# Epidemiological Profile of Individuals who Died from Malignant Lung Neoplasms in Campinas-SP between 2013 and 2023

*Perfil Epidemiológico dos Indivíduos que Foram a Óbito por Neoplasias Pulmonares Malignas na Cidade de Campinas-SP entre 2013 e 2023*

Perfil Epidemiológico de los Individuos que Fallecieron por Neoplasias Pulmonares Malignas en Campinas-SP entre 2013 y 2023

**Camilly Reis Lara[1]; Samira Fernandes Ghosn[2]; Mariana Ayumi Hirose[3]; Patricia Ucelli Simioni[4]**

ABSTRACT

**Introduction**: Lung cancer is one of the main causes of global mortality, with high rates in Brazil, especially among smokers. **Objective**: To analyze the epidemiological profile of mortality due to malignant neoplasms of the bronchi and lungs in Campinas-SP, from 2013 to 2023. **Method**: Data from the Mortality Information System (SIM) were used to evaluate deaths due to lung cancer, with calculation of mortality by age, sex, age group, color/race and education. **Results:** 1,985 deaths were recorded in Campinas-SP, with increased mortality in 2023. Fifty-six percent of deaths occurred among men. The majority were white, predominantly in the age range of 70-79 years old. The mortality profile in Campinas is similar to Brazil's, however, the level of education is higher. This can be attributed to the high Human Development Index (HDI) of Campinas (0.816), compared to the national HDI (0.766), which suggests that high education can influence expanded awareness about disease prevention and early diagnosis. **Conclusion:** The study reveals that lung cancer mainly affects white men, aged between 70 and 79 years old, smoking being the main risk factor. Despite Campinas' high HDI, educational disparities influence access to preventive measures. Public policies should focus on vulnerable groups, like men, older adults and individuals with low level of education to improve lung cancer detection and reduce mortality.

**Keywords:** Lung Neoplasms/mortality; Mortality/trends; Mortality Registries; Epidemiology/statistics & numerical data; Tobacco Use Disorder.

RESUMO

**Introdução:** O câncer de pulmão é uma das principais causas de mortalidade global, com altas taxas no Brasil, especialmente entre tabagistas. **Objetivo:** Analisar o perfil epidemiológico da mortalidade por neoplasias malignas de brônquios e pulmões em Campinas-SP, no período de 2013 a 2023. **Método:** Dados do Sistema de Informações sobre Mortalidade (SIM) foram utilizados para avaliar óbitos por câncer de pulmão, com cálculo de mortalidade por idade, sexo, faixa etária, cor/raça e escolaridade. **Resultados:** Foram registrados 1.985 óbitos em Campinas-SP, com aumento de mortalidade em 2023. Cinquenta e seis por cento dos óbitos ocorreram entre os homens. A maioria era branca e a faixa etária predominante foi de 70 a 79 anos. O perfil de mortalidade em Campinas assemelha-se ao observado no Brasil, porém, observa-se nível de escolaridade superior. Isso pode ser atribuído ao elevado Índice de Desenvolvimento Humano (IDH) de Campinas (0,816), comparado ao IDH nacional (0,766), o que sugere que a maior escolaridade na população pode influenciar a maior conscientização sobre prevenção e diagnóstico precoce da doença. **Conclusão:** O estudo revela que o câncer de pulmão afeta principalmente homens brancos, entre 70 e 79 anos, com o tabagismo como principal fator de risco. Apesar do alto IDH de Campinas, as disparidades educacionais influenciam o acesso às medidas preventivas. Políticas públicas devem focar em grupos vulneráveis, como homens, idosos e pessoas com menor escolaridade, para melhorar a detecção do câncer de pulmão e reduzir a mortalidade.

**Palavras-chave:** Neoplasias Pulmonares/mortalidade; Mortalidade/tendências; Registros de Mortalidade; Epidemiologia/estatística & dados numéricos; Tabagismo.

RESUMEN

**Introducción:** El cáncer de pulmón es una de las principales causas de mortalidad global, con altas tasas en el Brasil, especialmente entre fumadores. **Objetivo:** Analizar el perfil epidemiológico de la mortalidad por neoplasias malignas de bronquios y pulmones en Campinas-SP, de 2013 a 2023. **Método:** Se utilizaron datos del Sistema de Información de Mortalidad (SIM) para evaluar las muertes por cáncer de pulmón, con cálculo de la mortalidad por edad, sexo, grupo de edad, color/raza y educación. **Resultados:** Se registraron 1985 muertes en Campinas-SP, con aumento de la mortalidad en 2023. Cincuenta y seis por ciento de las muertes ocurrieron entre hombres. La mayoría era blanca y el grupo de edad predominante era el de 70 a 79 años. El perfil de mortalidad en Campinas es similar al observado en el Brasil, sin embargo, hay un mayor nivel de educación. Esto puede atribuirse al alto Índice de Desarrollo Humano (IDH) de Campinas (0,816), en comparación con el IDH nacional (0,766), lo que sugiere que una mayor educación de la población puede influir en una mayor conciencia sobre la prevención y el diagnóstico temprano de la enfermedad. **Conclusión:** El estudio revela que el cáncer de pulmón afecta principalmente a hombres blancos, entre 70 y 79 años, siendo el tabaquismo el principal factor de riesgo. A pesar del alto IDH de Campinas, las disparidades educativas influyen en el acceso a medidas preventivas. Las políticas públicas deberían centrarse en los grupos vulnerables, como los hombres, los ancianos y las personas con menor nivel educativo, para mejorar la detección del cáncer de pulmón y reducir la mortalidad.

**Palabras clave:** Neoplasias Pulmonares/mortalidad; Mortalidad/tendencias; Registros de Mortalidad; Epidemiología/estadística & datos numéricos; Tabaquismo.

[1-4]Universidade Anhembi Morumbi, Departamento de Medicina. Piracicaba (SP), Brasil.
[1]E-mail: camillyreis03@gmail.com. Orcid iD: https://orcid.org/0009-0008-3477-0157
[2]E-mail: samiraghosn@gmail.com. Orcid iD: https://orcid.org/0009-0008-5783-6235
[3]E-mail: mah.hirose730@gmail.com. Orcid iD: https://orcid.org/0009-0008-4002-9066
[4]E-mail: psimioni@gmail.com. Orcid iD: https://orcid.org/0000-0002-6951-5040
**Corresponding author:** Patricia Ucelli Simioni. Universidade Anhembi Morumbi. Av. Rio das Pedras, 1601 – Pompéia. Piracicaba (SP), Brasil. CEP 13425-380.
E-mail: psimioni@gmail.com

## INTRODUCTION

Cancer is one of the leading mortality causes in the world, accounting for millions of deaths each year[1]. According to the World Health Organization (WHO), 30% to 50% of cancers can be avoided by prevention and detection strategies, although adequate treatment is essential for managing the disease. According to the National Cancer Institute (INCA), lung cancer is one of the most incident and lethal neoplasms[1,2], in addition to being the third most frequent among men and the fourth among women in Brazil. As for mortality, it remains the second largest cause of death due to neoplasms in both sexes[3,4].

The estimated incidence of lung cancer in Brazil for 2023-2025 is 32,560 new cases annually, corresponding to 15.06 cases per 100 thousand inhabitants. In Campinas (SP), the estimate for 2023 is 1,200 patients, considering the population of 1,139,047 inhabitants in 2022. Although frequent, the diagnosis is usually delayed due to unspecific symptoms. The incidence in men has declined in recent decades, unlike in women. This information is essential for public health strategies, such as prevention programs[4,5].

Pulmonary neoplasms are classified into two groups: Small-cell lung cancer and non-small cell cancer, composed mainly of adenocarcinomas and squamous cell carcinomas[6,7]. Lung cancer symptoms vary according to the location of the neoplasm and the presence of metastases. Central neoplasms cause persistent cough, blood sputum, and recurrent pneumonia. However, when cancer spreads to other parts of the body, clinical manifestations depend on the affected organs, with the brain, bones, liver, and adrenal glands being the most common sites of dissemination[8].

Lung cancer diagnosis is based on a combination of clinical assessment and imaging tests, such as X-rays and computed tomography. For diagnostic confirmation and staging of the disease, complementary tests are required, including bronchoscopy, fine needle aspiration puncture, lymph node biopsy, and/or PET-SCAN. Staging is performed using the Tumor-Node-Metastasis system (TNM)[9], recommended by the Union for International Cancer Control (UICC), which assesses tumor size, lymph node involvement, and metastases[10].

The main risk factors for developing lung cancer are related to life habits, especially smoking. In addition, exposure to air pollution, passive smoking, genetic predisposition, occupational exposure, and family history of lung cancer is also considered risk factors[8,11].

In Campinas, a city located in the interior of the State of São Paulo, neoplasms rank second among the main causes of death, being responsible for approximately one-fifth of inhabitant's deaths. Cancer mortality varies according to tumor type, gender, and age group. Among elderly people aged 70 years or older, men present higher mortality rates[12].

According to the Brazilian Institute of Geography and Statistics (IBGE)[13], the municipality of Campinas had a population of 1,139,047 inhabitants in 2022 and had a 98.28% degree of urbanization. The Human Development Index (HDI) of the city was estimated at 0.816 in 2021, one of the highest in the country, reflecting better socioeconomic conditions and quality of life when compared to the national average, whose HDI is 0.766[14].

Given this context, this study aims to analyze the mortality due to malignant neoplasms of bronchi and lungs in the city of Campinas-SP and discuss the epidemiological profile of individuals who died of this disease in the period from 2013 to 2023. This analysis excludes the malignant neoplasm of the trachea due to its lower incidence and complexity in the diagnosis and treatment. In addition, the research addresses challenges in clinical staging, waiting time for treatment, and population diagnostic programs, based on relevant references such as the Cancer Foundation's thematic bulletins.

## METHOD

This study is characterized as epidemiological, ecological, and analytical research, aimed at analyzing the mortality due to malignant neoplasms of bronchi and lungs in the city of Campinas, State of São Paulo, from 2013 to 2023. Data on deaths was obtained from the Mortality Information System (SIM)[15], maintained by the Ministry of Health, through the Department of Informatics of the National Health System (DATASUS) platform.

Data collection used the tenth edition of the International Statistical Classification of Diseases and Related Health Problems (ICD-10)[16], specifically the C-34 code, which corresponds to malignant neoplasms of the bronchi and lungs. The analysis period covered January 2013 to December 2023, with data being stratified according to sociodemographic variables such as age, gender, color/race, and education.

The age groups were organized according to the SIM classification. The data was classified by sex (male and female) and by color/race, according to the categories established by IBGE, which include white, brown, black, and yellow. In addition, education was categorized according to the years of study reported in SIM.

Data from INCA and information from the Global Cancer Observatory[17,18] served as the theoretical basis.

Since this study used secondary public domain data provided by DATASUS, there was no need to submit the project to the Research Ethics Committee. The data analyzed is anonymous and free to access, according to the ethical guidelines established by the Ministry of Health, according to Resolution no. 510/16[19] of the National Health Council.

The exclusion of ICD C-33 (trachea) in the analysis was a methodological choice to focus exclusively on lung cancers, although ICD-10 usually encompasses the trachea. This exclusion is justified by the low prevalence of tracheal malignant neoplasms in the city of Campinas, which would make the inclusion of data from this ICD irrelevant to the objectives of the study, not significantly impacting the conclusions on malignant neoplasms of the bronchi and lungs. In addition, to facilitate comparisons, crude and age-adjusted mortality rates were calculated for the variables under study, focusing on the evolution of lung cancer in recent decades.

This methodology seeks to provide a detailed analysis of mortality due to pulmonary neoplasms in the city of Campinas, based on official and validated data sources, offering a significant contribution to the understanding of the epidemiological profile of individuals who died of this disease in the region.

## RESULTS

Smoking remains a significant risk factor for the development of pulmonary neoplasms in Brazil. In 2013, the prevalence of smokers in the adult population was approximately 11.3%, being more common among men than among women. In the following years, there was a slight decrease in smokers, reaching 9.8% in 2019. Between 2020 and 2021, this decrease was less intense, but in 2023, this number was reduced to about 9.3%, with most smokers still composed of men[4].

According to the data obtained, the total number of deaths due to malignant neoplasms of bronchi and lungs in the city of Campinas-SP, from 2013 to 2023, was 1,985 deaths. The year 2023 presented the highest number of records, with 207 deaths, corresponding to 10.42% of the total. On the other hand, the lowest records occurred in the years 2016 and 2021, with 160 (8.0%) and 164 (8.2%) deaths, respectively (Table 1).

Regarding age distribution, the number of deaths was observed to increase with age. The 70-79 years age group was the most affected, with 623 (31.4%) cases, followed by the 60-69 years age group, with 578 (29.1%), followed by the 80 year and over age group, with 392 (19.7%). The younger population, aged 20-29 years, presented only four deaths (0.2%) (Table 2).

When analyzing mortality by sex, the study revealed that males were the most affected, with 1,114 (56.1%) deaths, while females had 871 (43.8%) deaths (Table 3). Regarding color/race, the white population represented most deaths, with 1,547 (77.9%) cases. There were 253 (12.7%) deaths in the brown population, 127 (6.4%) in the black population, and 32 (1.6%) in the yellow population. In addition, 26 (1.3%) records did not present information about the person's color/race (Table 3).

The white population presented the highest number of deaths in both sexes, totaling 676 cases among women and 871 among men. In absolute terms, white men recorded 28.8% more deaths than white women. The highest concentration of mortality occurred in the most advanced age groups, from 60 to 79 years, reflecting the increased risk of aging. The brown population was the second most

Table 1. Number of deaths per year and crude mortality rate

| Female | | | |
|---|---|---|---|
| Year | No. of deaths | Total population | Mortality rate |
| 2013 | 78 | 559,248 | 0.139473007 |
| 2014 | 63 | 559,248 | 0.112651275 |
| 2015 | 85 | 559,248 | 0.151989815 |
| 2016 | 62 | 559,248 | 0.110863159 |
| 2017 | 78 | 559,248 | 0.139473007 |
| 2018 | 84 | 559,248 | 0.150201699 |
| 2019 | 83 | 559,248 | 0.148413584 |
| 2020 | 77 | 559,248 | 0.137684891 |
| 2021 | 72 | 559,248 | 0.128744314 |
| 2022 | 91 | 596,034 | 0.152675854 |
| 2023 | 98 | 596,034 | 0.164420151 |
| Male | | | |
| Year | No. of deaths | Total population | Mortality rate |
| 2013 | 106 | 520,865 | 0.203507627 |
| 2014 | 112 | 520,865 | 0.215026926 |
| 2015 | 101 | 520,865 | 0.19390821 |
| 2016 | 98 | 520,865 | 0.188148561 |
| 2017 | 108 | 520,865 | 0.207347393 |
| 2018 | 105 | 520,865 | 0.201587743 |
| 2019 | 87 | 520,865 | 0.167029845 |
| 2020 | 97 | 520,865 | 0.186228677 |
| 2021 | 92 | 520,865 | 0.176629261 |
| 2022 | 99 | 543,013 | 0.182316077 |
| 2023 | 109 | 543,013 | 0.200731843 |

**Source:** Mortality Information System (SIM).

Table 2. Number of deaths by age group and adjusted mortality rate by age from 2013 to 2023

| Age group | No. of deaths by age group | Age-adjusted mortality rate | Total no. of deaths |
|---|---|---|---|
| 20 to 29 years old | 4 | 0.002015113 | 1985 |
| 30 to 39 years-old | 12 | 0.00604534 | 1985 |
| 40 to 49 years old | 72 | 0.03627204 | 1985 |
| 50 to 59 years old | 304 | 0.153148615 | 1985 |
| 60 to 69 years old | 578 | 0.291183879 | 1985 |
| 70 to 79 years old | 623 | 0.313853904 | 1985 |
| 80 years old and over | 392 | 0.197481108 | 1985 |

**Source:** Mortality Information System (SIM).

Table 3. Number of deaths by color/race, among women and men, from 2013 to 2023

| Female 2013-2023 | | | | | | |
|---|---|---|---|---|---|---|
| | Race/Color | | | | | Total |
| Age group | White | Black | Yellow | Brown | Ignored | Absolute number |
| 20 to 29 years old | 2 | - | - | 1 | - | 3 |
| 30 to 39 years-old | 4 | - | - | 2 | - | 6 |
| 40 to 49 years old | 20 | 4 | - | 9 | - | 33 |
| 50 to 59 years old | 101 | 17 | - | 25 | 1 | 144 |
| 60 to 69 years old | 193 | 18 | 1 | 28 | 3 | 243 |
| 70 to 79 years old | 206 | 17 | 6 | 33 | 1 | 263 |
| 80 years old and over | 150 | 10 | 4 | 15 | - | 179 |
| Total — Absolute number | 676 | 66 | 11 | 113 | 5 | 871 |
| Total — Approximate relative distribution (%) | 78% | 8% | 1% | 13% | 1% | 100% |
| Male 2013-2023 | | | | | | |
| | Race/Color | | | | | Total |
| Age group | White | Black | Yellow | Brown | Ignored | Absolute number |
| 20 to 29 years old | - | - | - | 1 | - | 1 |
| 30 to 39 years-old | 3 | - | - | 3 | - | 6 |
| 40 to 49 years old | 28 | 2 | 1 | 8 | - | 39 |
| 50 to 59 years old | 109 | 11 | 1 | 34 | 5 | 160 |
| 60 to 69 years old | 249 | 24 | 5 | 50 | 7 | 335 |
| 70 to 79 years old | 298 | 17 | 8 | 31 | 6 | 360 |
| 80 years old and over | 184 | 7 | 6 | 13 | 3 | 213 |
| Total — Absolute number | 871 | 61 | 21 | 140 | 21 | 1,114 |
| Total — Approximate relative distribution (%) | 78% | 5% | 2% | 13% | 2% | 100% |

**Source:** Mortality Information System (SIM).

represented, with 113 deaths among women and 140 among men. In this group, brown men presented more deaths than brown women, maintaining an age pattern of gradual increase in mortality with aging, especially after 60 years old.

Among the black population, women recorded 66 deaths, while men presented 61, being one of the few cases in which female mortality exceeded male mortality, with a difference of 8.2%. This trend reversal may indicate

disparities in access to diagnosis or treatment between the sexes. The yellow population had the lowest absolute number of deaths, with 11 cases among women and 21 among men. In this group, men presented almost twice as many deaths as women. In addition, records with ignored information about color/race were more prevalent in men, totaling 21 cases, compared to only 5 cases among women.

In terms of education, most deaths, 1,313 (66.1%), did not have available information about the educational level of the deceased, which reveals an important gap in the data collected. Among the 672 (33.9%) deaths with education information, 219 (11%) occurred among people with 8 to 11 years of study, 204 (10.2%) among those with 12 years of study or more, 175 (8.8%) among people with 4 to 7 years of study, 43 (2.1%) among those with 1 to 3 years of study, and 31 (1.5%) among individuals with no education (Table 4).

Among the female deaths with available information, a more balanced distribution among the different levels of education was observed. The majority occurred among women with 8 to 11 years of study (101 cases), followed by those with 12 years of study or more (82 cases) and 4 to 7 years of study (78 cases). The most affected age groups were the 60-79-year-olds, with a progressive increase in mortality according to aging, with less frequent deaths in younger ages. The number of deaths was relatively low among women with 1 to 3 years of study (17 cases) and no study (17 cases), suggesting a possible underreporting or lower prevalence of the disease in these groups.

Among men, education also played a relevant role, but with a higher concentration of deaths among those with higher levels of education. The highest number of deaths was recorded among men who studied for 12 years or more (122 cases), followed by those who studied for 8 to 11 years (118 cases) and 4 to 7 years (97 cases). This distribution may reflect different patterns of exposure to risk factors, such as smoking, or even greater access to diagnosis among men with higher education. As in women, the most advanced age groups concentrated most of the deaths, especially the 60-79-years-old group.

## DISCUSSION

The data evaluated were extracted from SIM, a national database managed by the Ministry of Health, which provides information on mortality from several causes, and shows that malignant neoplasm of the bronchi and lung is one of the main causes of mortality among men and women in Brazil[20].

In general, men presented higher mortality rates in all categories of color/race and age groups. The difference was especially remarkable among the more advanced ages, such as the 60-79 years age group, which may be related to factors such as higher exposure to smoking and occupational differences. The analysis by age group reveals a progressive increase in mortality with aging in both sexes, the 70-79 years group being the most affected. On the other hand, mortality was reduced among young people, with few records in the 20-39 years age group, which reflects the long period of latency that is characteristic of lung cancer. This data shows the predominance of male mortality compared to female mortality, especially the white population as the most affected group in both sexes and corroborates the literature that points to smoking as a predominant risk factor among men, which is reflected in high male mortality. However, it is important to note that lung cancer mortality rates among men have decreased over time, although they are still at higher levels compared to women.

This scenario is worrying, since many cases are diagnosed in advanced stages, compromising the effectiveness of treatment and prognoses of patients. Kumar et al.[21] emphasize that late diagnosis often correlates with the absence of effective early diagnosis and limited perception of early symptoms by patients, which slows the search for medical care. In Brazil, lung cancer screening is not incorporated into the National Health System (SUS) but is recommended by medical societies for high-risk groups. In addition, there is a correlation between smoking reduction and the decrease in mortality due to lung neoplasms. Although the historical context of public policies, such as the National Program for Tobacco Control (PNCT), has been fundamental for reducing smoking, lung cancer is still one of the main causes of death in the country, due to the high prevalence and resistance of some groups to these measures[7,21].

In addition to the aforementioned aspect and the challenges already known in the treatment of smoking, the use of other forms of nicotine and the development of commercially viable forms of synthetic nicotine can interfere with smoking cessation treatments as in tobacco control policies[22]. The commercialization of electronic smoking devices (ESD) began in 2003, which were presented as a means of harm reduction and a tool for smoking cessation. However, these devices are known to contain nicotine, flavorings, and liquid substances, such as propylene glycol and glycerin, a composition that does not yet have its pulmonary and systemic effects fully understood. Studies have indicated the ability of ESD to alter the composition of pulmonary surfactants, a lipoprotein substance necessary for respiratory homeostasis, and to induce oxidative lesions, chronic inflammation, and accelerated lung aging, just like traditional means of smoking[23].

Table 4. Number of deaths by schooling among women and men from 2013 to 2023

| Female 2013-2023 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Education | | | | | | Total | |
| Age group | None | 1 to 3 years | 4 to 7 years | 8 to 11 years | 12 years and over | Ignored | Absolute number | Approximate relative distribution (%) |
| 20 to 29 years old | - | - | - | 2 | - | 1 | 3 | 0% |
| 30 to 39 years-old | - | - | - | 1 | 3 | 2 | 6 | 1% |
| 40 to 49 years old | - | - | 3 | 7 | 5 | 18 | 33 | 4% |
| 50 to 59 years old | - | 4 | 5 | 18 | 12 | 105 | 144 | 17% |
| 60 to 69 years old | 2 | 5 | 16 | 36 | 22 | 162 | 243 | 28% |
| 70 to 79 years old | 9 | 5 | 29 | 30 | 22 | 168 | 263 | 30% |
| 80 years old and over | 6 | 3 | 25 | 7 | 18 | 120 | 179 | 21% |
| Total — Absolute number | 17 | 17 | 78 | 101 | 82 | 576 | 871 | 100% |
| Total — Approximate relative distribution (%) | 2% | 2% | 9% | 12% | 9% | 66% | 100% | 100% |

| Male 2013-2023 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Education | | | | | | Total | |
| Age group | None | 1 to 3 years | 4 to 7 years | 8 to 11 years | 12 years and over | Ignored | Absolute number | Approximate relative distribution (%) |
| 20 to 29 years old | - | - | - | 1 | - | - | 1 | 0% |
| 30 to 39 years-old | - | - | - | - | 2 | 4 | 6 | 1% |
| 40 to 49 years old | - | 2 | 2 | 4 | 4 | 27 | 39 | 4% |
| 50 to 59 years old | 1 | 4 | 12 | 19 | 12 | 112 | 160 | 14% |
| 60 to 69 years old | 2 | 11 | 24 | 41 | 37 | 220 | 335 | 30% |
| 70 to 79 years old | 5 | 4 | 38 | 34 | 47 | 232 | 360 | 32% |
| 80 years old and over | 6 | 5 | 21 | 19 | 20 | 142 | 213 | 19% |
| Total — Absolute number | 14 | 26 | 97 | 118 | 122 | 737 | 1,114 | 100% |
| Total — Approximate relative distribution (%) | 1% | 2% | 9% | 11% | 11% | 66% | 100% | 100% |

**Source:** Mortality Information System (SIM).

The PNCT, coordinated by INCA, aims to reduce the impact of smoking on public health through measures such as increased taxes on tobacco products, prohibition of advertising, 100% smoke-free environments, and educational campaigns. In addition, it offers free treatment for smoking cessation via SUS and encourages economic alternatives to tobacco cultivation. In line with the WHO Framework Convention on Tobacco Control (FCTC), the

PNCT reduced the prevalence of smokers in Brazil from 34.8% in 1989 to 9.1% in 2022[24].

Moreover, studies[25] indicate that the advice of a qualified health professional is essential to support users who wish to cease tobacco consumption. They facilitate the process and assist in coping with the difficulties of beginning treatment, such as moments of cravings and symptoms of withdrawal crises. In this sense, Primary Health Care (PHC) has a privileged and strategic position for developing the actions provided by the PNCT, based on the care qualities found in this scenario. Among the attributes considered essential to PHC, integrity is highlighted. Thus, doctors and health professionals must work in an integrated manner to also support smoking cessation, thus contributing to the promotion of public health care in the country[25].

Despite efforts, 2023 saw a significant increase in the number of deaths from malignant neoplasms of bronchi and lungs in Campinas-SP, with 207 deaths, which can be associated with several factors, including the impact of the COVID-19 pandemic. Data from the literature suggests that limited access to health care and prioritization of resources to combat COVID-19 affected the treatment of several conditions, including cancer because it resulted in a significant decrease in screening tests and the beginning of oncological treatments. During the pandemic years, especially in 2020 and 2021, many cancer diagnoses were delayed due to the burden on health services and the fear of contagion. This interruption in early detection and treatment of cancer, as well as underreporting and additional challenges, such as treatment interruptions and uncertainties regarding continuous care, may have contributed to an increase in deaths in subsequent years[8,22,26,27].

Therefore, 2023 mortality data reflect not only the chronic burden of lung cancer but also the side effects of the pandemic, which may have exacerbated the situation for many cancer patients. This highlights the importance of strengthening the strategies of early diagnosis of the population since lung cancer has high lethality and can be treated properly when diagnosed early.

The analysis of education data shows a complex relationship between educational level and mortality due to lung cancer in the 2013-2023 period, with notable differences between men and women. A significant aspect is the absence of complete information since 66.1% of the records did not specify the education level of the deceased, representing an important gap in understanding the impact of the educational level on deaths.

The comparison between the sexes shows that men had a higher absolute number of deaths in all education categories. This is most evident in people who studied for 12 years or more and for 8 to 11 years, where the number of deceased men was significantly higher than the number of deceased women. On the other hand, women presented a more distributed mortality within the different levels of education, which may reflect inequalities in socioeconomic and cultural factors or access to health services.

Finally, the high proportion of records with ignored education information in both sexes represent an obstacle to further analysis. This lack of data compromises the understanding of the impact of the educational level on lung cancer mortality, especially concerning possible social inequalities and the role of education in the prevention and treatment of the disease. These findings reinforce the importance of improving the quality of demographic and socioeconomic information records to guide more effective public health policies.

The prevalence of smoking is higher among individuals with lower education levels and, generally, among the more advanced age groups, with the highest incidence of lung cancer deaths occurring in people aged 70 years or older. Although public health efforts have contributed to a reduction in the number of smokers, smoking remains one of the main preventable causes of lung cancer, and the fight against smoking remains a priority in public health policies in Brazil[24,28].

The disparity in the education profile observed in Campinas can be partially attributed to the variations in HDI between the city and Brazil. In 2021, Campinas presented a 0.816 HDI, higher than the national mean of 0.766[1]. Studies suggest that high HDI is associated with better conditions and greater access to health services, factors that positively influence cancer treatment[29-32].

However, it is necessary to emphasize, as stated earlier, that the absence of data on the education of recorded deaths reveals a significant gap in information collection, which may limit the interpretation of data and the comparison with the national statistics. Therefore, as argued by Van Hoogstraten et al., the collection of detailed demographic data is essential for a deeper understanding of the epidemiological profile of cancer and the development of more effective intervention strategies[32].

Although Campinas has a high HDI (0.816) compared to the national average (0.766), this may not reduce inequalities in access to information and health. Populations with low schooling, even in areas with high HDI, face difficulties in accessing information about smoking and present a higher prevalence of smokers. In addition, the lower availability of adequate treatment contributes to disparities in mortality, indicating that a high HDI does not eliminate inequalities in coping with cancer. Data analysis is also impaired by the large number of information ignored, limiting the accuracy of conclusions.

The implementation of early diagnosis strategies may be essential, especially for groups with higher risk, such as those less educated and those who did not participate in smoking cessation campaigns. Low dose computed tomography has proved effective in reducing lung cancer mortality in high-risk populations. However, this strategy faces challenges such as high cost, need for infrastructure, and management of false positives. In addition, it would be necessary to invest in training professionals for early diagnosis, which could overload the healthcare system. Although it can save lives, it is crucial to evaluate economic viability and large-scale implementation in Brazil, considering inequalities in healthcare access[33].

The increase in mortality with aging reinforces the need for prevention and early diagnosis policies, especially for populations at higher risk. It is also essential to reduce inequalities in access to diagnosis and treatment, especially among black and brown men and women, who face barriers to accessing the healthcare system. The data of this study reveals an epidemiological pattern of lung cancer in Campinas, according to Bergamo et al. In São Paulo, the mortality rate has decreased, especially among men. Although the incidence among women increases, men still show higher mortality due to higher exposure to smoking. Analyzing age and sex-adjusted mortality rates is essential to understand population trends and comparisons[26,28,34].

Prolonged exposure to smoking over decades is a critical risk factor for developing lung cancer, a chronic and progressive disease. The prevalence of this addiction is higher among men, but it also affects women considerably. Smoking cessation has shown, over the years, a direct association with reducing the risk of mortality due to this neoplasm[35]. Thus, the importance of reducing the prevalence of this risk factor for controlling the incidence of lung cancer, a disease that develops gradually, often after years of exposure to tobacco smoke[36].

Due to the different stages of the smoking epidemic among men and women, women up to 55 years old are expected to have a reduction in lung cancer mortality only in 2021-2026, even though they have lower mortality and incidence rates than men. In contrast, for women aged 75 years or older, mortality should continue to increase until 2036-2040. Among men, lung cancer mortality rates in Brazil have been decreasing since the beginning of the 21st century[37].

In addition, it is necessary to analyze the data of the Hospital-based Cancer Registries Integrator (*Integrador RHC*) on clinical staging and time between diagnosis and treatment of lung cancer in Brazil, which reveal a significant prevalence of cases in advanced stages, reflecting the late detection of the disease. The considerable time between diagnosis and treatment negatively impacts the survival of patients, given the aggressive character of lung cancer. In addition, the high incidence and mortality rates between 2020 and 2023 indicate an alarming lethality, raising the need to discuss the implementation of early population diagnostic programs, although the effectiveness of these programs depends on factors such as regional variability and challenges in access to the health system. The analysis of discrepancies between data on "hospital morbidity" and information from the mortality system also reveals gaps, such as the high proportion of ignored data and the predominance of cases in people who studied for up to 7 years, suggesting a relationship between lower education and greater vulnerability to lung cancer. Underreporting and lack of complete data make it difficult to assess the situation accurately, which reinforces the importance of more effective data collection strategies for understanding and fighting the disease[37-39].

The limitations of this study include the possibility of underreported deaths in SIM, as well as the possibility of errors in the completion of death certificates, which may impact the quality of the data used. In addition, because this research is ecological, the results reflect population trends and do not allow direct inferences about cause-and-effect relationships at the individual level.

## CONCLUSION

The data from Campinas reflect, mostly, the trends observed in Brazil, evidencing lung cancer as a persistent public health challenge. The epidemiological profile of the city shows a higher prevalence of this type of cancer among white men and the elderly, which highlights the urgent need for specific strategies for these groups, in line with the guidelines of the National Cancer Control Policy (PNCC).

Although this study focused on mortality, not incidence, the data confirm the high rate of deaths due to the disease, consistent with national statistics. Smoking remains the main risk factor, especially among men, reinforcing the need to intensify public policies aimed at preventing tobacco use and cessation of habit, which emphasize the importance of cancer prevention and control actions. In addition, early identification of lung cancer and awareness of the signs and symptoms of the disease are key to reducing mortality.

The conclusion is that implementing effective strategies, such as educational campaigns and stricter anti-smoking policies, is essential for health promotion and prevention, according to the principles of PNCC. A more in-depth analysis of sociodemographic factors, such as schooling, is crucial for the development of more accurate and targeted public health actions that effectively address the groups most affected by the disease.

## CONTRIBUTIONS

All the authors have substantially contributed to the study design, acquisition, analysis and interpretation of the data, wording, and critical review. They approved the final version for publication.

## DECLARATION OF CONFLICT OF INTERESTS

There is no conflict of interest to declare.

## FUNDING SOURCES

None.

## REFERENCES

1. Organização Pan-Americana da Saúde [Internet]. Brasília, DF: OPAS; [2000]. Câncer. [Acesso 2024 dez 12]. Disponível em: https://www.paho.org/pt/topicos/cancer#:~:text=As%20causas%20mais%20comuns%20de

2. World Health Organization [Internet]. Geneva: WHO; [2000]. Cancer Fact Sheet, 2025 fev 3. [Acesso 2024 dez 12]. Disponível em: https://www.who.int/news-room/fact-sheets/detail/cancer

3. International Agency for Research on Cancer [Internet]. Lyon: IARC; ©1965-2025. Cancer Tody (version 1.1) 2024 fev 8. [Acesso 2024 dez 12] Disponível em: https://gco.iarc.fr/today/en/dataviz/bars?mode=cancer&group_populations=1&types=0v

4. Instituto Nacional do Câncer. Estimativa 2023: incidência de câncer no Brasil [Internet]. Rio de Janeiro: INCA; 2022. [Acesso 2024 dez 12]. Disponível em: https://www.inca.gov.br/publicacoes/livros/estimativa-2023-incidencia-de-cancer-no-brasil

5. Instituto Nacional de Câncer [Internet]. Rio de Janeiro: INCA; [2000]. Síntese de resultados e comentários, 2023 fev 1. [Acesso 2024 dez 12]. Disponível em: https://www.gov.br/inca/pt-br/assuntos/cancer/numeros/estimativa/sintese-de-resultados-e-comentarios

6. Instituto Nacional de Câncer [Internet]. Rio de Janeiro: INCA; [2000]. Câncer de pulmão, 2022 jun 6 atualizado em 2022 jul 18. [Acesso 2024 dez 12]. [Disponível em: https://www.gov.br/inca/pt-br/assuntos/cancer/tipos/pulmao

7. Silva APS, Almeida PS, Santos VS, et al. Targeted therapies for the treatment of non-small-cell lung cancer: monoclonal antibodies and biological inhibitors. Hum Vaccin Immunother. 2017;13(4):843-53. doi: https://doi.org/10.1080/21645515.2016.1249551

8. Instituto Nacional de Câncer [Internet]. Rio de Janeiro: INCA; [2000]. O que é câncer 2022 jul 31 atualizado em 2022 jul 14. Disponível em: https://www.gov.br/inca/pt-br/assuntos/cancer/o-que-e-cancer

9. Brierley JD, Gospodarowicz M, Wittekind Ch, editors. TNM Classification of Malignant Tumours. 8 ed. Chichester, West Sussex, UK: Wiley Blackwell; 2017.

10. Siegel RL, Miller KD, Jemal A. Cancer statistics, 2020. CA Cancer J Clin. 2020;70(1):7-30. doi: https://doi.org/10.3322/caac.21590

11. Liang H, Zhou X, Zhu Y, et al. Association of outdoor air pollution, lifestyle, genetic factors with the risk of lung cancer: A prospective cohort study. Environ Res. 2023;218: 114996. doi: https://doi.org/10.1016/j.envres.2022.114996

12. Secretaria Municipal de Saúde de Campinas (SP). Boletim de mortalidade: mortalidade por neoplasias [Internet]. 2018 [acesso 2024 dez 12];56:1-8. Disponível em: https://saude.campinas.sp.gov.br/boletins/mort_56/boletim_mortalidade_56_mai_2018.pdf

13. Cidades@ [Internet]. Rio de Janeiro: Instituto Brasileiro de Geografia e Estatística; c2017. Panorama Campinas; [acesso 2024 nov 2]. Disponível em: https://www.ibge.gov.br/cidades-e-estados/sp/campinas.html

14. Prefeitura Municipal de Campinas (SP) [Internet]. Campinas: PMC; [2021]. A cidade. [acesso 2024 dez 12]. Disponível em: https://www.campinas.sp.gov.br/secretaria/planejamento-e-desenvolvimento-urbano/pagina/a-cidade

15. SIM: Sistema de Informação sobre Mortalidade [Internet]. Versão 3.2.1.2. Brasília (DF): DATASUS. [data desconhecida] - [acesso 2024 set 24]. Disponível em: http://sim.saude.gov.br/default.asp

16. Organização Mundial da Saúde. CID-10: Classificação Estatística Internacional de Doenças com disquete. Vol. 3, Índice Alfabético. São Paulo: Edusp; 2008.

17. International Agency for Research on Cancer. Global Cancer Observatory [Internet]. Lyon (France): IARC; c1965-2023 [acesso 2024 set 27]. Disponível em: https://gco.iarc.fr

18. Instituto Nacional de Câncer [Internet]. Rio de Janeiro: INCA; [2000]. Prevalência do tabagismo, 2022 out 19 atualizado em 2025 jan 7. [acesso 2025 fev 27];Disponível em: https://www.gov.br/inca/pt-br/assuntos/gestor-e-profissional-de-saude/observatorio-da-politica-nacional-de-controle-do-tabaco/dados-e-numeros-do-tabagismo/prevalencia-do-tabagismo

19. Conselho Nacional de Saúde (BR). Resolução n° 510, de 7 de abril de 2016. Dispõe sobre as normas aplicáveis a pesquisas em Ciências Humanas e Sociais cujos procedimentos metodológicos envolvam a utilização de dados diretamente obtidos com os participantes ou de informações identificáveis ou que possam acarretar riscos maiores do que os existentes na vida cotidiana, na forma definida nesta Resolução. Diário Oficial da União, Brasília, DF. 2016 maio 24; Seção 1:44.

20. Painel IDHM [Internet]. [sem local]: United Nations Development Programme; 2021. [acesso 2024 set 27]. Disponível em: https://www.undp.org/pt/brazil/desenvolvimento-humano/painel-idhm

21. Kumar D, Singh S. "Factors causing treatment delays and its impact on treatment outcome in patients of lung cancer: An analysis." Ann Oncol. 2017;28(2):ii7. doi: https://doi.org/10.1093/annonc/mdx087.008

22. Silva ALO, Moreira JC. Sais de nicotina e nicotina sintética: novos desafios para um velho problema. Rev Bras Cancerol. 2022;68(4):e-202846. doi: https://doi.org/10.32635/2176-9745.RBC.2022v68n4.2846

23. Silva PS, Barone BV, Diegues JD, et al. Relação entre o uso de cigarros eletrônicos e doenças pulmonares. Braz J Hea Rev. 2024;7(3):e69666. doi: https://doi.org/10.34119/bjhrv7n3-095

24. Ministério da Saúde (BR). Política Nacional de Controle do Tabaco [Internet]. Rio de Janeiro: INCA; 2015. [acesso 2024 set 27]. Disponível em: https://www.inca.gov.br/sites/ufu.sti.inca.local/files/media/document/politica-nacional_de-controle-do-tabaco-2015.pdf

25. Pires GAR, Charlo PB, Martins Marques FRD, et al. Longitudinal treatment of smoking in Primary Health Care: an evaluation research. Rev Bras Enferm. 2022;75(4):e20210420. doi: https://doi.org/10.1590/0034-7167-2021-0420

26. Malta DC, Gomes NP, Silva AL, et al. Mudanças nas doenças crônicas e os fatores de risco e proteção antes e após a terceira onda da COVID-19 no Brasil. Cien saúde coletiva. 2023;28(12):3659-71. doi: https://doi.org/10.1590/1413-812320232812.08252022

27. Caminha I, Andrade A, Silva L, et al. Impacto da pandemia de COVID-19 no diagnóstico de câncer de pulmão no Nordeste brasileiro. J Bras Pneumol. 2022;48(6):e20220248. doi: https://dx.doi.org/10.36416/1806-3756/e20220248

28. May L, Thompson D, Roberts T, et al. Sex differences in lung cancer. Cancers (Basel). 2023;15(12):3111. doi: https://doi.org/10.3390/cancers15123111

29. Shao SY, Liu Z, Zhang H, et al. Impact of national human development index on liver cancer outcomes: transition from 2008 to 2018. World J Gastroenterol. 2019;25(32):4749-63. doi: https://doi.org/10.3748/wjg.v25.i32.4749

30. Sadovsky ADI, Ramos NM, Silva O, et al. Índice de Desenvolvimento Humano e prevenção secundária de câncer de mama e colo do útero: um estudo ecológico. Cad Saude Publica. 2015;31(7):1539-50. doi: http://dx.doi.org/10.1590/0102-311X00073014

31. Machado F, Silva E, Lima R, et al. Socioeconomic determinants and health: an analysis of cancer incidence in Brazil. Cad Saude Publica. 2020;36(7):1539-50.

32. Van Hoogstraten LM, Pena F, Moreira A, et al. Global trends in the epidemiology of bladder cancer: challenges for public health and clinical practice. Nat Rev Clin Oncol. 2023;20(5):287-304. doi: https://doi.org/10.1038/s41571-023-00744-3

33. National Comprehensive Cancer Network (NCCN). Lung cancer screening [Internet]. [sem local]: NCCN; 2023. [acesso 2024 set 27]. Disponível em: https://www.nccn.org/patients/guidelines/content/PDF/lung_screening-patient.pdf

34. Bergamo FS, Lima J, Souza M, et al. Trends in lung cancer incidence and mortality in Brazil: a retrospective analysis. J Cancer Epidemiol. 2022;2022:101234. doi: https://doi.org/10.1016/j.jtho.2023.09.720

35. Huxley R, Loef M, Lee I, et al. Impact of smoking and smoking cessation on lung cancer mortality in the Asia-Pacific region. Am J Epidemiol. 2007;165(11):1280-6. doi: https://doi.org/10.1093/aje/kwm002

36. Painel de Indicadores – PNS: [Internet]. Rio de Janeiro: Fiocruz; 2024. [acesso 2024 set 27]. Disponível em: https://www.pns.icict.fiocruz.br/painel-de-indicadores-mobile-desktop/

37. Carvalho de Souza M, Giunta DH, Szklo AS, et al. The tobacco epidemic curve in Brazil: where are we going? Cancer Epidemiol. 2020;67:101736. doi: https://doi.org/10.1016/j.canep.2020.101736

38. Integrador RHC: Registros Hospitalares de Câncer [Internet]. Rio de Janeiro: INCA. [2012] – [acesso 2019 maio 20]. Disponível em: https://irhc.inca.gov.br

39. Fundação do Câncer. Publicações [Internet]. Rio de Janeiro: Fundação do Câncer; ©1991-2025. [acesso 2024 nov 20]. Disponível em: https://www.cancer.org.br/publicacoes/info-oncollect/#:~:text=A%20Funda%C3%A7%C3%A3o%20do%20C%C3%A2ncer%20apresenta,da%20doen%C3%A7a%20em%20nosso%20pa%C3%ADs