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Lung cancer and occupational exposure: hospital-based case-control study

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Câncer de pulmão e exposição ocupacional: estudo caso-controle de base hospitalar

Cáncer de pulmón y exposición profesional: estudio caso-control hospitalario

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ABSTRACT

Objective: To analyze the relationship between occupation and lung cancer in patients at a national referral hospital for cancer care in southern Brazil.

Method: Hospital-based case-control study conducted between February and October 2019. Occupational histories were coded according to international classifications and translated into occupations associated with lung cancer (List A and B). The odds ratios were adjusted for smoking, with a 95% confidence interval, calculated by conditional logistic regression.

Results: 99 cases and 227 controls were included. Among men, the occupation of painters (list A) was associated with lung cancer (OR = 14.3; 95% CI: 1.8-116.5), there were no occupations in list B associated with lung cancer. In women, no increased risks were found.

Conclusions: It has been shown that exposure to occupational carcinogens among repair and construction painters increases the risk of lung cancer.

Keywords: Lung neoplasms. Case-control studies. Occupational exposure. Carcinogenic substances, products and materials. Occupational health.

RESUMO

Objetivo: Analisar a relação entre ocupação e câncer de pulmão em pacientes de um hospital de referência nacional para atendimento oncológico no Sul do Brasil.

Método: Estudo caso-controle de base hospitalar realizado entre fevereiro e outubro de 2019. Os históricos ocupacionais foram codificados de acordo com classificações internacionais e traduzidos em ocupações associadas ao câncer de pulmão (Lista A e B). As odds ratios foram ajustadas para tabagismo, com intervalo de confiança de 95%, calculadas por regressão logística condicional.

Resultados: Foram incluídos 99 casos e 227 controles. Entre os homens a ocupação de pintores (lista A) estava associada ao câncer de pulmão (OR= 14,3; IC 95%: 1,8-116,5), não houve ocupações da lista B associadas ao câncer de pulmão. Nas mulheres não foram encontrados riscos aumentados.

Conclusões: Evidenciou-se que a exposição aos carcinógenos ocupacionais entre pintores de reparo e da construção civil aumentam o risco de câncer de pulmão.

Palavras-chave: Neoplasias pulmonares. Estudos de casos e controles. Exposição ocupacional. Substâncias, produtos e materiais carcinogênicos. Saúde do trabalhador.

RESUMEN

Objetivo: Analizar la relación entre la ocupación y el cáncer de pulmón en pacientes ambulatorios de un hospital nacional de referencia para la atención oncológica en el sur de Brasil.

Método: Estudio caso-control hospitalario realizado entre febrero y octubre de 2019. Se codificaron los antecedentes laborales según clasificaciones internacionales y se tradujeron a ocupaciones asociadas con el cáncer de pulmón (Lista A y B). Las *odds ratios* se ajustaron para el tabaquismo, con un intervalo de confianza del 95%, calculada por regresión logística condicional.

Resultados: se incluyeron 99 casos y 227 controles. Entre los hombres, la ocupación de pintores (lista A) se asoció con el cáncer de pulmón (OR = 14,3; IC del 95%: 1,8-116,5), no hubo ocupación de la lista B asociada con el cáncer de pulmón. En las mujeres, no se encontraron mayores riesgos.

Conclusiones: Se ha demostrado que la exposición a carcinógenos ocupacionales entre los pintores de la reparación y la construcción aumenta el riesgo de cáncer de pulmón.

Palabras clave: Neoplasias pulmonares. Estudios de casos y controles. Exposición profesional. Sustancias, productos y materiales carcinogénicos. Salud laboral.

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INTRODUCTION

Lung cancer has been the leading cause of cancer incidence and mortality worldwide, with 2.1 million new cases of lung cancer (11.6% of total cases) and 1.8 million deaths predicted in 2018, representing about one in five (18.4%) cancer deaths[1].

In Brazil,17,760 new cases are predicted in men and 12,440 in women for each year of the 2020-2022 triennium. These values correspond to incidence rates of 17.0 (men) and 11.6 (women) per 100 thousand people/year[2].

In the southern region of the country, the distribution of lung cancer incidence in men has the second highest incidence rate (31.1/100 thousand) and, in women, it is the third highest in this region (18.66/100 thousand). For the State of Paraná, a high incidence rate among men is estimated for the year 2020, from 15.96 to 17.08 per 100,000 men/year[2].

Worldwide, geographic and temporal patterns in the incidence of lung cancer disease and mortality are mainly determined by tobacco consumption, the main etiological factor in lung carcinogenesis (85 to 90%). Other risk factors, such as genetic susceptibility, poor diet, occupational exposure and air pollution, can act independently or together with smoking for this disease[3].

The most common work-related cancer is lung cancer[4], representing almost a quarter (23%) of all agent-cancer associations[5]. Several carcinogenic agents are recognized through scientific studies, among them, the agents that are present in work activities represent risk factors for the occurrence of this disease[6,7].

The most important occupational lung carcinogens are: silica, asbestos, diesel, radiation, metals such as nickel, chromium VI, arsenic, beryllium and cadmium, exposures during coke manufacturing, rubber production, smelting of iron and steel, among other circumstances[8].

In the last five decades (1971-2020), the complexity of exposure in work environments led the International Agency for Research on Cancer (IARC) to consider, in some cases, the entire work process as definitely carcinogenic or suspected for humans[5]. In this way, additional occupations, productive sector/industries or work processes are considered, classified by the IARC as Group I lung carcinogens and called complex situation: aluminum production industries; of coke; rubber; iron and steel casting; painting; hematite mining; welding vapor; Acheson process[8].

Although the relationship between occupation and certain types of tumors has been studied for many years in the world, the occupational lung tumor is largely underestimated. In researches covering several populations and industries on three continents (Asia, Europe and North America), the number of recognized cases of occupational lung cancer consists of a small fraction (<3%) of the total number of estimated cases[5].

In Brazil, in addition to a poor investigation of the occupational history of cancer patients, there are few occupational records available on occupational cancer in hospital databases or in official statistics[9], which makes it difficult to search for causality and, consequently, to elucidate cases of occupational or work-related cancer.

Studies on the relationship between cancer and occupation depend on obtaining a consistent occupational history and an adequate classification of occupational and exposure groups.

Specifically related to lung cancer, exposures are classified into two lists of industries/field of activity and occupations recognized (list A) or suspected (list B) to be associated with lung cancer[10,11], based on evaluations of carcinogenic risks described by IARC[4]. These lists are used as a standardized tool to quantify the burden of occupational lung cancer[10].

As cancer is a disease with long latency periods, the retrospective assessment of occupational exposure to carcinogens requires instruments that retrieve information about the past or recent work history of individuals that are able identify exposure to carcinogens and associate them with cancer. Therefore, this research, based on an epidemiological, case-control, hospital-based study on lung cancer related to occupational factors, made it possible to explore in depth the occupational history of the research participants, in order to assess the risk of lung cancer.

Identifying the effects of exposure to carcinogens present in the work environment and assessing the relative frequency of exposure and its risks can contribute to health surveillance and the control of this deadly disease. Therefore, the hypothesis of this research was: the risk of lung cancer is higher among individuals who had occupational exposure to some type of carcinogenic substance, when compared to individuals not exposed.

The objective was to analyze the relationship between occupation and lung cancer in patients at a national referral hospital for cancer care in southern Brazil.

METHOD

An observational, case-control, hospital-based epidemiological study. The research scenario comprised the Thorax outpatient services (cases) and Orthopedics and Physical therapy (controls) of a large philanthropic hospital located in Curitiba/PR, focusing on the clinical and surgical treatment of adult and pediatric patients with oncology from the entire South Region and also from other regions of the country, according to the specialties.

Individuals of both genders were included; residents in the State of Paraná for more than six months; patients from other states who were being followed up by the hospital for more than six months; adult patients older than 35 years (this age was chosen due to the latency time of 12 to 20 years between exposure and results). As cases, patients diagnosed or suspected of having primary lung cancer with topographic location of the tumor according to the 10th revision of the International Classification of Diseases (ICD-10) with code C34 (Malignant neoplasm of bronchus and lung) were included, including its subcategories. In the Control group were included patients treated at the same hospital for benign neoplasms or other diseases and conditions without a history or suspicion of lung cancer.

Patients with a confirmed history of previous chronic obstructive pulmonary disease were excluded; and patients or their caregivers with cognitive difficulty.

To estimate the population to be studied, data from the hospital's annual epidemiological report were used. We identified 267 patients diagnosed with lung cancer (case group) treated at the Thorax outpatient clinic in the year prior to this research, and 529 patients diagnosed with benign tumors (control group) at the Orthopedics outpatient clinic of the hospital, that same year.

The selection of controls was considered in the proportion of 2:1 (two controls for each case), with pairing by gender and age group in five years. To this end, participants in the control group were interviewed, preferably among patients at the Orthopedics outpatient clinic, and later, at the Physical therapy outpatient clinic, to add participants to the sample and reach a 2:1 proportion in a timely manner, since this outpatient clinic attended to patients referred from the Orthopedics outpatient clinic during extended hours.

The sample calculation considered the prevalence of exposure to carcinogenic substances linked to economic and occupational activities estimated at 20 to 30% among controls and an odds ratio for lung cancer from 2.0. It was considered a statistical power of 80% and a significance level of 0.05, for the proportion of 2:1, thus, an estimated sample of 140 participants in the case group was obtained, with the possibility of losses of more 10% of the sample during the research. It is observed that the sample size calculation serves to guide planning and not as an absolute condition, since the possibility of calculating adjusted odds ratios through multivariate logistic regression allows the results of the analysis to occur without loss of statistical power, even in samples smaller than the estimated.

Data collection was conducted between February and October 2019, in the hospital's outpatient services. Participants were selected by convenience sampling according to their presence at the clinics, based on the printed agenda of daily appointments for each service, and respecting the eligibility criteria, in order to minimize selection bias between cases and controls. Before and after each interview, information was collected from the electronic medical record on the diagnosis of each case, using the standard ICD-10 for diagnosis and histopathological or immunohistochemical examination for confirmation.

The participant was invited to the interview and the acceptance was confirmed after reading and signing the Free and Informed Consent Form (FICF). The interview lasted approximately 20 minutes and was conducted in a room previously defined by the hospital management, in a reserved environment, to maintain the confidentiality and integrity of the participants.

Cases and controls were personally interviewed, and the interview questionnaires were filled in by the researcher himself, based on the responses of the participant and/or his companion, if necessary.

Three types of forms were used, comprising a sociodemographic questionnaire, a general occupational questionnaire, and a specialized occupational questionnaire. As there is no validated data collection instrument for occupational exposure to the various lung carcinogens agents present in the work environment, the questionnaires were standardized and elaborated by the researchers, based on considerations described in the international literature and in national cancer surveillance guidelines related do work. After the elaboration of the questionnaires, a pilot test was performed with three patients from the case group and six controls to verify the necessary adjustments. These tests were later included in the research sample.

The first stage of the interview included a questionnaire with sociodemographic variables, smoking (tobacco use), family history of cancer and history of infectious diseases, with 17 closed questions and four open questions.

In the second stage it was included information on general occupational history and a detailed description listing all the individual's employment during lifetime, up to the time of the interview. The occupations were recorded and described by the researchers in chronological order in an open question, as the participant freely told his or her occupational history. Soon after each occupation identified in the free history, the researchers recorded in another structured question as a chart, passing along with the interviewee the information about the individual's age, year of beginning and end of the exercise in each occupation, the position held, as well as the corporate name, city and field of activity or productive sector of the company or employer.

Gaps in time between one job and another, such as unemployment, illness, work at home, or the overlapping of length of service by juxtaposition of job bonds and seasonal or temporary work periods were also investigated and recorded by the researchers. In addition, if there were significant changes in the function or production process in the working period reported by the participant, in the same company, these periods were recorded separately, highlighting the changes that occurred in working conditions.

For the last stage, the questionnaire consisted of a set of 10 specific questions (five open and five closed) focused on the occupations reported in the second stage, with exposure to lung carcinogens, which were of interest in this research. The company's activities, raw materials, final product, workers' functions, maintenance of machines, the type of construction in which they worked, the presence of gases, fumes or dust, and other information were included that could provide an indication of possible exposure to chemical or physical agents causing lung cancer.

During the interviews, the researchers used a list of occupations and carcinogens substances from Group 1 and 2 of the IARC(8), classification to assist in identifying the probable participants' occupational exposures.

During the analysis procedures, industries/field of economic activity and occupations were blindly coded with relation to case or control status by two of the authors, following the International Standard Industrial Classification of All Economic Activities (ISIC)(12) and the Standard Classification of Occupations (ISCO)(13). The codes were then translated into occupations known (list A) or suspected (list B) for being associated with lung cancer(4), according to a standard tool for the analysis of occupational lung cancer in epidemiological studies(10), and according to the code table of list A and B(11). Individuals with positions on both lists were assigned to List A, and to List B only if they had never worked in List A occupations; the reference group was identified in the analyses as never employed in occupations belonging to lists A or B.

For some occupational groups, such as painters, the ISCO code is highly specific. In these cases, no code for the industries (productive sectors) was used. In some cases, when the ISIC code seemed to represent the industry (productive sector) in question in a very specific way, it was cross-classified with the group called workers (manual workers in services, purchases, crafts and production(10).

The analyses were performed separately for each gender. For the descriptive analysis, discrete and categorical variables were described in absolute (n) and relative (%) frequencies and in median and interquartile ranges between 25 and 75% (p25-p75). The statistical tests used for the comparative analysis of the variables were the non-parametric, Mann-Whitney and Chi-Square tests. To estimate odds ratios (OR) and 95% confidence intervals (CI), conditional logistic regression was used. The following variables, which could interfere in the association between lung cancer and occupational risks, were treated as potential confounding variables and adjusted in the models: age (categories of 5 years old), education (three categories: no education, incomplete elementary and secondary school, and complete high school or college), residence, smoking (ever/never), accumulated cigarette consumption (packs/year), years since smoking cessation.

The smoking analysis performed supported the stratification of smoking in the logistic regression analyses, in order to avoid confounding bias and support the hypothesis of an independent effect between occupations and carcinogens in the work environment.

For individuals never employed in List A or List B occupations, systematic exploratory analyses were performed on unique ISIC codes (1 – 3 digits) and ISCO codes (1 – 3 and 5 digits). The results for industries/occupations were calculated for at least three male or female individuals. Statistical analyzes were performed using Stata Statistical Software-version 16.

The research was approved by the Research Ethics Committee under Opinion No.3,621,603, and presented to eligible individuals as a health survey not particularly related to cancer.

RESULTS

This research consists of 326 observations, with 99 cases (54 F and 45 M) and 227 controls (149 F and 78 M), which defines a ratio of 2.3:1 between controls and cases. In females, the proportion of controls was higher, 2.7:1, and in males, 1.7:1. The median age was higher for cases than for controls. Among cases, incomplete elementary school prevailed. Men had more jobs than women. Two-thirds of the participants were from the Municipality of Curitiba and the metropolitan region of Curitiba. (Table 1).

Among the cases, a quarter of women had never smoked, while men, only 6.7%. In both genders, current smokers accounted for more than a third (>33.3%) of cases. Almost half of the men (cases and controls) were ex-smokers and <35% of the women. The cumulative tobacco use increased from 40 packs/year in 53.3% of men (cases). The highest median of years for smoking was among men. Men had stopped smoking more time than women (Table 2).

Table 1 – Sociodemographic and occupational characteristics of cases and controls by gender. Paraná, Brazil, 2019

Characteristics	Feminine		Masculine	
	Cases (n=54)	Controls (n=149)	Cases (n=45)	Controls (n=78)
	n (%)	n (%)	n (%)	n (%)
Age (years)				
< 45	1 (1.9)	34 (22.8)	2 (4.4)	19 (24.4)
45 to 49	4 (7.4)	23 (15.4)	1 (2.2)	7 (9.0)
50 to 54	7 (13.0)	21 (14.1)	2 (4.4)	15 (19.2)
55 to 59	6 (11.1)	24 (16.1)	7 (15.6)	12 (15.4)
60 to 64	11 (20.3)	16 (10.8)	10 (22.2)	9 (11.5)
65 to 69	7 (13.0)	16 (10.8)	6 (13.4)	5 (6.4)
70 to 74	7(13.0)	9 (6.0)	7 (15.6)	6 (7.7)
75	11 (20.3)	6 (4.0)	10 (22.2)	5 (6.4)
Median (p25-p75)*	63(56.5-72,5)*	54(46-63)*	65(58.5-73)*	54(46-63)*
	P<0.001†		*P<0.001*†	
Education (years)				
< 3 (incomplete elementary)	36 (66.7)	65 (43.6)	28 (62.2)	31 (39.8)
4 a 10 (incomplete high school)	6 (11.1)	27 (18.1)	6 (13.4)	20 (25.6)
>11 (complete high school and college)	12 (22.2)	57 (38.3)	11 (24.4)	27 (34.6)
	P=0.01‡		*P=0.04*‡	
Number of employments				
1	11 (20.3)	33 (22.1)	7 (15.6)	14 (17.9)
2	21 (39.0)	56 (37.6)	6 (13.4)	12 (15.4)
3	11 (20.3)	29 (19.5)	11 (24.4)	23 (29.5)
4	5 (9.3)	16 (10.7)	10 (22.2)	23 (29.5)
>5	6 (11.1)	15 (10.1)	11 (24.4)	6 (7.7)
	P=0.88‡		*P=0.20*‡	

Table 1 – Cont.

Characteristics	Feminine		Masculine	
	Cases (n=54)	Controls (n=149)	Cases (n=45)	Controls (n=78)
	n (%)	n (%)	n (%)	n (%)
Residence				
Curitiba	22 (40.7)	54 (36.2)	23 (51.2)	36 (46.1)
Curitiba Mesoregion	21 (39.0)	39 (26.2)	11 (24.4)	16 (20.5)
South, North, West and Midwest region of Paraná	11 (20.3)	51 (34.2)	9 (20.0)	25 (32.1)
Other states (SP, SC, MT)	0 (0.0)	5 (3.4)	2 (4.4)	1 (1.3)
	P=0.55‡		*P=0.59*‡	

Source: Research data, 2021.
*Median and interquartile range (p25-p75)
† Mann-Whitney Test (P<0.05)
‡ Chi-Square Test (P<0.05)

When analyzing List A industries and occupations (Table 3), there was no association with lung cancer among women. Only two cases (one in shipbuilding and in construction industry painters) and one control (ceramics and pottery) had already been employed in occupations on the list A. Among men, seven cases (15.6%) and six controls (7.7%) had previously worked in list A occupations, with an overall OR of 4.1; after additional adjustment for education, the odds ratio remained unchanged. The risk for painters was high (OR= 14.3).

Table 2 – Distribution of cases and controls by gender, according to tobacco use. Paraná, Brazil, 2019

Variable	Female		Male	
	Cases (n=54)	Controls (n=149)	Cases (n=45)	Controls (n=78)
	n (%)	n (%)	N (%)	n (%)
Smoking				
Non-smoker	14 (25.9)	83 (55.7)	3 (6.7)	35 (44.9)
Former smoker	19 (35.1)	37 (24.8)	23 (51.1)	32 (41.0)
Smoker	21 (37.0)	29 (19.5)	19 (42.2)	11 (14.1)
	*P=0.001**		*P<0.001**	
Smoker				
Smoker and former-smoker	40 (74.1)	66 (44.3)	42 (93.3)	43 (55.1)
	*P<0.001**		*P<0.001**	

Table 2 – Cont.

Variable	Female		Male	
	Cases (n=54)	Controls (n=149)	Cases (n=45)	Controls (n=78)
	n (%)	n (%)	N (%)	n (%)
Accumulated consumption (packs/year)				
Non-smoker	14 (25.9)	83 (55.7)	3 (6.7)	35 (44.9)
< 10	6 (11.1)	34 (22.8)	4 (8.9)	15 (19.2)
10 to 19	7(13.0)	12 (8.1)	5 (11.1)	15 (19.2)
20 to 29	5 (9.2)	10 (6.7)	5 (11.1)	4 (5.1)
30 to 39	9 (16.7)	4 (2.7)	4 (8.9)	2 (2.6)
> 40	13 (24.1)	6 (4.0)	24 (53.3)	7 (9.0)
Median (p25-p75)†	19.6(14-43)†	8.0(4.0-23)†	41(21-61.3)†	10(5.0-27.5)†
	P<0.001‡		*P<0.001*‡	
Average consumption per day (cigarettes)				
Median (p25-p75)†	12.3(7.5-20)†	9.0(3.0-20)†	20(11-30)†	15.0(5.0-20)†
	P<0.001‡		*P<0.00*‡	
Smoking duration (years)				
Median (p25-p75)†	38(34-50)†	24(9-37.5)†	41(31-53.5)†	22(10-33.5)†
	P<0.001‡		*P<0.001*‡	
Time without smoking (years)				
0 or < 1	36 (66.6)	112 (75.1)	22 (48.9)	46 (59.0)
2 to 7	5 (9.3)	7 (4.7)	6 (13.3)	4 (5.1)
8 to 15	5 (9.3)	3 (2.0)	8 (17.8)	4 (5.1)
16 to 25	5 (9.3)	12 (8.1)	5 (11.1)	9 (11.6)
> 26	3 (5.5)	15 (10.1)	4 (8.9)	15 (19.2)
Median (p25-p75)†	9.0(4.0-21)†	21(13.5-31)†	12.0(6.0-22)†	22.5(15.5-34.5)†
	P=0.09‡		*P=0.04*‡	

Source: Research data, 2021.
* Chi-Square Test (P<0.05).
† Median and interquartile range (p25-p75).
‡ Mann-Whitney test (P<0.05)

For occupations of List B, the overall OR was 0.9 (95% CI: 0.2-3.4), based on five cases and 15 exposed controls (Table 4). There were few women exposed in specific occupations, except for meat workers (two cases and seven exposed controls, OR=0.7). Among men, 11 cases (24.4%) and 21 controls (27.0%) had worked in List B occupations, with no overall increased risk (OR = 0.8). There was no association between woodworkers and carpenters, nor for general transport, but a greater number of exposed people were observed in the transport sector, with five cases (11.1%) and 10 controls (12.8%).

Table 3 – Risk of lung cancer for industry (productive sector) and definitive occupations (List A) associated with lung cancer by gender. Paraná, Brazil, 2019*

Industry (ISIC-71 Code)	Occupation/Process (ISCO-68 Code)†	Cases n (%)	Controls n (%)	OR‡	95% CI	OR§	95% CI
Female		54 (26.6)	149 (73.4)				
Never worked in list A or list B industries or occupations		47 (87.0)	133 (89.3)	1.0	-	1.0	-
Worked in list A industries or occupations‖		2 (3.7)	1 (0.7)	13.5	0.6- 287.2	18.5	0.8- 412.8
Male		45 (36.6)	78 (63.4)				
Never worked in list A or list B industries or occupations		18 (40.0)	27 (34.6)	1.4	0.5-4.0	1.4	0.5-4.5
Worked in List A industries or occupations		7 (15.6)	6 (7.7)	4.1	0.8-22.6	4.1	0.7-24.5
Others							
None ISIC	Painters (construction; automobiles and other uses) (931†; 939†)	5 (11.1)	3 (3.9)	14.0	1.9- 101.9	14.3	1.8- 116.5

Source: Research data, 2021.
*Calculations were performed for occupations with at least three exposed.
† One symbol = † indicates that all 5-digit codes within that code are considered.
‡ OR calculated with logistic regression models, adjusted for age, gender, smoking and residence.
§ OR also adjusted for schooling.
‖ Occupations definitely recognized (list A) or suspected (list B) of being associated with lung cancer; refer to Ahrens and Merletti (1998) and Mirabelli et al. (2001) for definitions and exact codes.

Table 4 – Risk of lung cancer for industry (productive sector) and suspected occupations (List B) of being associated with lung cancer by gender. Paraná, Brazil, 2019*

Industry (ISIC-71 Code)	Occupation/Process (ISCO-68 Code)†	Cases n (%)	Controls n (%)	OR‡	95% CI	OR§	95% CI
Female		54 (26.6)	149 (73.4)				
Never worked in list A or list B industries or occupations		47 (87.0)	133 (89.3)	1.0	-	1.0	-
Worked in list B industries or occupations‖ (never in list A)		5 (9.3)	15 (10.1)	0.9	0.2-3.2	0.9	0.2-3.4
Food (3111) or (No ISIC)	Butchers and meat workers (workers, 45130) or (773†)	2 (3.7)	7 (4.7)	0.8	0.1-4.5	0.7	0.1-4.4
Rubber (3551, 3559) or (No ISIC)	Various occupations in rubber manufacturing (workers) or (90120-40, 90190, 902†)	1 (1.9)	3 (2.0)	1.0	0.05-21.6	1.0	0.05-21.6
Male		45 (36.6)	78 (63.4)				
Never worked in list A or list B industries or occupations		18 (40.0)	27 (34.6)	1.0	-	1.0	-
Worked in List B industries or occupations§ (never in List A)		11 (24.4)	21 (27.0)	0.9	0.2-3.0	0.8	0.2-3.4
Food (3111) or (No ISIC)	Butchers and meat workers (workers, 45130) or (773†)	1 (2.2)	4 (5.1)	0.07	0.0-3.7	0.04	0.0-9.5
Wood or wood products (No ISIC)	Carpenters, woodworkers (81†, 954†)	4 (8.9)	5 (6.4)	1.5	0.2-11.1	1.6	0.1-16.7
Transport		5 (11.1)	10 (12.8)	0.9	0.1-4.6	0.8	0.1-5.0
(No ISIC)	Bus and truck drivers (98540-60)	4 (8.9)	9 (11.5)	0.6	0.1-3.9	0.5	0.06-4.1

Source: Research data, 2021.
* Calculations were performed for occupations with at least three exposed.
† One symbol= † indicates that all 5-digit codes within that code are considered.
‡ OR calculated with logistic regression models, adjusted for age, gender, smoking and residence.
§ OR also adjusted for schooling.
‖ Occupations definitely recognized (list A) or suspected (list B) of being associated with lung cancer; refer to Ahrens and Merletti (1998) and Mirabelli et al. (2001) for definitions and exact codes.

DISCUSSION

It was sought to estimate the risk of lung cancer in industries (productive sectors) and occupations that are classified in lists A (definitely) and B (suspected) associated with lung cancer.

There was evidence of an association between painters and lung cancer. Namely, workers in the group of painters sand walls, apply wall coverings, decorative and protective coatings to articles made of wood, metal, textiles and other materials. Among the cases of painters in this research, two were from the construction industry; one painted handicraft and used automotive varnish; another was a car painter and; and the fifth case was a painter of wooden furniture. Among the controls, one was also a car painter and; and the other two, from construction industry.

However, the large number of substances that are normally present in work environments as a painter and their interdependence do not easily allow the isolation of the carcinogen agent that contributes to the development of cancer. In the case of painters, they are exposed to multiple agents, such as cadmium, chromium VI, benzene, tetrachlorethylene, gasoline, HPA, sulfur vapors, and other organic or chlorinated solvents[14].

Multiple exposure patterns are commonly found in occupational epidemiological studies[14]. The presence of several toxic substances in paints and the apparent vulnerability of workers exposed to these substances highlight the need to continually assess the effects of these exposures on the health of painters[15].

Currently there is sufficient evidence from epidemiological studies to suggest an increased risk of lung cancer in painters in the construction industry. A meta-analysis conducted in 2020 stratified the categories of painters and proved the association between painters and lung cancer. The overall OR was 1.26 (95% CI 1.09-1.44); the association was stronger for construction and repair painters[16].

The increase in risk is directly related to the activity that the worker performs, thus, discussing the activity of these painters in line with the construction sector is essential, as 50% of the painters in this research were from the construction industry sector. These are exposed to various carcinogens agents, in addition to toxins and solvents in paints. In the task of sanding walls, painters are also exposed to silica and asbestos.

Significant exposure to potential carcinogens, such as asbestos and crystalline silica, has been provided as evidence of the relationship between work and occupational cancers, including lung cancer, in commercial painters[17].

A Canadian case-control study highlights that occupational exposure to crystalline silica in the form of quartz dust in construction is omnipresent, and that most silica exposure occurs at low to moderate levels, among workers such as: painters, plumbers, plasterers and bricklayers[18].

In addition to silica, exposure to asbestos fibers is highlighted as a potential risk factor for lung cancer. A recent hospital-based case-control study supports the association of asbestos exposure and lung cancer, in which the most frequent occupation was technical workers in construction industry, followed by car mechanics and the rest in other industries that handle materials containing asbestos[19].

Another case-control study also describes that asbestos exposures can occur during the maintenance, renovation and modification of existing public, residential and commercial buildings[18].

The description of data by type of painter and tasks performed can further elucidate the role of different causative agents and have important implications for work policies and compensation for occupational cancer in painters[16]. Continued efforts to estimate the burden of occupational cancer are important as scientific evidence and economic trends evolve.

Therefore, a North American study among nearly 18,000 construction workers and Department of Energy (DOE) workers in the United States pointed to the need to include the risk of occupational exposures in clinical guidelines as an eligibility factor for lung cancer screening by low dose computed tomography (CT). In addition, the results achieved demonstrated that the risk of death from lung cancer in 5 years of work in the construction industry or in the US DOE was comparable to the risk of a personal history of cancer, a family history of cancer, or a diagnosis of chronic obstructive pulmonary disease (COPD)[20].

The data from this research, as well as from the few literatures cited, demonstrate the importance and magnitude of occupational hazards in construction industry painters and repairs in the development of lung cancer.

However, Brazil does not have specific legislation that regulates the registration and control of paints, varnishes and coating materials regarding chemical substances and their respective concentrations present in these materials, only for lead there is a law that came into force only after 2008. Thus, the other substances continue without a legal monitoring program to assess the respective concentrations present in paints and varnishes[15].

Among women, there were no occupations with three or more exposed cases for which the OR was calculated specifically for each occupation belonging to List A.

In both genders, the results related to the industries and occupations belonging to List B, that is, suspected of being associated with lung cancer, did not show an association with lung cancer. It can be assumed that, in part, these data are related to the small number of participants exposed in these occupations or because they are occupations with lower carcinogenic risk.

It is noteworthy that the data analysis from this research was restricted to economic sectors and occupations that had a minimum number of cases and controls (at least three exposed individuals). Thus, not all categories could be analyzed, some admittedly more likely to be exposed to carcinogens substances, and this limited broader comparisons with results obtained in other studies.

The small sample size, with a restricted number of cases and controls in some of the variables studied, prevented more detailed analyses and, also, small samples can estimate wide confidence intervals to demonstrate the probability that the interval contains the real value of the parameter of interest. However, these analysis restrictions imposed by the available sample can certainly be overcome in future analyses including multicenter studies, with more robust samples.

The sample selection bias of the controls in this research limited the gender matching between male cases and controls. Another limitation concerns recall bias, commonly presented in case-control studies with a retrospective approach.

CONCLUSIONS

The outcomes point out that working as a painter conferred a higher risk of developing lung cancer among the men in this research, which confirms that carcinogenic agents related to the occupation of painter, recognized for decades by the IARC, are still present in Brazilian work environments, making more emphatic the assertion of vulnerability of these painters to occupational exposures.

Due to the limited evidence from case-control studies in the country until now, research such as this one is essential to analyze the variability of carcinogenic exposures at work and may contribute to the elucidation of work-related cancers.

The results support the need for instrumentalization of health services so that they can identify the causes of diseases related to chemical agents that result in lung cancer. It is recommended the use of more accurate instruments for occupational interviews in health practice, in order to help workers' health professionals in the recognition and notification of specific occupational exposure situations, and in the actions of prevention and surveillance in worker's health, more effectively.

It is suggested that policies and strategies for environmental control and health surveillance be strengthened in workplaces where there are still hazardous exposures, over which the worker has little control.

It is also noteworthy the improvement in the information obtained and recorded in the patients' medical records, since occupational data are minimally recorded or often, not elucidated between the worker's exposures and the pathology under study. Therefore, it is suggested that universities arouse students' interest in evaluating work history and its relationship with workers' chronic diseases, such as lung cancer, and thus train professionals who recognize the binomial disease and work.

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