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Work-related cancer notifications in Brazil: an analysis of Brazilian Information System for Notifiable Diseases from 2007 to 2023

Notificações de câncer relacionado ao trabalho no Brasil: uma análise do Sistema de Informações de Agravos de Notificação, de 2007 a 2023

Abstract

Objectives: To analyze reported cases of work-related cancer in Brazil, 2007-2023, according to sociodemographic, occupational, spatial, and temporal profiles. **Methods:** A descriptive study using SINAN data, considering age, occupation, federative unit, type of cancer, work situation, and smoking, by sex. **Results:** There were 4,567 notifications in the period, far below estimates. Men accounted for 71.8% of registrations, and most registrations occurred in workers aged over 70. Non-melanoma skin, lung, prostate, and breast cancers predominated. Analysis of the types of cancer suggests an association with occupation, with the most registered occupations being professionals involved in farming, construction workers, and service workers. There was an upward trend in notifications over time. During the COVID-19 pandemic, there was a sharp drop and, from 2022 onwards, notifications began to rise again but did not return to pre-pandemic levels. Paraná and Minas Gerais led the way in terms of the number of notifications. **Conclusion:** There was an under-reporting of work-related cancer cases with regional and sex inequalities, with a concentration of cases in certain occupations and types of cancer. It is necessary to promote preventive measures in the workplace and intensify reporting.

Keywords: Occupational Cancer; Health Information Systems; Occupational Health.

Resumo

Objetivos: Analisar os casos notificados de câncer relacionado ao trabalho no Brasil, 2007-2023, segundo perfil sociodemográfico, ocupacional, espacial e temporal. **Métodos:** Estudo descritivo com dados do Sistema de Informações de Agravos de Notificação (SINAN), com estratificação por sexo. **Resultados:** Houve 4.567 notificações no período, muito abaixo das estimativas. O sexo masculino concentrou 71,8% dos registros, e a maioria dos registros se refere a casos em trabalhadores com mais de 70 anos. Predominaram os cânceres de pele não melanoma, de pulmão, de próstata e de mama. As ocupações mais frequentes foram na agropecuária, construção civil e serviços. Observou-se tendência de crescimento das notificações ao longo do tempo. Na pandemia da covid-19, houve uma redução acentuada e, a partir de 2022, as notificações voltaram a crescer, mas não retornaram aos patamares pré-pandêmicos. Paraná e Minas Gerais exibiram os maiores números de notificações. **Conclusão:** Evidenciou-se subregistro de casos de câncer relacionado ao trabalho, com desigualdades regionais e entre os sexos, havendo concentração de casos em determinadas ocupações e tipos de câncer. É necessário promover medidas de prevenção nos ambientes de trabalho e intensificar a notificação.

Palavras-chave: Câncer Ocupacional; Sistemas de Informação em Saúde; Saúde do Trabalhador.

Introduction

Work-related cancer (WRC) is caused by exposure to risk factors, agents, and situations present in the work environment and process, even after exposure has ceased¹. This condition has its frequency, onset or severity modified by work².

In Brazil, estimates by the National Cancer Institute (INCA) indicate that in the three-year period 2023-2025 there will be 704,000 new cases of cancer and that between 8% and 16% of these are due to occupational exposure. Considering the distribution by sex, it is estimated that 2.2% of cases in women and 10.8% of cases in men arise from factors related to the workplace^{3,4}.

A potentially carcinogenic occupational agent is one whose exposure can increase the incidence of malignant tumors or reduce the latency period between exposure and the onset of cancer⁵. More than 500 occupational agents of a physical, chemical, or biological nature have already been classified by the International Agency for Research on Cancer (IARC) in groups 1 (carcinogenic to humans), 2A (probably carcinogenic), or 2B (possibly carcinogenic) and are associated with various types of cancer. In addition to these, risk factors associated with the organization of work, such as night work, have also been linked to some types of cancer due to their ability to lead to dysregulation of the circadian cycle^{2,6}.

Although scientific literature recognizes the association between cancer and working conditions and that numerous carcinogens are present in various work environments, WRC is still underestimated².

In 2004, the Ministry of Health included WRC on the compulsory notification list in the Brazilian Information System for Notifiable Diseases (SINAN), but the number of records in Brazil is still low, reflecting the underreporting of work-related diseases, including WRC^{7,8}.

In addition to under-reporting, notification is uneven throughout the country. Carvalho-Filho et al.⁹ identified underreporting of WRC and variations in incidence between states in the Southeast. Dutra et al.¹⁰ observed heterogeneity in notification trends for the federative unit (FU) from 1990 to 2019.

An effective notification system can contribute to the analysis of the magnitude of the problem in workers' health, support the description of the occurrence of these diseases among workers who are exposed and at greater risk, and to better understand the causal relationships between cancer and exposure to substances present in the workplace and, consequently, subsidize actions to control and prevent this disease.

The aim of this study was to analyze the data on WRC notifications recorded on SINAN between 2007 and 2023, describing temporal and spatial trends and characterizing the sociodemographic and occupational profile of the most notified types of cancer, according to sex.

Methods

This is a descriptive cross-sectional study based on secondary data from SINAN on WRC notifications. Although compulsory notification of WRC was introduced in 2004, the data on Notifiable Diseases and Injuries in SINAN, including WRC, is only publicly available for the period 2007 onwards, and the complete series is available until 2023. Therefore, records from 2007 to 2023 coded as malignant neoplasms (codes between C00-C97) and myelodysplastic syndrome (D46), according to the International Classification of Diseases (ICD-10), were included.

The database analyzed contains direct information from SINAN and some derived variables: year of notification, FU, sex, age group, declared color/race, occupation (according to the Brazilian Classification of Occupations - CBO), work situation, specific ICD-10 diagnosis, workplace exposures, and smoking. The entire anonymized dataset supporting the results of this study is available at <https://datasus.saude.gov.br/transferencia-de-arquivos/#> and was analyzed using R¹¹.

The variable referring to workplace exposure from the SINAN database was not used in this study, since many records were not filled in or contained the term “other exposures” (without specifying the agent), which made it impossible to identify the possible carcinogens involved.

Both the temporal dimension (variation in WRC notifications over time) and the spatial dimension (distribution of notified cases by state) were considered. We also analyzed the distribution of total reported cases by sex, according to sociodemographic characteristics, occupation and smoking. A more in-depth analysis was carried out for the three most reported types of cancer among women and men.

This study was not submitted to the Research Ethics Committee because it used secondary data, in the public domain, without identifying the individuals, in accordance with Resolution 674/2022 of the National Health Council.

Results

Between 2007 and 2023, 4,567 cases of WRC were reported in Brazil, covering the different ICD-10 specific diagnoses (C00 – C97 and D46), of which 28.2% (1,286/4,567) were for females and 71.8% (3,281/4,567) for males.

The temporal evolution of WRC notifications in Brazil over the period studied is shown in **Figure 1**: the dashed line represents the total number of notifications per year and the red and blue lines represent the numbers among women and men, respectively.

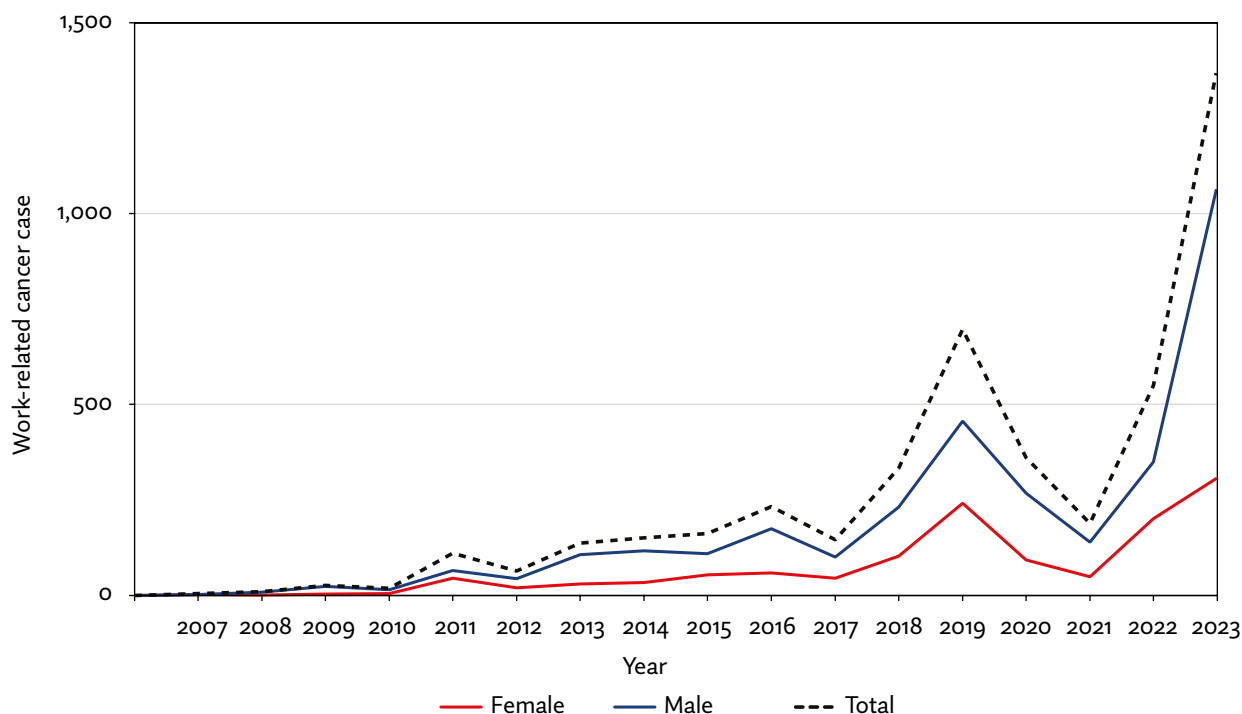


Figure 1 Temporal evolution of notified cases of work-related cancer. Brazil, SINAN, 2007-2023

Source: SINAN (Ministry of Health)

The analysis shows an upward trend in the number of notifications overall and for both sexes, with a higher number of notified cases among men than among women. Between 2007 and 2010, notifications were relatively low for both sexes, with a moderate increase from 2011 onwards. In 2017 there was a drop, mainly due to the reduction in male registrations. In 2019, there was a significant jump in registrations for both sexes, followed by a

drop in 2020. In 2022, notifications began to recover but still did not return to the levels of 2019. This only occurs in 2023, when there is a significant increase in cases registered for both sexes.

On the map of the spatial distribution of reported WRC cases, **Figure 2**, it can be seen that some states stand out with very high numbers of records, while others record few or no cases over the years.

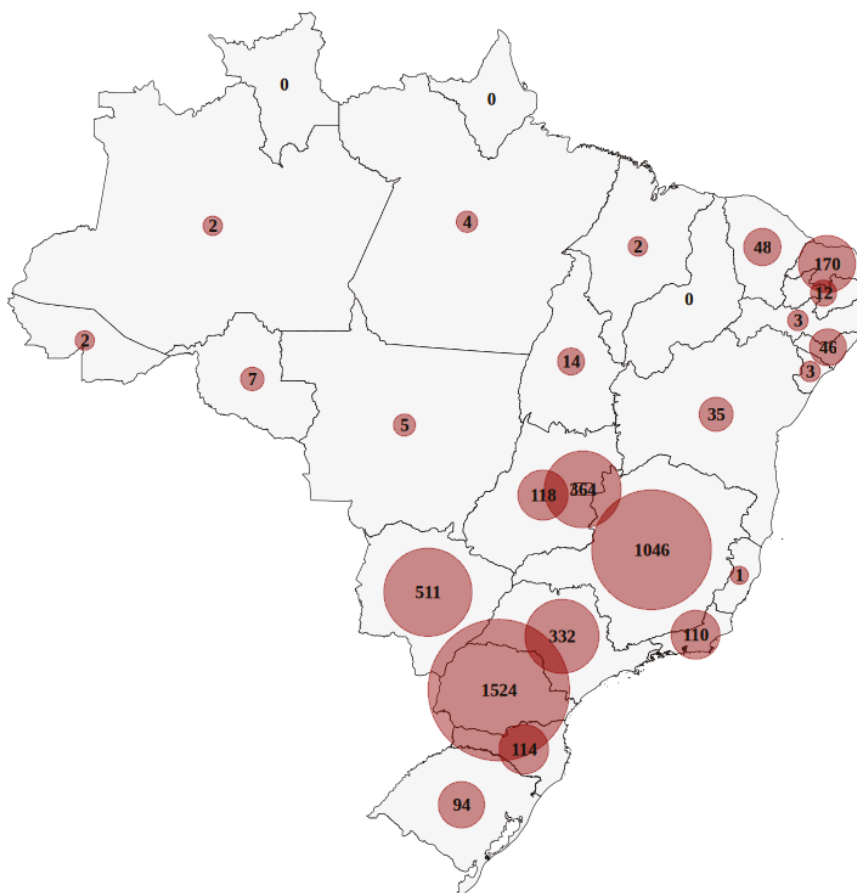


Figure 2 Spatial distribution of notified cases of work-related cancer. Brazil, SINAN, 2007-2023
Source: SINAN (Ministry of Health).

Paraná led the way in terms of the number of notifications, accounting for 33.4% of all cases, and had 29.9% of the records for women and 34.7% for men. Minas Gerais comes in second place, with 22.9% of cases, showing a significant difference between the sexes: 12.3% of records for women compared to 27.1% for men. Mato Grosso do Sul accounts for 11.2% of notifications, with a higher proportion of records relating to women (19.1% vs. 8.1% among men). The Federal District accounts for 8.0% of cases, 12.4% among women and 6.2% among men. Only 7.0% and 0.6% of cases were registered in the Northeast and North regions, respectively. Amapá, Roraima, and Piauí did not report any WRC cases in the period.

Table 1 shows how WRC notifications between 2007 and 2023 are distributed according to sociodemographic, occupational, and smoking characteristics. It can be seen that WRC cases are concentrated in people aged 70 or over (42.4%), followed by the 60 to 69 age group (27.4%) and the 50 to 59 age group (18.2%). Together, these three age groups account for 88.0% of registered cases. The distribution for both women and men follows a similar pattern.

Table 1 Sociodemographic, occupational, and smoking characteristics of work-related cancer records. Brazil, SINAN, 2007-2023

	Female		Male		Total	
	n	%	n	%	n	%
Age group						
Up to 29 years old	3	0.2	30	0.9	33	0.7
30 to 39 years old	43	3.3	75	2.3	118	2.6
40 to 49 years old	135	10.5	232	7.1	367	8.0
50 to 59 years old	249	19.4	583	17.8	832	18.2
60 to 69 years old	317	24.6	933	28.4	1250	27.4
70 or more	528	41.1	1407	42.9	1935	42.4
Not known	11	0.9	21	0.6	32	0.7
Color/race						
White	875	68.0	2183	66.5	3058	67.0
Black/Brown	261	20.3	790	24.1	1051	23.0
Other	150	11.7	308	9.4	458	10.0
Occupation						
Agricultural workers	549	42.7	1112	33.9	1661	36.4
Agricultural Producers	235	18.3	321	9.8	556	12.2
Mining and construction workers	4	0.3	584	17.8	588	12.9
Cross-functional workers	20	1.5	312	9.5	332	7.3
Service workers	198	15.4	107	3.3	305	6.7
Commercial Salespeople and Service Providers	44	3.4	69	2.1	113	2.5
Retired/Pensioner	27	2.1	74	2.2	101	2.2
Mid-Level Technicians in Administrative Sciences	11	0.9	26	0.8	37	0.8
Textile, leather, clothing, and graphic arts workers	28	2.2	29	0.9	57	1.2
Managers	8	0.6	22	0.7	30	0.6
Other	162	12.6	625	19.0	787	17.2
Employment situation						
Self-employed	479	37.2	1245	37.9	1724	37.7
Retired	337	26.2	990	30.2	1327	29.1
Registered employee with a formal contract	74	5.8	417	12.7	491	10.7
Unregistered employee	35	2.7	75	2.3	110	2.4
Freelance workers	23	1.8	36	1.1	59	1.3
Civil servant	33	2.6	35	1.1	68	1.5

Continue

Continuation						
Unemployed	17	1.3	44	1.3	61	1.3
Temporary work	13	1.0	18	0.5	31	0.7
Registered civil servant	14	1.1	25	0.8	39	0.9
Cooperative	3	0.2	13	0.4	16	0.3
Employer	1	0.1	6	0.2	7	0.2
Other	50	3.9	70	2.1	120	2.6
Ignored	207	16.1	307	9.4	514	11.3
Smoking						
Yes	141	11.0	700	21.3	841	18.4
Former smoker	210	16.3	943	28.8	1153	25.2
No	682	53.0	1120	34.1	1802	39.5
Not known	253	19.7	518	15.8	771	16.9
Total	1.286	100.0	3.281	100.0	4.567	100.0

Source: SINAN (Ministry of Health).

Most cases were among white workers (67.0%), 68.0% among women, and 66.5% among men. Black/brown records appear in 23.0% of cases (20.3% among women and 24.1% among men). Regarding smoking, 39.5% of the cases recorded were among non-smokers, corresponding to 53.0% of records among women and 34.1% among men. On the other hand, for ex-smokers this proportion was 25.2% (16.3% among women vs. 28.7% among men) and for active smokers it was 18.4% (11.0% among women vs. 21.3% among men).

Considering occupation by CBO, agricultural workers accounted for 36.4% of records, with 42.7% of all reported cases among women and 33.9% among men. Extractive industry and construction workers account for 12.9% of cases (0.3% of women vs. 17.8% of men) and agricultural producers account for 12.2% (18.3% of women vs. 9.8% of men).

Regarding work status, many of the WRC notifications were among self-employed workers, with 37.7% of the total registrations, with similar percentages in the registrations for women (37.2%) and men (37.9%). Pensioners were the second most notified group (29.1%), with 26.2% of registrations among women and 30.2% among men.

Tables 2 and 3 show the sociodemographic, occupational, and smoking characteristics of the three most frequent types of cancer in women (non-melanoma skin, breast, and lung) and men (non-melanoma skin, lung, and prostate), respectively.

Table 2 Sociodemographic, occupational, and smoking characteristics of women with work-related cancer (non-melanoma skin, lung and breast). Brazil, SINAN, 2007-2023

	Non-melanoma skin		Bronchi and lungs		Breast	
	n	%	n	%	n	%
Age group						
Up to 29 years old	1	0.2	-	-	1	0.6
30 to 39 years old	16	2.4	-	-	10	5.7
40 to 49 years old	37	5.4	2	3.5	43	24.4
50 to 59 years old	106	15.6	7	12.3	48	27.3
60 to 69 years old	154	22.6	28	49.1	40	22.7
70 or more	361	53.1	20	35.1	33	18.7
Not known	5	0.7	-	-	1	0.6
Color/race						
White	476	70.0	34	59.6	118	67.0
Black/Brown	83	12.2	23	40.4	51	29.0
Other	121	17.8	-	-	7	4.0
Federative unit						
Acre	-	-	-	-	-	-
Amapá	-	-	-	-	-	-
Amazonas	2	0.3	-	-	-	-
Pará	1	0.2	-	-	-	-
Rondônia	5	0.7	-	-	-	-
Roraima	-	-	-	-	-	-
Tocantins	3	0.4	-	-	1	0.6
Alagoas	17	2.5	-	-	-	-
Bahia	7	1.0	-	-	4	2.3
Ceará	9	1.3	-	-	2	1.1
Maranhão	1	0.2	-	-	-	-
Paraíba	3	0.4	-	-	-	-
Pernambuco	-	-	-	-	-	-
Piauí	-	-	-	-	-	-
Rio Grande do Norte	7	1.0	17	29.8	-	-
Sergipe	-	-	-	-	-	-
Distrito Federal	138	20.3	-	-	-	-
Goiás	4	0.6	-	-	-	-

Continue

Continuation						
Mato Grosso	1	0.2	-	-	-	-
Mato Grosso do Sul	243	35.7	-	-	1	0.6
Espírito Santo	-	-	-	-	-	-
Minas Gerais	118	17.4	4	7.0	-	-
Rio de Janeiro	4	0.6	5	8.8	24	13.6
São Paulo	3	0.4	2	3.5	50	28.4
Paraná	67	9.9	19	33.3	94	53.4
Rio Grande do Sul	27	4.0	-	-	-	-
Santa Catarina	20	2.9	10	17.6	-	-
Occupation						
Agricultural workers	390	57.4	9	15.8	37	21.0
Agricultural Producers	90	13.2	12	21.0	28	15.9
Mining and construction workers	1	0.2	1	1.8	-	-
Cross-functional workers	3	0.4	3	5.3	4	2.3
Service workers	83	12.2	8	14.0	45	25.6
Salespeople and Trade Service Providers	40	5.9	-	-	-	-
Pensioner	9	1.3	-	-	7	4.0
Mid-Level Technicians in Administrative Sciences	7	1.0	-	-	-	-
Workers in the Textile, Tanning, Clothing and Graphic Arts Industries	13	1.9	6	10.5	3	1.7
Managers	2	0.3	-	-	3	1.7
Other	42	6.2	18	31.6	49	27.8
Employment situation						
Self-employed	220	32.4	20	35.1	67	38.1
Retired	193	28.4	19	33.2	34	19.3
Registered employee with a formal contract	20	2.9	7	12.3	10	5.7
Unregistered employee	19	2.8	-	-	9	5.1
Freelance worker	18	2.7	2	3.5	-	-
Civil servant	17	2.5	-	-	4	2.3
Unemployed	11	1.6	1	1.8	2	1.1
Temporary work	10	1.5	-	-	2	1.1
Registered civil servant	3	0.4	1	1.8	7	4.0
Cooperative	3	0.4	-	-	-	-
Employer	-	-	-	-	-	-

Continue

Continuation						
Other	19	2.8	2	3.5	14	8.0
Unknown	147	21.6	5	8.8	27	15.3
Smoking						
Yes	61	9.0	16	28.1	24	13.6
Former smoker	73	10.7	29	50.9	34	19.3
No	325	47.8	10	17.5	107	60.8
Unknown	221	32.5	2	3.5	11	6.3
Total	680	100.0	57	100.0	176	100.0

Source: SINAN (Ministry of Health).

Table 3 Sociodemographic, occupational, and smoking characteristics of men with work-related cancer (non-melanoma skin, lung and prostate). Brazil, SINAN, 2007-2023

	Non-melanoma skin		Bronchi and lungs		Prostate	
	n	%	n	%	n	%
Age group						
Up to 29 years old	2	0.1	3	1.2	-	-
30 to 39 years old	20	1.5	1	0.4	-	-
40 to 49 years old	75	5.4	8	3.1	1	0.5
50 to 59 years old	193	14.0	50	19.5	23	11.3
60 to 69 years old	339	24.5	101	39.5	67	32.8
70 or more	744	53.8	91	35.5	113	55.4
Not known	9	0.7	2	0.8	-	-
Color/race						
White	1018	73.7	117	45.7	140	68.6
Black/Brown	185	13.4	108	42.2	56	27.5
Other	179	12.9	31	12.1	8	3.9
Federative unit						
Acre	-	-	-	-	-	-
Amapá	-	-	-	-	-	-
Amazonas	-	-	-	-	-	-
Pará	2	0.1	-	-	-	-
Rondônia	1	0.1	-	-	-	-
Roraima	-	-	-	-	-	-
Tocantins	5	0.4	-	-	-	-

Continue

Continuation						
Alagoas	24	1.7	-	-	-	-
Bahia	9	0.7	3	1.2	1	0.5
Ceará	22	1.6	-	-	1	0.5
Maranhão	-	-	-	-	-	-
Paraíba	7	0.5	-	-	-	-
Pernambuco	-	-	1	0.4	-	-
Piauí	-	-	-	-	-	-
Rio Grande do Norte	8	0.6	82	32.0	-	-
Sergipe	-	-	-	-	-	-
Distrito Federal	189	13.7	-	-	-	-
Goiás	5	0.4	8	3.1	4	2.0
Mato Grosso	1	0.1	-	-	-	-
Mato Grosso do Sul	247	17.8	3	1.2	-	-
Espírito Santo	-	-	-	-	-	-
Minas Gerais	610	44.0	18	7.0	6	2.9
Rio de Janeiro	-	-	6	2.4	14	6.9
São Paulo	8	0.6	33	12.9	24	11.8
Paraná	174	12.6	71	27.7	154	75.4
Rio Grande do Sul	40	2.9	2	0.8	-	-
Santa Catarina	30	2.2	29	11.3	-	-
Occupation						
Agricultural workers	629	45.5	49	19.1	29	14.2
Agricultural Producers	146	10.6	7	2.7	40	19.6
Mining and construction workers	224	16.2	75	29.4	23	11.3
Cross-functional workers	143	10.3	18	7.0	34	16.6
Service workers	45	3.3	6	2.3	3	1.5
Commercial Salespeople and Service Providers	39	2.8	-	-	4	2.0
Retired/Pensioner	27	2.0	-	-	16	7.8
Mid-Level Technicians in Administrative Sciences	14	1.0	-	-	-	-
Workers in the Textile, Tanning, Clothing and Graphic Arts Industries	2	0.1	5	2.0	4	2.0
Managers	9	0.7	-	-	2	1.0
Other	104	7.5	96	37.5	49	24.0

Continue

Continuation						
Employment situation						
Self-employed	555	40.2	66	25.8	67	32.8
Retired	393	28.5	95	37.1	76	37.2
Registered employee with a formal contract	98	7.1	45	17.6	35	17.1
Unregistered employee	34	2.5	4	1.6	4	2.0
Freelance worker	20	1.4	7	2.7	-	-
Civil servant	18	1.3	2	0.8	2	1.0
Unemployed	15	1.1	6	2.3	2	1.0
Temporary work	14	1.0	-	-	1	0.5
Registered civil servant	10	0.7	2	0.8	1	0.5
Cooperative	6	0.4	3	1.2	-	-
Employer	1	0.1	-	-	-	-
Other	24	1.7	8	3.1	2	1.0
Not known	194	14.0	18	7.0	14	6.9
Smoking						
Yes	232	16.8	83	32.4	29	14.2
Former smoker	270	19.5	115	44.9	89	43.6
No	539	39.0	33	12.9	76	37.3
Not known	341	24.7	25	9.8	10	4.9
Total	1.382	100.0	256	100.0	204	100.0

Source: SINAN (Ministry of Health).

Malignant non-melanoma skin neoplasm - C44

Non-melanoma skin cancer (NMSC) was the most common neoplasm, with 2,062 notifications, representing 45.2% (2,062/4,567) of all records in the period. In terms of sex distribution, NMSC accounted for 52.9% of female records (680/1,286) and 42.1% of male records (1,382/3,281).

Tables 2 and **3** show the distribution of cases of NMSC in women and men, respectively, according to the variables studied. There was a higher concentration among workers over the age of 40, especially over the age of 70, with more than 50.0% of cases in both sexes. The majority of cases of NMSC, 72.5%, occurred among white individuals, 70.0% of whom were women and 73.7% of whom were men. The spatial distribution of reported cases of NMSC follows a similar pattern to that shown in **Figure 1**, with Paraná, Minas Gerais, Mato Grosso do Sul and the Federal District also standing out, accounting for 83.2% of female records and 88.3% of male records. With regard to smoking, a large proportion of those registered were individuals who had never smoked (47.8% of women and 39.0% of men).

As for occupation, half of the cases were registered among agricultural workers^c (49.4%), followed by agricultural producers^d (11.4%), and extractive industry and construction workers (10.9%). Among women, the majority of registrations were among female agricultural workers (57.4%), followed by female agricultural producers (13.2%) and female service workers (12.2%). The distribution among men was also more frequent among agricultural workers (45.5%), followed by mining and construction workers (16.2%) and agricultural producers (10.6%).

In terms of employment, self-employed workers accounted for 37.6% of CPNM notifications, 32.4% of women and 40.2% of men. Pensioners also account for a significant proportion of cases (28.4% for both sexes).

Malignant neoplasm of the bronchi and lungs - C34

Malignant neoplasm of the bronchi and lungs accounted for 6.9% of WRC notifications in the period (313 cases), and was the third most common among women, with 4.4% of notifications (57/1,286), and the second most common among men, with 7.8% of registrations (256/3,281).

Tables 2 and 3 show that notifications of work-related bronchial and lung cancer cases are concentrated in the 60-69 and 70+ age groups. These two age groups account for 84.2% of female notifications and 75.0% of male notifications. The data shows that 48.2% of the cases were among white people, 59.6% of the female cases and 45.7% of the male cases. Black/brown individuals accounted for 41.9% of cases (40.4% among women and 42.2% among men). The spatial distribution of reported lung cancer cases shows that the states of Rio Grande do Norte and Paraná accounted for 63.2% of female cases and 59.8% of male cases. With regard to smoking, 46.0% of records were among ex-smokers (50.9% among women and 44.9% among men) and 31.6% among active smokers (28.1% among women and 32.4% among men). Individuals with no history of smoking accounted for only 13.7% of registrations in the period (17.5% for women and 12.9% for men).

The distribution by occupation shows that workers in the mining and construction industries accounted for 24.3% of the records for this neoplasm, followed by agricultural workers, with 18.5% of notifications. Among women, 21.1% of registrations were among agricultural producers, 15.8% for agricultural workers and 14.0% for service workers. Among men, the most frequent registrations were among extractive industry and construction workers, with 29.3% of registered cases, followed by agricultural workers, 19.1%, and metal and composite processing workers, 7.4% of registrations.

In terms of work status, 36.4% of bronchial and lung cancer cases were among retired people, 33.3% among women and 37.1% among men. Among active workers, cases of this neoplasm were more frequent among the self-employed, with 27.5% of records (35.1% among women and 25.8% among men).

Malignant neoplasm of the breast - C50

Breast cancer was the second most registered type of WRC among women, accounting for 13.7% of all female registrations between 2007 and 2023 (176/1,286) and occurring among women aged 50 to 59 (27.3%), 40 to 49 (24.4%) and 60 to 69 (22.7%).

Table 2 shows a predominance of registrations among white female workers, with 67.0% of all female notifications. The spatial distribution of notified breast cancer cases shows that the state of Paraná stands out with 53.2% of

^c They treat livestock and look after their reproduction, prepare the soil for planting and manage cultivation areas, carry out maintenance on the property, and process and organize agricultural products for sale. Only those who work in both agricultural and livestock activities are classified under this heading.

^d They plant crops and raise animals, they set up infrastructure and manage agricultural property, they manage human resources, they process and market plant and animal products.

registrations. As for smoking, 60.8% of the records were among non-smokers, 19.3% among ex-smokers and 13.6% among smokers.

Also in this table, the distribution of breast cancer records showed that female service sector workers accounted for 25.6% of cases, followed by female agricultural workers (21.0%), female agricultural extraction workers (15.9%) and female mid-level technicians in the biological and health sciences (9.7% of records).

In terms of employment status, self-employed women accounted for 38.1% of the records. Retired women were the second group with the most notifications, accounting for 19.3% of female cases. With regard to female workers with an employment contract, the percentages of cases registered among those with a formal contract and those without were similar, 5.7% and 5.1% respectively.

Malignant neoplasm of the prostate - C61

The third most reported type of WRC among men was prostate cancer, corresponding to 6.2% (204/3,281) of all male registrations in the period.

Table 3 shows that the first records of this neoplasm began to appear after the age of 40, albeit in a minimal proportion (0.5% in the 40-49 age group). The number increases from the age of 50, reaching 11.3% in the 50 to 59 age group. However, it is from the age of 60 onwards that we see the highest concentration of registered cases: 32.8% in the 60 to 69 age group and 55.4% in men aged 70 or over. Together, these last two age groups account for 88.2% of all reported cases of this neoplasm.

White men account for the majority of cases (68.6%), while black/brown men account for 27.5% of cases. The spatial distribution of reported cases of prostate cancer also shows the state of Paraná in the spotlight, with 75.5% of the records. With regard to smoking, ex-smokers represented the largest group, with 43.6% of the records. Non-smokers also had a considerable share of cases (37.3%). Among active smokers, the percentage was 14.2%.

Farmers accounted for 19.6% of prostate cancer registrations, followed by cross-functional workers^e (16.7%) and farm workers (14.2%).

Considering the work situation in WRT records, retirees represented the group most affected by this neoplasm (37.3% of cases), followed by self-employed workers (32.8%) and formal workers with a formal contract (17.2%).

Discussion

The study shows significant inequalities in the notification of WRC in Brazil. Analysis of SINAN data between 2007 and 2023 reveals a low frequency of registrations and differences in sociodemographic, regional and occupational profiles.

In 2020, the first year of the COVID-19 pandemic, there was a significant drop in notifications compared to previous years, probably due to the difficulty in accessing diagnostic and notification services during this period. The higher concentration of registrations for males throughout the period follows the pattern observed in other studies in Brazil, which indicate a higher occurrence of WRC among men⁹. The inequality in registrations by state can be explained, in part, by the specificities of the epidemiological surveillance system for WRC implemented locally, such as the case of Minas Gerais, which in 2019 adopted specific actions aimed at registering WRC, resulting in a clear increase in notifications in the state⁷. This shows that the WRC investigation/notification process can be implemented in each state/municipality through actions aimed at certain types of cancer that local teams consider a priority for surveillance.

^e Cross-functional workers include supervisors of packaging and labeling workers, robot and special equipment operators, vehicle drivers and operators of lifting and load handling equipment, rail shunting and load handling workers and production packers and feeders.

Studies estimate that 8% to 16% of all cancer cases are work-related³. Applying this estimate to the 704,000 cases expected for the three-year period 2023-2025 in Brazil⁴, a much higher number of notifications would be expected than the 4,567 cases recorded in 17 years, indicating significant underreporting on SINAN. According to Andrade et al.⁷, underreporting on SINAN has various causes associated with problems in diagnosing and identifying cases, the complexity of pathologies and service routines, among others. In the specific case of WRC, they add that the lack of knowledge about occupational carcinogens and the length of time between exposure and the occurrence of cancer are factors that make it even more difficult to establish a causal link, thus increasing underreporting.

The concentration of notifications in people over 60 reinforces the possible association with longer exposure to carcinogenic factors in the workplace and age as a risk factor for various types of cancer^{9,12}. The predominance of records in white individuals may be due to the concentration of notifications in the South and Southeast regions, areas with a higher proportion of white population¹³. Smoking is a significant risk factor for several types of cancer, especially lung cancer^{4,14,15}, although its relationship with some types, such as skin and breast cancer, is controversial¹⁶⁻¹⁸. The potential interaction between occupational exposure and smoking must be considered in a relevant way in the case of WRC¹⁹⁻²¹. As an example of this interaction, Algranti²¹ highlights the synergistic association between smoking and exposure to asbestos for lung cancer.

The volume of WRC records among agricultural workers, in both sexes, suggests the influence of exposure to pesticides. Many of these products, widely used in Brazilian agriculture, are classified by the IARC as carcinogenic or potentially carcinogenic to humans. Specifically for skin, prostate and breast cancers, there is scientific evidence associating exposure to pesticides with an increased risk of the disease^{16,22}.

The relatively high number of records among retirees reinforces the issue of the prolonged latency period of cancer, as well as the possible cumulative effect of some occupational exposures^{23, 24}.

Non-melanoma skin cancer is the most common cancer in Brazil, affecting men and women of adult age in similar proportions, and cumulative exposure to ultraviolet rays is the main risk factor^{4,23-26}. According to the IARC, prolonged and continuous exposure to ultraviolet radiation is classified as Group 1 (proven carcinogenic to humans)¹⁶. As found in this study, the literature shows that fair-skinned individuals are more susceptible to developing this type of cancer, especially those with a history of prolonged exposure to the sun^{18,23}. Workers whose activities are carried out over a long period of time exposed to the sun, such as those in agriculture and construction, have a higher risk of being affected by this type of neoplasm, which suggests that chronic cumulative exposure to ultraviolet radiation is involved in the genesis of the disease^{23,26}.

Occupational exposure to pesticides may also contribute to the higher number of cases of NMSC among agricultural workers and producers. In Brazil, pesticides are commonly used in agricultural practice and these compounds often contain components that are carcinogenic¹⁹. In addition, some chemical products present as impurities in many pesticides, such as arsenic and its compounds, can also cause NMSC^{23,27}. Lee et al.²³ add that combined exposure to arsenic and UV radiation potentiates the carcinogenic effects of UV radiation, increasing the likelihood of genetic mutations and the development of non-melanoma skin cancer. Despite the absence of information on exposure to pesticides in the WRC investigation form on SINAN, the hypothesis of an association with the onset of NMSC should be considered, especially given the high number of reported cases of this cancer among professionals involved in agricultural exploitation.

Lung cancer, the third most common cancer recorded on SINAN among women and the second most common among men, has smoking as its main risk factor^{4,14,15}, responsible for 80-85% of cases diagnosed worldwide¹⁴. Estimates suggest that between 17% and 29% of cases of this neoplasm are related to occupational exposure²⁸. Considering INCA's estimate of 32,560 new cases of this type of cancer for 2023⁴, between 5,500 and 9,400 cases of work-related lung cancer were expected in Brazil in 2023, a much higher number than that recorded over the 17 years studied here, which was 313 notifications (72 records in 2023). Worldwide, there is a downward trend in lung cancer incidence rates among men and an increase among women, which may be associated with the pattern of smoking behavior between the sexes^{4,29}.

It is well known that working in the construction industry is considered a risk factor for lung cancer^{2,14}. This branch of activity concentrates male workers, which may be contributing to the large difference in the number of records between the sexes (one female record vs. 75 male records). The number of reports of lung cancer among agricultural workers may be related to exposure to pesticides, many of which are classified as carcinogens^{14,22}. The herbicide monosodium acid methane-arsenate, also known as MSMA, authorized in Brazil for tobacco cultivation, and the insecticide diazinone, used on various agricultural crops, are associated with an increased risk of lung cancer²².

Breast cancer was the second most common type of WRC among women, with a predominance of white women, which is in line with the literature, although it is worth mentioning that the most aggressive forms are diagnosed among black and brown women^{2,3,6,30}. We found a higher frequency of breast cancer registrations among women who did not smoke. Smoking is considered by the IARC to be an agent with limited evidence of association with breast cancer¹⁸. Genetic, hereditary, reproductive, excess weight, hormone therapy and so-called environmental and occupational factors are prominent in the genesis of this neoplasm.

In the occupational sphere, exposure to pesticides, radiation and night work are the main risk agents^{2,18}. This study found that female workers in the service sector and those involved in agricultural activities accounted for the majority of breast cancer cases. The higher frequency of records among female workers in the service sector may be associated with night work, since night work is more common in the service sector than in industrial sectors³¹. Among female night shift workers, Nogueira et al.³² found a predominance in service sector activities, with 25.8% of mid-level health professionals. According to the IARC¹⁶, night work is classified in Group 2A (potentially carcinogenic). One of the most widely accepted mechanisms for this association is that exposure to artificial light at night suppresses melatonin production, which influences hormone production and consequently increases the chance of breast cancer⁶. The relatively high percentage of records of this neoplasm among professionals involved in agricultural extraction may be associated with the use of pesticides, which is one of the factors related to breast cancer^{2,22,3}.

The third most reported type of WRC among men was prostate cancer. Worldwide, it is the second most common type of cancer in men, second only to NMSC^{2,12}. Estimates indicate that 1% of prostate cancer cases are work-related². Considering that the estimated number of new cases of this type of cancer is 71,730 for 2023⁴, an approximate total of 717 cases was expected that year, a much higher figure than that recorded over the 17 years studied here, which was 204 notifications (48 records in 2023).

Age is an important risk factor for prostate cancer, since around 75% of new cases worldwide occur after the age of 65^{4,12}. Following this trend, this study found that the majority of prostate cancer registrations occurred among workers over the age of 65. Smoking and occupational exposure to pesticides are considered risk factors for prostate cancer^{22,34,35}.

This study has some limitations, mainly related to the quality and completeness of the data from SINAN. The incomplete filling in of variables, such as occupation, work situation and occupational exposures, makes it difficult to infer whether the reported cancers were the result of occupational exposures or whether they are related to other factors. In addition, the underreporting of WRC cases and the inconsistency in records between different federative units compromise a better estimate of this disease in the country. In statistical terms, these data, as they are recorded, do not provide the necessary structure for causal inference, but they have allowed us to describe the profile of WRC notifications, pointing out trends and hypotheses.

Conclusion

The analysis of SINAN data between 2007 and 2023 shows that the number of WRC notifications is lower than expected, with more frequent registrations among men. There is an upward trend in notifications, with a significant drop during the COVID-19 pandemic, suggesting the vulnerability of the information and surveillance system to health emergencies. Regional inequalities in registrations are striking, with a concentration of WRC registrations in the South and Southeast, while some states in the Northeast and North have no notifications.

Non-melanoma skin cancer was the most reported cancer for both sexes, followed by lung cancer, with prostate cancer for men and breast cancer for women also recorded. Analysis of the types of cancer suggests an association with occupation, with the most recorded occupations being professionals involved in agricultural activities construction workers and service workers. The high percentage of records of these types of cancer among professionals involved in farming highlights the issue of occupational exposure to pesticides as a risk factor. Effective public policies aimed at controlling and regulating the use of agrochemicals are essential to promote the reduction of exposure to agrochemicals in work environments and the consequent prevention of WRC.

In the case of women, breast cancer was also reported more frequently in the service sector, which may be associated with night work. Future studies could help to elucidate this hypothesis, since SINAN data does not allow this relationship to be gauged directly.

Bearing in mind that underreporting is high and unequivocal, there is a need to establish measures to implement and strengthen reporting services throughout the country, which will contribute to the creation of a real epidemiological profile of WRC at a national level.

Considering that exposure to carcinogens in the workplace can be reduced or even eliminated through prevention and control measures, an efficient information system plays a fundamental role in improving surveillance actions and, consequently, acting to prevent WRC.

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