

Ubirani Barros Otero^a <https://orcid.org/0000-0003-1464-2410>Fernanda de Albuquerque Melo Nogueira^a <https://orcid.org/0000-0003-0331-3873>Christiane Soares Pereira Madeira^a <https://orcid.org/0000-0002-6819-1945>João Silvestre Silva-Junior^{b,c} <https://orcid.org/0000-0001-7541-5946>Marcia Bandini^d <https://orcid.org/0000-0003-2899-090X>

^aInstituto Nacional de Câncer, Coordenação de Prevenção e Vigilância, Área Técnica Ambiente, Trabalho e Câncer. Rio de Janeiro, RJ, Brazil.

^bCentro Universitário São Camilo. São Paulo, SP, Brazil.

^cFaculdade de Medicina da Universidade de São Paulo, Departamento de Medicina Legal, Bioética, Medicina do Trabalho e Medicina Física e Reabilitação. São Paulo, SP, Brazil.

^dUniversidade Estadual de Campinas, Faculdade de Ciências Médicas, Departamento de Saúde Coletiva. Campinas, SP, Brazil.

Contact:

Ubirani Barros Otero

E-mail:

uotero@inca.gov.br

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Work-related cancer: The Brazilian National Cancer Institute's Experience in Updating the Ministry of Health's 2020 List of Work-Related Diseases

Câncer relacionado ao trabalho: relato de experiência do Instituto Nacional do Câncer na atualização da Lista de Doenças Relacionadas ao Trabalho do Ministério da Saúde no Brasil

Abstract

Objective: To report the experience of the Technical Area on Environment, Work and Cancer of the Brazilian National Cancer Institute (ATATC/INCA) in the 2020 revision and update of the List of Work-Related Diseases (LWRD) by the Ministry of Health, with emphasis on the chapter on neoplasms. **Methods:** In 2019, a literature review and comparative analysis of national, foreign and international lists of work-related diseases were conducted. The list published by the International Agency for Research on Cancer (IARC/WHO), considering groups 1, 2A, and 2B, was adopted as the gold standard. Contributions were discussed in workshops with experts, submitted to public consultation, and evaluated by a management group from the Ministry of Health. **Results:** The 2020 LWRD was organized by agents/ risk factors and diseases, increasing from 182 to 347 disease codes and from 14 to 50 types of neoplasms. New occupational risk factors were included, such as night work, viruses (HPV, HIV), pollutants, and chemical substances. Vulnerable occupations, such as sex workers, were also considered. **Conclusion:** The updated LWRD reflects scientific advances and expands the recognition of occupational neoplasms, enhancing worker health protection and supporting public policies for cancer surveillance and prevention in the workplace.

Keywords: Occupational Cancer; Occupational Health; Occupational Diseases; Occupational Exposure; Public Policy.

Resumo

Objetivo: Relatar a experiência da equipe da Área Técnica Ambiente, Trabalho e Câncer do Instituto Nacional de Câncer (ATATC/INCA) na revisão e atualização da Lista de Doenças Relacionadas ao Trabalho (LDRT) do Ministério da Saúde em 2020, com ênfase no capítulo sobre neoplasias. **Métodos:** Em 2019, foi realizada uma revisão de literatura e análise comparativa de listas nacionais, estrangeiras e internacionais de doenças relacionadas ao trabalho. Adotou-se como padrão-ouro a Lista da Agência Internacional de Pesquisa em Câncer (IARC/OMS), considerando os grupos 1, 2A e 2B. As contribuições foram discutidas em oficinas com especialistas, submetidas à consulta pública e analisadas por um grupo gestor do Ministério da Saúde. **Resultados:** A LDRT 2020 foi organizada por agentes/fatores de risco e por doenças, ampliando de 182 para 347 os códigos de doenças e de 14 para 50 os tipos de neoplasias. Foram incorporados novos fatores ocupacionais, como trabalho noturno, vírus (HPV, HIV), poluentes e substâncias químicas. Também foram consideradas ocupações vulneráveis, como profissionais do sexo. **Conclusão:** A atualização da LDRT refletiu avanços científicos e ampliou o reconhecimento das neoplasias ocupacionais, promovendo maior proteção à saúde dos trabalhadores e subsidiando políticas públicas de vigilância e prevenção do câncer relacionado ao trabalho.

Palavras-chave: Câncer Ocupacional; Saúde do Trabalhador; Doenças Profissionais; Exposição Ocupacional; Política Pública.



Introduction

In 2016, the World Health Organization (WHO) estimated that approximately 1.88 million deaths were attributed to occupational exposures, 80.7% of which were work-related chronic non-communicable diseases (NCDs)¹. In this scenario, cardiovascular diseases and cancer stood out as the main causes of premature death in 127 countries, with cancer being the second leading cause of death worldwide². In the same year, it was estimated that 19.2% of deaths from NCDs were attributed to work-related cancer (WRC), which ranked 4th, totaling 291,661 deaths, in addition to approximately 6 million years of healthy life lost due to disability resulting from WRC. The literature shows that between 30% and 50% of cancers can be prevented by reducing exposure to risk factors and implementing health promotion and disease prevention strategies. Early detection, timely treatment and appropriate care are also key to reducing the cancer burden^{1,3}.

In Brazil, the National Cancer Institute (INCA) estimates that there will be around 704,000 new cases of cancer per year between 2023 and 2025. Excluding non-melanoma skin cancer, the most frequent types among men are expected to be prostate, colon and rectum, lung, stomach, oral cavity, esophagus, bladder, larynx, non-Hodgkin's lymphoma, and liver. Among women, the most common types are breast, colon and rectum, cervix, trachea, bronchi and lung, thyroid gland, stomach, corpus uteri, ovary, pancreas, and non-Hodgkin's lymphoma. Of these, nine types have a recognized relationship with work, except for endometrial cancer, which is mostly associated with hormonal factors⁴.

According to the International Agency for Research on Cancer (IARC), there are currently 525 agents classified as carcinogenic to humans, 79 of which are present in occupational settings and associated with 38 types of cancer⁵. Occupational exposure to carcinogens can be associated with 4% to 20% of cancer cases, varying according to the type of agent, tumor location, gender, and geographic region⁶.

From 1999 to 2020, the List of Work-Related Diseases (LWRD) was in force in Brazil, which included 14 ICD-10 codes from the neoplasms chapter⁷. To meet the guidelines of the Organic Health Law (1990)⁸, Decree No. 7.602/2011, which establishes the National Policy on Occupational Safety and Health (PNSST)⁹, and Ordinance GM/MS No. 1.823/2012, which recommends periodic reviews of the LWRD¹⁰, the General Coordination of Occupational Health of the Department of Environmental and Occupational Health and Surveillance of Public Health Emergencies of the Health Surveillance Secretariat of the Ministry of Health (CGSAT/DSASTE/SVS/MS) conducted a process of reviewing the list between 2019 and 2020, culminating in the publication of its updated version in 2020^{11,12}. Although it was revoked shortly thereafter¹³, the LWRD-2020 was republished by means of Ordinance GM/MS No. 1,999/2023¹⁴. The most recent version, from 2024, kept the chapter on neoplasms unchanged¹⁵.

INCA, linked to the Ministry of Health's Specialized Health Care Secretariat (SAES), is the main body responsible for formulating and coordinating national cancer prevention, diagnosis, treatment, and control policies and programs. Its actions aim to reduce cancer incidence and mortality in Brazil, promoting the health of the population¹⁶.

The Technical Area on Environment, Work and Cancer (ATATC), of INCA's Prevention and Surveillance Coordination (CONPREV), works to produce studies, surveillance actions, and formulate guidelines for WRC prevention. Its focus includes the identification of carcinogenic agents in occupational and environmental settings, covering chemical, physical, and biological risks. The ATATC has contributed to strengthening cancer surveillance systems and implementing public policies to protect workers¹⁷.

This article aims to report on the experience of the ATATC/INCA team in the process of reviewing and updating the LWRD, with an emphasis on the chapter on neoplasms, published in 2020.

Methods

The process of updating the LWRD in 2020 was carried out in five stages: 1. Preparation of the first draft of the update Brazilian list; 2. Workshop with a group of specialists to analyze and discuss the proposal for the first version; 3. Development of the second version of the LWRD based on the contributions from stage 2, followed by a public consultation; 4. Preparation of the third version of the update of the LWRD; and 5. Publication of the updated LWRD¹².

Due to the complexity of the WRC topic, the ATATC/INCA team set up a group to discuss the neoplasms chapter. Between August and September 2019, a literature review was carried out based on national and foreign lists of carcinogens and their occupational neoplasms. The International List of Carcinogens published by the IARC of the WHO¹⁸ was adopted as the gold standard for decision-making.

This list classifies chemical, physical, and biological agents and exposure/occupation circumstances according to their carcinogenic potential in humans. The agents evaluated are selected by experts based on two criteria: exposure must occur in the population and the agents must pose a potential risk to human health. These include chemical products (e.g. formaldehyde), complex mixtures (e.g. air pollution), occupational exposures (e.g. aluminium industry, painter's occupation), physical agents (e.g. ionizing and non-ionizing radiation), biological agents (e.g. hepatitis B virus), drugs (e.g. cyclosporine), and lifestyle factors (e.g. alcohol consumption)¹⁸.

The agents are organized as follows¹⁸: Group 1 - sufficient evidence of carcinogenicity in humans, based on robust epidemiological studies (cohort and case-control), experimental findings in animals, and mechanisms of carcinogenesis in human cells or tissues; Group 2A - probably carcinogenic agents, with limited evidence in humans, sufficient in animals, or strong mechanistic evidence demonstrating key characteristics of human carcinogens; Group 2B - possibly carcinogenic agents, with only one of the following elements: limited evidence in humans, sufficient in animals, or strong mechanistic evidence; Group 3 - not classifiable as to its carcinogenicity to humans, including agents whose carcinogenicity cannot be determined based on the available evidence.

The classification is periodically reviewed as new evidence emerges¹⁹. Therefore, the evaluation process is dynamic, and classifications can change over time. The precautionary principle guided the selection of the carcinogens incorporated into the LWRD 2020. Thus, all agents classified as Group 1 (n = 122), Group 2A (n = 93), Group 2B (n = 319) were included, according to the IARC monographs (volumes 1-129) published until 2019¹⁸.

Another source used was the 10th revision of the International Classification of Diseases and Related Health Problems (ICD-10), to identify whether there was specific coding for each type of cancer by primary location. The ICD-10 neoplasms were related to the agents, occupations, and exposure circumstances on the IARC list¹⁸.

The technical assessment carried out by the ATATC team resulted in five categories of suggestions for the new LWRD: (i) editing - proposed modification, exclusion, or inclusion of occupational agents/risk factors; (ii) editing with addition - suggested inclusion of new agents/risk factors or occupational categories; (iii) exclusion - due to overlap with other ICD-10 categories or, in the case of code C30 (malignant neoplasm of the nasal cavity and middle ear), the middle ear was excluded, keeping only the nasal cavity and sinuses, according to IARC Group 1; (iv) inclusion - agents, risk factors, or occupations present in IARC Groups 1, 2A, or 2B; and (v) rejection - when the neoplasm was already included in another ICD-10 category, or the agent did not belong to IARC Groups 1, 2A, or 2B, or was included in only one or no reference lists - in accordance with the recommendation for inclusion based on at least two lists.

The group contributed to Stage 1, during the targeted consultation promoted by CGSAT/DSASTE/SVS/MS in August 2019, and Stage 2, at the face-to-face workshop to analyze the first version of the update. The suggestions were submitted via an electronic form (FormSUS) to the CGSAT/MS Management Group and made available for public consultation. Subsequently, meetings were held between the management group and the Ministry of Health coordinator to discuss all the LWRD topics, including cancer. At the final consensus meeting, INCA's group of experts presented and justified maintaining most of the neoplasms already listed in the 1999 LWRD, as well as the inclusion of agents from IARC Groups 1, 2A, and 2B. In most cases, there was consensus between the experts and the Ministry of Health management group, indicating that these choices were more appropriate for occupational health surveillance.

Results

The LWRD was structured as a two-entry system, comprising two lists: A and B. List A agents and/or risk factors with their respective work-related diseases, while List B contains work-related diseases with their corresponding agents and/or risk factors. The 2020 update increased the number of diagnosis codes from 182 to 347, including WRC. The revised 2020 list expanded the number of neoplasms from 14 to 50. This represents an increase of more than 300% compared to the number of neoplasms listed in the 1999 LWRD.

Table 1 presents a comparative analysis of the LWRD versions regarding the editing of agents and/or risk factors. For example, malignant neoplasm of the stomach (C16), previously related only to asbestos, is now associated with occupational risk factors such as chemical agents from the rubber industry, lead compounds, textile production and processing, and ionizing radiation (X-rays and/or gamma rays).

Table 1 Malignant neoplasms and their etiological agents and/or occupational risk factors, according to the 1999 and 2020 versions of the List of Work-Related Diseases (LWRD)

ICD-10	Type of malignant neoplasm	Occupational agents and/or risk factors - LWRD 1999	Occupational agents and/or risk factors - LWRD 2020	
C16	Stomach	Asbestos	Exposure to chemical agents used in the rubber production process, including the vulcanization process; and/or asbestos; and/or inorganic lead compounds; and/or chemical agents used in the production and processing of fabrics, in work activities; Exposure to ionizing radiation (X-rays and/or gamma rays) in work activities.	
C22.3	Liver angiosarcoma	Arsenic and its arsenical compounds; vinyl chloride	Not included in LWRD 2020	
C25	Pancreas	Vinyl chloride; epichloridine; aliphatic and aromatic hydrocarbons from the petroleum industry	Exposure to ionizing radiation (thorium-232 and its decay products; and/or X-rays and/or gamma rays) in work activities.	
C30 to C31	Nasal cavity and paranasal sinuses	Ionizing radiation; nickel and its compounds; wood dust and other organic dust from the furniture industry; dust from the leather industry; organic dust (in the textile industry and bakeries), oil industry	C30 Nasal cavity	Exposure to chemical agents used in the production process of isopropyl alcohol; and/or hexavalent chromium and its compounds; and/or formaldehyde; and/or nickel and its compounds; and/or dust from the leather industry; and/or wood dust; and/or glues and solvents used in carpentry and joinery activities; and/or organic dust, in work activities; Exposure to ionizing radiation (radium-226 and/or radium-228, and products of their decay) in work activities.

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			C31 Sinuses	Exposure to chemical agents used in the production process of isopropyl alcohol; and/or hexavalent chromium and its compounds; and/or formaldehyde; and/or nickel and its compounds; and/or dust from the leather industry; and/or wood dust; and/or glues and solvents used in carpentry and joinery activities; and/or organic dust from the furniture industry, during work activities; Exposure to ionizing radiation (radium-226 and radium-228, and their decay products) in work activities.
C32	Larynx	Asbestos		Exposure to asbestos; and/or acid mists; and/or chemical agents used in the rubber production process, including the vulcanization process; and/or mustard gas, and/or chemical agents used in the production and processing of fabrics, during work activities; Exposure to human papillomavirus type 16 in work activities.
C34	Bronchi and lung	Arsenic and its arsenical compounds; asbestos; beryllium, cadmium, or their compounds; chromium and its toxic compounds, vinyl chloride; chloromethyl ethers; free silica; tar, pitch, bitumen, mineral coal, paraffin, and waste products of these substances; ionizing radiation; coke oven emissions; nickel and its compounds; acrylonitrile; aluminum industry (foundries); mineral oil mists (cutting oil); metal foundries		Exposure to chemical agents from aluminum production; and/or arsenic and its compounds; and/or asbestos; and/or beryllium and its compounds; and/or bis chloromethyl ether and chloromethyl methyl ether; and/or cadmium and its compounds; and/or hexavalent chromium and its compounds; and/or coal gasification; and/or coal tar; and/or emissions from coke ovens; and/or emissions from diesel engine exhaust; and/or emissions from the iron and steel smelting process; and/or antineoplastic drugs MOPP (vincristine-prednisone-nitrogen-mustard-procarbazine mixture); and/or nickel and its compounds; and/or particulate matter and atmospheric air pollution; and/or organic solvents; and/or chemical agents used in the rubber production process, including the vulcanization process; and/or crystalline free silica dust; and/or soot; and/or welding fumes; and/or mustard gas; and/or acid mists; and/or benzene; and/or biomass fuel (mainly wood); and/or bitumen and its residues; and/or carbon electrode manufacturing; and/or silicon carbide; and/or coal electrode production; and/or combination of alpha-chlorinated toluenes and benzoyl chloride; and/or diazinone; and/or pesticides; and/or pigments and solvents used in printing processes; and/or 2,3,7,8-TCDD; and/or chemical agents used in the production and processing of fabrics, in work activities; Exposure to ionizing radiation (plutonium; and/or radium-222 and its decay products; and/or radon; and/or X-rays; and/or gamma rays) in work activities.

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C40	Bones and articular cartilage of the limbs (including bone sarcoma)	Ionizing radiation	Exposure to ionizing radiation (radium-224 and/or radium-226 and/or radium-228, and their decay products; and/or plutonium; and/or X-rays and/or gamma rays; and/or radioactive iodine, including iodine-131) in work activities.
C44	Other skin neoplasms	Arsenic and its arsenical compounds; tar, pitch, bitumen, mineral coal, paraffin, and waste products of these substances causing skin epithelioma; ionizing radiation; ultraviolet radiation	Exposure to arsenic and its compounds; and/or coal tar; and/or soot; and/or coal distillation (coal); and/or untreated mineral oil; and/or shale oil; and/or creosote; and/or hydrocarbons from the oil refining process; and/or azathioprine; and/or cyclosporine; and/or organophosphorus pesticides (parathion) in work activities; Exposure to non-ionizing radiation (ultraviolet); and/or ionizing radiation (X-rays and/or gamma rays) in work activities; Exposure to HIV; and/or human papillomavirus types 5 and/or 8, in work activities.
C45	Mesothelioma, Mesothelioma of the pleura (C45.0), Mesothelioma of the peritoneum (C45.1), and Mesothelioma of the pericardium (C45.2)	Asbestos	Exposure to asbestos; and/or erionite; and/or fluoroedenite in work activities; and/or painting activities.
C67	Bladder	Tar, pitch, bitumen, mineral coal, paraffin, and waste products of these substances; aromatic amines and their derivatives (Beta-naphthylamine, 2-chloroaniline, benzidine, o-toluidine, 4-chloro-ortho-toluidine), coke oven emissions	Exposure to arsenic and its compounds; and/or chemical agents resulting from the production of aluminium; and/or chemical agents used in the production of magenta; and/or chemical agents used in the production of auramine; and/or organic solvents; and/or chemical agents used in the rubber production process, including the vulcanization process; and/or aromatic amines (4-aminobiphenyl; and/or 2-naphthylamine; and/or 4-chloro-ortho-toluidine; and/or ortho-toluidine; and/or benzidine; and/or toluidine); and/or coal tar; and/or perchloroethylene and other agents used in dry cleaning processes; and/or diesel engine exhaust emissions; and/or formaldehyde and other chemical substances used in cosmetic hair products; and/or 2-mercaptobenzothiazole; and/or pigments and solvents used in printing processes; and/or soot; and/or tetrachloroethylene; and/or cyclophosphamide; and/or chemical agents used in the production and processing of fabric, in work activities; Exposure to ionizing radiation (X-rays and/or gamma rays) in work activities; Exposure to <i>Schistosoma haematobium</i> in work activities.

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C91 to C95	Leukemia	Benzene, ionizing radiation, ethylene oxide, antineoplastic agents, electromagnetic fields, chlorinated pesticides (chlordane and heptachlor)	Exposure to benzene; and/or organochlorine pesticides (lindane, pentachlorophenol, DDT) and organophosphates (diazinone, glyphosate, malathion); and/or 1,3-butadiene; and/or formaldehyde; and/or dichloromethane; and/or methylene chloride; and/or chemical agents used in the rubber production process, including the vulcanization process; and/or ethylene oxide; and/or organic solvents; and/or hydrocarbons from the oil refining process; and/or PCBs; and/or polychlorophenols or their sodium salts; and/or styrene; and/or trichloroethylene; and/or 2,3,7,8- TCDD; and/or antineoplastic drugs (azathioprine, bussulfan, chlorambucil, cyclophosphamide, cyclosporine, etoposide with cisplatin and bleomycin, bischloroethyl nitrosourea - BCNU, melphalan, mitroanthrone, nitrogen mustard, MOPP, semustine (methyl-CCNU), teniposide, thiotepa, treosulfan); and/or dichlorophenoxyacetic acid (2, 4-D); and/or chemical agents used in the production and processing of fabrics, in work activities; Exposure to ionizing radiation (fission products, including strontium-90; and/or phosphorus-32; and/or thorium-232 and its decay products; and/or X-rays and/or gamma rays) in work activities; Exposure to hepatitis C virus (HCV); and/or HIV; and/or hepatitis B virus (HBV); and/or human T-cell lymphotropic virus type 1 (HTLV 1); and/or Epstein-Barr virus; and/or <i>Plasmodium falciparum</i>, in work activities.
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MOPP: vincristine–prednisone–nitrogen mustard–procarbazine combination; TCDD: tetrachlorodibenzo-p-dioxin; HIV: human immunodeficiency virus; DDT: dichloro-diphenyl-trichloroethane; PCB: polychlorinated biphenyls.

Hepatic angiosarcoma (C22.3), a rare tumor, was removed from the 2020 LWRD. However, its agents and risk factors, such as arsenic and arsenical compounds, remain associated with other work-related neoplasms, such as cancer of the liver (C22), bronchi and lungs (C34), skin (C44), prostate (C61), kidney (C64), and bladder (C67).

In the case of malignant neoplasm of the pancreas (C25), the occupational agents identified in 1999 (vinyl chloride, epichlorohydrin, and petroleum hydrocarbons) were replaced by ionizing radiation (thorium-232, X-rays, and gamma rays).

The 2020 LWRD now distinguishes between neoplasms of the nasal cavity (C30) and malignant neoplasms of the middle ear (C30.1), excluding the latter. For neoplasm of the nasal cavity (C30.0) and malignant neoplasm of the sinuses (C31), new occupational risk agents were included, such as products from isopropyl alcohol, hexavalent chromium, formaldehyde, glues, and solvents used in carpentry.

In 1999, the occupational agent associated with malignant neoplasm of the larynx (C32) was asbestos. In 2020, acid mists, agents used in rubber and textile production, mustard gas, and exposure to human papillomavirus type 16 (HPV-16) were included. For malignant neoplasm of the bronchi and lung (C34), the 1999 list included arsenic, asbestos, beryllium, cadmium, chromium, free silica, among others. In 2020, exposures to diesel engine emissions, antineoplastic drugs, particulate matter, air pollution, organic solvents, mustard gas, chemical agents from rubber and fabric production, and ionizing radiation were added.

Malignant neoplasms of bones and articular cartilage (C40), including bone sarcoma, had ionizing radiation as a risk factor in 1999. In the 2020 version, new agents were detailed, such as radium-224, -226, -228 and their decay products, plutonium, X-rays, gamma rays, and radioactive iodine, including iodine-131.

Regarding malignant neoplasms of the skin (C44), the list has been expanded to include coal tar, soot, mineral oils, creosote, hydrocarbons from oil refining, various pesticides, non-ionizing radiation, and exposure to viruses such as human immunodeficiency virus (HIV) and human papillomavirus types 5 and 8.

For mesothelioma (C45), exposure to other mineral fibers (erionite and fluoroedenite) and occupational exposure during painting activities were included as risk factors.

Noteworthy is the expansion of carcinogenic agents related to bladder cancer (C67), indicating an increase in occupational risk for this type of cancer, compared to the first edition of the list.

Occupational exposures associated with leukemia (C91 to C95) in 1999 included benzene, ionizing radiation, ethylene oxide, antineoplastic agents, electromagnetic fields, and chlorinated pesticides (chlordane and heptachlor). In 2020, the list was expanded to include additional agents, including organochlorine and organophosphorus pesticides, 1,3-butadiene, formaldehyde, dichloromethane, methylene chloride, chemicals from the rubber and textile industry, organic solvents, hydrocarbons from oil refining, polychlorinated biphenyls (PCBs), polychlorophenols, styrene, trichloroethylene, tetrachlorodibenzo-p-dioxin (TCDD), various antineoplastic drugs, dichlorophenoxyacetic acid, as well as exposure to viruses (HCV, HIV, HBV, HTLV-1, Epstein-Barr) and *Plasmodium falciparum*.

As for the types of cancer added to the LWRD in 2020 (**Table 2**), there are 35 new work-related neoplasms. Particularly notable is the inclusion of night shift work as a risk factor for malignant neoplasms of the colon (C18), breast (C50), and prostate (C61). It should also be noted that six neoplasms (C14, C21, C51, C52, C53, and C60) are related to sex workers, as this professional is recognized by the Brazilian Classification of Occupations (CBO). All suggestions were accepted and incorporated into the LWRD 2020.

Table 2 List of malignant neoplasms and their agents and/or occupational risk factors added to the List of Work-Related Diseases (LWRD) in the version published in 2020

ICD-10 code	Type of malignant neoplasm	Occupational agents and/or risk factors
C00	Malignant neoplasm of the lip	Exposure to non-ionizing radiation (ultraviolet) in work activities.
C06	Malignant neoplasm of other and unspecified parts of the mouth	Exposure to human papillomavirus type 16 and/or 18 during work activities.
C08	Malignant neoplasm of other and unspecified major salivary glands	Exposure to ionizing radiation (X-rays and/or gamma rays; and/or radioactive iodine, including iodine-131) in work activities.
C09	Malignant neoplasm of the tonsil	Exposure to HPV type 16 during work activities.
C11	Malignant neoplasm of the nasopharynx	Exposure to formaldehyde and/or wood dust and/or Epstein-Barr virus during work activities.
C14	Malignant neoplasm of other sites and ill-defined sites of the lip, oral cavity and pharynx	Exposure to wood dust and/or HPV type 16 during work activities.

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C15	Malignant neoplasm of the oesophagus	Exposure to perchloroethylene and other agents used in dry cleaning processes; and/or chemical agents used in the rubber production process, including the vulcanization process; and/or chemical agents used in the production and processing of fabrics, in work activities; Exposure to ionizing radiation (X-rays and/or gamma rays) in work activities.
C18	Malignant neoplasm of the colon	Exposure to asbestos in work activities; Exposure to ionizing radiation (X-rays and/or gamma rays) in work activities; Working night shifts.
C20	Malignant neoplasm of the rectum	
C21	Malignant neoplasm of the anus and anal canal	Exposure to HPV type 16 and/or 18 and/or 33 and/or HIV during work activities.
C22	Malignant neoplasm of the liver and intrahepatic bile ducts	Exposure to aflatoxin; and/or vinyl chloride; and/or 1,2-dichloropropane; and/or arsenic and its compounds; and/or organochlorine pesticides (DDT); and/or trichloroethylene; and/or dichloromethane in work activities; Exposure to ionizing radiation (plutonium and/or thorium-232 and their decay products; and/or X-rays and/or gamma rays) in work activities; Exposure to HBV; and/or HCV; and/or HIV in work activities.
C23	Malignant neoplasm of the gallbladder	Exposure to ionizing radiation (thorium-232 and its decay products) in work activities.
C41	Malignant neoplasm of bone and articular cartilage of other and unspecified localizations	Exposure to ionizing radiation (radium-224 and/or radium-226 and/or radium-228, and their decay products; and/or plutonium, X-rays and/or gamma rays; and/or radioactive iodine, including iodine-131) in work activities.
C43	Malignant melanoma of the skin	Exposure to PCBs in work activities; Exposure to non-ionizing radiation (ultraviolet and/or infrared) in work activities.
C46	Kaposi's sarcoma	Exposure to herpes simplex type 1 (HVS-1) and/or HIV in work activities.
C49	Malignant neoplasm of connective tissue and other soft tissues	Exposure to 2,3,7,8- TCDD; and/or polychlorophenols or their sodium salts in work activities; Exposure to ionizing radiation (radioactive iodine, including iodine-131) in work activities.
C50	Malignant neoplasm of the breast	Exposure to organochlorine pesticides (dieldrin); and/or ethylene oxide; and/or PCBs in work activities; Exposure to ionizing radiation (X-rays and/or gamma rays) in work activities. Working night shifts.
C51	Malignant neoplasm of the vulva	Exposure to human papillomavirus type 18 and/or 33 and/or HIV during work activities.

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C52	Malignant neoplasm of the vagina	Exposure to human papillomavirus type 16 and/or HIV during work activities.
C53	Malignant neoplasm of the cervix	Exposure to human papillomavirus type 16 and/or 18 and/or 26 and/or 31 and/or 33 and/or 35 and/or 39 and/or 45 and/or 51 and/or 52 and/or 53 and/or 56 and/or 58 and/or 59 and/or 66 and/or 67 and/or 68 and/or 70 and/or 73 and/or 82 and/or HIV in work activities.
C56	Malignant ovarian neoplasm	Exposure to asbestos in work activities; Exposure to ionizing radiation (X-rays and/or gamma rays) during work activities.
C60	Malignant neoplasm of the penis	Exposure to human papillomavirus type 16 and/or 18; and/or HIV in work activities.
C61	Malignant neoplasm of the prostate	Exposure to arsenic and its compounds; and/or cadmium and its compounds; and/or organophosphorus pesticides (malathion); and/or chemical agents used in the rubber production process, including the vulcanization process; and/or chemical agents used in the production and processing of fabrics, in work activities; Exposure to ionizing radiation (X-rays and/or gamma rays; and/or thorium-232 and its decay products) in work activities; Working night shifts.
C62	Malignant neoplasm of the testicles	Exposure to organochlorine pesticides (DDT); and/or N, N-dimethylformamide; and/or perfluorooctanoic acid in work activities.
C64	Malignant neoplasm of the kidney, except renal pelvis	Exposure to trichloroethylene; and/or arsenic and its compounds; and/or cadmium and its compounds; and/or perfluorooctanoic acid; and/or pigments and solvents used in printing processes; and/or welding fumes in work activities; Exposure to ionizing radiation (X-rays and/or gamma rays; and/or thorium-232 and its decay products) in work activities.
C65	Malignant neoplasm of the renal pelvis	Exposure to aristolochic acid during work activities.
C66	Malignant neoplasm of the ureters	
C69	Malignant neoplasm of the eye and appendages	Exposure to non-ionizing radiation (ultraviolet); and/or HIV in work activities.
C71	Malignant neoplasm of the brain	Exposure to ionizing radiation (X-rays and/or gamma rays); and/or non-ionizing radiation (radiofrequency electromagnetic fields - including those from cordless phones) in work activities.
C72	Malignant neoplasm of the spinal cord, cranial nerves and other parts of the central nervous system	

Continue

C73	Malignant neoplasm of the thyroid gland	Exposure to ionizing radiation (X-rays and/or gamma rays; and/or radioactive iodine - including iodine-131) in work activities.
C82 to C85	Lymphomas	Exposure to benzene; and/or organochlorine pesticides (lindane, pentachlorophenol, DDT) and organophosphates (diazinone, glyphosate, malathion); and/or 1,3-butadiene; and/or formaldehyde; and/or dichloromethane; and/or methylene chloride; and/or chemical agents used in the rubber production process, including the vulcanization process; and/or ethylene oxide; and/or organic solvents; and/or hydrocarbons from the oil refining process; and/or PCBs; and/or polychlorophenols or their sodium salts; and/or styrene; and/or trichloroethylene; and/or 2,3,7,8-TCDD; and/or antineoplastic drugs (azathioprine, bussulfan, chlorambucil, cyclophosphamide, cyclosporine, etoposide with cisplatin and bleomycin, bischloroethyl nitrosourea - BCNU, melphalan, mitoxanthone, nitrogen mustard, MOPP, semustine (methyl-CCNU), teniposide, thiotepa, treosulfan); and/or dichlorophenoxyacetic acid (2, 4-D); and/or chemical agents used in the production and processing of fabrics, in work activities; Exposure to ionizing radiation (fission products, including strontium-90; and/or phosphorus-32; and/or thorium-232 and its decay products; and/or X-rays and/or gamma rays) in work activities; Exposure to HCV; and/or HIV; and/or HBV; and/or human T-cell lymphotropic virus type 1 (HTLV 1); and Epstein-Barr virus; and/or <i>Plasmodium falciparum</i> in work activities.

MOPP: vincristine–prednisone–nitrogen mustard–procarbazine combination; TCDD: tetrachlorodibenzo-p-dioxin; HIV: human immunodeficiency virus; HCV: hepatitis C virus; HBV: hepatitis B virus; DDT: dichloro-diphenyl-trichloroethane; PCB: polychlorinated biphenyls.

The ATATC technical group decided to reject the inclusion of 39 malignant neoplasms, according to predefined technical criteria. These neoplasms were excluded because: they were already included in another category based on ICD-10; they were not classified by the IARC as Group 1, 2A or 2B; they appeared on only one foreign list; or did not appear on any foreign reference list. The technical recommendation adopted was to consider for inclusion only neoplasms associated with occupational exposures that were present on at least two foreign lists.

Despite the established methodology, some exceptions were considered: code C06 (other and unspecified parts of the mouth) was included due to occupational risks identified among sex workers, as recognized in the CBO; code C40 (malignant neoplasms of bones and cartilage of limbs), because it appears on two foreign lists (Colombia and Italy); and code C85 (non-Hodgkin's lymphoma of other and unspecified types) because it appears on three foreign lists (Australia, Italy, and Spain). The other malignant neoplasms suggested for rejection were not incorporated into the 2020 LWRD, in line with the recommendation of INCA's technical experts.

Discussion

In this study, we observed an increase in the number of agents, circumstances of exposure, and types of neoplasms incorporated into the LWRD, Cancer module, after the 2020 revision. This increase was due to the inclusion of all agents classified as Groups 1, 2A, or 2B, as defined in Interministerial Ordinance No. 9 (October 7, 2014), jointly issued by the Ministries of Labor and Employment, Health and Social Security²⁰. At the time, the ministries fully adopted the IARC list then in force, establishing the Brazilian National List of Carcinogenic Agents for Humans (LINACH)²⁰.

The decision to update the LWRD was further supported by the scientific advances incorporated by the IARC in 2019, when ten key characteristics of carcinogens proposed by Smith et al. were recognized²¹, which explain biological and molecular changes that favor the development of neoplasms. These mechanisms have contributed to a broader understanding of the causal pathways of WRC.

It is important to note that the updated version of the LWRD (2020) was published simultaneously with two fundamental works in the field: the book “*Ambiente, Trabalho e Câncer: aspectos epidemiológicos, toxicológicos e regulatórios*”⁴ (Environment, Work and Cancer: epidemiological, toxicological and regulatory aspects⁴) and the “*Atlas do Câncer Relacionado ao Trabalho no Brasil: Análise Regionalizada e Subsídios para a Vigilância em Saúde do Trabalhador*”²² (Atlas of Work-Related Cancer in Brazil: Regionalized Analysis and Subsidies for Occupational Health Surveillance²²). Both publications introduced new types of cancer not previously covered, expanding the scope for recognizing cancers of occupational origin. INCA now lists at least 34 anatomical locations potentially associated with occupational cancer, considering agents from IARC groups 1, 2A, and 2B⁴. It should be noted that the Atlas contains a national list of group 1 agents recognized as priorities for surveillance of exposure to occupational carcinogens in the Brazilian population²².

A comparison between the two versions of the LWRD shows the expansion and diversification of risk factors for various types of cancer. In 1999, exposure to occupational agents was more limited and was generally attributed to a single specific agent, as in the case of malignant neoplasm of the stomach (C16), whose predominant factor was asbestos⁷. In 2020, the inclusion of other factors for this neoplasm, such as chemical rubber agents, lead compounds, and ionizing radiation, reflects advances in scientific and epidemiological knowledge on the multiple occupational factors involved in the causation of this cancer¹¹. Shah and colleagues observed that the likelihood of gastric cancer was high (30 to 56% higher) among workers who were exposed to various chemical agents²³.

More recently, additional occupational carcinogens were recognized, such as some organic solvents, air pollution, diesel engine emissions and viruses (HPV and HIV, for example). The inclusion of night work as a risk factor for breast, colon and prostate cancer, based on the 2019 IARC review¹⁸, represents an important milestone, especially in the Brazilian context, where 15.5% of the employed population worked night shifts, according to the National Health Survey in 2019²⁴. This insertion broadens the view of organizational aspects of the work process that, until then, were little valued in the discussion about the etiology of cancer²⁵.

Another relevant development was the recognition of specific occupational categories, such as sex workers (CBO 5198-05), who are vulnerable and often marginalized, and whose occupational exposure to infectious agents, such as HPV, was considered. The association of HPV with various types of cancer (cervix, anus, penis, among others) justifies its inclusion in the LWRD, considering occupational exposure in this category²⁶. According to the Ministry of Health, oncogenic types of HPV, for example, is responsible for almost 100% of cervical cancer cases²⁷. Thus, exposure to this virus attributed to cervical cancer and other organs (C14, C21, C51, C52, C53, and C60) would not be included as an occupational agent in the LWRD, if there were no recognized exposed category. The inclusion and mention of this occupational category in the LWRD reinforces the commitment of the health sector, as a public policy aimed at this specific population, with regard to cancer.

Regarding carcinogens, the inclusion of some pesticides in the new list, which had not previously been included, should be highlighted. In March 2015, the IARC evaluated the carcinogenicity of the herbicide glyphosate and the insecticides malathion and diazinone as probable carcinogens for humans (Group 2A) and the insecticides tetrachlorvinphos and parathion as possible carcinogens for humans (Group 2B)²⁸. In June 2015, it was the turn of the herbicide 2,4 D (Group 2B), DDT (Group 2A), and lindane (Group 1), the latter classified as carcinogenic to humans^{29,30}.

In the case of glyphosate, for example, the mechanisms identified include genotoxicity and oxidative stress, and it has been identified as a potential cause of non-Hodgkin's lymphoma^{28,31}. Data from the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA) shows that glyphosate will be increasingly used in Brazil between 2009 and 2023, mainly on soybean, corn and cotton crops, which highlights risks to environmental health, workers and rural communities³².

For 2,4-D, there is robust evidence that it causes oxidative stress and immunosuppression and is also associated with non-Hodgkin's lymphoma²⁹⁻³⁰. Despite this evidence, there are still differences between the international classifications and the assessments of the Brazilian National Health Surveillance Agency (ANVISA), which requires greater alignment between regulatory bodies³³.

For future revisions of the LWRD, it is recommended to include automotive gasoline engine exhaust, as it was classified in 2025 as a carcinogen (Group 1) by the IARC³⁴, with an association with an increased risk of acute myeloid leukemia and bladder cancer, and limited evidence (group 2) in other sites, such as the stomach and kidney. Workers in the fuel production, transportation, and retail chain are particularly exposed, mainly through inhalation. The INCA has already recommended the progressive replacement of gasoline engine exhaust and the implementation of vapor recovery systems at filling stations³⁵.

Another category that deserves inclusion in the LWRD is firefighters. The IARC classified this occupation as a carcinogen (Group 1) in 2023, especially for mesothelioma and bladder cancer, and limited evidence for colon, prostate, and non-Hodgkin's lymphoma, among others. The occupational exposure of firefighters is complex, involving aromatic hydrocarbons, particles, combustion gases, firefighting foams, among other agents, as well as additional risks such as night work and ultraviolet radiation³⁶.

Thus, the 2020 version of the LWRD significantly expanded both the number of occupational categories and the range of recognized carcinogens. Many of these agents act synergistically, resulting in an increased risk of cancer, either through higher incidence or by reducing the latency time for the clinical appearance of tumors²².

Conclusion

The periodic review of the LWRD meets a legal mandate and plays a fundamental role in promoting public health. It contributes to establishing the causal link between disease and occupational activities, guides health surveillance and supports the formulation of public policies for prevention of occupational diseases.

The ATATC's participation in the process of updating the LWRD was an important milestone, especially in view of constant transformations in work environments, including new industrial processes, chemical substances, and technologies. As these advances occur, new health risks also arise, which makes it essential to periodically update the LWRD, as mandated by Brazilian legislation. This update enabling health professionals to identify emerging threats early and implement effective preventive and corrective measures.

The increase in the number of agents and risk factors related to malignant neoplasms has resulted in more comprehensive and up-to-date legislation, capable of supporting managers in their decision-making, while also improving access to information for workers and employers regarding occupational risks – particularly WRC. A robust and up-to-date list enables educational initiatives, fosters prevention and helps reduce the incidence of work-related diseases, thereby contributing to safer and healthier workplaces.

The continuous updating of the LWRD is therefore essential to ensure effective surveillance and protection of workers' health, in line with international best practices and the latest scientific knowledge. Decisions based on IARC monographs and comparisons with foreign lists ensure the technical and scientific rigor of the LWRD, giving it legitimacy and strengthening its role as a strategic instrument for occupational and public health.

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