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COVID-19 cases and deaths and smoking in Brazilian capitals and regions: an ecological study

Casos e óbitos por COVID-19 e tabagismo nas capitais e regiões brasileiras: estudo ecológico

Casos y muertes por COVID-19 y tabaquismo en las capitales y regiones Brasileñas: estudio ecológico

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ABSTRACT

Objective: To analyze the relationship between COVID-19 cases and deaths and the percentage of smokers in the capitals and regions of Brazil. **Methods:** An ecological study was carried out in the Brazilian regions to assess the number of cases and deaths by COVID-19 from March to December 2020 and the prevalence of smoking in 2019 based on the Coronavirus Panel databases of the Health Surveillance Secretariat and the System for Surveillance of Risk and Protective Factors for Chronic Diseases by Telephone-based Survey (*Vigilância de Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico - VIGITEL – 2019*). With information extracted in January 2021, the COVID-19 incidence and mortality coefficients were calculated by Brazilian capital and region and Pearson's correlation was used to verify the relationship between the study variables. A significance level of 5% was adopted. **Results:** Bivariate analyses showed positive correlations between female smokers and COVID-19 incidence coefficient in capitals of the Midwest region (r=0.957; p=0.043), and between male smokers and COVID-19 mortality coefficient in the capitals of the Northeast (r=0.706; p=0.034). **Conclusion:** Smoking had an impact on the incidence of COVID-19 cases and deaths in several Brazilian capitals, which warns that smoking can be a predisposing factor and worsen the clinical status of patients.

Descriptors: Pandemics; SARS-CoV-2; Cigarette Smoking; Health Surveys.

RESUMO

Objetivo: *Analisar a relação entre casos e óbitos por COVID-19 e o percentual de tabagistas nas capitais e regiões do Brasil.* ***Métodos:*** *Realizou-se estudo ecológico nas regiões brasileiras do número de casos e óbitos por COVID-19, de março a dezembro de 2020, e a prevalência de tabagismo em 2019, a partir dos bancos de dados do Painel Coronavírus da Secretaria de Vigilância em Saúde e do Sistema de Vigilância de Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico*

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(VIGITEL – 2019). Com informações extraídas em janeiro de 2021, calcularam-se os coeficientes de incidência e mortalidade por COVID-19 por capital brasileira e região, bem como se utilizou a correlação de Pearson para verificar a relação entre as variáveis do estudo. Adotou-se nível de significância de 5%. ***Resultados:*** *Análises bivariadas mostraram correlações positivas entre tabagistas do sexo feminino e coeficiente de incidência de COVID-19 nas capitais da região do Centro-Oeste (r=0,957; p=0,043), e entre fumantes do sexo masculino e coeficiente de mortalidade de COVID-19 nas capitais do Nordeste (r=0,706; p=0,034).* ***Conclusão:*** *O tabagismo teve impacto na incidência de casos e óbitos por COVID-19 em diversas capitais brasileiras, alertando que o fumo pode ser fator de predisposição e agravamento do estado clínico dos pacientes.*

Descritores*: Pandemias; SARS-CoV-2; Fumar Cigarros; Inquéritos Epidemiológicos.*

RESUMEN

Objetivo: *Analizar la relación entre casos y muertes por COVID-19 y el porcentaje de tabaquistas en las capitales y regiones del Brasil.* ***Métodos:*** *Fue realizado estudio ecológico en las regiones brasileñas del número de casos y muertes por COVID-19, de marzo a diciembre de 2020, y la prevalencia de tabaquismo en 2019, a partir de bases de datos del Panel Coronavirus de la Secretaria de Vigilancia en Salud y del Sistema de Vigilancia de Factores de Riesgo y Protección para Enfermedades Crónicas por Encuesta Telefónica (VIGITEL – 2019). Con informaciones extraídas en enero de 2021, se calcularon los coeficientes de incidencia y mortandad por COVID-19 por capital brasileña y región, también se utilizó la correlación de Pearson para verificar la relación entre las variables del estudio. Fue adoptado nivel de significancia de 5%.* ***Resultados:*** *Los análisis bivariados mostraron correlaciones positivas entre tabaquistas del sexo femenino y coeficiente de incidencia de COVID-19 en las capitales de la región del Centro-Oeste (r=0,957; p=0,043), y entre fumadores del sexo masculino y coeficiente de mortandad de COVID-19 en las capitales del Nordeste (r=0,706; p=0,034).* ***Conclusión:*** *El tabaquismo tuvo impacto en la incidencia de casos y muertes por COVID-19 en diversas capitales brasileñas, advirtiendo que el humo puede ser factor de predisposición y agravamiento del estado clínico de los pacientes.*

Descriptores*: Pandemias; SARS-CoV-2; Fumar Cigarrillos; Encuestas Epidemiológicas.*

INTRODUCTION

As of December 2019, in the city of Wuhan, China, a high number of cases of acute respiratory syndromes began to be reported, with the etiological agent coronavirus 2 (SARS-CoV-2)[1] being later identified. Due to the high transmission capacity of the disease, on January 30, 2020, the SARS-CoV-2 outbreak was announced as a Public Health Emergency of International Concern[1,2]. On March 11, 2020, the disease was classified as a pandemic by the World Health Organization (WHO)[3].

Tackling the pandemic has been a major challenge for global public health, mainly due to its rapid spread and serious potential for complications, especially in groups with comorbidities[4]. Previously infected patients with conditions such as heart disease, lung disease, diabetes mellitus or hypertension presented critical/mortal clinical conditions compared to healthy patients[5].

Although smoking was initially not identified as a risk factor for unfavorable outcomes in patients with COVID-19, tobacco use has been proven to predispose individuals to Noncommunicable Diseases (NCDs) and the worsening of existing comorbidities[5].

Smokers may also be more vulnerable to infection with the coronavirus due to the constant contact of fingers with lips, increasing the risk of contamination via the oral mucosa, and greater exposure by sharing mouthpieces for smoke inhalation, as in the case of hookah and electronic smoking devices (ESDs)[6]. In addition, the emission of vapor droplets by these devices also represent a way of spreading SARS-CoV-2[5].

Infected patients who used tobacco (in all its forms) had a higher risk of intubation and death compared to non-smokers[7]. This association may be related to endothelial dysfunction and chronic inflammation caused by tobacco in the body, impairing defense mechanisms[8]. Thus, smoking is a habit that contributes to the transmission, infection and worsening of COVID-19[9].

The COVID-19 pandemic mobilized government efforts to tackle it, but the outcome is linked to an older pandemic that is still responsible for thousands of deaths annually worldwide: smoking[9]. Despite the development of actions for tobacco control in Brazil since the 1980s, with the creation of the National Tobacco Control Program (*Programa Nacional de Controle do Tabagismo – PNCT*) by the Ministry of Health in 1986, the COVID-19 pandemic represents a new challenge for strengthening actions to prevent smoking and encourage smoking cessation[10].

Although there are insufficient data on the impact of epidemics on smoking, studies reveal that smokers exposed to natural disasters tend to increase the frequency of smoking in relation to non-exposed smokers in addition to favoring the relapse of former smokers[11]. Furthermore, in situations of social isolation, smokers end up exposing non-smokers to secondhand smoke, which can cause damage similar to active smoking[11]. Thus, this study aims to analyze the relationship between cases and deaths by COVID-19 and the percentage of smokers in the capitals and regions of Brazil.

METHODS

This is an ecological study that used secondary data extracted in January 2021 from two different publicly accessible databases to collect information on the variables cases/deaths by COVID-19 and percentage of smokers in all capitals grouped by region of Brazil .

The collection of data from the Coronavirus Panel of the Health Surveillance Secretariat (*Secretaria de Vigilância em Saúde – SVS*)[12] to calculate the coefficient of incidence and mortality by COVID-19 was initially performed by obtaining the variables total number of cases and deaths by COVID-19 from March to December 2020 regardless of age range. These indicators are frequently used in epidemiological studies of secondary data from electronically processed information systems[13].

The calculation of the COVID-19 incidence coefficient was obtained by dividing the number of accumulated cases of COVID-19 from March to December 2020 in each Brazilian capital by the total number of inhabitants in the respective capital without distinction of age range. Then, the factor ratio was multiplied by 1000[13]. The COVID-19 mortality rate followed the same formula described.

The total number of inhabitants was obtained through the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística – IBGE*)[14] based on 2020 estimates to support the calculation of the coefficients. However, for this calculation, the age range was not selected due to the inherent limitations of the system.

Following that, the percentage of smokers in Brazilian capitals and the Federal District was obtained in 2019 through the System for Surveillance of Risk and Protective Factors for Chronic Diseases by Telephone-based Survey (*Vigilância de Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico – VIGITEL*)[15]. For that, the 2019 version of VIGITEL was used, which encompasses an annual probabilistic sample of the adult population (18+ years) residing in the capitals of the 26 Brazilian states and the Federal District obtained through telephone-based surveys[15]. Data were collected by capital and sex referring to the frequency of people who reported “currently smoking” and extracting the percentages for the following conditions: smokers, male smokers and female smokers. Further methodological details related to the VIGITEL sample design can be consulted in the study’s official publication[15].

Descriptive and inferential statistical analyses were performed using SPSS version 23.0. Pearson’s correlation was applied after the Shapiro-Wilk normality test to verify the relationship of the incidence and mortality coefficients of COVID-19 in each capital/region of the country with the percentage of smokers. The significance level was set at 5% ($p<0.05$).

The study is part of an umbrella project approved by the Research Ethics Committee of the University of Fortaleza under Approval No. 4.088.541.

RESULTS

In 2020, the highest COVID-19 incidence coefficients were recorded in the capitals of the Midwest, North and South regions. Boa Vista (129.29/1000 inhabitants), Aracaju (84.53/1000 inhabitants), Florianópolis (83.99/1000 inhabitants), Brasília (83.48/1000 inhabitants) and Porto Velho (82.32/1000 inhabitants) were the capitals with the highest incidence coefficients among Brazilian capitals.

The COVID-19 mortality coefficients were higher in the capitals of the Midwest, Southeast, North and Northeast regions. Rio de Janeiro (2.21/1000 inhabitants), Cuiabá (1.92/1000 inhabitants), Porto Velho (1.78/1000 inhabitants), Vitória and Recife, both with 1.64/1000 inhabitants presented the highest coefficients in Brazil (Table I).

The highest percentages of smokers were found in the capitals of the Southeast region, especially among men. Rio Branco (11.9%); Fortaleza and Recife, both with 7.9%; São Paulo (13.5%); Porto Alegre (14.6%) and Brasília (12%) lead the overall prevalence of smokers in their respective regions. In all capitals, there was a prevalence of smoking among men. Porto Alegre and São Paulo were the capitals with the smallest disparities in the prevalence of cigarette consumption between the sexes (Table I).

Table I - Descriptive analysis of COVID-19 incidence and mortality coefficients and percentages of smokers in the capitals of Brazil, 2021

Variables	Covid-19 incidence coefficient[a]	Covid-19 mortality coefficient	Smokers (%)[b]	Male smokers (%)[b]	Female smokers (%)[b]
North					
Belém	37.53	1.63	6.6	10.9	3.0
Boa Vista	129.26	1.44	7.2	10.2	4.3
Macapá	56.08	1.35	7.3	9.8	5.1
Manaus	37.67	1.55	5.2	8.5	2.2
Palmas	71.96	0.73	7.0	10.4	3.8
Porto Velho	82.32	1.78	8.0	11.7	3.9
Rio Branco	46.71	1.23	11.9	17.1	7.2
Northeast					
Aracaju	84.53	1.36	4.7	5.7	3.9
Fortaleza	30.68	1.56	7.9	10.7	5.4
João Pessoa	51.77	1.46	6.8	10.0	4.2
Maceió	35.64	1.07	5.5	5.9	5.1
Natal	38.97	1.36	7.6	9.1	6.3
Recife	30.87	1.64	7.9	10.6	5.7
Salvador	38.26	1.10	5.4	7.6	3.5
São Luís	24.11	1.18	4.8	7.4	2.7
Teresina	57.51	1.40	4.4	6.4	2.8
Southeast					
Belo Horizonte	25.04	0.74	9.9	12.0	8.2
Rio de Janeiro	24.57	2.21	10.1	12.5	8.1
São Paulo	32.79	1.28	13.5	15.6	11.7
Vitória	79.71	1.64	7.5	10.0	5.4
Sul					
Curitiba	38.19	1.02	11.3	11.7	11.0
Florianópolis	83.99	0.66	10.7	14.1	7.7
Porto Alegre	46.95	1.25	14.6	15.2	14.1
Midwest					
Brasília	83.48	1.14	12.0	15.8	8.6
Campo Grande	67.83	1.19	10.3	14.2	6.9
Cuiabá	66.52	1.92	7.9	10.7	5.3
Goiânia	52.18	1.37	8.7	14.0	4.0

Sources: [a]: Data obtained from the Coronavirus Panel System (per 1000 inhabitants), 2020; b: System for Surveillance of Risk and Protective Factors for Chronic Diseases by Telephone-based Survey (*Vigilância de Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico – VIGITEL*), 2019

In the bivariate analyses, positive correlations were found with statistical significance between female smokers and COVID-19 incidence coefficient in the capitals of the Midwest region (r=0.957, p=0.043) and between male smokers and COVID-19 mortality coefficient in the capitals of the Northeast region (r=0.706; p=0.034), as shown in Tables II and III, respectively. There were no significant correlations in the other regions of the country.

Table II - Relationship between COVID-19 incidence coefficient by region and the percentage of smokers according to sex, 2021.

Region[a]	Smokers[b]	Smokers Males[b]	Smokers Females[b]
North	r = -0.014 p = 0.976	r = -0.138 p = 0.768	r = 0.073 p = 0.876
Northeast	r = -0.442 p = 0.234	r = -0.481 p = 0.190	r = -0.262 p = 0.496
Southeast	r = -0.640 p = 0.360	r = -0.622 p = 0.378	r = -0.661 p = 0.339
South	r = -0.467 p = 0.691	r = 0.382 p = 0.750	r = -0.773 p = 0.437
Midwest	r = 0.775 p = 0.225	r = 0.390 p = 0.610	r = 0.957 p = 0.043*
Brazil	r = -0.041 p = 0.840	r = 0.05 p = 0.804	r = -0.152 p = 0.449

Sources: [a]: Data obtained from the Coronavirus Panel System (per 1000 inhabitants), 2020; b: System for Surveillance of Risk and Protective Factors for Chronic Diseases by Telephone-based Survey (*Vigilância de Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico – VIGITEL*), 2019; r: Pearson's correlation; p: significance value; *p<0.05

Table III - Relationship between COVID-19[a] mortality coefficient by Brazilian regions and the percentage of smokers according to sex, 2021.

Region	Tabagistas[b]	Tabagistas sexomasculino[b]	Tabagistas sexofeminino[b]
North	r = -0.179 p = 0.701	r = -0.125 p = 0.790	r = -0.293 p = 0.523
Northeast	r = 0.635 p = 0.066	r = 0.706 p = 0.034*	r = 0.397 p = 0.290
Southeast	r = -0.207 p = 0.793	r = -0.153 p = 0.847	r = -0.255 p = 0.745
South	r = 0.874 p = 0.323	r = 0.184 p = 0.882	r = 0.994 p = 0.069
Midwest	r = -0.589 p = 0.411	r = -0.813 p = 0.187	r = -0.274 p = 0.726
Brazil	r = -0.124 p = 0.539	r = -0.052 p = 0.796	r = -0.178 p = 0.375

Sources: [a]: Data obtained from the Coronavirus Panel System (per 1000 inhabitants), 2020; b: System for Surveillance of Risk and Protective Factors for Chronic Diseases by Telephone-based Survey (*Vigilância de Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico – VIGITEL*), 2019; r: Pearson's correlation; p: significance value; *p<0.05

DISCUSSION

At the beginning of the pandemic, there was no correlation between smoking and COVID-19 infection, as it was found that smoking did not cause aggravation, with a low prevalence of smoking among hospitalized patients with COVID-19[16]. However, with advances in knowledge, other systematic reviews showed that smoking was associated with severe cases of COVID-19[17,18].

In view of these divergent findings in the existing literature, we sought to investigate this problem in Brazil through official databases. In the present research, the results showed that smoking was related to the highest coefficients of incidence and mortality by COVID-19 in several Brazilian capitals/regions, thus warning that smoking could predispose and worsen the clinical condition of patients.

Thus, based on confirmation by other studies[17,18], data were obtained from a meta-analysis of 16 studies and 11,322 patients with COVID-19, which proved a relationship of active smoking and history of smoking with severe

cases of COVID-19[17]. Similarly, another meta-analysis of 18 studies found that active smoking and smoking history were related to intubation in intensive care and death[18]. Both reviews[17,18] reinforce the importance of further exploring these findings and encouraging patients and people at risk to have good health practices and seek to quit smoking.

Clinical research has highlighted smoking as a factor that worsens COVID-19[7,9,19]. A Chinese study that analyzed 1,590 patients hospitalized for COVID-19 concluded that smokers were at least three times more likely to have an unsatisfactory outcome when compared to non-smokers[19].

Another study showed that smoking is associated with a more severe clinical picture and worse prognosis during the course of COVID-19, including increasing the risk of hospitalization in intensive care units, orotracheal intubation (twice the risk), mechanical ventilation and death[7]. Thus, many tobacco-associated diseases are related to a worse prognosis for COVID-19[9].

The advance of SARS-CoV-2 infection was also observed in smokers, with it being approximately 14 times more aggressive than in non-smokers. This association may be related to endothelial dysfunction and chronic inflammation mediated by cytokines caused by tobacco in the body, which impairs defense mechanisms and increases susceptibility to infections by foreign bodies[5,8]. In addition, the interaction of SARS-CoV-2 and angiotensin-converting enzyme 2 (ACE2) in the airway epithelium of active smokers suggests a possible mechanism of disease aggravation that acts through one of the subtypes of nicotinic cholinergic receptors (NCR) in people who smoke[20].

As for behavioral changes that occurred in the pandemic, a study showed that there was an increase in the number of cigarettes smoked among smokers in social isolation. Of the participants, 34% reported an increase in cigarette consumption, with 22.5% increasing to 10 cigarettes a day and 5.1% to 20 cigarettes a day[21]. Another study showed that smokers, even those without associated comorbidities, present an average 73% higher risk of poor prognosis when compared to non-smokers[22].

With regard to the influence of the sex variable analyzed in the present study, there was a positive correlation between mortality and smoking in men in the Northeast region. A correlation was also observed between the incidence of cases and the consumption of cigarettes among women in the Midwest region when comparing the progress of patients infected with COVID-19 between the different sexes in the different regions of the country.

In that regard, it is clear that certain biological and behavioral conditions can have an impact on the contagion and progress of the SARS-CoV-2 infection, with external factors such as non-compliance with social isolation, lower demand for health services and greater tobacco use being more related to men[23]. In addition, a global analysis showed that the COVID-19 mortality rate is higher in men[23]. A study with data from 75 countries from all continents found no significant association in the prevalence of smoking among men and women with mortality from COVID-19. However, in low- and middle-income countries, there was a positive correlation between the prevalence of smoking in men with deaths due to complications from COVID-19[24].

As for Brazilian regions, in 2020 the Northeast region was one of the most impacted by the pandemic, mainly because of its vulnerable population[25,26]. This susceptibility can be represented by four factors: risk groups, unfavorable social factors, limited access to health services and proximity to outbreaks of contagion[25,26]. Although the prevalence of smoking in Brazil has decreased among men and women, it is higher among the less educated. However, in the Northeast and Midwest regions[27], women did not follow this decreasing trend.

Although the Brazilian health system has evolved, there are still neglected diseases impacting low-income populations. In the Northeastern states, there is also a greater spread of other infectious diseases which are associated with social vulnerability according to research[25]. With COVID-19, the poorest Brazilian regions were more susceptible to a negative prognosis[21].

In view of the findings of the present research, we seek to contribute to the discussion on the risk factors related to cases and deaths by COVID-19 in smokers in capitals and regions of Brazil, alerting to the expansion of care for this population, with policies on health promotion and intensification of the actions of the National Tobacco Control Program, as this could lead to alternatives for the reduction of unfavorable clinical outcomes. Additionally, the pandemic would be an opportunity to discuss important decision-making on smoking cessation due to the possibility of worse clinical outcomes and complications.

It should also be noted that failure to identify patients affected by COVID-19 as smokers may represent a limiting factor in the prognostic correlation between the disease and smoking. Thus, it is suggested that the assessment and recording of the patient's smoking status be included as a risk/disease factor in COVID-19 notifications and in medical records. In Brazil, Paraná was the only state to include smoking as a comorbidity in the notifications of cases and observed its presence in the proportion of 62.5% in men and 37.2% in women, with greater expression in individuals aged between 20 and 29 years[6]. Added to this, these results can contribute by adding evidence to strengthen the World Health Organization's statements that smokers are at greater risk of developing severe COVID-19 and death[28].

Among the limitations of the study, it is pointed out the limitation of the methodology used, which generates the risk of ecological fallacy. Another limiting point refers to the failure to perform direct standardization by age range as a result of the unavailability of age stratification in the database from which the number of cases and accumulated deaths of COVID-19 were extracted. Thus, cases and deaths of all age ranges were included in the calculations of the analyzed coefficients. The study, therefore, presents representative data from the analyzed geographic strata, but caution is needed in the analysis of the correlation. Given that, it is considered essential to invest in public policies aimed at expanding access to treatment for cessation and prevention of tobacco use, which may contribute to the reduction of risks and cases of deaths in smokers affected by COVID-19 and other diseases.

CONCLUSION

Smoking had an impact on the incidence of cases and deaths from COVID-19 in several Brazilian capitals, which warns that smoking can be a predisposing factor and worsen the clinical status of patients.

CONTRIBUTIONS

Sérgio André de Souza Júnior, **Juliana Carneiro Melo**, **Denise Nunes Oliveira**, **Ana Paula Vasconcellos Abdon** and **Christina César Praça Brasil** contributed to the study conception and design; the acquisition, analysis and interpretation of data; and the writing and revision of the manuscript. **Sarah Capelo Barroso Garcia** and **Felipe Maia Balbueno da Silva** contributed to the acquisition, analysis and interpretation of data; and the writing and revision of the manuscript. All authors have approved the version of the article to be published and are responsible for its content and integrity.

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