SHORT
COMMUNICATION

Received: 07/11/2018
Accepted: 06/26/2019
Funding: none

High-priority carcinogenic occupational agents and activities for health surveillance in Brazil

Estabelecimento de agentes e atividades ocupacionais carcinogênicas prioritárias para a vigilância em saúde no Brasil

Raphael Mendonça Guimarães[1], Daniela Buosi Rohlfs[2], Karla Freire Baêta[2], Renan Duarte dos Santos[2]

ABSTRACT | The aims of the present study were to assemble a list of carcinogens considered as having high priority for occupational health actions in Brazil and to describe the process followed to validate it. Through a literature review we retrieved the main carcinogens used in production activities in Brazil, the carcinogenicity classification developed by the International Agency for Research on Cancer (IARC) and corresponding types of cancer relevant within the Brazilian context. The list thus assembled was reviewed and validated by an expert panel. It includes known and suspected carcinogens found in the production process of some industries in Brazil, and might serve as orientation for future studies on the burden of occupational cancer.

Keywords | occupational exposure; occupational cancer; surveillance; carcinogens.

RESUMO | Os objetivos do artigo são apresentar uma lista de agentes carcinogênicos selecionados como prioritários para as ações de saúde do trabalhador no Brasil e descrever seu processo de validação. Foi realizada revisão bibliográfica sobre o tema, com o levantamento dos principais agentes carcinogênicos utilizados nas atividades ocupacionais no Brasil, a classificação de carcinogenicidade segundo a Agência Internacional de Pesquisa em Câncer (IARC) e respectivos tipos de câncer, considerando o contexto brasileiro, com validação e revisão final por especialistas. A lista final inclui agentes carcinogênicos, estabelecidos ou prováveis, presentes nos processos produtivos de algumas atividades econômicas no Brasil e fornece orientação para futuros estudos da carga do câncer por atividades econômicas.

Palavras-chave | exposição ocupacional; câncer ocupacional; vigilância; carcinógenos.

[1]Joaquim Venâncio Polytechnic School, Fundação Oswaldo Cruz – Rio de Janeiro (RJ), Brazil.
[2]Department of Environmental and Occupational Health, Ministry of Health – Brasília (DF), Brazil.
DOI: 10.5327/Z1679443520190289

INTRODUCTION

As a function of their prevalence, as well as their role as indicators of epidemiological transition, communicable diseases represent the most urgent reason for public health concern in developing countries. Over the course of the epidemiological transition, communicable diseases gradually give room to non-communicable conditions, and this progression is an indicator of social development[1]. Among the non-communicable diseases, the growing incidence of cancer has led public health researchers to strive to reach a better understanding of the genesis of disease and its relationship with the world of work.

The International Agency for Research on Cancer (IARC) recently evaluated more than 900 agents and classified more than 400 as definite or possible carcinogens. Of these, 168 agents and 12 exposure situations (particular jobs and industries) are found in occupational environments[2]. As a result, many epidemiological studies of the carcinogenic properties of several agents are conducted in occupational settings, where exposures are usually higher compared to the general environment.

Lack of knowledge on where exposures occur and on the number of affected workers poses a major challenge to the prevention of occupational cancer. In the beginning of the 2000s, Siemiatycki et al.[3] performed a broad-scoped survey and review of exposures to occupational carcinogens. Then, the CARcinogen EXposure (CAREX) surveillance system was launched to estimate, in collaboration with IARC, the contribution of occupational risk factors to cancer[4]. This model was replicated in several countries in recent years, taking also local particularities into account, such as stratification per sex and alternative approaches to estimate exposure to pesticides.

Several specialized technical departments of the Brazilian Ministry of Health are engaged in measuring and intervening on occupational and environmental risk factors for cancer, which efforts have led to several health surveillance procedures. A milestone within this context was the formulation of guidelines on occupational cancer to serve as grounds for actions implemented within the Unified Health System, the National Network for Integrated Workers Healthcare in particular. *Diretrizes para a vigilância do câncer relacionado ao trabalho* originally resulted from a request by the Ministry of Health for means to support actions implemented at Occupational Health Specialized Reference Centers targeting benzene. The guidelines' scope was enlarged over time, and thus they became a practical guide on cancer — including the role of carcinogens found in work processes and environments — easy to apply to occupational health surveillance by municipal, state and federal agencies[5].

From the perspective of policy formulation, the Ministry of Health needs to establish priorities with focus on surveillance and prevention reaching beyond the technical aspects mentioned in the aforementioned guidelines. We further call the attention to the need to orient actions implemented in the workplace to avoid exposure to occupational carcinogens, which are equally relevant for the control of cancer. Given the countless exposure situations and types of occupational cancer, national priorities should be established according to the local profile of economic activities and the peculiarities of work processes potentially dangerous for workers. Therefore, our aim in the present study was to assemble a list of carcinogenic agents considered as having high priority for occupational health actions in Brazil.

METHOD

We had resource to an adaptation of the CAREX method to select high-priority occupational exposures[4], whereby the following three criteria were applied: availability of evidence demonstrating that a given agent or activity is carcinogenic; whether such chemical or activity is related to work; and whether or not such agent or activity is found in Brazil. The first step of the study consisted in a review based on a systematic protocol. We did not perform a systematic review, since this method is not suitable to the subject of the present study (since we did not analyze one single cancer site or risk factor). To answer our first question, we surveyed the list and classification of carcinogens developed by IARC. IARC monographs identify definite or suspected carcinogenic hazards, in addition to 12 economic activities considered hazardous as such.

We included in our list agents classified as definite (Group 1), probable (Group 2A) or possible (Group 2B) carcinogens. We believe this was a strategic decision, given that some agents are considered a high priority for environmental and occupational health surveillance in Brazil, as for instance, pesticides, included in Group 2A or 2B as a function of their active principles. To comply with policies in force, we chose to increase the sensitivity of the selection criteria.

Next we considered agents or activities with direct relationship with production processes and called an expert panel to validate our selection. Panel members were: one expert in occupational health, two experts in oncology and epidemiology, two experts in epidemiology, one expert in epidemiology and occupational health, and one expert in all three fields. We took the theoretical-methodological aspects that ground categorization into account, as well as the profiles of occupational groups and the previous experience of the panel experts with specific aspects of the various work processes, as e.g. those in rural work, jobs involving handling solvents and so forth. We only included in the list groups and agents unanimously mentioned by all the panel members, and consequently excluded factors related to diet, physical activity, hormone activity and infectious agents.

Finally, to establish whether each analyzed agent and activity is relevant or not within the Brazilian context, we had resource to the National Household Sample Survey (Pesquisa Nacional por Amostra de Domicílio — PNAD) database and the Annual Report of Social Information (Relação Anual de Informações Sociais — RAIS) and only included activities with prevalence of over 1% in Brazil. Based on this information we developed a list of priorities for occupational cancer surveillance.

Since the present study did not consist in research involving human beings, ethical clearance was waived.

RESULTS

The first step of the present study consisted in a survey of the state of the art in carcinogenicity as available in IARC monographs and published meta-analyses; the results are described in Table 1. This list includes the main activities which involve exposure to at least one definite or potential carcinogen and the main occupational agents associated with at least one cancer site.

From this list we selected high-priority agents according to two criteria: number of cancer sites known to be definitely or probably associated with the analyzed exposure and the potential prevalence of exposed workers. Next we established a consensus on how to cluster such agents to facilitate relevant surveillance strategies. Table 2 describes the final list of high-priority categories of carcinogenic agents and circumstances.

As is shown, we established seven categories encompassing 43 potentially carcinogenic activities and agents found in the most prevalent production processes in Brazil. From the perspective of policy making, this list will help refine the focus of regulatory activities, including determination of exposure patterns, regulations and bans to imports and use of the included agents.

DISCUSSION

Classifying and establishing priorities for occupational carcinogens are necessary for several goals, including research, resource allocation and estimation of the burden of occupational cancer, all of which are part of ongoing efforts to prevent cancer and intervene on risk factors[1]. To be sure, occupational cancer and its associated factors are the subject of many publications on occupational medicine, toxicology, environmental health and occupational hygiene[2,5]. However, most such publications report experiences in developed countries[3]. Summarizing the available information on such a broad-scoped field as occupational cancer in developing countries for the purpose of designing public policies is an ambitious and essential task.

We should observe that the list of priorities described here does not include all possible occupational carcinogenic agents and circumstances. In many cases, we prioritized agents individually found under definite exposure circumstances. However, some occupations are characterized by multiple exposures, and thus individual evaluations of agents does not suffice to determine the actual intensity of exposure[3,5].

Upon investigating occupational carcinogens, in addition to its prevalence, one should also consider the level of exposure. Since there are no safe exposure limits, one

Table 1. Summary of information on significant potentially carcinogenic occupations and agents, according to the International Agency for Research on Cancer (IARC).

Carcinogenicity	Exposure circumstances	
	Agents	Occupations
Definite	2-naphthyl amine 4-aminobiphenyl 4,4'-methylene bis (2-methylaniline) Sulfuric acid Aerosols Aflatoxin Coal tar Asbestos Aromatic amines Arsenic Auramine Benzene, xylene and toluene Benzidine Benzopyrene Beryllium Polychlorinated biphenyls Lead Vinyl chloride Cadmium compounds Hexavalent chromium compounds Selected nickel compounds, including oxide and sulfide combinations Dyes (aromatic amines, aminophenol with hydrogen peroxide) Creosote Halogen derivatives Diesel Dioxins Erionite Diesel engine exhaust Bis (chloromethyl) ester and chloromethyl methyl ether (technical grade) Isopropanol manufacture Formaldehyde Soot Metal fumes Mustard gas Coal gasification Polycyclic aromatic hydrocarbons (PAH) Inorganic acid mists Isopropyl oils Mineral oil s Ortho-nitrobenzene Ortho-toluidine Antimony oxides Tar Pigments Leather dust Wood dust Thrusters Ionizing radiation Radon Crystalline silica Solvents Diisopropyl sulfate Asbestos-like fiber-containing talc Carbon tetrachloride Tetrachloroethylene Hair color Trichloroethylene Coal tar vapor	Hairdressers and barbers Carpentry and joinery Cement industry Auramine manufacture Isopropanol manufacture Magenta manufacture Furniture manufacture and cabinetmaking Boot and shoe manufacture and repair Jute spinning; Iron and steel founding Coal gasification Rubber industry Nickel refining industry Dry cleaning Timber mills Hematite mining, underground, with radon exposure Printing processes Painters Strong acid processes Aluminum production Coke production Production of art glass, glass containers and pressed ware Lacquer industries Ceramics industries

Continue...

Table 1. Continuation.

Carcinogenicity	Exposure circumstances	
	Agents	Occupations
Probable/possible	Sulfuric acid Benz(a)anthracene Lead Methylene chloride Dyes and solvents for dyeing and printing Dibenz(a h)anthracene Epichlorohydrin Isopropanol Formaldehyde Soot Non-arsenic pesticides Mercury Nickel Untreated and mildly treated mineral oils Textile dust during manufacture Non-ionizing radiation Paints Non-chlorinated solvents	Coal tar pitches Soap, detergent and battery manufacture Printing Leather manufacturing Textile manufacturing Petroleum products manufacturing Oil refining Steel welding and alloys Paints

Table 2. Final list of high-priority categories of potentially carcinogenic agents found in work processes and environments in Brazil.

Categories	Agents
Organic dusts	Textile dust
	Leather dust
	Wood dust
	Charcoal
Inorganic dusts	Silica
	Asbestos
Metals	Arsenic
	Cadmium
	Inorganic lead
	Copper
	Nickel
	Mercury
	Cobalt
	Beryllium
	Chromium
	Aluminum and steel
Solvents and combustion products	Benzene
	Xylene
	Toluene
	Diesel
	Polycyclic aromatic hydrocarbons (PAH)
Solvents and combustion products	Dioxins
	Ethylene oxide
	Benzopyrene
	Creosote
	Charcoal
	Tar
	Mineral oils
Radiation	Artificial ultraviolet radiation (UVA, UVB, UVC)
	Ionizing radiation
	Non-ionizing radiation (electromagnetic waves)
	Radon
	Solar radiation
Pesticides	Insecticides
	Herbicides
	Fungicides
Industrials chemicals	Polychlorinated biphenyls (PCB)
	Styrene oxide
	Polyvinyl chloride (PVC)
	Tetrachloroethylene
	Formaldehyde
	Rubber

should call into question the assumption that harm occurs above some definite cut-off point. For this reason, the sensitivity of the classification described here is higher than the one usually found in similar studies, and even in the legislation. In addition, we did not consider the strength of association, i.e. we included some circumstances considered to be hazardous even when association was weak (but consistent and significant). We neither considered the incidence of the associated type of cancer as inclusion criterion. The reason is that several cancer sites are known to be rare (e.g., nasal cavity mesothelioma)[5] but a large part can be attributed to the patient's occupation and thus are almost entirely preventable. Then, since our aim was to establish priorities for prevention and control measures, the list of priorities includes agents with ongoing or permanent risk of exposure.

We should observe that exposures vary according to the type of organizations and geographical regions (as a function of differences in main economic activities and feasibility of prevention and control measures)[4]. Given the large number of potential exposures to take into account vis-à-vis the implementation of preventive and control measures, determining priorities poses a challenge to health surveillance agencies. Yet, establishing priorities is paramount whenever budget claims surpass the available resources[2,3]. In this regard, resource allocation may be grounded on data, but also possible funding sources and the context of analysis should be taken into consideration.

CONCLUSION

While the relationship between cancer and work is quite well known, the present study represents an institutional framework for new policies in this field. Our motivation to publish the present study was to provide a list of high-priority carcinogens to be considered in surveillance actions in Brazil.

In regard to the possible use of the list in health situation analysis, there are some limitations in the availability, scope and quality of the information sources, since no nationwide survey has been yet conducted in Brazil to collect exact data on the prevalence or levels of exposure to occupational carcinogens. Therefore, a list of high-priority carcinogens will be useful in future studies seeking to draw general inferences based on information gathered from local sources, even though high-risk populations vary considerably in their demographic characteristics, lifestyle, patterns of access to healthcare and economic and industrial development. In last instance, the categories we established might contribute to the implementation of surveillance actions and occupational cancer control action plans.

REFERENCES

1. Santosa A, Wall S, Fottrell E, Högberg U, Byass P. The development and experience of epidemiological transition theory over four decades: a systematic review. Glob Health Action. 2014;7:23574. https://doi.org/10.3402/gha.v7.23574
2. Cogliano VJ, Baan R, Straif K, Grosse Y, Lauby-Secretan B, El Ghissassi F, et al. Preventable exposures associated with human cancers. J Natl Cancer Inst. 2011;103(24):1827-39. https://doi.org/10.1093/jnci/djr483
3. Siemiatycki J, Richardson L, Straif K, Latreille B, Lakhani R, Campbell S, et al. Listing occupational carcinogens. Environ Health Perspect. 2004;112(15):1447-59. https://doi.org/10.1289/ehp.7047
4. Peters CE, Ge C, Hall A, Davies H, Demers P. CAREX Canada: an enhanced model for assessing occupational carcinogen exposure. Occup Env Med. 2015;72(1):64-71. https://doi.org/10.1136/oemed-2014-102286
5. Instituto Nacional de Câncer José Alencar Gomes da Silva. Coordenação Geral de Ações Estratégicas. Coordenação Geral de Prevenção e Vigilância. Área de Vigilância do Câncer relacionado ao Trabalho e ao Ambiente. Diretrizes para a vigilância do câncer relacionado ao trabalho. Fátima Sueli Neto Ribeiro (ed.). Rio de Janeiro: INCA; 2012.

Corresponding address: Raphael Mendonça Guimarães – Escola Politécnica de Saúde Joaquim Venâncio – Avenida Brasil, 4,365, sala 318 – CEP: 21040-900 – Rio de Janeiro (RJ), Brazil – E-mail: raphael24601@gmail.com