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Research Article

Smoking prevalence and lung cancer morbimortality in Brazilian states

Prevalência de tabagismo e morbimortalidade por câncer de pulmão nos estados brasileiros

Prevalencia del tabaquismo y morbimortalidad por cáncer de pulmón en los estados brasileños

Silvya de Freitas Nunes[1], Kelser de Souza Kock[1]

[1]Universidade do Sul de Santa Catarina – Tubarão (SC), Brazil.

Abstract

Introduction: Lung cancer is a serious disease, being the second leading cause of death worldwide. Moreover, in some developed countries, it has already become the leading cause of death. About 90% of lung cancer cases are caused by cigarette smoking. **Objective:** To correlate the prevalence of smoking and lung cancer morbidity and mortality in Brazilian states, and to demonstrate their association with sex and age group as well. **Methods:** An ecological study on the prevalence of smoking and lung cancer morbidity and mortality in Brazilian states between 2013 and 2019, divided by sex and age group. The data collection databases Tabnet and National Health Survey were used. **Results:** The highest rates of mortality and hospital admissions were among men, in 2013 with a rate of 2.7 and 10, respectively, and in 2019 with 3.3 and 11.9, respectively. In addition, the highest prevalence of smoking was found in men, but this rate has fallen, while the number of women smokers has increased. The South region showed higher mortality rates in both periods studied, with rates of 4.9 and 5.8 per 100,000 inhabitants, and hospital morbidity with 19.9 and 23.5 per 100,000 inhabitants. The North region had the lowest prevalence, where in 2013, it had a death rate from lung cancer of 1.0 and hospital morbidity of 3.5/100 thousand inhabitants, and where in 2019, it had a mortality rate of 4.6 and hospitalizations of 1.6/100 thousand inhabitants. The correlation coefficients for hospital morbidity and smoking prevalence were R2=0.0628, r=0.251 and p=0.042, while for mortality and smoking prevalence, these were R2=0.0337, r=0.183 and p=0.140. **Conclusions:** In the present study, it can be inferred that there was a positive association between hospital morbidity rate and prevalence of smoking, while it was not possible to observe a correlation between lung cancer mortality rate and prevalence of smoking.

Keywords: Lung cancer; Tobacco use disorder; Tobacco products; Carcinogens.

Corresponding author:
Kelser de Souza Kock
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Resumo

Introdução: O câncer de pulmão é uma doença grave, sendo a segunda maior causa de morte em todo o mundo, entretanto, em alguns países desenvolvidos, tornou-se já a primeira causa de morte. Cerca de 90% dos casos de neoplasia pulmonares são causados pela inalação da fumaça do cigarro. **Objetivo:** Correlacionar a prevalência de tabagismo e morbimortalidade por câncer de pulmão nos estados brasileiros, além de demonstrar a associação destes com sexo e faixa etária. **Métodos:** Estudo de caráter ecológico acerca da prevalência de tabagismo e morbimortalidade por câncer de pulmão nos estados brasileiros, nos períodos de 2013 e 2019, dividida por sexo e faixa etária. Foram utilizados bancos de coleta de dados como o Tabnet e Pesquisa Nacional de Saúde. **Resultados:** As maiores taxas de mortalidade e internações hospitalares foram do público masculino, em 2013, com taxa de 2,7 e 10, respectivamente, e em 2019 com 3,3 e 11,9, respectivamente. Ademais, a maior prevalência de tabagismo foi encontrada nos homens; entretanto seu índice tem caído, enquanto a quantidade de mulheres tabagistas tem aumentado. A Região Sul demonstrou maiores números de mortalidade em ambos os períodos estudados, com taxas de 4,9 e 5,8 por 100 mil habitantes, e morbidade hospitalar com 19,9 e 23,5 por 100 mil habitantes. Já a Região Norte se configurou com as menores prevalências: em 2013 apresentou taxa de óbito por câncer de pulmão de 1,0 e morbidade hospitalar de 3,5/100 mil habitantes, em 2019 apresentou taxa de mortalidade de 4,6 e internações de 1,6/100 mil habitantes. Os coeficientes de correlação de morbidade hospitalar e prevalência de tabagismo foram R2=0,0628, r=0,251 e p=0,042, enquanto os de mortalidade e prevalência de tabagismo foram R2=0,0337, r=0,183 e p=0,140. **Conclusões:** Na presente pesquisa, pode-se inferir que houve associação positiva na comparação entre taxa de morbidade hospitalar e prevalência de tabagismo; em contrapartida, não foi possível observar associação positiva na correlação da taxa de mortalidade por câncer de pulmão e prevalência de tabagismo.

Palavras-chave: Neoplasias pulmonares; Tabagismo; Produtos do tabaco; Carcinógenos.

Resumen

Introducción: El cáncer de pulmón es una enfermedad grave, siendo la segunda causa de muerte en todo el mundo, sin embargo, en algunos países desarrollados, ya se ha convertido en la primera causa de muerte. Alrededor del 90% de los casos de neoplasias pulmonares están causados por la inhalación del humo del cigarrillo. **Objetivo:** Correlacionar la prevalencia de tabaquismo y la morbimortalidad por cáncer de pulmón en los estados brasileños, además de demostrar la asociación de estos con el género y el grupo de edad. **Métodos:** estudio ecológico sobre la prevalencia de tabaquismo y morbimortalidad por cáncer de pulmón en los estados brasileños, dentro de los períodos 2013 y 2019, divididos por sexo y grupo de edad. Se utilizaron bancos de recogida de datos como Tabnet y la Encuesta Nacional de Salud. **Resultados:** las mayores tasas de mortalidad e ingresos hospitalarios se dieron en el público masculino, en 2013 con una tasa de 2,7 y 10, respectivamente, y en 2019 con 3,3 y 11,9, respectivamente. Además, la mayor prevalencia del tabaquismo se encontró en los hombres, sin embargo, su tasa ha disminuido, mientras que la cantidad de mujeres fumadoras ha aumentado. La región Sur presentó cifras más altas de mortalidad en ambos periodos estudiados, con tasas de 4,9 y 5,8 por 100.000 habitantes, y de morbilidad hospitalaria con 19,9 y 23,5 por 100.000 habitantes. Mientras que la región Norte se configuró con las prevalencias más bajas, en 2013 presentó una tasa de mortalidad por cáncer de pulmón de 1,0 y una morbilidad hospitalaria de 3,5/100.000 habitantes, en 2019 presentó una tasa de mortalidad de 4,6 y hospitalizaciones de 1,6/100.000 habitantes. Los coeficientes de correlación para la morbilidad hospitalaria y la prevalencia del tabaquismo fueron R2=0,0628, r=0,251 y p=0,042, mientras que para la mortalidad y la prevalencia del tabaquismo fueron R2=0,0337, r=0,183 y p=0,140. **Conclusiones:** En la presente investigación se puede inferir que existe una asociación positiva en la comparación entre la tasa de morbilidad hospitalaria y la prevalencia de tabagismo, en contrapartida, no fue posible observar una asociación positiva en la correlación de la tasa de mortalidad por cáncer de pulmón y la prevalencia de tabagismo.

Palabras clave: Neoplasias pulmonares; Fumar tabaco; Productos del tabaco; Carcinógenos.

INTRODUCTION

Cancer is a term that covers more than a hundred different types of malignant diseases that have in common the disordered growth of cells, which divide quickly, tending to be very aggressive and uncontrollable. Neoplastic cells can destroy healthy tissues around them and also invade adjacent tissues or distant organs, spreading to other regions of the body, which characterizes metastasis.[1]

Currently, it is emphasized that lung cancer is caused mainly by inhalation of cigarette smoke, but only at the end of the 19th century, with the advent of mass production and advertising of cigarettes was the habit of smoking, in fact, popularized — which is why the disease was quite rare before the 20th century. Thus, research such as the confluence of epidemiology studies, animal experiments, cellular pathology and chemical analyses on the subject were presented as possible explanations for the increase

in lung cancer, until this evidence made it clear that the development of lung cancer was, by far, mainly caused by the inhalation of cigarette smoke [2]

Smoking is the leading cause of preventable death worldwide.[3] Of the more than 7,000 compounds inhaled during smoking, 72 have so far been identified as carcinogenic by the International Agency for Research on Cancer, showing that there is not just one carcinogen unique to tobacco smoke. The major chemical carcinogens found in cigarette smoke that have been shown to cause cancer in at least one animal species include 4-methylnitrosoamino-1-(3-pyridyl)-1-butapone (NNK), N-nitrosonornicotine (NNN), polycyclic aromatic hydrocarbons (PAH), radon and formaldehyde. Interestingly, nicotine, the most commonly known agent in cigarettes, has not been shown to be carcinogenic, however it has been shown to promote cell proliferation and division and inhibit apoptosis, and may therefore act synergistically with carcinogenic compounds in cigarette smoke to increase mutagenesis.[4] General mortality is twice as high in smokers compared to non-smokers and constitutes one of the biggest risk factors for other types of serious diseases, such as coronary diseases.[5]

Lung cancer is a serious disease and is characterized as being the second most common type of cancer, with 29,354 new cases estimated in 2019, among 16,733 men and 12,621 women,[1,6] and with 30,200 new cases estimated in 2020, being 17,760 men and 12,440 women. [7] Lung cancer is the main cause of cancer mortality, with 1.7 to 1.8 million deaths each year resulting from this neoplasm. This problem is also responsible for the highest age-standardized mortality rate (26.6 deaths per 100,000 inhabitants) among cancers. [8] Among neoplasms, lung cancer has been the most common type worldwide for several decades, making it a public health problem and ranking it second in mortality worldwide; in some developed countries it has become the leading cause of death.[9] Large cohort studies have found that at least 50% of long-term tobacco smokers will die from causes directly linked to smoking, and that smokers have an expected average lifespan ten years shorter than that of people who have never smoked. [10]

In Brazil, lung cancer is the second most common type of cancer among men and the fourth most common cancer among women.[8] With the use of tobacco, a concomitant increase in the occurrence of several types of tumors has been observed, but perhaps no one disease is as closely linked to smoking as lung cancer.[11] For Brazil, for each year of the 2020–2022 triennium, 17,760 new cases of lung cancer in men and 12,440 in women are estimated, values corresponding to an estimated risk of 16.99 new cases per 100 thousand men and 11.56 per 100 thousand women.[12]

In men, excluding non-melanoma skin tumors, lung cancer is the second most common malignant disease in the South (31.07/100,000) and Northeast (11.01/100,000) regions, and the third most common malignant in the Southeast (18.10/100 thousand), Central-West 15.11/100 thousand) and North (9.24/100 thousand) regions. For women, it is the third most common malignancy in the South (18.66/100 thousand) and Southeast (12.09/100 thousand) regions. In the Central-West (10.87/100 thousand), Northeast (8.86/100 thousand) and North (6.47/100 thousand) regions, it is in fourth place.[12]

Accordingly, our study attempted to contribute to a better understanding of smoking and its risks of mortality and morbidity associated with the development of lung cancer, considering a record of cases between 2013 and 2019 in the Brazilian states, in addition to playing a very important role in gaining knowledge and understanding the seriousness of the topic and, consequently, for a better understanding of the harms of smoking. From a public health point of view, the impact of the prevalence of smoking on lung cancer illness can be magnified.

Thus, the present research aimed to analyze the relationship between the prevalence of smoking and mortality from lung cancer in Brazilian states in the periods of 2013 and 2019.

METHODS

This was an ecological study with the aim of determining the effect and magnitude of the prevalence of smoking on lung cancer morbidity and mortality. Furthermore, the behavior of these variables in the years 2013 and 2019 was temporally evaluated.

Information regarding the prevalence of smoking was collected through the National Health Survey (PNS) database from 2013 and 2019. PNS is a nationwide, home-based health survey carried out by the Ministry of Health in partnership with the Brazilian Institute of Geography and Statistics (IBGE) in 2013 and 2019.[13]

The smoking prevalence data came from the website of the Brazilian Institute of Geography and Statistics (IBGE), by accessing the National Health Survey (PNS) page in the Health Indicators Panel, Module P — Lifestyles/Smoking, referring to current use of tobacco products, by state, in the years 2013 and 2019, periods that are available for consultation on the website. The numbers represent the percentage of individuals aged 18 and over who currently smoke cigarettes or other smoke-producing or non-smoke-producing tobacco products.

Data were collected considering the variables sex, age group (<40 years, 40 to 59 and 60 and over), and period 2013 and 2019, all data following the division referring to Brazilian states.[14]

Records about hospital morbidity and mortality due to lung neoplasms were analyzed and collected from the databases of the Department of Informatics of the Unified Health System (DATASUS) of the Ministry of Health, using the TABNET application, using the variables in the periods of 2013 and 2019 in Brazilian states.[15]

Lung cancer morbidity and mortality rates were calculated using the ratio between the frequency of hospitalizations and deaths and the estimated population for each year, age group and macro-region of residence, a result that was multiplied by the constant 100,000 (inhabitants), according to Equations 1 and 2 below:

Rate of hospital morbidity =(Number of hospitalizations carried out in each year, age group and Brazilian state/estimated population for each year, age group and macro-region) x 100,000 (1)

Rate of mortality =(Number of deaths recorded in each year, age group and macro-region / estimated population for each year, age group and Brazilian state) x 100,000 (2)

The study included data on hospital morbidity and mortality of patients diagnosed with lung cancer between 2013 and 2019 in Brazilian states, due to malignant neoplasia of the bronchi and lungs — included in the International Classification of Diseases (ICD-10) C34 — and patients (male and female) from whom the sample was obtained from the Tabnet/DATASUS database from 2013 and 2019.[16,17] Furthermore, incomplete data on hospital admissions and deaths from lung cancer were excluded.

The data were organized and stored in Microsoft Excel software and analyzed using the Statistical Package for the Social Sciences (SPSS) 20.0. Quantitative variables were described using measures of central tendency and data dispersion. Qualitative variables were described using absolute and percentage frequencies. Linear regression was performed to evaluate the association between smoking prevalence and lung cancer morbidity and mortality in Brazilian states, considering

the years 2013 and 2019 to increase statistical power. The level of statistical significance used was 5% ($p<0.05$).

We used the independent variables time (years 2013 and 2019) and relative frequency (%) of smokers by Brazilian state. The dependent variables referred to the epidemiological parameters sex (male and female), absolute and normalized lung cancer morbidity and mortality, by sex, age group and Brazilian state.

As the proposed study was of an ecological type, the database used as a data source is public domain and accessible and does not contain information on the identity of the participants or any personal information that allows individual identification or puts the confidentiality of the data at risk. Because of the foregoing, and as contained in Resolution of the National Health Council (CNS) 510/2016 Article 1, Sole Paragraph Items II, III and V, this project does not fall within the terms of CNS Resolution 466/2012 for registration and analysis by Ethics Committees for Research Involving Human Beings.

RESULTS

According to the data found in this study, the lowest frequency of cases of hospital morbidity due to lung neoplasms in both 2013 and 2019 was found in the state of Pará, in 2013, with a rate of 2.1 hospitalizations per 100 thousand inhabitants, corresponding to 172 absolute cases, and in 2019, with a hospital morbidity rate of 3.1 for every 100 thousand inhabitants, a number that corresponds to 265 hospital admissions. The highest frequency of hospital morbidity cases was in the state of Rio Grande do Sul, in 2013, with a rate of 27.5 hospitalizations for lung cancer, representing 3,039 absolute cases, as well as in 2019, with a rate of 31.9 and 3,634 cases.

Given the data collected, it was assessed that, in the period of 2013, Amazonas had the lowest frequency of mortality from lung cancer, 0.4 deaths for every 100 thousand inhabitants and 15 absolute cases. However, we demonstrated that in 2019, Pará had the lowest frequency of mortality cases due to lung neoplasms, with a rate of 1.1 deaths per 100 thousand inhabitants, equivalent then to 93 cases in the state. Furthermore, the highest frequency of lung cancer mortality was in Rio Grande do Sul in both periods studied: in 2013 with a rate of 6.4/100 thousand inhabitants, which represents 710 cases, and in 2019 with a rate of 7 .3/100 thousand inhabitants and 836 absolute cases. More information is included in Table 1.

In Figure 1A, one can observe the mortality and morbidity rates due to lung cancer corresponding to the years 2013 and 2019, in which it is possible to conclude a higher prevalence of deaths and hospitalizations due to lung cancer in males than in females in both periods.

Furthermore, in Figure 1B, which shows the mortality and hospital morbidity rates for lung cancer related to age group in 2013 and 2019, it is also possible to conclude that, in both periods, the numbers of deaths and hospital admissions due to lung cancer were more prevalent in individuals 60 and over, demonstrating the prevalence of the older population.

In Figure 2A, it is possible to observe the correlation between Brazilian states and the prevalence of smoking, from which it can be concluded that in 2013, the state of Acre was in first place in the prevalence of smoking, corresponding to 19%.

In Figure 2B, related to the prevalence of smoking, it is concluded that in 2019, the state with the highest percentage of smokers was Mato Grosso do Sul, with a prevalence of 16.3%.

Table 1. Morbidity and mortality rates from lung cancer in 2013 and 2019 by region and state.

Region	Hospital morbidity		Mortality	
	2013	2019	2013	2019
North Region	3.5	4.6	1.0	1.6
Rondônia	5.3	7.6	1.3	2.5
Acre	9.8	6.2	1.2	2.2
Amazonas	2.3	3.6	0.4	1.5
Roraima	3.9	5.1	1.4	2.1
Pará	2.1	3.1	0.9	1.1
Amapá	4.0	4.4	1.6	1.9
Tocantins	8.2	10.9	2.5	2.9
Northeast Region	5.5	8.9	1.5	2.3
Maranhão	3.2	6.3	0.9	2.1
Piauí	8.8	6.9	1.9	1.3
Ceará	7.8	11.6	2.0	3.4
Rio Grande do Norte	6.4	12.9	1.5	2.5
Paraíba	4.2	9.2	1.3	2.6
Pernambuco	6.1	13.2	1.7	2.8
Alagoas	4.4	9.1	1.1	2.5
Sergipe	4.2	7.0	1.7	2.5
Bahia	4.7	5.3	1.3	1.5
Southeast Region	11.0	13.6	3.0	3.8
Minas Gerais	10.6	13.7	2.7	3.0
Espírito Santo	14.9	14.7	3.0	3.5
Rio de Janeiro	9.9	10.8	3.6	3.7
São Paulo	11.2	14.4	3.0	4.2
South Region	19.9	23.5	4.9	5.8
Paraná	14.0	16.1	3.4	4.1
Santa Catarina	16.7	22.1	4.8	5.9
Rio Grande do Sul	27.5	31.9	6.4	7.3
Central-West Region	7.5	8.1	1.9	2.3
Mato Grosso do Sul	10.0	8.5	3.0	2.7
Mato Grosso	5.6	5.9	1.5	1.8
Goiás	6.0	6.5	1.3	1.9
Federal District	11.1	14.0	2.7	3.7

The data presented in Figure 3 describe the mortality and morbidity rates due to lung cancer and the prevalence of smoking in 2013 and 2019 both in Brazil as a whole and in Brazilian regions. In view of this, there was a drop in the smoking prevalence rate in all regions; on the other hand, it is still possible to see that there was an increase in hospitalizations and deaths due to lung neoplasms. The South region displayed the highest rate in terms of both hospital morbidity and mortality due to lung cancer and the prevalence of smoking in 2013 and 2019, while the north of the country was seen to be the region with the lowest rate of morbidity and mortality and also the lowest prevalence of smoking.

In Figure 4A, given the data collected, it can be seen in this study that in the comparison between smoking prevalence and hospital morbidity rate, a positive correlation was found with p=0.042, indicating an association between smoking prevalence and hospitalization for lung cancer.

However, according to data presented in Figure 4B, it was not possible to observe a significant correlation between lung cancer mortality and the prevalence of smoking, with p=0.140, showing that these variables are not associated. More information is given in Figure 4.

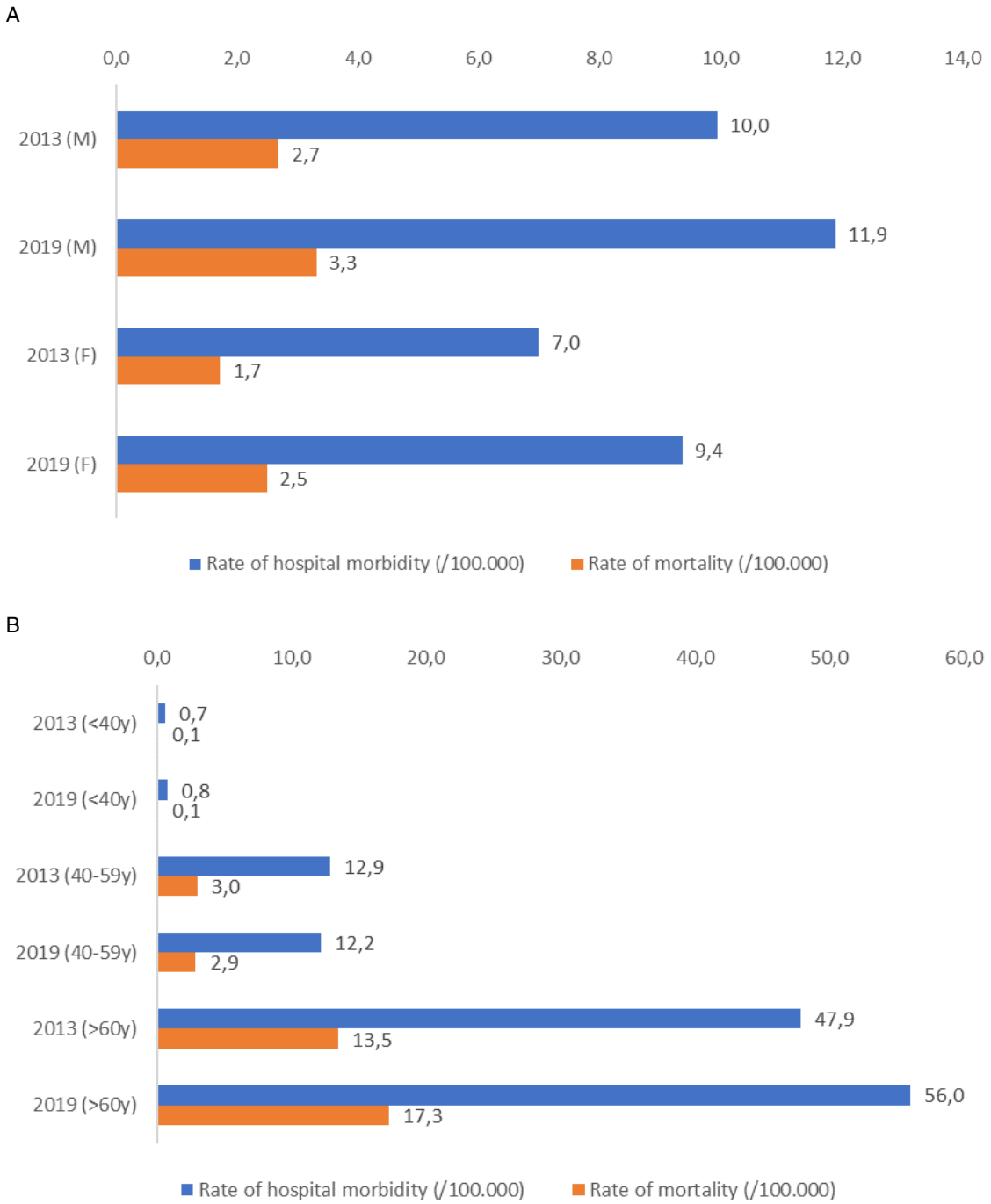
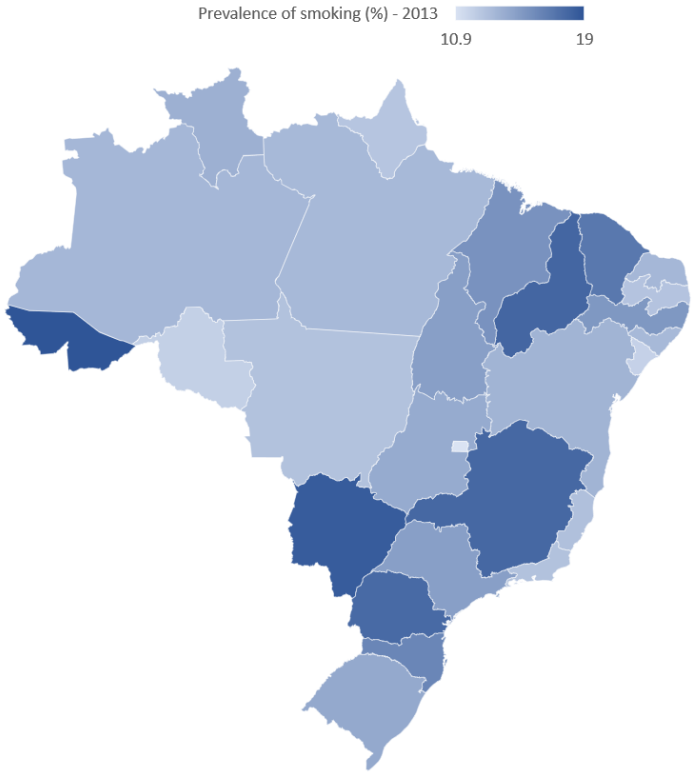


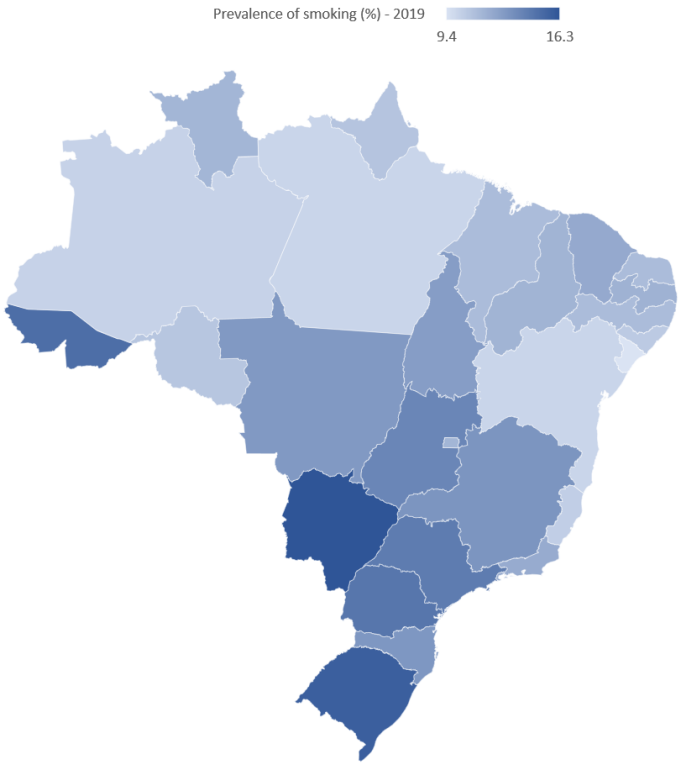
Figure 1. (A) Rates of hospital morbidity and mortality due to lung cancer by sex in 2013 and 2019. (B) Rates of hospital morbidity and mortality due to lung cancer by age group in 2013 and 2019.

A



States	Prevalence of smoking (%)
AC	19
MS	18.6
PI	18
MG	17.9
PR	17.8
CE	17
SC	16.2
MA	15.5
PE	15.2
TO	14.8
SP	14.8
RS	14.2
GO	14.1
RR	13.8
BA	13.6
AM	13.4
RN	13.4
PA	13.3
AL	13.3
ES	12.9
RJ	12.8
MT	12.8
PB	12.7
AP	12.6
RO	12
SE	11.9
DF	10.9

B



States	Prevalence of smoking (%)
MS	16.3
RS	15.8
AC	15.1
PR	14.7
SP	14.4
GO	13.9
MG	13.2
SC	13.1
MT	13
TO	12.8
CE	12.2
RJ	12.1
PB	11.8
PI	11.7
RR	11.6
DF	11.6
MA	11.3
RN	11.3
PE	11.3
AP	10.9
RO	10.8
AL	10.6
ES	10.4
AM	10.2
PA	10.1
BA	10.1
SE	9.4

Figure 2. (A) Map of Brazilian states and prevalence of smoking in 2013. (B) Map of Brazilian states and prevalence of smoking in 2019.

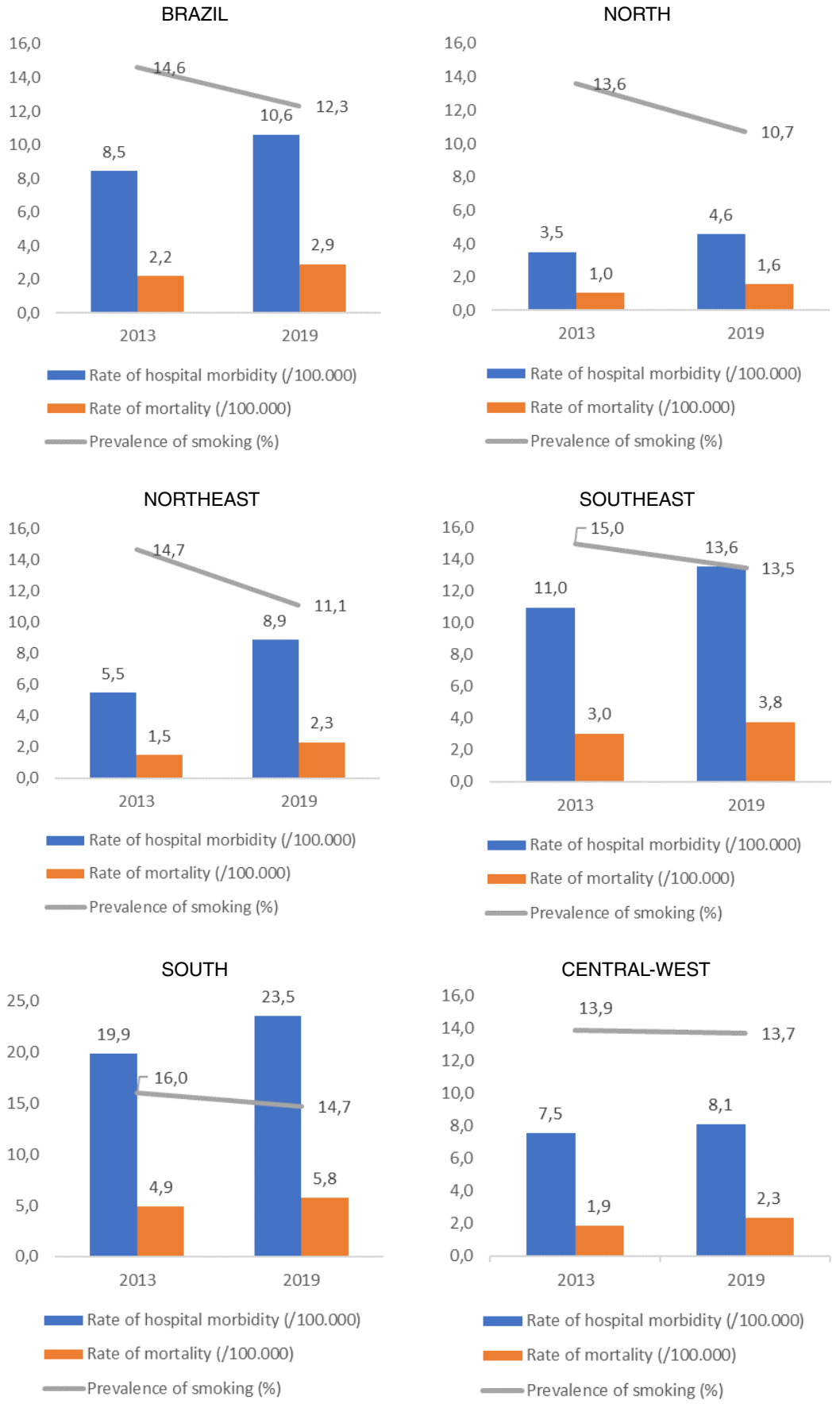


Figure 3. Rate of hospital morbidity, rate of mortality and prevalence of smoking in 2013 and 2019 in Brazil an in Brazilian regions.

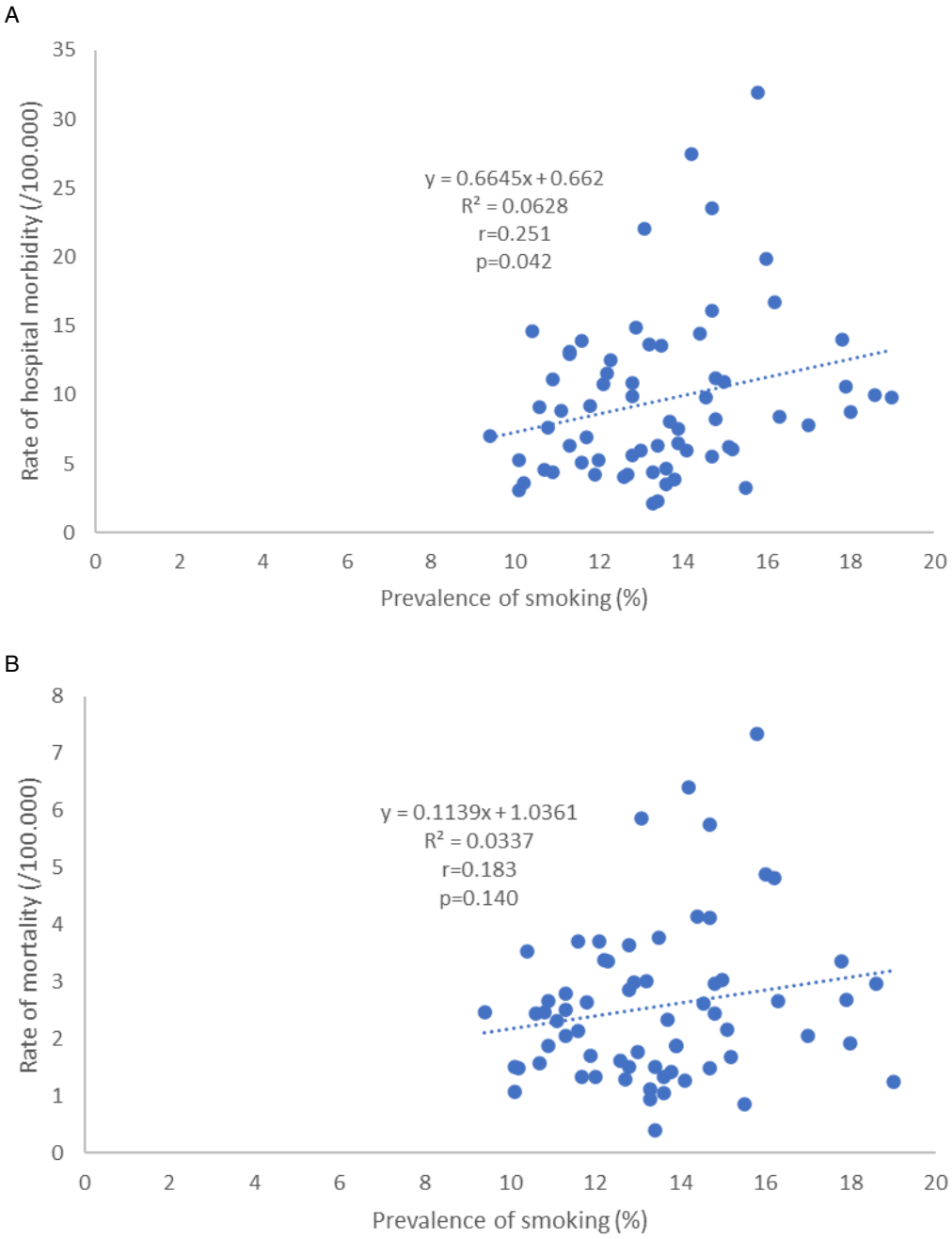


Figure 4. Point scatter plot according to hospital morbidity, mortality and smoking prevalence rates in Brazilian states.

DISCUSSION

The main findings of the present study indicated a reduction in the prevalence of smoking and an increase in morbidity and mortality from lung cancer in Brazilian states. A significant correlation was found between smoking prevalence and hospital morbidity due to lung cancer.

Regarding hospital morbidity due to lung neoplasms in 2013 and 2019 in Brazil, Pará was the state with the lowest rate, while the state of Rio Grande do Sul had the highest rate of hospitalizations. Regarding mortality, Amazonas had the lowest death rate from lung cancer in 2013 and Pará in 2019, while the state with the highest rate was Rio Grande do Sul in both periods. Therefore, the South region was the one

with the highest rates of hospital morbidity and mortality from lung cancer, as well as the highest smoking prevalence rate, in addition to being one of the regions that saw the least drop in the smoking rate from 2013 to 2019. At the same time, it can be observed that the north of the country had the lowest rate of hospital morbidity and mortality, as well as prevalence of smoking.

It is known that cancer is a multifactorial disease for which there are several risk factors. The higher prevalence of lung cancer in the South region and the lower prevalence in the North region may be a reflection of several of these factors, in addition to genetic predisposition; environmental factors, lifestyle, alcohol consumption, sedentary lifestyle, intake of processed foods, smoking and aging as well.[18] Furthermore, with regard to the prevalence of lung cancer, the South and Southeast regions were those with the highest morbidity and mortality rates. A likely explanation for this fact is that these two regions are those with the highest socioeconomic level in the country, with a larger population, a greater number of health services available and consequently greater diagnostic options, in addition to older populations, which results in higher prevalence of cancer.[19]

Another possible explanation for the higher incidence of lung cancer in the South and Southeast regions is climate change and the growth of industrialization, which generate concentrations of suspect particles, such as sulfur dioxide, associated with an increased risk of lung neoplasia regardless of smoking.[20]

In Brazil, lung cancer is the second most common type of neoplasm. Depending on the region and sex, the ranking may change; for example, for men, lung cancer is the second most common malignant disease in the South and Northeast regions, while for women, it is the third most malignant in the South and Southeast regions.[21] Considering the global scenario, the disease continues with great importance, precisely because it is the main cause of death from cancer among men and the second cause among women,[22] demonstrating the strong incidence and mortality of the disease not only in Brazil, but in the world as a whole.

Lung cancer already occupies the first place in the morbidity and mortality rankings currently, and in addition to this, it has also shown an increase in the incidence of this general mortality due to lung cancer in women, while in the male population, it has shown a decline — with the exception of three countries, including Brazil, Portugal and Bulgaria.[23]

In the present study, it was possible to observe a clear prevalence of morbidity and mortality due to lung cancer in males in Brazil, which corroborates the global prevalence. Therefore, the number of men who die from lung cancer is higher because it is believed that men are more exposed to smoking, have worse lifestyle and eating habits, are less aware of their health problems and also have little demand for health services.[24] However, when comparing the percentage increase in mortality and morbidity rates between the two sexes, the female population showed a greater growth pattern from 2013 to 2019 than the male population. While in the past it was considered that this type of cancer mainly afflicted men, in recent decades the number of female patients has increased, to such an extent that rates among women are becoming similar to those among men worldwide.[25]

One of the causes responsible for this incidence increasing mainly in women can be explained by a historical difference in the temporal delay in the pattern of smoking prevalence, that is, the habit of smoking spread later among women than in men.[26] Lung cancer is still the main villain of incidence and mortality for men, with high rates.[27] It is predicted, in women, that smoking prevalence rates will stop increasing after reaching their highest value in 2026–2030, as the smoking epidemic has not yet reached its global peak among this population. This is because, even though the number of female smokers has increased, there has been a concomitant increase in knowledge about the harms of tobacco along with the implementation of tobacco control measures, added to the fact that in some countries the habit of smoking continues to

be culturally unacceptable for women, making it difficult for there to be the same proportion of smokers between both sexes one day.[28]

Regarding the predominant age group, the present study corroborates the global prevalence, that is, hospital morbidity and mortality from lung cancer are more prevalent in individuals over 60, [29,30] demonstrating the prevalence of the older population. The likely explanations for the predominance of older people are based on the aging of the population and increased life expectancy, [30] as well as changes in lifestyle habits, as tobacco use reached its peak in the 1970s, which could be a of the reasons why the older population is more affected by lung cancer today. [31]

Furthermore, still in relation to the prevalence of smoking, it was observed that the South region was most prominent in the percentage of smokers, coming in first place, so this finding agrees with the results found in the study by Barros et al. [32]

On a global scale, the number of deaths from tobacco use is increasing. [33] Smoking prevalence is higher in countries where tobacco use started earlier. Although researchers find that, in general, there is a decrease in the smoking prevalence rate, especially among men; there is a contrast in relation to this rate, where in countries where the smoking epidemic began more recently, the trend found is an increase in prevalence, not a decrease. [22] This makes perfect sense, since in those countries that pioneered tobacco cultivation there is already a longer time for initiation, consolidation, perpetuation and, consequently, a subsequent drop in the prevalence of the habit of smoking.

Furthermore, in the present study, a positive association was observed between hospital morbidity rate and prevalence of smoking, showing that the habit of smoking is directly related to the increase in hospital admissions due to lung cancer. On the other hand, when evaluating the correlation between smoking and mortality from lung cancer, it was not possible to observe a significant association. Given this, some hypotheses can be put forth: although cigarette smoke is responsible for more than 90% of lung cancer cases,[34] there are other factors that may be related. For example, it is possible to mention atmospheric pollution from traffic and numerous industries that lead to greater exposure to carcinogens, such as polycyclic hydrocarbons and diesel smoke.[35] Smoking load and history of ex-smokers should also be considered; these individuals might not be smoking any more but already have the harmful effects of cigarettes. Furthermore, early diagnosis and treatment can reduce the chances of mortality.

Nevertheless, some limitations of the present study must be considered. We can mention the fact that, in the list of ICD-10 morbidities on the TABNET platform, the tab referring to lung cancer is listed as “Malignant neoplasm of trachea, bronchi and lungs”, making it impossible to isolate morbidity and mortality only from lung cancer, which can affect the number of diagnoses and deaths related to the disease. Therefore, the quality of information taken from secondary data becomes an obstacle to the accuracy of this research. Epidemiological studies have shown that the risk of lung cancer among continuous smokers increases depending on the duration of smoking.[34] In this sense, the TABNET platform does not allow a clear distinction between those patients who were diagnosed early in the development of the disease or later, which could perhaps interfere with the association between the duration of smoking and the appearance of the diagnosis, giving rise to an overestimation of prevalence. Furthermore, among the limitations, it was not possible to distinguish the histological subtypes of lung neoplasms, which could interfere with morbidity and mortality trends within the variables used, such as region, age group and sex. However, although there are such limitations, it is believed that the data are capable of describing patterns in the incidence of lung cancer and smoking, making it possible to measure the magnitude and impact of this disease in Brazilian regions.

CONCLUSION

It is concluded that there is an association between smoking prevalence and hospital morbidity due to lung cancer in Brazilian states, despite smoking prevalence rates falling and morbidity and mortality rates due to lung cancer increasing. Regarding sex, it is noteworthy that the highest frequencies of smokers were observed in men. The South region had the highest percentage of smoking; however, the states with the highest prevalence were Acre in 2013 and Mato Grosso do Sul in 2019. Despite being high, smoking prevalence rates have fallen over the years in all regions.

Furthermore, the findings of hospital morbidity and mortality due to lung cancer showed a higher prevalence of deaths and hospitalizations due to lung cancer in males than in females. Regarding the age group, it is also possible to conclude that morbidity and mortality rates due to lung cancer are higher in individuals 60, demonstrating the prevalence of the older population. With regard to mortality and hospital morbidity in the regions, it is concluded that the South had a higher rate of hospitalization due to lung cancer, as well as a higher number of deaths, while the North region had the lowest morbidity and mortality rates.

Finally, it can be said that lung cancer has gone from a rare disease to the most common and deadly neoplastic disease worldwide. The dynamics of mortality due to the ongoing disease is complex and represents a major challenge for SUS. Therefore, it is suggested that actions be implemented to reduce mortality and hospitalization from lung cancer, focused on preventing and reinforcing smoking control strategies, especially among women, with the aim of both reducing the number of male smokers and curbing the growth of female smokers so that at least they do not reach the male prevalence peak. Since smoking is the leading cause of preventable death in the world, and around 90% of lung cancer cases are caused by cigarette smoke, it makes sense to combat this practice to prevent new cases of lung cancer.

CONFLICT OF INTERESTS

Nothing to declare.

AUTHORS' CONTRIBUTIONS

KSK: Conceptualization, Formal analysis, Methodology, Project administration, Supervision, Validation, Writing – review & editing. SFN: Conceptualization, Data curation, Visualization, Investigation, Writing – original draft.

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