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Review Article

Scientometric Analysis of Articles on Spatial Epidemiology of Cancer in Iran: A Systematic Review

Mina Danaei[1], MD; AliAkbar Haghdoost[2], PhD; Hossein Safizadeh[3], PhD; Reza Malekpourafshar[4], MD; Ramin Moradi Baniasad[5], MSc Student; Mohsen Momeni[3], MD

[1]Neuroscience Research Center, Institute of Neuropharmacology, Kerman University of Medical Sciences, Kerman, Iran;
[2]HIV/STI Surveillance Research Center, and WHO Collaborating Center for HIV Surveillance, Institute for Futures Studies in Health, Kerman University of Medical Sciences, Kerman, Iran;
[3]Social Determinants of Health Research Center, Institute for Futures Studies in Health, Kerman University of Medical Sciences, Kerman, Iran;
[4]Pathology and Stem Cell Research Center, Kerman University of Medical Sciences, Kerman, Iran;
[5]Department of Non-communicable Diseases, Vice Chancellor for Health, Kerman University of Medical Sciences, Kerman, Iran

Correspondence:
Mohsen Momeni, MD;
Afzalipour Medical School, 22nd Bahman Blvd., Pazhoohesh Sq., Postal Code: 76169-14115, Kerman, Iran
Tel: +98 9131406404
Fax: +98 34 33257288
Email: m.momeni@kmu.ac.ir
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What's Known

- Estimates of pretest disease probability and geographical prevalence may improve paraclinical test interpretation and disease management.
- Physicians can make better clinical interpretations and diagnoses when equipped with information on the geographical prevalence of a disease.

What's New

- The scientometric analysis of studies on the spatial epidemiology of cancer indicated a suboptimal quality of the publications.
- Results showed large variations in high-risk breast cancer clusters. Gastrointestinal cancer clusters were more prevalent in the north and northwest of Iran, whereas skin cancer and acute lymphoblastic leukemia were higher in the central provinces.

Abstract

Background: Geographic information system (GIS) plays an important role in identifying areas with a high incidence of cancer. In the present study, based on a systematic review of studies by Iranian researchers, we performed a scientometric analysis of the published articles on the spatial epidemiology of cancer. In addition, the geographical distribution of certain types of cancer in Iran is presented.

Methods: A literature search was conducted using electronic databases such as PubMed and NLM Gateway, Institute for Scientific Information, Scopus, Google Scholar, and Cochrane Library for relevant articles published from 2000 to 2021. The search was performed using a combination of medical subject heading terms and keywords. A narrative synthesis was performed, and descriptive data were expressed as frequency and percentage.

Results: Of the 200 identified articles, 31 studies published in 15 different journals were included in this systematic review. Results showed a wide variation in high-risk breast cancer clusters. However, a similar incidence of gastrointestinal cancers has been reported, and high-risk clusters were identified in the north and the northwest of Iran. Skin cancer and acute lymphoblastic leukemia were more prevalent in the central provinces.

Conclusion: The current volume of studies on the spatial epidemiology of cancer in Iran, with a CiteScore quartile of Q1, is inadequate to guide health policymakers. The geographical distribution of many prevalent types of cancer has not been assessed by Iranian researchers. Furthermore, the classification of high- and low-risk geographical clusters of cancers was not completely homogeneous.

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Keywords ● Spatial analysis ● Geographic information systems ● Neoplasms ● Disease hotspot ● Iran

Introduction

Today, cancer has become one of the leading causes of death in the world.[1] This global trend in cancer cases is also evident in Iran as a result of the epidemiological transition (i.e., population aging and lifestyle changes). The incidence rate of cancer cases in Iran has almost doubled from 2000 to 2016, with breast, skin, and colorectal cancers being the most common. However, the

rate varied by province, such that some types of cancer showed a unique sample distribution with a high incidence in certain geographical areas.[2]

Recently, the science of geographic information system (GIS) has been coupled with the field of medicine for public health surveillance purposes.[3] GIS has been applied to identify the early spatial distribution of communicable and non-communicable diseases. In this regard, spatial and temporal heterogeneity analysis techniques have played an increasingly significant role in detecting areas of the high and low incidence of a disease.[4] The past decade has seen a sharp increase in the number of epidemiological studies using GIS, especially in the areas of cancer and environmental epidemiology. One important application of GIS is the identification of cancer clusters, i.e., the non-random geographical distribution of cancer cases.[5] The identification of high-risk geographical areas allows health system access to reliable cancer data (e.g., prevalence and risk factors) to implement efficient preventive strategies. However, in developing countries such as Iran, health systems lack adequate resources to conduct primary and secondary cancer prevention programs.[6]

Given the above, we performed a scientometric analysis of published articles by Iranian researchers on the spatial epidemiology of cancer in Iran. In addition, we determined the geographical distribution of certain types of cancer.

Materials and Methods

A systematic review was conducted in 2022 in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline.[7] The study was approved by the Research Ethics Committees of the Iran National Institute for Medical Research Development (IR.NIMAD.REC.1397.5240).

Eligibility Criteria

All articles on the spatial epidemiology of cancer in Iran, published from 2000 to 2021, were included in the study. The exclusion criteria were studies that only covered a single Iranian province, focused on cancer survival or mortality rates rather than its incidence, and those not using GIS to report the geographic distribution of cancer in Iran. In addition, articles not written in English, congress abstracts and presentations, and non-original articles were excluded.

Search Strategy

A literature search was performed on 5 April 2022 using a selection of electronic databases such as PubMed and NLM Gateway, Google Scholar, Institute for Scientific Information (ISI), Scopus, and Cochrane Library. The search was performed using a combination of medical subject heading (MeSH) terms and keywords. The keywords included [“Cancer” OR” Neoplasms”] AND [“Spatial “OR “Analysis” OR “Bayesian” OR “Spatial epidemiology” OR “Spatial analysis”] AND [“Geographic” OR “Geographic information system”], AND [“Iran”]. The search date was set from January 2000 to December 2021, and no filters were applied. The reference list of the eligible articles was reviewed for any additional articles.

Quality Assessment of the Articles

The quality of cross-sectional articles was assessed using the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist. The quality ratings of the 22-item STROBE checklist are classified as “good” (score>16), “fair” (11≤score≤16), and “poor” (score<11).[8] Accordingly, the quality of the articles was independently assessed by two reviewers, and possible disagreements were resolved in group discussions. Articles classified as “poor” were excluded from the systematic review.

Data Extraction

The data were extracted by two reviewers using Microsoft Excel 2016 edition (Microsoft, Redmond, WA, USA). The following information was extracted: Scientometric indicators of the journal (indexing and listing sources, CiteScore quartile, impact factor), the number of keywords in each article, MeSH keywords, data source (cancer registry or other sources), demographic or behavioral risk factors of cancer, the site of cancer, the method used to analyze the geographical distribution of cancer, and the high- or low-risk clusters.

Statistical Analysis

Descriptive data were presented in the form of figures and tables and expressed as frequency and percentage. In addition, narrative synthesis was performed to synthesize the obtained data from the systematic review.

Results

Of the 200 identified articles, 103 were duplicates, and 48 irrelevant or not meeting the inclusion criteria were excluded. Out of the remaining 49 eligible articles, 17 were excluded because of the full-text in Persian or the use of

methods other than GIS. Full-text review of the 32 articles was performed, and one article with a low STROBE score (poor quality) was removed. Eventually, 31 articles with a “good” or “fair” quality rating were included in the systematic review (figure 1).

The included articles were published in 15 different journals and focused on the spatial epidemiology of cancer. The first article was published in 2009 and the number of identified articles peaked in 2016 (n=6) (figure 2). The majority of articles were published in the Asian Pacific Journal of Cancer Prevention (APJCP) (n=14, 45.1%). The CiteScore quartile of four articles was Q1. The highest and the lowest impact factor of the journals were 6.49 and 1.09, respectively.

The majority of articles (45%) were published in APJCP (n=14). The CiteScore quartile of four articles was Q1, and the highest and the lowest impact factor of the journals were 6.49 and 1.09, respectively (table 1).

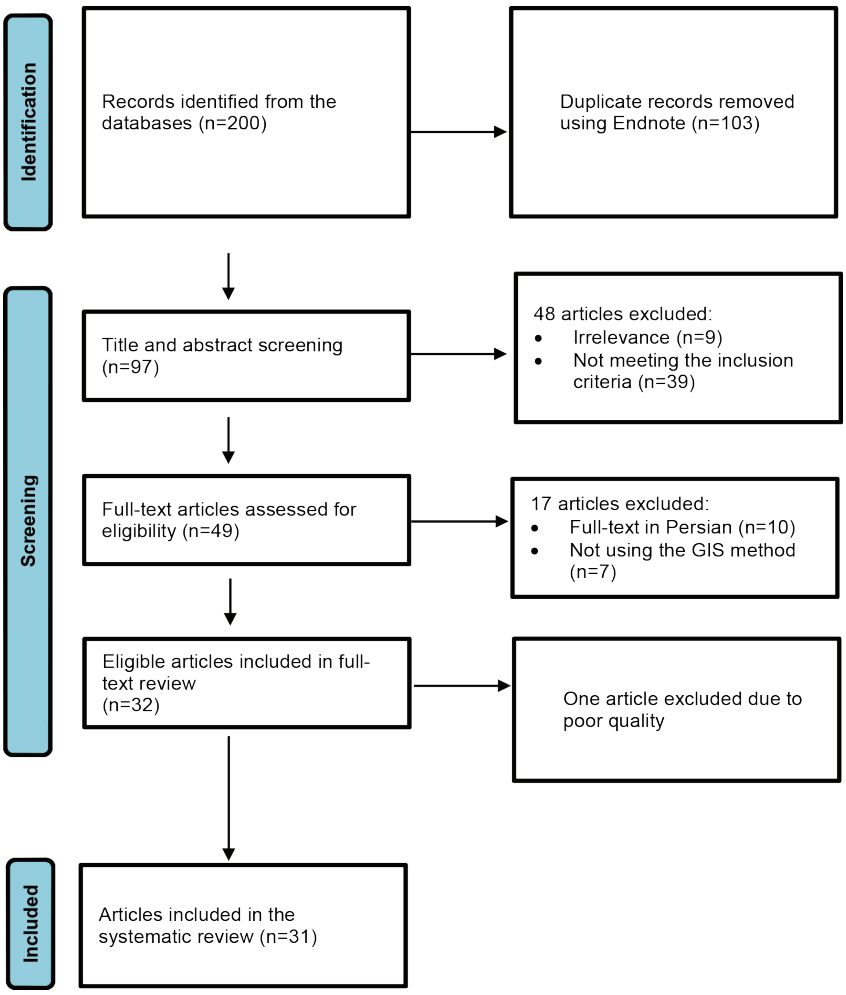

Figure 1: PRISMA flow diagram shows the article selection process for the systematic review.

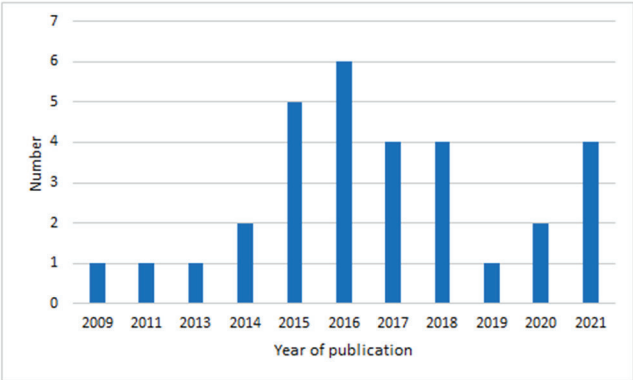

Figure 2: Annual distribution of the published articles included in the systematic review.

Table 1: Distribution of articles according to the scientometric indicators of the journals

Journal name	Journal index	CiteScore quartiles	IF	Articles (n)
Asian Pacific Journal of Cancer Prevention (APJCP)	Scopus, PubMed	Q2	-	14
Archives of Iranian Medicine (AIM)	ISI, Scopus, PubMed, Embase	Q2	1.09	1
Geospatial Health	ISI, Scopus, PubMed, DOAJ	Q2	1.21	2
International Journal of Cancer Management (IJCM)	ESCI (ISI), Scopus	Q3	-	1
Gastroenterology and Hepatology from Bed to Bench (GHFBB)	Scopus, PubMed, Embase	Q3	-	2
Eastern Mediterranean Health Journal (EMHJ)	ISI, Scopus, PubMed, Embase	Q2	1.62	1
Environmetrics	ISI, Scopus	Q2	1.90	1
PLOS ONE	ISI, Scopus, PubMed, Embase, DOAJ	Q1	3.24	1
International Journal of Environmental Research	ISI, Scopus, PubMed, Embase	Q1	6.49	1
Epidemiology and Health (epiH)	ISI, Scopus, PubMed	Q1	3.28	2
Iranian Journal of Cancer Prevention (IJCP)	Other	-	-	1
Journal of B.U.ON: Official journal of the Balkan Union of Oncology	Scopus, PubMed, Embase			1
Middle East Journal of Cancer (MEJC)	ESCI (ISI), Scopus, Embase	Q4	-	1
Shiraz E-Medical Journal (SEMJ)	Scopus, Embase	Q3	-	1
Stochastic Environmental Research and Risk Assessment (SERRA)	ISI, Scopus	Q1	3.37	1

IF: Impact factor

Table 2: A list of the most frequently used keywords in the included articles

Keywords	Frequency	Percent	MeSH terms
Iran	27	12.33	Yes
Epidemiology	13	5.94	Yes
Incidence	16	7.31	Yes
Spatial analysis	8	3.65	Yes
Cancer	8	3.65	No
Incidence pattern	4	1.83	No
Relative risk	4	1.83	No
Geographic information	4	1.83	No
Incidence rate	5	2.28	No
System	4	1.83	No
Breast cancer	8	3.65	No
Cluster analysis	4	1.83	Yes
Children	5	2.28	No
Breast neoplasm	2	0.91	Yes
Spatial	3	1.37	No
Esophageal cancer	2	0.91	No
Conditional autoregressive model	2	0.91	No
Ecological	4	1.83	No
Poisson distribution	2	0.91	Yes
Leukemia	4	1.83	No
Clustering	2	0.91	No
Risk factor	2	0.91	No
Bayesian model	3	1.37	No
Full Bayesian model	2	0.91	No
Stomach cancer	3	1.37	No
Seasonal variation	3	1.37	No
Spatial correlation	2	0.91	No
Geographic variation	2	0.91	No
Spatial autocorrelation	3	1.37	No
Skin cancer	2	0.91	No
Iran counties	2	0.91	No
Geographic distribution	2	0.91	No
Mapping	3	1.37	No
Lattice data	2	0.91	No
Lip cancer	2	0.91	No

Spatial statistics	2	0.91	No
Gastric cancer	3	1.37	No
Bayesian spatial analysis	2	0.91	No
Disease mapping	7	3.20	No
Area-to-area Poisson kriging	2	0.91	No
Esophagus cancer	1	0.46	No
Brain cancer	1	0.46	No
Trend	2	0.91	No
Lung cancer	2	0.91	No
Geographical regions	1	0.46	No
Human development index	1	0.46	No
Regression models	1	0.46	No
Bladder cancer	1	0.46	No
Spatiotemporal	1	0.46	No
Risk	1	0.46	Yes
Space-time scan statistics	1	0.46	No
Cluster identification	1	0.46	No
Gamma Poisson model	1	0.46	No
Log-normal model	1	0.46	No
BYM model	1	0.46	No
Colorectal neoplasms	1	0.46	Yes
Sex	1	0.46	Yes
Epidemiologic studies	1	0.46	Yes
Colorectal cancer	1	0.46	No
Geographical variation	1	0.46	No
Temporal	1	0.46	No
Esophageal cancer	1	0.46	No
Bayesian multilevel space-time model	1	0.46	No
Bayesian Spatio-temporal analysis	1	0.46	No
Spatio-temporal data	1	0.46	No
Bayesian disease mapping	1	0.46	No
Acute lymphoblastic leukemia	1	0.46	No
Climate	1	0.46	Yes
Environmental	1	0.46	No
Adaptive smoothing model	1	0.46	No
Cervix cancer	2	0.91	No
Spatio-temporal analysis	2	0.91	Yes
Bivariate disease mapping	1	0.46	No
Prevalent sites	1	0.46	No
Shared component model	1	0.46	No

MeSH: Medical subject heading

Frequently Used Keywords: The used keywords were highly heterogeneous. The most prevalent keywords were Iran (n=27), incidence (n=16), epidemiology (n=13), spatial analysis (n=8), and cancer (n=8). Of the 75 keywords in the articles, 14 were MeSH terms (table 2).

Types of Cancer: Of the 31 reviewed articles, Babaee,[9] Mahaki,[10] and Raei[11, 12] reported the 10, 7, and 2 most prevalent cancer types, respectively. The remaining 27 articles focused on only one cancer type. Breast and gastric cancers had the highest frequency in eight and five articles, respectively (table 3).

Data Sources: The data used in most articles (n=29, 93.5%) were obtained from the National Cancer Registry (NCR). One article used hospital data (3.25%), and another used NCR, death registry system, covariates from the National Population and Housing Census (NPHC) survey, and Households Income and Expenditure Survey (HIES) (3.25%).

Risk Factors: Association between cancer incidence and possible risk factors was not assessed in seven (22.58%) articles. The association between demographic risk factors and cancer incidence was assessed in 16 (51.61%), between behavioral risk factors and cancer incidence in eight (25.80%) articles, and between demographic and behavioral risk factors and cancer incidence in four (12.90%) articles.

Geographical Distribution of Cancer: The results of the studies showed a wide variation

Table 3: Details of cancer types, methods, and results extracted from the included articles

Authors	Cancer site	Study period	Method applied	High-risk clusters	Low-risk clusters
Kavousi et al.[13]	Lip cancer	2002 to 2005	Hierarchical Bayesian approach	Khorasan, Kerman, Yazd (the eastern provinces)	Western provinces (except for Ilam)
Soleimani et al.[14]	Gastrointestinal tract cancers	2010	Full Bayesian smoothing method and Moran's I index	North, northwest, west, and northeast of Iran	-
Zayeri et al.[15]	Skin cancer	2008 to 2010	Classic and full Bayesian models	Central and highland regions	-
Mahdavifar et al.[16]	Breast cancer	2009	Hot Spot Analysis (Getis -Ord Gi*)	Tehran, Isfahan, Yazd, Markazi, Fars (central provinces)	Sistan-Baluchestan, Khorasan, South Khorasan, Zanjan
Pakzad et al.[17]	Stomach cancer	2009	Hot spot Analysis (Getis -Ord Gi*)	Northwest of Iran (both men and women)	-
Pakzad et al.[18]	Skin cancer	2016	Hot Spot Analysis (Getis -Ord Gi*)	Central provinces and desert regions (women only) Yazd, Qom (men only)	Sistan-Baluchistan, Kerman, Hormozgan
Olfatifar et al.[19]	Breast cancer in women	2004 to 2010	Anselin Local Moran's I index method	East and northeast of Iran	-
Ahmadi et al.[20]	Breast cancer	2011	Global and local indicators of spatial autocorrelation (LISA), Moran's I index, and Getis–Ord Gi*	Mazandaran, Tehran, Alborz, Isfahan, Markazi	-
Najafimehr et al.[21]	Esophageal cancer	2004 to 2010	Routine and spatial Poisson generalized linear mixed models	Northern half of Iran	Southern half of Iran
Pourhoseingholi et al.[22]	Colorectal cancer	2005 to 2008	Bayesian and Poisson regression models spatial analysis using GIS	East Azerbaijan	South Khorasan
Rahimzadeh et al.[23]	Breast cancer in women	2000 to 2003 and 2008 to 2010	Bayesian spatial model	North Khorasan, Alborz, Ilam	Qazvin, Qom, Yazd
Rahimi Pordanjani et al.[24]	Acute lymphoblastic leukemia in children	2006 to 2014	Mann-Whitney U, Joinpoint regression analysis, Global Moran's I, and Anselin Local Moran's I	Fars, Kohgiluyeh-Boyerahmad	Kermanshah, Zanjan, Kurdistan
Babaee et al.[9]	10 most prevalent cancer types	2014	Anselin Local Moran's I index method, fixed distance band option	Northwest provinces, Semnan (stomach and breast cancers)	-
Asmarian et al.[25]	Gastric cancer	2003 to 2010	Area-to-area Poisson kriging and Besag-York-Mollie (BYM) spatial models	North and northwest of Iran (Ardabil)	Sistan-Blochestan
Asmarian et al.[26]	Esophageal cancer	2003 to 2007	Area-to-area Poisson Kriging method	North, northwest, and northeast provinces (Ardebil, Mazandaran, Kordestan)	
Bab et al.[27]	Lung cancer	2000 to 2005	Poisson regression model	Mountainous regions	Western provinces of the Caspian Sea
Haddad-Khoshkar et al.[28]	Prostate cancer	2005 to 2008	Empirical and full Bayesian models	Fars, Semnan, Isfahan, Tehran	Sistan-Baluchestan
Jafari-Koshk et al.[29]	Bladder cancer	2004 to 2008	Hierarchical Bayesian framework	Guilan, Semnan	-
Jafari-Koshk et al.[30]	Breast cancer	2004 to 2008	Bayesian space-time model	Tehran, Isfahan, Yazd	-
Kavousi et al.[31]	Gastric cancer	2004 to 2009	Space-time scan statistics	North, northwest, and central provinces (particularly Ardabil, Kurdistan, Mazandaran, and Gilan)	-

Khazaei et al.[32]	Lung cancer	2008	Mapping the incidence by ArcGIS	Central and southern provinces	-
Khoshkar et al.[33]	Breast cancer	2005 to 2008	Bayesian spatial ecological regression models	Khorasan-Razavi, Lorestan, Hamedan	Ardebil, Kohgiluyeh-Boyerahmad
Khosravi Shadmani et al.[34]	Colorectal cancer	2008		Central, northern, and western provinces	Southeastern provinces
Pakzad et al.[35]	Colorectal cancer	2009	Analysis of hot spots (Getis-Ord Gi*)	Central provinces and north of Iran	
Rahimi Pordanjani et al.[36]	Acute lymphoblastic leukemia	2006 to 2014	Global Moran's I, Optimized hotspot analysis (OHSA), Global Poisson regression (GPR), Geographically weighted Poisson regression (GWPR)	South, southwest, and mideast of Iran	North and northwest of Iran
Raei et al.[11]	Breast and cervix uteri cancers	2004 to 2009	Adaptive smoothing model, Spatio-temporal mapping	Around the central-northern half of Iran (breast cancer). Northeastern part of Iran (cervix uteri cancer)	Northwest and southeast of Iran (breast and cervix uteri cancers)
Rahimi Pordanjani et al.[37]	Acute lymphoblastic leukemia	2006 to 2014	Getis-Ord general G (GOGG) index, Optimized hot spot analysis	South, central region, and east of Iran	North and west of Iran
Rastaghi et al.[38]	Esophageal cancer	2005 to 2007	Bayesian multilevel space-time model	Northeast and northwest regions and some parts of the central regions	Desert and southern regions
Sharafi et al.[39]	Gastric cancer	2003 to 2010	Bayesian spatial and Bayesian Spatio-temporal models	Northwest of Iran	Southeast of Iran
Raei et al.[12]	Breast and cervix uteri cancer	2004 to 2009	Hierarchical Bayesian models	Tehran, Isfahan, Mazandaran, Gilan (breast cancer) Tehran, Golestan, Khuzestan, Khorasan-Razavi (cervix uteri cancer)	North Khorasan, Zanjan, Chaharmahal-Bakhtiari, Sistan-Baluchestan, and Kohgiluyeh-Boyerahmad (breast cancer) Zanjan, Chaharmahal-Bakhtiari, Sistan-Baluchestan, and Kohgiluyeh-Boyerahmad (cervix uteri cancer)
Mahaki et al.[10]	Esophagus, stomach, bladder, colorectal, lung, prostate, and female breast cancer	2007	Full Bayesian model	Fars and northwestern provinces	Hormozgan, Sistan-Baluchestan, South Khorasan, Kerman

in high-risk breast cancer clusters. However, to a large extent, the results of high-risk clusters for other types of cancer were similar. Gastrointestinal cancer was reported as a high-risk cluster in the north and northwest of Iran, whereas skin cancer and acute lymphoblastic leukemia were in the central provinces (table 3).

Discussion

In the past decade, there has been a sharp rise in GIS-based studies in the fields of cancer and environmental epidemiology. GIS mapping of health data is a valuable and effective tool to support health system policymakers in making informed decisions. For example, cancer maps link geographic features with the incidence of the disease allowing epidemiologists to identify and track its global, local, and focal clusters.[40]

Of the 31 included studies, only four articles achieved the journal's highest CiteScore quartile of Q1. The highest and the lowest impact factor of the journals were 6.49 and 1.09, respectively. The results showed that the keywords used in

the articles were highly heterogeneous. Of the 75 keywords used, only 14 were MeSH terms. This means that only a small portion of the reviewed articles (indexed in PubMed Central, MEDLINE, and Scopus) used correct keywords. Keywords accuracy is a prerequisite to efficiently access manuscripts in the MEDLINE database via PubMed. In this regard, the results of a previous study showed that only 60% of keywords in biomedical journal articles were closely related to MeSH.[41] Therefore, journals should be more critical of the correct use of MeSH keywords in the article review process.[42]

The reviewed articles assessed the geographical patterns of breast, gastrointestinal, skin, lip, prostate, bladder, cervix uteri, and lung cancers as well as leukemia. A previous study reported that the epidemiological patterns of breast, gastrointestinal, urologic, thyroid, and respiratory system cancers were the most serious neoplasia in Iran.[43] It seems that the geographical distribution of thyroid, urologic, and respiratory system cancers has not been assessed in Iranian studies. However, two studies not eligible for inclusion in our review assessed the geographical distribution of these types of cancer.[44, 45] Therefore, a comprehensive assessment of the geographical distribution of all types of cancer in Iran is recommended to guide health policymakers in devising cost-effective prevention and intervention programs in hotspot regions.

The data used in most of the included articles (93.5%) were based on the Iranian NCR database. This is indicative of the importance of national cancer registration for epidemiological research and cancer control. The first cancer registry in Iran was initiated in Tehran in 1955. In the following years, other provinces such as Fars and Kerman as well as northern provinces followed suit.[46] Nowadays, cancer registration is implemented across Iran, but with a varying degree of data quality. The results of a quality assessment of the cancer registry in five Iranian provinces from 2008 to 2011, using a capture-recapture method, showed a relatively low data quality in terms of completeness and validity.[47] Moreover, a 2009 evaluation of cancer registry systems at two hospitals in Shiraz showed data completeness at about 58% for both centers.[48] Similar evaluations in Ardebil[49] (2006-2008) and Golestan[50] (2004-2006) provinces showed the sensitivity of the cancer registry system at 36% and 94.1%, respectively.

In reviewing the included articles, we observed fluctuations in the reported high-risk clusters of cancer. This is in line with the results of a previous study showing a significant variation in the prevalence of different types of cancer across all Iranian provinces.[51] They reported a high incidence of cancer in the northern and northwestern provinces of Iran. While this could be true in these geographical areas, the sensitivity and completeness of the cancer registry system in these provinces should be taken into account.

The main limitation of the study is the sole inclusion of articles written in English, since some other epidemiological studies could have been in Persian. In addition, publications in English by Iranian researchers may contain incorrect use of words (biased language). These could undermine the findings of our systematic review. Another limitation is that only a limited number of electronic databases were searched.

Conclusion

Several studies with different assessment approaches to the spatial epidemiology of cancer have been conducted in Iran. However, the amount and quality of available research in this field are inadequate to guide health policymakers. Among the reviewed articles, only a few achieved the journal's highest CiteScore quartile of Q1. In addition, most used keywords were not MeSH terms. These studies failed to assess the geographical distribution of many prevalent types of cancer. Besides, classifications of high- and low-risk geographical cancer clusters were not completely homogeneous.

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Authors' Contribution

M.D: Research conceptualization, study design, and drafting of the manuscript; A.A.H: Research conceptualization, study design, and review of the manuscript; H.S., R.M: Acquisition and interpretation of the data and review of the manuscript; R.M.B: Acquisition and interpretation of the data and drafting the manuscript; M.M: Research conceptualization, study design, and drafting the manuscript. All authors approved the submission of the manuscript and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Conflict of Interest: None declared.

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