INPLASY

Geographic information systems for occupational cancer surveillance: Scoping review

INPLASY202430058
doi: 10.37766/inplasy2024.3.0058
Received: 14 March 2024
Published: 14 March 2024

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ADMINISTRATIVE INFORMATION

Support - External supports were not use.

Review Stage at time of this submission - The review has been completed but not published.

Conflicts of interest - None declared.

INPLASY registration number: INPLASY202430058

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 14 March 2024 and was last updated on 14 March 2024.

INTRODUCTION

Review question / Objective Primary research question: What are the applications of Geographic Information Systems used for monitoring occupationally related cancer worldwide?
Sub-questions: What tools (software, hardware, etc.) have supported the structure of a public health surveillance program that has used GIS? How have cancer surveillance systems using GIS been constructed worldwide? What variables have been considered for cancer monitoring based on GIS? What indicators in the monitoring of occupationally related cancer have been integrated into GIS?
General objective
To determine the applications of Geographic Information Systems for public health surveillance of occupationally related cancer, as reported in the scientific literature.
Specific objectives: Identify indicators of morbidity, mortality, coverage, access, timeliness, and inequity in health services used in cancer monitoring systems based on GIS, according to the literature.
Identify indicators for monitoring environmental agents used in cancer studies based on GIS, according to the literature.
Describe the advantages and limitations worldwide regarding the use of Geographic Information Systems (GIS) for monitoring occupationally related cancer.

Background Geographic Information Systems (GIS) are computerized systems capable of articulating, assembling, storing, and manipulating spatial or cartographic information, in order to show the real conditions of a georeferenced variable being studied. In health, GIS has been widely used, combining demographic, environmental variables, etc., with indicators such as morbidity, mortality, to map or georeference conditions of interest and also reach interventions in public policy. As a result, the generation of maps with health events has been facilitated, through

which it has been possible to show risk factors, distribution of services, availability of resources (physical, human, infrastructure, etc.), as well as making tangible some social determinants of health to favor interventions for damage control or reorganization of health services, based on the needs of the population, through nosogeography.

In cancer, there is evidence of maps on mortality since the 1800s in England and its relationship with environmental exposure. Currently, the American Cancer Society, with the IARC (International Agency for Research on Cancer), and the Union for International Cancer Control, have developed a collaborative tool that provides global information on cancer in the world, its geographical distribution, risk factors, and prevention and control methods, which can be observed in different maps.

There are also other publications related to the geographical distribution of cancer. For example, the Atlas of mortality in Spain, in India, and in Latin America such as the Atlas of Cancer Mortality in Argentina and in Chile. In the case of Colombia, through efforts of the National Cancer Institute and the Agustín Codazzi Geographic Institute and with inputs from the National Statistics Department (DANE), a Cancer Mortality Atlas has been periodically developed, whose first edition was published in 1994, which compiled information between 1989-1991 and represented cartographically the mortality from oncological pathology by large regions and departments.

The Cancer Atlas developed by the IARC demonstrates the occupational risk factor associated with the development of oncological pathology to diagram it both on its website and in a digital document. In Colombia, the cancer atlas documents some findings suggesting carcinogenic agents as risk factors to explain the distribution of mortality at the municipal level. However, to date, a specific national occupational cancer atlas has not been documented, where risk agents are broken down, active cases are documented, and variables such as qualification of origin and the geographical distribution of documented cases are considered. This work aims to answer the following research question: What are the characteristics of Geographic Information Systems in health worldwide, for cancer surveillance? This answer is expected to be the input for a second phase of the project, to identify key elements in the construction of an occupational cancer atlas as a public health surveillance tool based on GIS.

Rationale Cancer is a major health issue, being the leading cause of death worldwide. According to the World Health Organization (WHO), in 2020, cancer caused 10 million deaths. It is also estimated that there will be a 32% increase in cancer cases by 2030, with more than 5 million new diagnoses in the Americas each year, due to changes in the population pyramid.

While it has been identified that there are shared risk factors for cancer and other non-communicable diseases, such as tobacco use, harmful alcohol consumption, low intake of fruits and vegetables, and lack of physical activity, WHO has also identified that occupational exposure to carcinogens such as physical agents (ionizing and non-ionizing radiation), biological agents (hepatitis B and C, HIV), and chemicals (a variety identified by IARC) are relevant in oncology and should be identified and managed. This is especially important considering that, in general, between 30 and 50% of cancer cases are preventable.

In the case of Colombia, according to the Carcinogenic Agents Manual developed in 2006, the following were identified as occupationally impactful: 4 biological agents, 1 physical agent, 35 chemicals, 7 mixtures, and 13 exposure circumstances, with 33 classified in Group 1 and 27 in Group 2A by IARC. According to the same work by the INC, there is a recognized absence and need for a national information system that meets the needs of occupational cancer monitoring and epidemiological surveillance in Colombia. Having such a resource could contribute to the gradual elimination of underreporting and impact the understanding of occupational risk factors for health professionals, workers, and employers in the country.

In this sense, being able to map cases of occupational cancer in Colombia using Geographic Information Systems (GIS) could be a fundamental step towards a robust surveillance system for occupational carcinogens of interest to the country, with the potential impact on public policy.

In line with the renewal of its designation as a WHO Collaborating Centre for Occupational Health, Universidad El Bosque is committed to supporting the development of certain products of interest for worker health, including the construction of a proposal for a national chemical substances observatory and the construction of a high-exposure registry for occupational hazards and their impact on worker health. This commitment is aligned with the PAHO Plan of Action on Workers' Health 2015-2025, which describes the following: "Strategic Line of Action #2 Develop and implement comprehensive occupational health programs that identify and control hazardous exposures and other risk conditions in selected economic sectors. Strategic Line of Action #5: Strengthening diagnostic capacity, information systems, epidemiological

surveillance, and research on diseases, accidents, and deaths."
PAHO/AMRO (which includes the following countries: Chile, Colombia, Costa Rica, El Salvador, Peru) requires providing models for the creation of national observatories that allow for the monitoring of occupational exposures to certain groups of substances, in order to define priorities for surveillance and monitoring, as well as their impact in workplaces.

METHODS

Strategy of data synthesis The synthesis is conducted using a qualitative analysis, following the JBI methodological guidance and adhering to the PRISMA protocol for Scoping PRISMA ScR reviews. Literature search was conducted in the following databases: PubMed, Embase, Scopus, Bireme (BVS), taking into account the selected keywords. Specific search strategies were employed to identify articles of interest, standardizing key terms in each of the thesauri, which corresponded to the following algorithms:
*For PubMed: "Neoplasms"[Mesh] AND (("Public Health"[Mesh]) AND ("Public Health Surveillance"[Mesh] OR "Public Health Informatics"[Mesh] OR "Public Health Practice"[Mesh] OR "Public Health Administration"[Mesh] OR "Environment and Public Health"[Mesh] OR "Public Health Systems Research"[Mesh])) AND "Geographic Information Systems"[Mesh]

*For Embase: ('public health surveillance'/exp OR 'public health surveillance' OR (('public'/exp OR public) AND ('health'/exp OR health) AND ('surveillance'/exp OR surveillance))) AND ('geographic information system' OR 'geographic mapping' OR 'geographic distribution') AND (2018:py OR 2019:py OR 2020:py OR 2021:py OR 2022:py) AND ('neoplasm' OR 'malignant neoplasm' OR cancer)
*For Scopus: 5 (TITLE-ABS-KEY (neoplasms) OR TITLE-ABS-KEY (cancer) AND TITLE-ABSKEY ("geographic information systems")) AND PUBYEAR > 2017 AND PUBYEAR > 2017

*Para Bireme BVS: (cancer) AND ("sistemas de información geográfica") AND (year_cluster:[2018 TO 2022])
Characteristics of the Studies
A total of 55 articles from 24 different nations were evaluated: the United States (17 results, corresponding to 30.90%), China (5 results, corresponding to 9.09%), France (4 results, corresponding to 7.27%), Iran (3 results, corresponding to 5.45%), Poland (2 results, corresponding to 3.63%), Australia, Canada, Denmark, Nigeria, and Thailand (2 results each, corresponding to 3.63% each). Lastly, Germany, Colombia, Korea, Cuba, Ghana, Indonesia, Japan, Jordan, Malaysia, Pakistan, Sudan, and South Africa each contributed one result, corresponding to 1.81% individually.
Regarding the selected observation period, the year with the highest number of publications was 2018 with 14 articles each year, corresponding to 25.45%, followed by 2019 and 2021 with 13 articles each, representing 23.63% each, 2022 with 9 articles corresponding to 16.33%, and finally 2020, with 6 articles corresponding to 10.9% of the articles found.
Regarding the study type, it was found that the methodological design of most articles was descriptive, with 33 ecological studies (60%) and 9 cross-sectional studies (16.36%). 2 systematic review or literature review studies were found (3.63%), 5 case-control studies (9.09%), 4 cohort studies (7.27%). Additionally, 2 mathematical modeling studies were documented.

Types of Cancer Studied
In relation to the types of cancer studied, there was a great variety among the articles in the review. The most studied were 1. breast cancer with 18 references 2. lung cancer with 12 references. 3. gastroesophageal cancer and colorectal cancer, with 15 references 4. liver cancer 5. skin cancer and melanoma, ovarian cancer, prostate cancer; additionally, 11 articles reviewed cancer in general or did not specify the type of cancer to be studied, and some of these also studied several types of cancer simultaneously (head and neck cancer, breast, lung, colorectal, bladder, gastroesophageal, prostate, thyroid, liver, ovarian, pancreas, skin cancer). 20% of the articles referred to the study of cancer of particular occupational interest such as lung and malignant mesothelioma. Additionally, 16.366% of the articles studied industrial emissions as air pollutants such as dioxins, and their association with breast cancer; polluted air due to PM 2.5 and its association with hepatocellular carcinoma, cadmium pollution and its association with gastrointestinal, hepatic, and pulmonary cancer, and a study that modeled the airborne dispersion of cadmium with the appearance of breast cancer as well as aquifer contamination by metals and its association with cancer in general. Likewise, the association of pesticides with thyroid cancer was studied in one of the references, and likewise, the vulnerability of certain skin phototypes to skin cancer was measured through GIS exposure to UV rays. All the studies cited represent occupational

interest, especially regarding exposure to chemical and physical risks.

GIS Used

Regarding the Geographic Information System (GIS) used, the articles mention the following software for data processing: Geocode API, QGIS, ArcGIS, Satscan, ArcMap, Geographic Information System, and digital cartographic base of GEOCUBA, GeoDa. Of these, the most prevalent GIS was ArcGIS (33 references corresponding to 60%), followed by QGIS (6 references corresponding to 10.9%). It was found that 6 articles corresponding to 10.9% did not specify which GIS was used. The remaining proportion corresponded to other GIS; In turn, 9.09% of the references corresponding to 5 articles used more than one GIS.

Spatial Analysis Method Used

Regarding the spatial analysis method, it was documented that 30.9% of the articles (corresponding to 17 studies) used descriptive methods, 50.9% used analytical methods (28 studies), and 12.72% used mixed methods. The remaining proportion corresponded to articles that, due to their study design, did not directly apply any type of spatial analysis.

Eligibility criteria Identification of relevant studies: Inclusion criteria were defined based on the Population, Context, and Concept (PCC) strategy:

This Scoping review will include evidence from the period 2012 to 2022. The search will be limited to studies in English, Portuguese, and Spanish. Observational studies, including case-control, cohort, cross-sectional, ecological studies, and case series will be included. Experimental studies in humans, as well as systematic reviews, meta-analyses, scoping reviews, and critical literature reviews, will be included. Studies involving both sexes and any geographic location will be included. Exclusion criteria will include articles related to diseases other than cancer, studies in children and adolescents, narrative reviews, and animal studies.

Concept: Geographic Information Systems (GIS) are a set of tools and computerized systems capable of articulating, assembling, storing, and manipulating spatial or cartographic information, in order to show the real conditions of a georeferenced variable being studied. They integrate and relate political, security, social-cultural, economic, environmental, occupational aspects, etc., and contribute effectively to decision-making in public policy.

Context: The identification of GIS applications will be particularly in the context of epidemiological surveillance of cancer and occupational cancer worldwide.

Quality assessment and data extraction: Three researchers will independently assess studies to determine if they meet eligibility criteria after evaluating titles and abstracts. This process will be conducted using the Rayyan® web platform, which allows blinded article selection. In case of disagreement, decisions will be made by consensus among the research group. The PRISMA SR statement will be used to guide the review process according to the predetermined checklist. Bias assessment of articles will not be conducted, according to the methodological stipulation for Scoping Reviews.

Source of evidence screening and selection Three researchers will independently assess the studies to determine their eligibility after reviewing the titles and abstracts. This process will be conducted using the Rayyan® web platform, which allows for blinded article selection. Any disagreements will be resolved through consensus among the research group. The review process will be guided by the PRISMA SR statement and its predetermined checklist. Bias assessment of the articles will not be performed, in line with the methodological guidelines for Scoping Reviews.

Data management The studies were uploaded to the Rayyan® web platform, and to blind the article selection, three pairs of researchers independently assessed the studies to determine compliance with the eligibility criteria after evaluating the titles and 6 the abstracts. When there was disagreement or discrepancy, the decision was made by the principal investigator. A table was developed in a spreadsheet to synthesize the information obtained. The following information was extracted from each of the selected articles: Title, authors, year of publication, country of publication, type of article, objectives and type of cancer studied, relevant results, type of GIS used, spatial analysis methodology, indicators documented in the article, advantages and disadvantages of GIS indicated. The indicators were categorized into the following groups: morbidity and mortality (including incidence, prevalence, mortality), access (defined as the user's ability to use health services), coverage (number of people potentially in contact with health service), modeling of environmental agents (environmental agents present in water, air, or land such as metals, pesticides, dioxins, and others, with potential carcinogenic risk to humans), inequality (defined as disparity in the provision of health service based on social determinants of health), timeliness (defined as the user's ability to

obtain the services they require without delays that endanger their life or health). The PRISMA SR statement was used to guide the review process according to the predetermined checklist. Bias assessment of the articles was not conducted, following the methodological stipulations for Scoping Reviews. The analysis of the results was narrative.

Reporting results / Analysis of the evidence A total of 766 articles were found in the selected databases (102 in PUBMED, 399 in EMBASE, 260 in SCOPUS, and 5 in BIREME-bvs). After identifying and removing 117 duplicate articles, the remaining 649 articles were reviewed. Following title and abstract screening, 528 articles that did not meet the inclusion criteria were excluded. A total of 121 articles were read in full and evaluated for eligibility, of which 66 were excluded for the following reasons: 1) they were not from the period 2018 to 2022 (50 articles excluded), 2) they did not address Geographic Information Systems (5 articles excluded), 3) studies conducted in children (1 article excluded), 4) they were not related to occupational interest (studies related to genetically derived cancer, cancer derived from dietary habits, cancer derived from the use of psychoactive substances, and cancer associated with HPV or other sexually transmitted infections) (5 articles excluded), 5) languages other than Spanish, English, and Portuguese (4 articles excluded), 6) non-existent DOI, therefore full-text access could not be obtained (1 article excluded). Finally, 55 articles were included in the qualitative synthesis of the review.

Presentation of the results Sánchez , Diana Carolina ; Talero, Lorena lisbeth; mejia duarte, Jose ferney; Cardenas, Silvio; Urazán, Juan; Peñaranda, Sara Sofia (2024), “Sistemas de información geográfica para vigilancia del cáncer de interés ocupacional: Scoping Review”, Mendeley Data, V2, doi: 10.17632/6fjs3hcww9.2.

Language restriction only randomized clinical trials published in English, Spanish and Portuguese will be considered for inclusion.

Country(ies) involved Colombia.

Keywords Geographic information systems, occupational cancer, epidemiological surveillance, Public health, Occupational disease.

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