



HEALTH SCIENCES

Evolution of the scientific literature on esophageal cancer from 1945 to 2020: a bibliometric analysis

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Abstract: The aim of this study was to use bibliometric techniques to provide a longitudinal view of the evolution over more than 50 years of the literature on esophageal cancer without focusing on a specific area. The Web of Science Core Collection database was searched for published articles on esophageal neoplasm. Different aspects of the articles were analyzed - country, journal, authors, keywords, and topics. The search returned 24,215 articles - the journal Diseases of the Esophagus present the most number of manuscripts (n = 858), followed by Annals of Surgical Oncology (n = 475). The most cited article was one by van Hagen et al. (2012) (2,807 citations). The most prevalent topic was oncology (n = 10,448), followed by surgery (n = 4,944). Most articles were original research (n = 22,697), mainly with the basic science study design and published by institutions in China. The analysis of the variables chosen, identified China as the country with the highest number of articles and showed that authors and institutions in Asia stand out when it comes to production of scientific information on esophageal cancer.

Key words: Bibliometric analysis, Esophageal cancer, Oncology, Review.

INTRODUCTION

Esophageal cancer is the seventh most common and the sixth most fatal type of cancer worldwide (Sung et al. 2021). It is often divided into two histological subtypes: esophageal adenocarcinoma (EAC) and esophageal squamous cell carcinoma (ESCC) (Zulfiqar et al. 2013, Pickens 2022). ESCC is the most frequently occurring subtype in the world, but EAC has been increasingly identified in developed countries (Peters et al. 2021, Lipenga et al. 2021). Alcohol consumption, smoking, Barrett's esophagus, gastric reflux, and obesity are the risk factors for the development of esophageal neoplasia (Lu et al. 2021, Gokulan et al. 2019). Chemoradiation is the treatment of choice for patients considered ineligible for esophagectomy, due to cardiac

comorbidities or general clinical frailty (Allum et al. 2014, Wang & Marshall 2021).

Bibliometric analysis evaluates the importance of articles published in a specific research area (Mainwaring et al. 2020). Citation frequency is a measure to determine the impact of the published articles on the scientific community. Bibliometrics is a valuable tool to promote and identify areas with underestimated potential (Akmal et al. 2020, Mörschbacher & Granada 2022). The R-tool Biblioshiny is a software used for bibliometric analysis (Liu et al. 2020). This program it lists and analyzes country networks, institutions, co-citations, journals, and references based on bibliographic records collected from the Web of Science (WoS) (Chang et al. 2015). The aim of this study was

to use bibliometric techniques to provide a longitudinal view of the evolution over more than 50 years (1945 to 2020) of the literature on esophageal cancer without focusing on a specific area.

MATERIALS AND METHODS

Data were collected from WoS on September 17, 2021 to avoid biases and discrepancies caused by database updates. WoS is considered the main data source for bibliometric analyses, providing comprehensive and multidisciplinary data on the literature listed (Archambault et al. 2009, Yin et al. 2021, Zhang et al. 2022). To ensure that all relevant articles were identified, the appropriate search terms were compiled and combined as follows: TS = “cancer*” OR “Neoplasm*” OR “Carcinoma*” OR “Adenocarcinoma*” OR “Squamous cell*” and TS= “Esophageal” OR “Oesophageal” OR “Esophagus”.

In this study, only articles and reviews written in English and published between 1945 and 2020, were considered. As no experiments on animals or humans were performed, no ethical approval was required. The thematic search strategy employed to collect all documents relevant to the subject was based on the article title. Search accuracy was increased by excluding documents classified as book chapters, notes, editorials, letters, or errata; only journal articles were considered.

The bibliometric information of the selected articles was exported as .CSV (comma-separated values) files using the WoS access of the University of Taquari Valley for subsequent data processing. The main bibliometric indicators analyzed were; (I) the most influential articles on esophageal cancer (total number of citations), (II) country/region, (III) productivity (number of publications), (IV) year of publication, (V) research institution, (VI) source/journal in which

the articles were published, (VII) keywords, and (VIII) topic. Standard competition ranking (SCR) was used to rank some variables from one to ten.

The Hirsch index (h-index) and impact factor were used as bibliometric indicators to evaluate research impact and/or quality. Hirsch created the h-index in 2005 to measure the scientific development of authors, journals, institutions, and countries; the index is proportional to research productivity and number of citations—a high h-index indicates that the publication has had a significant impact on the development of the scientific community’s knowledge (Hirsch 2005). The quality of each article was measured by the impact factor of the journal that published it (Journal Citation Report®, JCR) (Thomson Reuters 2020).

Data analysis

Bibliometric mapping and network visualization were developed in the R-tool Biblioshiny (Chang et al. 2015), and the most frequent terms in the titles of the articles were selected. Microsoft Excel 2021 (Microsoft Corporation, Redmond, Washington, USA) was used to analyze quantitative variables such as publication and citation counts and journal citation reports.

RESULTS

The WoS search returned 24,215 articles published since 1945. The ten most influential articles on esophageal cancer (total number of citations) showed 17,243 citations collectively (Table I) in 60% of those articles, the impact of surgery alone was compared with chemotherapy, radiotherapy, combined surgery, and monoclonal antibody use on disease-free survival (Herskovic et al. 1992, Walsh et al. 1996, Mandard et al. 1994, Cooper et al. 1999, Fuchs et al. 2014, Van Hagen et al. 2012). The most cited

Table I. The ten most cited articles on esophageal cancer.

SCR	Authors	Title	Journal	Year	Total Citation
1st	van Hagen P. et al.	Preoperative chemoradiotherapy for esophageal or junctional cancer	<i>New England Journal of Medicine</i>	2012	2807
2nd	Enzinger PC. & Mayer RJ.	Esophageal cancer	<i>New England Journal of Medicine</i>	2003	2168
3rd	Lagergren, J., Bergström, R., Lindgren, A., & Nyrén, O.	Symptomatic gastroesophageal reflux as a risk factor for esophageal adenocarcinoma	<i>New England journal of medicine</i>	1999	2139
4th	Devesa, S. S., Blot, W. J., & Fraumeni Jr, J. F.	Changing patterns in the incidence of esophageal and gastric carcinoma in the United States	<i>Cancer</i>	1998	1651
5th	Herskovic A. et al.	Combined chemotherapy and radiotherapy compared with radiotherapy alone in patients with cancer of the esophagus	<i>New England Journal of Medicine</i>	1992	1557
6th	Walsh T. et al.	A comparison of multimodal therapy and surgery for esophageal adenocarcinoma	<i>New England Journal of Medicine</i>	1996	1524
7th	Pennathur, A., Gibson, M. K., Jobe, B. A., & Luketich, J. D.	Oesophageal carcinoma	<i>The Lancet</i>	2013	1485
8th	Mandard, A. M. et al.	Pathologic assessment of tumor regression after preoperative chemoradiotherapy of esophageal carcinoma	<i>Clinicopathologic correlations Cancer</i>	1994	1338
9th	Cooper, JS. et al.	Chemoradiotherapy of locally advanced esophageal cancer: long-term follow-up of a prospective randomized trial (RTOG 85-01)	<i>Jama</i>	1999	1297
10th	Fuchs, CS et al.	Ramucirumab monotherapy for previously treated advanced gastric or gastro-oesophageal junction adenocarcinoma (REGARD): an international, randomised, multicentre, placebo-controlled, phase 3 trial.	<i>The Lancet</i>	2014	1277

article (2,807 citations) was one by Van Hagen et al. (2012) published in the *New England Journal of Medicine*, which compared the use of surgery alone with chemoradiotherapy associated with surgery as a form of treatment for patients with esophageal or esophagogastric junction cancer in the period from 2004 to 2008 it was published by the research group of the Erasmus MC Cancer Institute, located in Rotterdam, the Netherlands.

Analysis of the geographical distribution of scientific production (Figure 1) revealed the

following: Seven countries from three continents (Asia, America, and Europe) published approximately 90% of the articles. Of the 105 countries that published articles, 79 (75.23%) presented less than 100, an indication of few groups with high scientific production rates in this field. China presents the highest number of articles (n = 7,720 [31.88%]), followed by the US with 5,119 (21.13%) and Japan with 4,939 (20.39%); whereas some countries in South America, Africa, and Europe had none.

Ten authors presented the highest number of articles, 2,181 collectively (Table II). The author name with the most articles was Li, Y., but because there are multiple authors from different institutions named Li, Y., this name was excluded from the analysis. Consequently, Kuwano, H. was the author with the highest number of articles (n = 257 [6.91%]) and cited 7,704 times, followed by Wang, Y. with 248 articles

(4.14%) and 4,615 citations and Zhang, Y. with 243 articles (4.01%) and 4,474 citations.

The first articles in this field were by de Nielsen 1945, Clark 1945, Sweet 1945a, Tomlinson & Wilson 1945, Boros 1945, Gaffney 1945, Sweet 1945b and Hoover 1945. These articles ranged from case reports to surgical management in the treatment of esophageal cancer. The number of articles continuously increased annually over

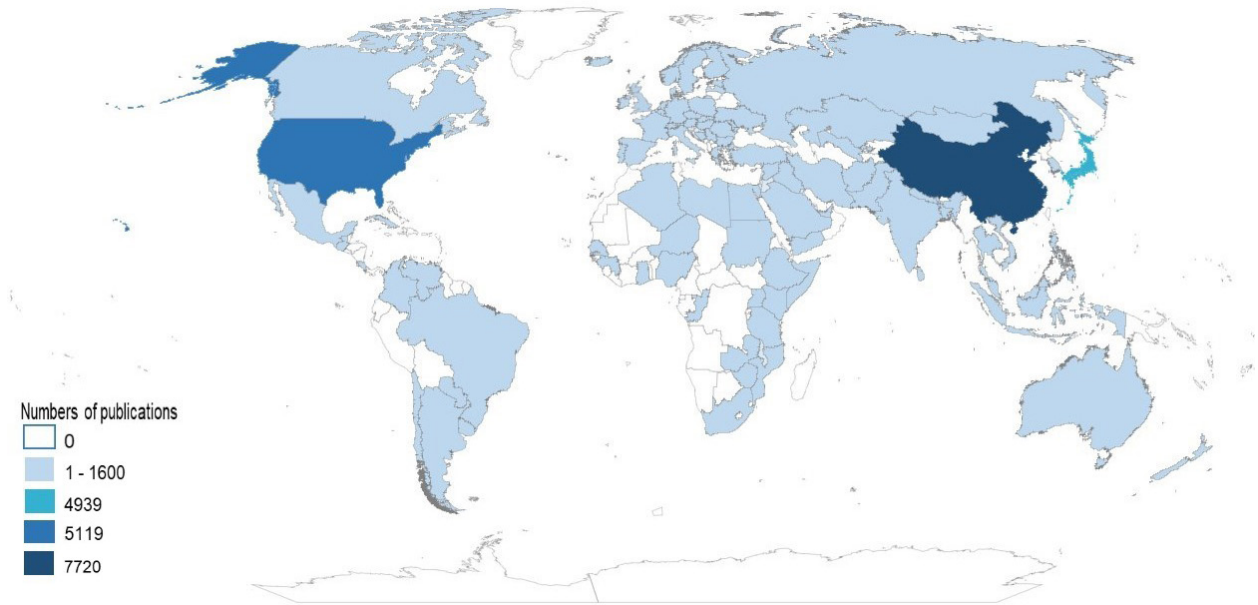


Figure 1. Geographical distribution of articles on esophageal cancer. Software: Microsoft Excel 2021.

Table II. The most productive authors in the field of esophageal cancer research.

SCR	Author	Articles (24215)	H-index	Total citations (656394)	(%)	Citation/ document
1st	Kuwano, H.	257	50	7704	6,91	29,98
2nd	Wang, Y.	248	35	4615	4,14	18,61
3rd	Zhang, Y.	243	33	4474	4,01	18,41
4th	Mori, M.	235	51	7866	7,06	33,47
5th	Kato, H.	218	53	9090	8,15	41,70
6th	Sugimachi, K.	206	45	5789	5,19	28,10
7th	Watanabe, M.	206	39	5147	4,62	24,99
8th	Doki, Y.	192	44	6453	5,79	33,61
9th	Li, J.	190	33	3504	3,14	18,44
10th	Wang, J.	186	29	4049	3,63	21,77

time. The highest productivity was observed in 2020 with 2,108 articles (8.70%) - only a few were published from 1945 to 1980 ($n = 789$ [3.25%]), whereas more than half ($n = 14,995$ [61.92%]) were published from 2010 - 2020 (Figure 2).

Among the institutions with the highest number of articles, it was noted that a majority are located in China (Table III), with Zhengzhou University leading the list with 875 articles, 16,688 citations, and an h-index of 57, followed by the Chinese Academy of Medical Sciences & Peking Union Medical College with 777 articles, 27,418 citations, and an h-index of 80 and the University of Texas System with 657 articles, 30,171 citations, and an h-index of 85.

The journal *Diseases of the Esophagus* had the highest number of articles ($n = 858$), totaling 14,237 citations (Table IV), followed by the *Annals of Surgical Oncology* with 475 articles and 12,136 citations. Although the *Cancer* journal had the third-highest number of articles ($n = 450$), it had the highest number of citations (30,424) and, consequently, the highest h-index (90). Furthermore, considering its high impact factor, the *International Journal of Cancer* (7,396) has demonstrated publication specificity and relevance to the scientific community in the field of esophageal cancer research.

Keywords represent a brief summary of an article, while clustering and multiple correspondence analyses can quickly determine

the specialty and the development of research articles in a specific area. These analyses were performed using the R-tool Biblioshiny. The 500 most cited articles in 2020 were selected to build a keyword co-occurrence network. Two main areas were identified in the articles, one associated with the genetic expression of tumors and prognosis, and the other related to different esophageal cancer histological types and treatment response. The word “cancer” was used to represent 119 articles, followed by “expression” (112 articles), “survival” (75 articles), and “proliferation” (54 articles) (Figure 3).

The most representative topic in the articles was oncology (43.15%), followed by surgery (20.42%) (Figure 4). Other topics such as experimental research in medicine and cell biology and pathology were covered in 18.5% of the articles. Of the 24,215 articles, 93.73% are original research and 42.66% are open access.

DISCUSSION

This is the first bibliometric analysis to verify all existing publications on esophageal cancer. It includes 24,215 articles published from 1945 to 2020, and the most cited article was published in 2012 by van Hagen et al. (2012). Among the articles with the highest number of citations, eight are original studies on epidemiological data, different forms of treatment, and risk

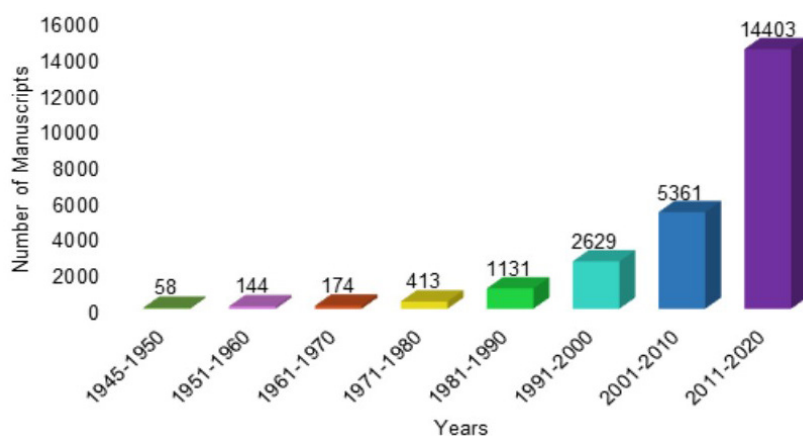


Figure 2. Growth trend of articles on esophageal cancer from 1945 to 2020. Software: Microsoft Excel 2021.

Table III. The ten most productive institutions in the field of esophageal cancer research.

SCR	Institutions (8465)	Document (24215)	Country	H-Index	Total citation (656394)	Citation/ document
1st	Zhengzhou University	875	China	57	16688	19,07
2nd	Chinese Academy Of Medical Sciences Peking Union Medical College	777	China	80	2418	35,29
3rd	University Of Texas System	657	USA	85	30171	45,92
4th	Sun Yat Sen University	631	China	51	13955	22,12
5th	Peking Union Medical College	566	China	66	17030	30,09
6th	Utmd Anderson Cancer Center	543	USA	78	25373	46,73
7th	Shandong University	452	China	33	5495	12,16
8th	Nanjing Medical University	446	China	42	8243	18,48
9th	National Cancer Center Japan	438	Japan	69	19758	45,11
10th	Kyushu University	413	Japan	58	11621	28,14

Table IV. Distribution of articles on esophageal cancer in journals.

SCR	Journal	Number of article (24215)	Total citations (656394)	Citation/ documents	H-index	Impact factor
1st	Diseases of the Esophagus	858	14237	16,59	46	3,429
2nd	Annals of Surgical Oncology	475	12136	25,55	50	5,344
3rd	Cancer	450	30424	67,61	90	6,860
4th	World Journal of Gastroenterology	405	9351	23,09	45	5,742
5th	Anticancer Research	389	5398	13,88	34	2,480
6th	International Journal of Cancer	362	20547	56,76	79	7,396
7th	Annals of Thoracic Surgery	346	13025	37,64	60	4,330
8th	Oncotarget	313	5485	17,52	35	5,168
9th	Oncology Reports	305	4885	16,02	32	3,906
10th	Oncology Letters	301	2299	7,64	20	2,967

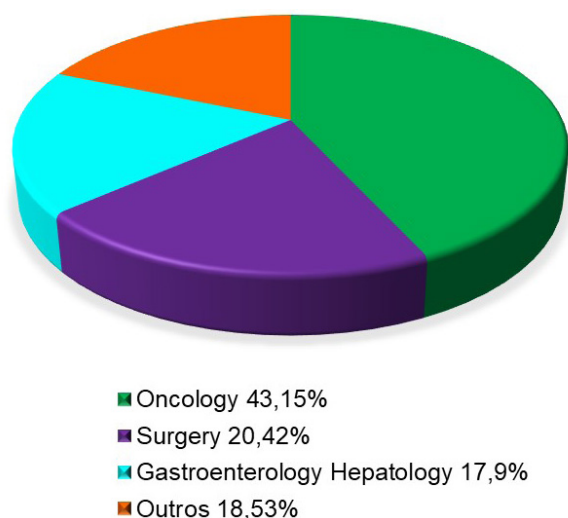


Figure 4. Distribution of articles by topic. Software: Microsoft Excel 2021.

diagnosis, and survival indicate the need to understand the high mortality of esophageal cancer and identify possible correlations between genetic patterns and resistance to the chemoradiotherapy treatment used. They seek to identify genes or proteins that would be linked to the development of esophageal neoplasia that can serve as biomarkers for screening and diagnosis (Wang et al. 2018, Chu et al. 2020).

However, while bibliometric analysis could be useful for identifying the main topics and publications within a specialty, it can be limited by several types of bias. The use of only one database (WoS), even if widely used, to search for articles on esophageal cancer could have led to omission from the analysis of articles published in journals not indexed in WoS. The search based on the article title could have led to exclusion of articles not containing the keywords for esophageal neoplasia used in the search. Finally, the exclusion of textbooks, lectures, and conference abstracts could have led to a loss of information relevant to the area investigated. These biases could have influenced the accuracy of the results of the bibliometric search.

This study identified the most influential articles on esophageal cancer published from

1945 to 2020. Analysis of the variables chosen identified China as the country with the highest number of articles and showed that authors and institutions in Asia stand out when it comes to production of scientific information on esophageal cancer.

The results of this bibliometric analysis have the potential to inform key stakeholders (academic journals, health policymakers, and funding agencies) about trends and gaps, such as biomarker research, in scientific production on esophageal cancer and guide future research. Thus, these data can help avoid the duplication of research efforts and waste of valuable resources.

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