

PATTERNS OF WORK-RELATED CANCER IN BRAZIL: A 19-YEAR ANALYSIS WITH EMPHASIS ON HEALTHCARE WORKERS

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ABSTRACT: **Background:** Work-related cancer (WRC) is underdiagnosed and underreported due to the difficulty of establishing a causal relationship between occupational exposure and disease. Healthcare professionals exposed to antineoplastic agents, particularly nurses and pharmacists, represent a high-risk group that remains insufficiently investigated in epidemiological surveillance. **Methods:** An observational, retrospective, longitudinal, ecological epidemiological study was conducted using secondary data from the Notifiable Diseases Information System (SINAN/DATASUS), covering WRC notifications in Brazil from 2007 to 2025. The temporal, geographical, demographic and occupational distributions were analyzed, with particular emphasis on healthcare professionals exposed to antineoplastic agents. The variables were described using absolute and relative frequencies. **Results:** A total of 8,413 WRC notifications were identified during the study period. Skin, breast and lung cancers were the main diagnoses; agricultural workers accounted for the highest absolute number of cases. Men aged 50–79 years predominated, with the highest concentration of cases in the South and Southeast regions. Among healthcare professionals, nursing notifications increased gradually after 2018; however, only 30 cases were attributed to exposure to antineoplastic agents, including nine among nurses and none among pharmacists. These findings reveal a discrepancy between the low number of notifications and the evidence identifying these professionals as a high-risk group, suggesting underreporting and weaknesses in surveillance. **Conclusions:** Strengthening WRC surveillance requires improved training for reporting professionals, more thorough occupational investigations and more comprehensive records in SINAN, thereby supporting policies aimed at preventing occupational cancer and protecting the health of workers exposed to carcinogens, particularly in oncology and the agricultural sector.

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INTRODUCTION

Work-related cancer (WRC) represents a major public health concern, particularly among workers chronically exposed to potentially carcinogenic chemical, physical and biological agents. It is estimated that between 3% and 8% of cancer cases are associated with occupational exposure. Despite its relevance, WRC remains frequently underdiagnosed and overlooked, particularly because of the difficulties involved in establishing a causal relationship, the long latency period of the disease and limited risk awareness among workers and employers [1].

The underreporting of WRC cases undermines the development of public policies aimed at workers' health, hindering the implementation of strategies for prevention, monitoring and the reduction of occupational exposure. Moreover, it weakens the ability of surveillance systems to identify higher-risk groups and monitor epidemiological trends related to occupational diseases [2].

In this context, occupational health and safety services play a fundamental role in monitoring workers' occupational histories through the documentation of occupational exposures, the duration of contact with hazardous agents and the control measures implemented in the workplace. Such information is essential for the development of epidemiological studies and for strengthening surveillance activities related to WRC [3].

Brazil has a highly diverse economy and workforce, exposing different groups of workers to multiple potentially carcinogenic agents according to the economic sector and the activities performed. The main types of cancer associated with occupational exposure include lung, skin, breast and bladder cancers, which are frequently associated with prolonged exposure to chemicals, radiation and other hazardous agents present in the workplace [4].

In order to strengthen the epidemiological surveillance of this condition, the Brazilian Ministry of Health established compulsory notification of work-related cancer cases through Ordinance GM/MS No. 5,201/2024 [5]. In Brazil, these cases are recorded in the Notifiable Diseases Information System (Sistema de Informação de Agravos de Notificação – SINAN), which is populated by healthcare professionals throughout the country. The system enables the monitoring of suspected and confirmed cases, contributing to the identification of epidemiological patterns and supporting the planning of prevention and control measures aimed at improving workers' health [6].

In addition, Brazil continues to face significant weaknesses in the reporting of WRC cases to SINAN. The main factors associated with underreporting include difficulties in establishing a causal relationship between occupational exposure and cancer development, the long latency period of the disease, technical limitations among professionals responsible for case investigations, and inconsistencies in the completion of notification forms and epidemiological investigation records [7].

In addition to exposure to well-established carcinogenic agents, such as asbestos, silica and benzene, other potentially harmful compounds may also pose risks to workers' health. In this context, antineoplastic drugs are particularly noteworthy, as they are widely used in oncology services and are regarded as potentially carcinogenic, mutagenic and teratogenic substances. Healthcare professionals, particularly nurses and pharmacists involved in the preparation and administration of these medicines, may be continuously exposed to them in the workplace as a result of their occupational activities [8].

Against this background, there is a paucity of comprehensive national studies on WRC, particularly those addressing the exposure of healthcare professionals to antineoplastic drugs. Despite the occupational plausibility of these risks, epidemiological evidence remains limited regarding the magnitude of the problem and the identification of potential gaps in surveillance and reporting systems. In this regard, further investigation of the subject is essential to strengthen strategies for the prevention, monitoring and protection of the health of workers exposed to occupational hazards in the workplace.

Accordingly, this study aimed to analyse the geographical, demographic and occupational distribution of WRC notifications in Brazil between 2007 and 2025, identifying the main occupational groups, cancer types and potential reporting gaps, with particular attention to nurses and pharmacists occupationally exposed to antineoplastic drugs.

METHODS

This was an observational, retrospective, longitudinal and ecological epidemiological study based on secondary data obtained from the Department of Informatics of the Brazilian Unified Health System (DATASUS) using the TabNet data tabulation tool. Notifications of work-related cancer (WRC) recorded in the Notifiable Diseases Information System (SINAN) between 2007 and 2025 were analyzed.

Data were collected in April 2026 from the “Notifiable Diseases and Conditions – 2007 onward (SINAN)” section, using the search term “work-related cancer”. All notifications available in the system during the study period were included. Given the inherent time lag between notification and consolidation of records within the system, data for 2024 and 2025 may be underestimated compared with those from previous years.

The variables analyzed were categorised as follows: demographic variables (sex, age group and race/skin color), occupational variables (occupation and exposure to antineoplastic drugs), clinical variables (International Classification of Diseases – ICD) and geographical variables (federative unit in which the notification was recorded).

The data were organized in electronic spreadsheets and analyzed using descriptive statistics, with absolute and relative frequencies. Indicators were presented at both national and federative-unit levels.

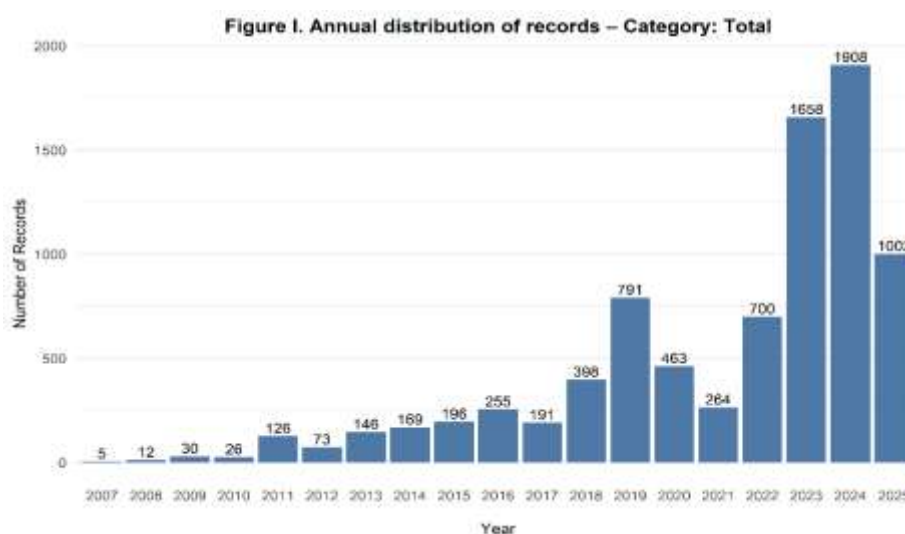
As this study used secondary, publicly available data with no identification of participants, review by a Research Ethics Committee was not required, in accordance with Resolution No. 510/2016 of the Brazilian National Health Council.

RESULTS

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This study identified a total of 8,413 WRC cases in Brazil between 2007 and 2025, based on data retrieved in April 2026 from the DATASUS/TabNet/SINAN system, which provides the country's official data, as shown in Figure 1.

Figure 1: Temporal distribution of WRC notifications in Brazil, 2007–2025 [9].



Percentages were calculated based on the overall number of WRC notifications (8,413 records) reported to SINAN between 2007 and 2025 (Tables 1 and 2).

Table 1 presents an analysis of the five main types of neoplasm associated with WRC, whereas Table 2 focuses on the five main occupational groups associated with WRC.

Table I: Representation of the distribution of the five main ICDs recorded to classify WRC [9].

Rank	ICD	Type of Neoplasm	Total cases	%
1	C44	Other malignant skin neoplasms	2,999	35.6
2	C50	Malignant neoplasm of the breast	583	6.9
3	C34	Malignant neoplasm of the bronchi and lungs	477	5.7
4	C61	Malignant neoplasm of the prostate	413	4.9
5	C16	Malignant neoplasm of the stomach	244	2.9

Source: Ministry of Health – Notifiable Diseases Information System (Sinan Net). The categories "White or Unknown", "Brazilian Classification of Occupations without definition" and "Not informed" were excluded. Total number of notifications during the study period: 8,413.

Data obtained from SINAN included 97 different International Classification of Diseases (ICD) categories among workers with WRC. Similarly, analysis of the occupations recorded identified 639 different occupational categories, with the majority of notifications involving agricultural workers, a group that represents one of the largest segments of the Brazilian workforce.

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Table II: Representation of the distribution of the five main occupational categories with WRC notifications [9].

Rank	Occupation	Number of records	%
1	Agricultural worker in general	2,237	26.6
2	Multipurpose agricultural producer	750	8.9
3	Agricultural mobile worker	667	7.9
4	Bricklayer	605	7.2

Rank	Occupation	Number of records	%
			2.9
5	Truck Driver (regional and international routes)	241	

Source: Ministry of Health – Notifiable Diseases Information System (Sinan Net). The categories "White or Unknown", "Brazilian Classification of Occupations without definition" and "Not informed" were excluded. Total number of notifications during the study period: 8,413.

The data presented in Table 3 show a concentration of WRC diagnoses in older age groups, with the highest frequencies observed among individuals aged 65–79 years (38.0%) and 50–64 years (35.1%). Younger age groups accounted for a smaller proportion of cases, particularly among individuals under 35 years of age. A marked predominance of diagnoses was observed among males (67.5%), whereas females accounted for 32.5%. Analysis by race/skin color showed a predominance of self-identified White individuals (68.8%), followed by Brown (Pardo) individuals (18.4%) and Black individuals (5.4%). The Yellow (0.6%) and Indigenous (0.2%) categories were less represented.

Table III: Demographic characteristics of reported cases of work-related cancer (CRT) in Brazil, 2007–2025 [9].

Feature	n	%
Age group		
<1 year	32	0.4
5–9	1	0.0
10–14	1	0.0
15–19	6	0.1
20–34	184	2.2
35–49	1,055	12.5
50–64	2,955	35.1
65–79	3,198	38.0
80+	981	11.7

Sex

Male	5,681	67.5
Female	2,731	32.5
Ignored	1	0.0

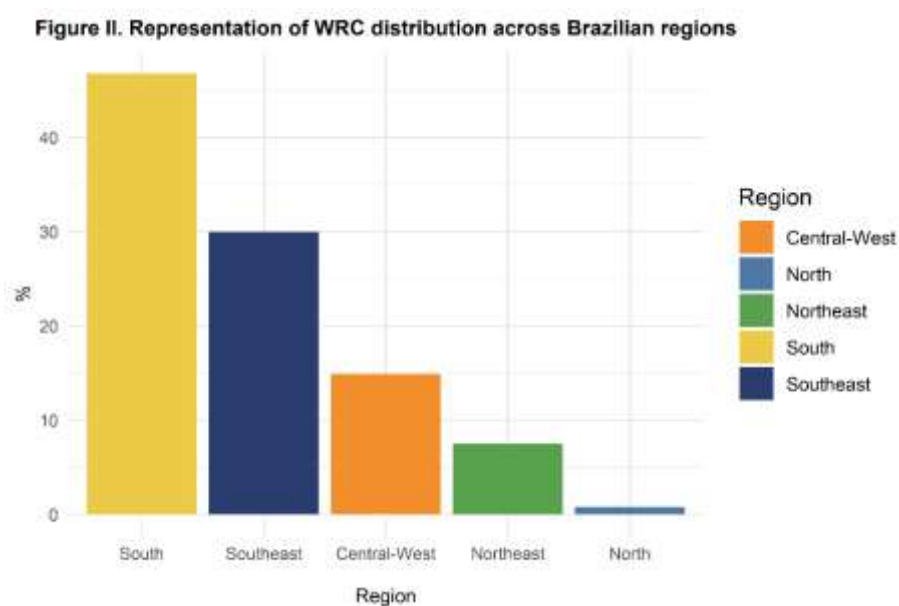
Race/Skin color

White	5,789	68.8
Brown (Pardo)	1,549	18.4
Ignored/Blank	559	6.6
Black	453	5.4
Yellow	50	0.6
Indigenous	13	0.2

The data presented in Figure 2 show a marked concentration of WRC notifications in the South region of Brazil, which accounted for 46.8% of cases, followed by the Southeast (30.0%) and Central-West (14.9%) regions. The Northeast (7.5%) and North (0.8%) regions accounted for significantly smaller proportions of cases.

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Figure 2: Distribution of WRC cases across the Brazilian regions [9].



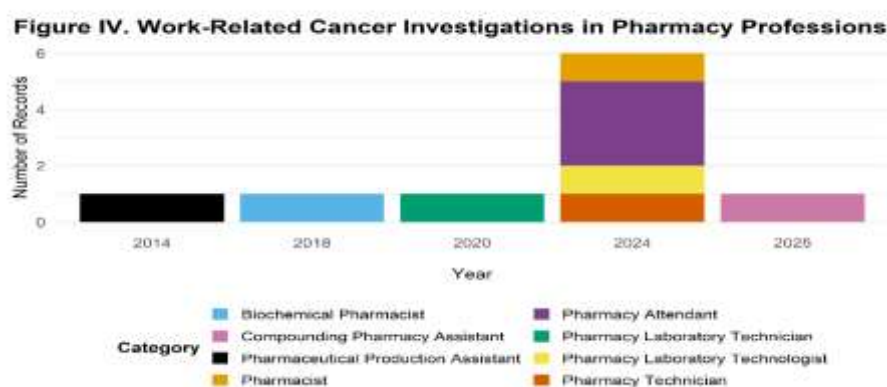
Another important aspect of WRC concerns healthcare professionals who routinely handle hazardous drugs, particularly nursing professionals and those working in oncology pharmacy.

As shown in Figure 3, no records were identified between 2007 and 2010, followed by a low number of notifications between 2011 and 2017. From 2018 onward, a gradual increase was observed, continuing through 2019. A more pronounced increase was observed after 2022, resulting in a greater concentration of notifications during this period and reaching a peak of 27 notifications in 2024. A reduction in the number of notifications was observed in 2025; however, this finding should be interpreted with caution, as it may reflect data that have not yet been fully consolidated owing to the time lag between notification and data consolidation within the system, rather than necessarily indicating a decline in incidence.

Figure 3: Temporal distribution of the number of WRC notifications among nursing professionals in Brazil between 2011 and 2025 [9].



Figure 4: Distribution of the number of WRC cases among pharmacy professionals [9].



The distribution of WRC associated with exposure to antineoplastic drugs comprised a total of 30 cases over the 19-year study period. Of these, nine records involved nursing professionals, whereas no cases were recorded among pharmacy professionals.

DISCUSSION

This study provides a national overview of WRC notifications in Brazil, highlighting important disparities related to gender, regional distribution and occupational exposure, as well as limitations in epidemiological surveillance systems. The findings reinforce the complexity involved in recognizing and monitoring occupational cancer and also highlight significant challenges in the identification, investigation and reporting of suspected and confirmed cases in the Brazilian context.

Considering that the Brazilian population was estimated at 213,421,037 inhabitants in 2025, according to data published by the Brazilian Institute of Geography and Statistics [10], the 8,413 WRC notifications recorded over the study period represent a very small proportion, supporting the hypothesis that the cases under study are subject to underdiagnosis and underreporting.

Against this background, occupational cancer represents a major public health concern worldwide. In Europe alone, approximately 120,000 new cases and 80,000 deaths are estimated to be associated with occupational exposure, although only a small proportion of these cases are officially recognized as work-related diseases [11]. Similarly, previous studies indicate that between 2% and 8% of all cancer diagnoses are associated with occupational exposures [1-8]. Nevertheless, WRC remains widely underdiagnosed and underreported in several countries.

In Brazil, compulsory notification of WRC cases has been recommended since 2004. However, many healthcare services have not yet fully incorporated this practice because of operational difficulties and limitations related to the investigation process, highlighting the need for the continuous updating of national and international guidelines [8-12].

This situation differs from that observed in countries such as Malaysia, where case notification depends exclusively on the clinical judgment of healthcare professionals and is not mandatory [3].

These differences demonstrate the heterogeneity of occupational cancer surveillance systems internationally and reinforce the need to strengthen notification strategies worldwide [8].

In addition, skin cancer is the most commonly diagnosed type of cancer worldwide overall, with unprotected exposure to ultraviolet radiation being a major risk factor that is often overlooked by occupational health and safety services. When cancer is considered from an occupational perspective, this pattern remains unchanged, as the highest number of WRC notifications was associated with skin neoplasms ($N = 2,999$), according to Brazilian notification data [13].

Consistent with Brazilian WRC data, lung cancer ranks third among neoplasms globally, as it does among national notifications of work-related cases of this disease ($N = 477$) [14].

The types of cancer identified are also associated with the occupational activities accounting for the highest numbers of WRC notifications in Brazil. Occupational activities involving cumulative exposure to chemical substances such as pesticides, insecticides, organic solvents and paints, which are characteristic of the occupations listed in Table 2, may involve carcinogenic exposures in the workplace over time [15]. However, the higher absolute number of notifications in these occupational categories also reflects the substantial size of this workforce nationally. Therefore, the observed data should not be interpreted in isolation as direct indicators of a higher relative risk to workers.

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The predominance of males observed in this study may be related to the greater participation of men in occupations historically associated with exposure to potentially carcinogenic agents, such as agriculture, construction, transport and industrial sectors involving physical, chemical and environmental hazards [11]. These occupational environments frequently expose workers to substances such as asbestos, silica, pesticides, hydrocarbons and heavy metals, which are recognized as being associated with the development of neoplasms [16-17-18-19].

With regard to age, the higher frequency of cases among individuals aged 50 years or older is consistent with the cumulative nature of occupational exposure and the long latency period characteristic of cancer development. The latency period represents one of the main limiting factors in establishing a causal relationship between occupational exposure and a cancer diagnosis. For solid tumors, this interval may exceed 20 years, whereas for haematological malignancies it may exceed five years, requiring a detailed investigation of the duration of exposure, the substances involved and the use of personal protective equipment [12].

Some types of occupational cancer may have even longer latency periods. Mesothelioma cases, for example, frequently have a latency period exceeding 15 years, with an average of approximately 32 years. Similarly, lung cancer associated with asbestos exposure may have a latency period ranging from 10 to 40 years [20]. These findings reinforce the need for continuous surveillance strategies and systematic follow-up of workers previously exposed to carcinogenic agents throughout their working lives.

Conversely, a small proportion of WRC cases were reported among children, as shown in Table 3. In this regard, exposure during the prenatal period may affect the fetus and subsequently result in a confirmed case of WRC. This process may continue during the postnatal period, when the child is exclusively breastfed. If the mother is occupationally exposed, breast milk may become contaminated [21].

The regional inequalities identified in this study suggest not only differences in occupational exposure profiles across Brazilian regions, but also important disparities in diagnostic capacity, epidemiological surveillance and notification systems. Although the official figures reported by the Ministry of Health between 2007 and 2025 may not appear alarming in absolute terms, it is important to recognize the existing difficulties in reporting suspected WRC cases through SINAN.

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Difficulties in establishing a causal relationship between occupational exposure and cancer are frequently associated with the absence of a detailed occupational history, insufficient information in medical records and limitations in exposure investigation processes [22]. Furthermore, the omission of relevant data and the limited consolidation of public policies addressing occupational cancer compromise the quality of epidemiological analyses and hinder the development of more effective preventive strategies [23].

Operational and technical limitations within healthcare services also contribute to the underreporting of cases. The investigation and notification process requires appropriately trained professionals who are able to recognize occupational risk factors and accurately complete epidemiological notification forms. Consequently, many cases may remain unidentified or be incorrectly classified. Similar difficulties in establishing the relationship between cancer and occupational activity have also been observed in other countries, demonstrating that this challenge is not unique to Brazil [24-11].

In this context, the implementation of multidisciplinary occupational health surveillance systems may contribute significantly to strengthening prevention strategies,

monitoring occupational exposures, investigating cases and improving notification processes [11].

Brazil exhibits considerable economic and occupational diversity across its geographical regions. In this study, the South and Southeast regions accounted for the largest numbers of WRC notifications, which may be related to higher levels of economic development, greater industrial concentration and better-developed healthcare infrastructure, facilitating both diagnosis and epidemiological reporting [25].

The South region, which accounted for the highest proportion of notifications, has a high concentration of occupational activities related to agriculture, livestock farming, construction, mining, metallurgy and the furniture industry. These sectors are frequently associated with exposure to dust, solvents, metals, hydrocarbons, pesticides and other potentially carcinogenic substances [26]. Similarly, the Southeast region has a high concentration of major industrial activities associated with the oil, natural gas, pulp, marble, steel, metallurgy and tourism sectors, which may also represent important sources of occupational exposure [27].

Among the occupational groups analyzed in this study, nursing and pharmacy professionals working in oncology hospitals warrant particular attention, as they represent groups whose occupational exposure to antineoplastic agents is continuous, predictable and amenable to systematic monitoring. This differs from other workers whose exposure may be more diffuse and difficult to control. Oncology nurses and pharmacists constitute a clearly defined at-risk population. This specificity makes these professionals a strategic group for strengthening WRC surveillance, particularly because health-related processes within oncology treatment units are routinely monitored [28-29-30].

Such exposure occurs both during the preparation and administration of these drugs and, in the case of nursing staff, through contact with the bodily fluids of patients undergoing antineoplastic treatment. In this context, occupational exposure to these agents represents an important risk, with adverse effects reported in the literature including carcinogenic potential, impaired fertility and congenital abnormalities in the offspring of exposed workers [8].

According to Figures 2 and 3 of the present study, WRC cases were identified in both occupational groups. However, when antineoplastic exposure was considered, Brazilian records showed very low numbers among nursing professionals (N = 9) and no cases among pharmacy professionals. This discrepancy is consistent with underreporting, although it may also reflect

a genuine reduction in exposure resulting from protective measures. It should also be emphasized that the absence of notifications should not be interpreted as an absence of occupational risk. Rather, it may reflect the limitations of a disease-based surveillance system in identifying cancers characterized by long latency periods and complex exposure histories.

Healthcare professionals exposed to these drugs are routinely monitored and instructed to use engineering control measures designed to reduce occupational exposure and associated harm. Measures such as the appropriate use of personal protective equipment (PPE), robotic equipment and closed-system drug-transfer devices may significantly reduce occupational risks [31].

It is also important to note that data from the Federal Nursing Council (COFEN) indicate that the Brazilian nursing workforce comprises 3,066,183 professionals, including nurses (27.7%), nursing technicians (63.6%) and nursing assistants (8.5%), whereas the Federal Pharmacy Council (CFF) estimates that approximately 400,000 pharmacists are professionally active in the country. This difference in workforce size is likely to persist within oncology services, where the number of nursing professionals per healthcare unit is generally proportionally greater than the number of pharmacists because of the nature of their respective activities. However, there are no consolidated official data on the exact number of nurses and pharmacists specifically involved in the preparation and administration of antineoplastic drugs in Brazil, which prevents comparison of notification rates within this population. Therefore, despite this limitation, the complete absence of records among pharmacists over the 19-year period is noteworthy and is compatible with both the smaller size of this professional group and underreporting. Based on the available data, it is not possible to distinguish between these two hypotheses [32-33].

Conversely, professionals responsible for reporting cases may have limited knowledge of workers' occupational routines and of which substances encountered in those routines are considered carcinogenic [34]. The researchers propose the use of an online questionnaire to facilitate the collection of information essential for establishing a causal relationship between cancer and occupational activity [35].

A study conducted in India reported findings reflecting a situation similar to that observed in Brazil. The country has specific recommendations for the notification of certain occupational diseases; however, healthcare professionals and employers often fail to report these cases. This failure to report prevents WRC figures from accurately reflecting the true

burden of the disease, thereby hindering public health measures aimed at protecting workers [36].

The quality and completeness of epidemiological data are essential for accurately mapping WRC cases and identifying vulnerable groups. However, incomplete records, missing information and insufficient investigation of occupational histories continue to represent major limitations for epidemiological analyses and for the development of more effective occupational health policies [37].

The findings reveal critical inequalities in WRC surveillance and highlight structural limitations that hinder the full recognition of this condition as an important public health problem. To the authors' knowledge, this study is among the first national investigations to simultaneously analyse the epidemiological profile of WRC and occupational exposure to antineoplastic drugs among healthcare professionals, thereby addressing an important gap in the Brazilian scientific literature.

CONCLUSIONS

The total of 8,413 notifications recorded during the study period is notably low, considering national estimates that between 3% and 8% of all cancer cases are attributable to occupational exposures. Malignant neoplasms of the skin, breast and lung predominated in the distribution, a finding consistent with the risk profiles of the occupational groups most affected. The predominance of male workers and the concentration of cases among individuals aged 50 years or older are consistent with the cumulative nature of occupational exposure and the long latency periods characteristic of most solid tumors, which may exceed two decades.

The South and Southeast regions accounted for 76.8% of the WRC notifications recorded during the study period, whereas the North and Northeast regions accounted for only 8.3%. This distribution may reflect not only differences in occupational and exposure profiles across Brazilian regions, but also heterogeneity in the capacity of healthcare services to recognize, investigate and report the relationship between cancer and occupational activity. Therefore, the lower proportion of records in the North and Northeast regions should not be directly interpreted as indicating a lower occurrence of WRC, as it may reflect, among other factors, differences in the sensitivity of regional surveillance systems.

A particularly concerning finding relates to healthcare professionals exposed to antineoplastic drugs. Despite well-established evidence regarding the potential carcinogenic,

mutagenic and teratogenic risks of these agents, only nine WRC cases were identified among nursing professionals and none among pharmacists throughout the entire study period. This discrepancy may reflect underreporting, but it may also be partially explained by a genuine reduction in exposure resulting from protective measures and by the fact that the disease latency period may not yet have fully elapsed. The limited familiarity of professionals responsible for reporting cases with the specific risks associated with oncology settings constitutes an important barrier to recognizing the causal relationship and appropriately recording cases.

Taken together, these findings highlight the need to strengthen occupational cancer surveillance in Brazil through three converging strategies: (1) continuous training of healthcare professionals to recognize and appropriately document WRC; (2) improvement of SINAN data quality through standardized instruments for obtaining occupational histories and active surveillance protocols; and (3) development of evidence-based public policies targeting occupational groups at higher risk, particularly rural workers and professionals working in oncology services.

These findings provide a comprehensive overview of the distribution of WRC in Brazil and offer evidence regarding records involving professionals exposed to antineoplastic drugs, thereby establishing a basis for future investigations. Prospective research using longitudinal designs and standardized instruments for collecting occupational histories is needed to reduce the gap between the actual and recorded burden of occupational cancer in Brazil, as well as to improve surveillance and prevention strategies for workers exposed to carcinogenic agents.

LIMITATIONS:

The present study is subject to the limitations inherent in the use of secondary data, including variability in the completeness of notifications across states and the inability to establish causal relationships at the individual level. The study design also does not allow us to determine whether the low frequency of cases among professionals exposed to antineoplastic drugs results from underreporting or from a genuine reduction in exposure, reinforcing the need for investigations based on individual-level exposure data.

The data analyzed may be affected by temporary underreporting resulting from the time required for records to be consolidated within the system, which may limit the study. Similarly, the absence of a specific population denominator for each occupational category precludes the

calculation of adjusted incidence rates. Therefore, the comparisons of frequencies across occupations presented in this study should be interpreted as descriptive, reflecting both exposure profiles and the relative size of each occupational workforce.

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ETHICS STATEMENT

This study involved the secondary analysis of publicly available data. No human participants were directly involved; therefore, ethics approval and informed consent were not required.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data supporting the findings of this study are openly available from the Notifiable Diseases Information System (SINAN/DATASUS) of the Brazilian Ministry of Health and comprise notifications of work-related cancer in Brazil from 2007 to 2025. Data were extracted in April 2026 and are available at <https://datasus.saude.gov.br/informacoes-de-saude-tabnet/>

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