
Heart disease	1.05	1.04 - 1.06	<0.001
Saturation <95%	1,027	1.023 - 1.03	<0.001

PR: prevalence ratio; CI: confidence interval.

Discussion

Of all the suspected cases tested and reported, just over half had positive laboratory results for COVID-19. In this context, clinical and epidemiological data are required for diagnosis, combined with the RT-PCR (reverse transcription-polymerase chain reaction) test. In contrast, diagnostic tests are essential for treatment and isolation, aiming at interrupting the transmission cycle (Shyu et al., 2020).

Regarding the national panorama, the Brazilian Institute of Geography and Statistics (IBGE, 2020) is attentive to the insufficient testing of the population, based on the results of the National Household Sample Survey (PNAD in Portuguese), which shows the contingent of 28.6 million of Brazilians tested, equivalent to 13.5% of the population, until mid-November 2020. Of these, it is estimated that 6.5 million (23.7%) tested positive, similar to another study that showed that 27% of tests performed were positive for COVID-19 (Escobar, Rodriguez, & Monteiro, 2021). The higher prevalence of positive cases in this study is due to the inclusion of only hospitalized patients. According to national protocols, the profile of these patients points to infection with moderate to severe symptoms, excluding people with mild symptoms.

Furthermore, the present research shows that although the lowest proportion of total cases was observed among people with higher education, the highest proportion of positive cases was found in this group. The same happened in the multivariate analyses, where the prevalence of the disease was observed in people with a higher level of education. While studies have shown that the years of schooling are inversely related to the risk of contamination, this study points out that highly educated persons may have a higher frequency of positive COVID-19 results when hospitalized. This may be related to greater access to healthcare services and the possibility of seeking care during working hours without jeopardizing their remuneration (Cestari et al., 2020; Nunes et al., 2020).

As for the age of those infected by COVID-19, there was an increase in the frequency of involvement for each year, with a median of 58 years in positive cases. From this perspective, the results are similar to other studies (Pollard, Morran, & Nestor-Kalinoski, 2020; Wang et al., 2020), which list the age group of 50-60 years as the most affected by the disease, in agreement with the Korean Society of Infectious Diseases (Korean Society of Infectious Diseases, 2019).

Given the above, the age distribution of COVID-19 cases differs from other seasonal respiratory infections, such as influenza, as children and adolescents become infected and sick less frequently compared to people between 20 and 70 years. Therefore, the difference in the age distribution patterns of COVID-19 infection in China, Korea, and Italy is reiterated, so that China shows a predominance of cases in the age group of 40 to 69 years while, in Korea, peaks of infection are seen in the age groups of 20 to 29 years and 50 to 59 years. Italy, in turn, has a predominance of the age groups from 50 to 59 years and over 80 years (Salzberger et al., 2020).

Similarly, in the Brazilian panorama, studies refer to the age groups from 30 to 59 years as the most affected by the disease, according to the Brazilian Institute of Geography and Statistics (Araujo Filho et al., 2020; IBGE, 2020; Sousa et al., 2020; Escobar et al. al., 2021). Therefore, the results of this study reveal a preponderance of females among those infected, while men were less likely to have a positive laboratory test result for COVID-19. In the meantime, literature findings reveal that the disparity in coronavirus infection between the sexes is explained by biological, behavioral, social, and systemic factors implicated in disease vulnerability, progression, and outcomes (Gausman & Ianger, 2020; Spagnolo, Manson, & Joffe, 2020).

Given the above, the distribution of the infection between the sexes may reflect the movement and social activities of individuals in different societies, differing according to the population studied. This panorama is visualized in the study carried out by the Korean Society of Infectious Diseases (2020), which revealed the disparity in the proportion of infection by sex in two Korean populations with different habits and experiences. The first showed 63.7% of infected females, compared to 41.9% in the second population.

Furthermore, in a review, the authors point out that the prevalence of COVID-19 in males ranged from 37.5% to 77% in selected studies (Abate, Kassie, Kassaw, Aragie, & Maresha, 2020), compared to the percentages of 59 .9% and 60.3% obtained in other studies (Docherty et al., 2020; Richardson et al., 2020).

However, the predominance of females among those infected in the present study can be attributed to the higher proportion of females among health professionals in Brazil, especially nursing professionals, who are more prone to exposure to the virus, as well as to the diagnosis and notification (Lima et al., 2020; Moura et al., 2020; Oertel-Prigione, 2020). At the same time, women are more often the home and family caregivers, increasing the risk of exposure to the virus (Gausman & Ianger, 2020).

Nevertheless, the diagnosis of COVID-19 was associated with comorbidities, so the frequency of positive tests was reported in a greater proportion in obese, diabetic, and cardiac patients. The literature has heterogeneous data on the subject, such as in a Brazilian study (Guan et al., 2020), which reports that 83.1% of COVID-19 positive cases had at least one comorbidity, while in another study conducted in China, only 25% of the sample had comorbidities (Grasselli et al., 2020). In Italy, 60.5% of confirmed cases had comorbidities (Richardson et al., 2020).

In most studies, the morbidities reported were hypertension, diabetes, and heart disease (Cao, Liu, Xiong, & Cai, 2020; Docherty et al., 2020; Grasselli et al., 2020; Guan et al., 2020; Lima et al., 2020; Moura et al., 2020; Oertel-Prigione, 2020; Richardson et al., 2020; Sousa et al., 2020), similar to this investigation. Thus, the presence of chronic diseases is highlighted as a risk factor for the outcomes of severe COVID-19 and death due to the intense inflammatory process triggered by the exacerbated immune response of the virus in the bronchial epithelial cells (Salzberger et al., 2020; Zhou et al., 2020).

Regarding the symptoms, most patients had fever and oxygen saturation < 95%, with a lower proportion of anosmia. These findings corroborate studies that suggest that the proportion of symptomatic patients among those infected is 55% to 60% (Brasil, 2020), with fever and cough among the most frequent clinical signs, followed by dyspnea and myalgia (Brasil, 2020; Cao et al., 2020; Docherty et al., 2020; Teich et al., 2020).

In adults, mild cases of COVID-19 are characterized by signs and symptoms of flu-like illnesses, such as cough, sore throat, and runny nose, whether or not followed by fever, anosmia (olfactory dysfunction), ageusia (gustatory dysfunction), diarrhea, abdominal pain, myalgia, fatigue, and headache. In moderate cases, fever or persistent cough can be seen, with progressive worsening of other symptoms, such as adynamia, prostration, hyporexia, and diarrhea, especially in the presence of a risk factor. Therefore, in severe cases, dyspnea, persistent feeling of pressure in the chest, oxygen saturation below 95% in room air, and cyanosis are the main symptoms (Brasil, 2020).

The Chinese Center for Disease Control and Prevention (2020) points out that about 90% of all infections are uncomplicated, that is, asymptomatic, oligosymptomatic, or with mild to moderate symptoms, so the rate of complications is highly dependent on the age and comorbidities of patients (Salzberger et al., 2020).

As for the study's limitations, we highlight the observation of predictor variables and outcome simultaneously, not being possible to establish causal relationships between them. Besides, secondary databases are subject to incorrect and incomplete filling. In addition, the data only comprised the first year of the pandemic in Brazil, and it is impossible to work with cases from 2021, given the unavailability of data. Given the findings, it is necessary to conduct further investigations into SARS-CoV-2 infection, its relationships with sociodemographic characteristics, and contamination or worsening outcomes.

Thus, the study contributes to nursing and health as a whole since, by estimating the prevalence of confirmed cases of COVID-19 and its statistical association with sociodemographic and clinical variables, it promotes the dissemination of evidence about the national pandemic landscape. Thus, it becomes possible to establish and detect risk factors and highlight groups vulnerable to the disease to support both the direction of public health actions and clinical practice.

Conclusion

The study of the prevalence of confirmed cases of COVID-19 among hospitalized Brazilian patients showed a high prevalence and statistical association with clinical and sociodemographic variables. In the Brazilian scenario, epidemiological studies are potential generators of useful evidence for fighting the SARS-CoV-2 pandemic, given the possibility of establishing the risk related to illness and recognizing risk factors. Finally, it reiterates the potential that prevalence studies can have in supporting public health actions aimed at groups with greater vulnerabilities and greater risk of exposure to the virus.

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