AWARI
Vol. 5, 2024. 1-13, DOI: 10.47909/awari.714

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ORIGINAL ARTICLE

Mapping and analyzing the scientific outcomes of medical library and information sciences (1990-2022)

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ABSTRACT

Background. The rapid advancement of medical knowledge and technology was precipitating transformations in healthcare, necessitating novel approaches to the dissemination of information. Medical library and information sciences (MLIS) assumed a pivotal role in facilitating access to information sources and conducting literacy programs. This study endeavored to analyze the scientific outcomes of MLIS from 1990 to 2022 to elucidate the underlying themes and contributions that were shaping the discipline.

Methods. This study employed a cross-sectional descriptive method with a scientometric approach. Data were gathered from the Web of Science in September 2024. The analysis was conducted using Excel version 2019 software and VOSviewer 1.6 software. In this visualization, the size of the circles represented the weight based on the co-occurrence of subjects, with a maximum length of 30. The data normalization method used for network visualization was Min. strength and association strength.

Results. In the field of MLIS, the United States was the leading producer of scientific output, with Iran ranking sixth. Tanya P. Bardin and Daniel Eric Burgard were the most prolific writers. The scientometric map identified five clusters of research activity, focusing on professional tasks, technology, user nature, organizational issues, and citation-related fields.

Conclusions. The analysis of MLIS literature from 1990 to 2022 revealed a rapidly expanding and highly specialized field, with the greatest quantity of production occurring in 2008. The key research areas encompassed Information Science, Library Science, and Health Care Sciences Services. Scientometric mapping revealed distinct clusters focusing on professional tasks, technology and Internet use, user-oriented services, organizational issues, and citation-related fields. These findings underscored the pivotal role of MLIS professionals in supporting healthcare. However, challenges persisted in methodological diversity, international collaboration, and research transparency. It was crucial to address these challenges in order to ensure that MLIS continued to wield significant influence in the future of healthcare.

Keywords: medical library and information sciences; science mapping; scientometrics.

How to cite: Rahimi, A., Varmazyar, R., Ghalavand, H., & Shirshahi, S. (2024). Mapping and analyzing the scientific outcomes of medical library and information sciences (1990-2022). *AWARI; 5*, 1-13. DOI: 10.47909/awari.714.

Received: 04-09-2024 / **Accepted:** 12-12-2024 / **Published:** 20-12-2024

AWARI
Vol. 5, 1-13, DOI: 10.47909/awari.714

1. INTRODUCTION

The ongoing expansion of medical knowledge and remarkable technological advancements are driving significant changes within healthcare institutions. In response, it is imperative that innovative methods of information delivery be developed, not only for the benefit of patients but also for the benefit of practitioners (Daei *et al.,* 2017). Medical library and information sciences (MLIS) represent a nexus where information professionals, healthcare practitioners, researchers, and patients converge to access, organize, and utilize a vast array of knowledge resources in the digital age. Medical libraries, in conjunction with dedicated librarians, serve a vital function in aiding healthcare professionals at all stages of their careers, from students to attending physicians (Chatterjee *et al.,* 2006). This is achieved by providing access to cutting-edge information sources and facilitating information literacy programs (Geda, 2021).

Although the significance of MLIS is increasing in the healthcare sector, a comprehensive analysis and synthesis of the scientific outcomes generated within this field is still lacking. While individual studies have examined specific aspects of MLIS research, such as information retrieval algorithms or user behavior patterns, a holistic understanding of the field's trajectory and impact has yet to be fully realized. Accordingly, this study aims to address this gap by conducting a comprehensive mapping and analysis of the scientific outcomes of MLIS from 1990 to 2022. By examining the breadth and depth of research conducted within this timeframe, we intend to identify the underlying themes, methodological approaches, and contributions that have shaped the discipline over the past three decades. Through this endeavor, we pursue the following objectives:

1. Identify key themes and trends: The objective of this synthesis is to identify the key thematic areas that have emerged within the field of MLIS, including information retrieval, health informatics, evidence-based practice, and scholarly communication.
2. Assess methodological approaches: A fundamental element of comprehending scientific findings is the assessment of the methodological techniques utilized by researchers within the field.
3. Evaluate research impact and collaboration networks: The mapping of scientific outcomes associated with MLIS will facilitate the assessment of the impact of research outputs, including publication citations, academic collaborations, and knowledge dissemination activities.
4. Inform future research and practice: The objective of this study is to provide a comprehensive overview of the field of MLIS and to inform future research agendas and professional practices within the field.

The objective of this study is to contribute to the ongoing discourse on the role of information sciences in shaping the future of healthcare, fostering interdisciplinary collaboration, and stimulating further inquiry into the complex challenges facing the field.

2. LITERATURE REVIEW

The significance of medical libraries can be traced back centuries, with Millar (1976) underscoring their indispensable role in advancing medical knowledge. The establishment of the first formal medical library in the United States in 1760, as documented by Brinton (1924), marked the beginning of a trajectory of growth and innovation within the field. The formalization of MLIS courses in the late 1940s and 1950s, as documented by Schacher (2001), further underscored the recognition of information sciences as essential components of healthcare education and practice. A review of surveys conducted in the late 20th century revealed the pivotal role of medical libraries in medical education. For instance, a survey conducted by Earl (1996) demonstrated that many medical schools incorporated library skill instruction into their curricula, with librarians playing a crucial role in fostering lifelong learning among healthcare professionals. Further research assessing the impact of medical library services on healthcare literature has reinforced the significance of MLIS in influencing medical decision-making and shaping scholarly discourse. Studies by Sherwill-Navarro and Wallace (2004) and Marshall (1992) have demonstrated that

medical library resources exert a considerable influence on clinical decisions and contribute to the relevance and dissemination of medical research.

Despite its contributions, the field of MLIS faces challenges and opportunities for growth. Zare-Farashbandi *et al*. (2018) underscored the necessity to update MLIS curricula to align with technological advancements and community needs. Similarly, Hashemian *et al*. (2023) identified barriers in MLIS education in Iran, emphasizing the importance of addressing curriculum, faculty, and student-related obstacles to enhance the field's relevance and effectiveness. Professional organizations such as the Medical Library Association have underscored the importance of research literacy among health sciences librarians. The research imperative introduced by the Medical Library Association (2007) highlighted the necessity for librarians to master scientific research methods and apply evidence-based practices in their work. Subsequent studies, such as those by Eldredge *et al*. (2012), have expanded upon this imperative, addressing evolving priorities and offering frameworks for future research efforts within MLIS. In a study of 930 articles in health sciences librarianship, Gore *et al*. (2009) found that while progress is evident, there are areas for improvement. These include diversifying research methodologies and addressing barriers for practicing librarians conducting research. Similarly, Shokraneh and Shiramin (2011) highlighted the importance of updating syllabi in countries like Iran. This is to equip librarians with the necessary skills to provide accurate information and support improved healthcare outcomes.

By evaluating the impact of research and the networks of collaboration, we seek to contextualize our scientific mapping analysis within the broader landscape of MLIS scholarship. This involves identifying influential studies, collaborative networks, and knowledge dissemination activities. Furthermore, the literature review highlights challenges and opportunities for future research and practice within MLIS. It also provides a lens through which to interpret our scientific mapping findings and draw implications for advancing scholarship and professional practice in the field.

3. METHODS

This study employed a cross-sectional descriptive method with a scientometric approach. Data were retrieved from the Web of Science (WoS) in September 2024. To ensure comprehensive coverage within the field, searches were conducted using a specific strategy: Refine results for "medical library" (Topic) and Preprint Citation Index (Exclude–Database) and MEDLINE® or Web of Science Core Collection or Grants Index or ProQuest™ Dissertations & Theses Citation Index or Zoological Record (Database). Finally, apply a time span limitation to encompass results from 1990 to September 2024. This resulted in the identification of 2,737 records. The data, in its original plain text format, was then consolidated into a single file. For analysis, the WoS analysis section was utilized, complemented by the use of Excel version 2019 software for table creation. VOSviewer 1.6 software was employed to generate science maps and co-occurrence maps, which enabled the identification of scientific clusters and newly formed co-occurrence clusters. In this visualization, the size of the circles signifies the weight based on the co-occurrence of subjects, with a maximum length of 30. The data normalization method employed for network visualization was Min. strength and association strength. Irrelevant data were excluded during the data review process. It is important to note that the analyzed samples were of a scientific nature, namely research articles, reviews, and books. Consequently, this study does not raise any ethical considerations.

4. RESULTS

The data were analyzed using VOSviewer 1.6 and Excel software in order to identify key trends and insights in the field of MLIS. The following sections present a detailed examination of the data, highlighting significant findings and patterns. As illustrated in Table 1, the United States, Canada, and England represent the top three science-producing nations in this specific field, while Iran occupies the sixth position with a production rate of 0.658%.

No.	Countries/regions	Record count	Percentage of 2,737 (%)
1	USA (United States)	1,283	46.876
2	Canada	42	1.535
3	England	55	1.937
4	India	24	0.877
5	Peoples R China	23	0.840
6	Iran	18	0.658
7	Russia	14	0.512
8	France	13	0.475
1,128 record(s) do not contain data in the field being analyzed.			

Table 1. Countries producing scientific research in the MLIS.
Note: MLIS: Medical library and information sciences.

A review of the literature in the field of MLIS reveals a consistent upward trajectory since 1990 (Chart 1). Publications in this field have been included in the WoS citation database since 1992, with 2008 representing a notable inflection point in terms of output.

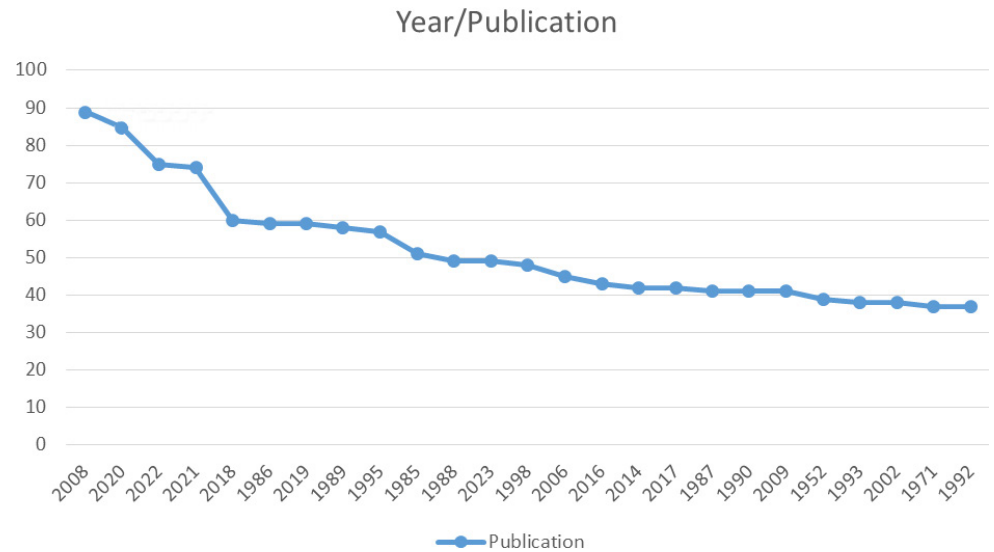


Chart 1. Research process in the MLIS. Note: MLIS: Medical library and information sciences.

The field of "Information Science, Library Science" has the highest proportion of research publications at 61.381%. Therefore, it is the top-ranked research area. The next most-cited field is "Health Care Sciences Services." Conversely, "Public Environmental Occupational Health" has the lowest share at 5.882%, placing it at the 11th rank. It is noteworthy that 22.579% of the publications in this field are not categorized under any specific research field in the WoS (Table 2).

In the field of MLIS, the "University of California System" and the "University of Washington" are the most prominent institutions contributing to research output. Out of 1,256 records, they account for 45.89% of the scientific productions in this field. Additionally, nearly half of the records lack affiliation in the WoS database, which represents a substantial number and underscores a noteworthy gap in the data (Table 3).

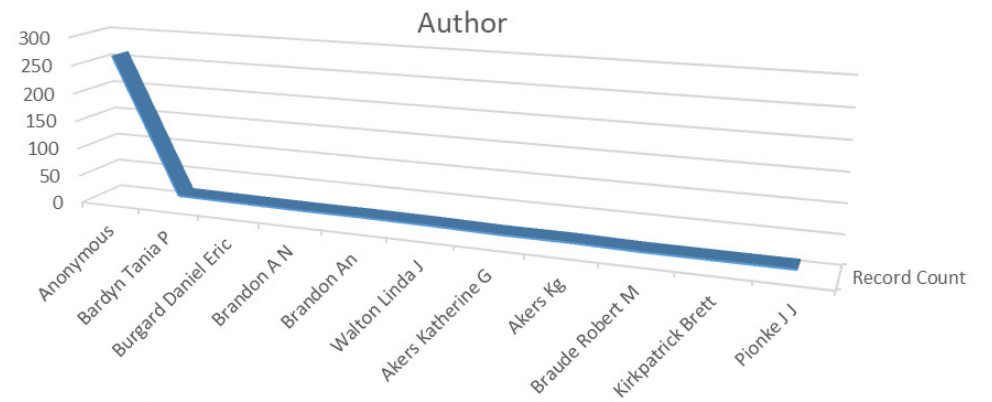
In the production of scientific literature in the field of MLIS, articles without the author's name account for the highest number of records, with 265 articles. The most prolific writers in this field are Bardyn Tania P and Burgard Daniel Eric, who have published 20 and 19 articles, respectively (Chart 2).

No.	Research areas	Record count	Percentage of 2,737 (%)
1	Information Science, Library Science	1,680	61.381
2	Health Care Sciences Services	632	23.091
3	Education Educational Research	432	15.784
4	Computer Science	425	15.528
5	Medical Informatics	323	11.801
6	Communication	307	11.217
7	History	286	10.449
8	General Internal Medicine	214	7.819
9	Behavioral Sciences	210	7.673
10	Psychology	205	7.490
11	Public Environmental Occupational Health	161	5.882
618 record(s) (22.579%) do not contain data in the field being analyzed.			

Table 2. Research areas of WoS in the field of medical librarianship and information.
Note: WoS: Web of Science.

No.	Affiliations	Record count	Percentage of 2,737 (%)
1	University of California System	73	2.667
2	University of Washington	47	1.717
3	NIH National Library of Medicine NLM	44	1.608
4	University of California Los Angeles	43	1.571
5	National Institutes of Health NIH USA	42	1.535
6	University of Illinois System	31	1.133
7	Yale University	31	1.133
8	University of Maryland Baltimore	30	1.096
9	Weill Medical College of Cornell University	27	0.986
10	University of Iowa	25	0.913
11	University of North Carolina	24	0.877
1,256 record(s) (45.890%) do not contain data in the field being analyzed.			

Table 3. The main universities producing science in the field of MLIS.
Note: MLIS: Medical library and information sciences.



	Anonymous	Bardyn Tania P	Burgard Daniel Eric	Brandon A N	Brandon An	Walton Linda J	Akers Katherine G	Akers Kg	Braude Robert M	Kirkpatrick Brett	Pionke J J
Record Count	265	20	19	18	18	17	15	15	13	13	13

Chart 2. The primary authors who contribute to the field of MLIS.
Note: MLIS: Medical library and information sciences.

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The "NIH National Library of Medicine (NLM)," "National Institute of Health (NIH) USA," and "United States Department of Health and Human Services" allocate 352, 71, and 65 funds, respectively, for conducting research in the mentioned field. This accounts for about 18% of the funds provided, and all of these institutes are based in the United States (Table 4).

No.	Funding agencies	Record count	Percentage of 2,737 (%)
1	NIH National Library of Medicine (NLM)	352	12.861
2	National Institutes of Health (NIHo USA	71	2.594
3	United States Department of Health Human Services	65	2.375
4	NIH Office of the Director	10	0.365
5	NIH National Cancer Institute (NCI)	9	0.329
6	NIH National Institute on Drug Abuse (NIDA)	9	0.329
7	NSF Directorate for Computer Information Science Engineering (CISE)	8	0.292
8	NSF Division of Computer Network Systems (CNS)	7	0.256
9	United States Public Health Service	6	0.219
10	National Cancer Institute	5	0.183

Table 4. The main institutions that provide research funds in the field of MLIS.
Note: MLIS: Medical library and information sciences.

The general scientometric map of this field is comprised of five clusters, as illustrated in Figure 1. The following section will examine each of these clusters in turn.

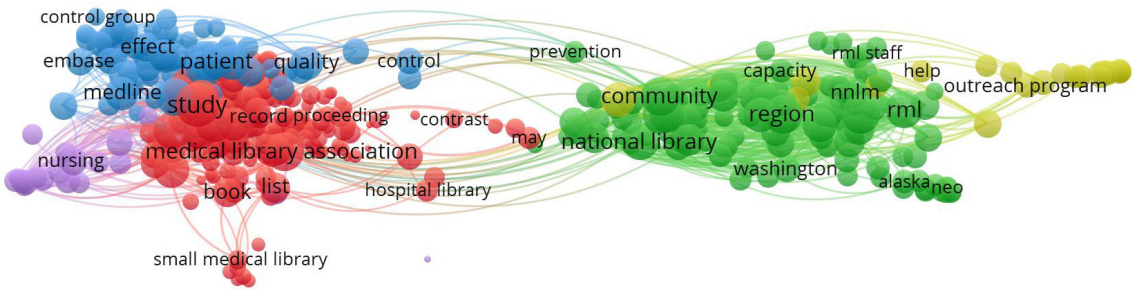

Figure 1. General scientometric map of the MLIS.
Note: MLIS: Medical library and information sciences.

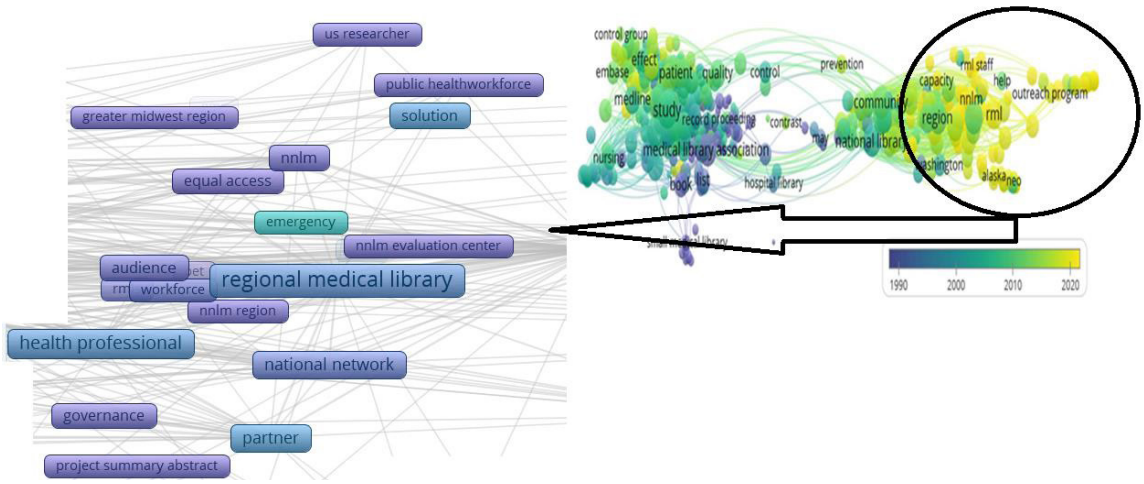

Figure 2. General scientometric map of the MLIS (based on time).
Note: MLIS: Medical library and information sciences.

Figure 2 presents a scientometric map of this field, delineating its evolution and changes from 1990 to 2024. Over the course of the past three decades, the prominence of specific keywords has become increasingly evident. These include "us researcher," "public health workforce," "solution," "greater midwest region," "equal access," "emergency," "regional medical library," and "health professional." In contrast, at the outset of the WoS citation database's indexing of scientific productions, keywords such as "archive," "code," "list," and "books," primarily associated with library administration and cataloging, were prevalent. The scientometric map illustrates the growing specialization of librarianship and medical information in comparison to general librarianship over the past decade. Additionally, it underscores the rising significance of keywords pertaining to health, medicine, and medical information in both research and the professional domain of this scientific field.

The initial cluster on this scientific map, which is also the largest, encompasses 197 items. These items are predominantly associated with professional management, cataloging, abstracting, and indexing in medical libraries. Notable items within this field include "abstract," "account," "acquisition," "alphabetical title," "annual meeting," "archive," "army medical library," and "author index" (Figure 3).

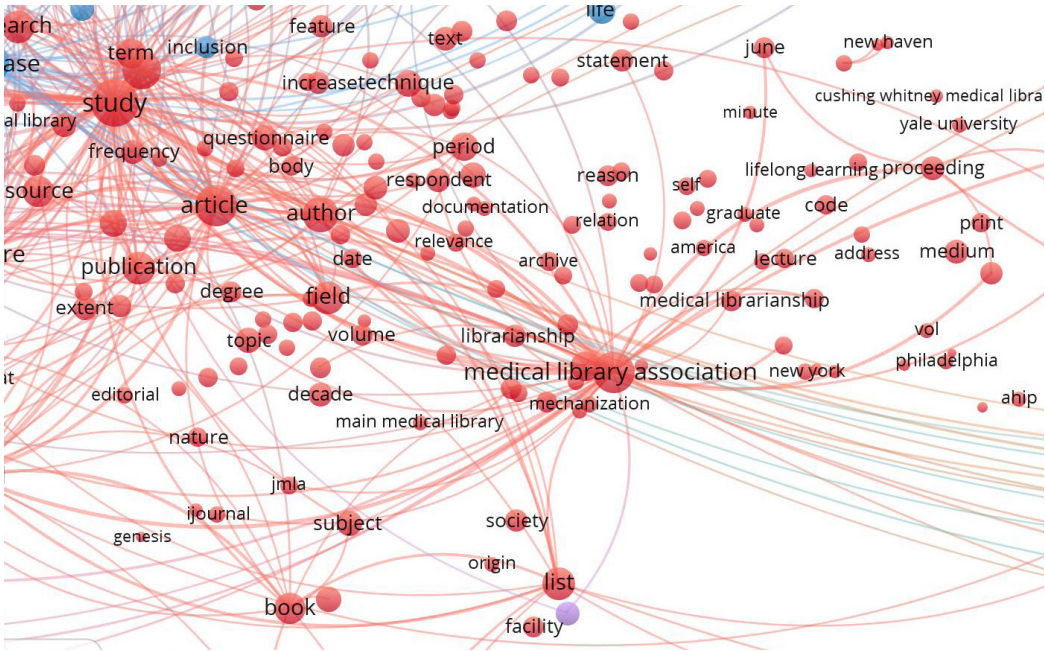

Figure 3. First cluster of scientometric map (MLIS).
Note: MLIS: Medical library and information sciences.

The second cluster, comprising 127 items, includes terms such as "administrative core," "audience," "bioinformatics," "biomedical information," "broadband internet," "capacity," and "chair." This cluster represents the shift in the scientific field toward technology and the use of the Internet in medical libraries. It clearly demonstrates the beginning of maturation and change in the field of medical librarianship, marking its separation from the field of librarianship and public information (Figure 4).

The third cluster contains 86 items, encompassing terminology such as "adult," "age," "child," "choice," "clinical decision making," "confidence interval," and "Cochrane library." This cluster underscores the emphasis on user-oriented medical libraries, underscoring the significance of users across different age groups and encompassing current medical topics such as "clinical decision making," "Cochrane library," and "cancer." This shift in the field of librarianship and medical information indicates a transition toward user-centric and specialized content, signifying a substantial evolution in medical libraries (Figure 5).

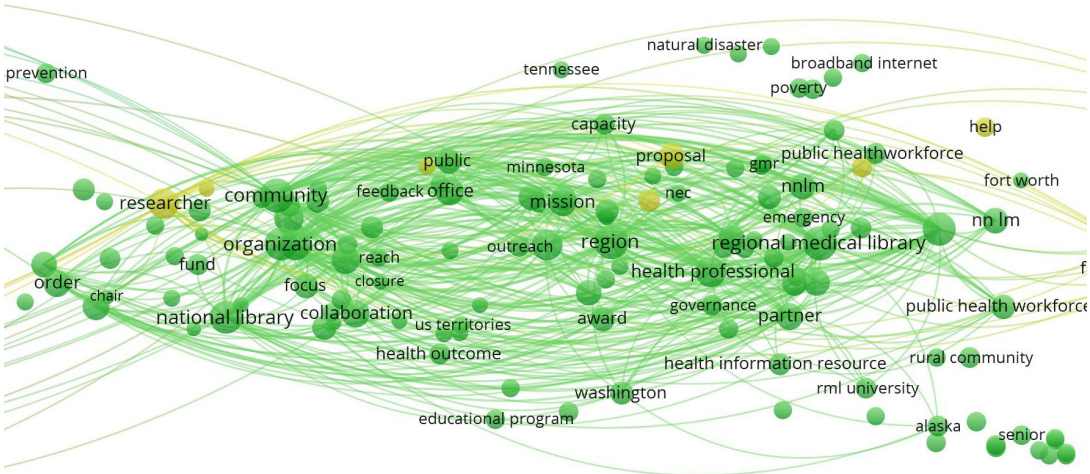

Figure 4. Second cluster of scientometric map (MLIS).
Note: MLIS: Medical library and information sciences.

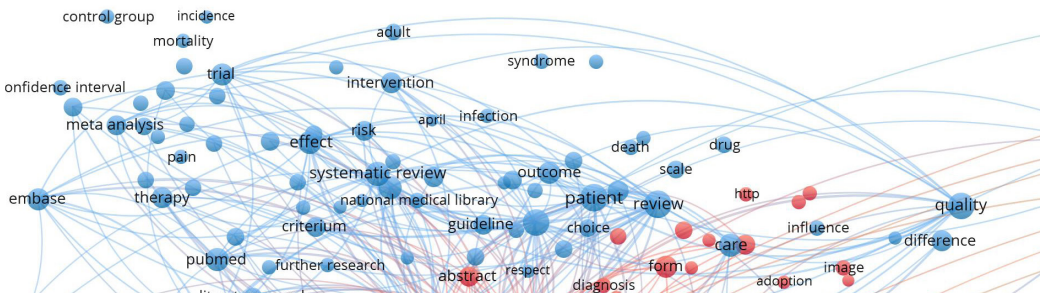

Figure 5. Third cluster of scientometric map (MLIS).
Note: MLIS: Medical library and information sciences.

The fourth cluster is comprised of 30 items, including terms such as "agency," "consumer," "educational session," "funding opportunity," "authoritative health info," "increase access," and "healthier community," which collectively indicate the significance of organizational issues. In particular, this cluster underscores the pivotal role of the parent organization in the governance and provision of medical libraries. It can be surmised that the genesis of this cluster was shaped by organizational considerations and the communication and accessibility needs of medical libraries (Figure 6).

Figure 6. Fourth cluster of scientometric map (MLIS).
Note: MLIS: Medical library and information sciences.

The fifth and final cluster in the scientometric map represents the field of medical librarianship and information. It comprises 21 items. The terms "allied health literature," "allied health resources," "citation," "citation analysis," "core journal," "cumulative index," "indexing," and "PubMed Medline" within this cluster indicate the importance of fields related to citation, such as the PubMed citation database and the selection of core journals. Furthermore, the appearance of items such as "citation analysis" and "indexing" indicates the emergence of scientometrics within the scientific domain of medical librarianship and information. This underscores the pivotal role of citations and citation databases in the selection of core journals and the assessment of scientific outputs through citation analysis within the fifth cluster (Figure 7).

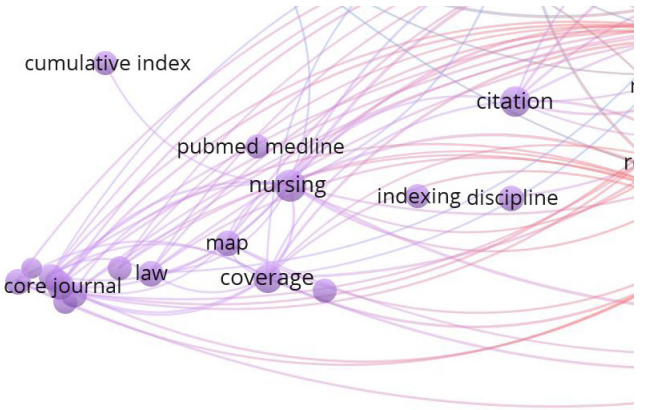

Figure 7. Fifth cluster of scientometric map (MLIS).

5. DISCUSSION

The scientometric analysis of MLIS from 1990 to 2022 reveals several significant trends that reflect the evolving nature of the field. As indicated in the analysis, the United States, Canada, and England emerged as the primary contributors to MLIS research, with the United States exhibiting a dominant presence in both scientific output and funding. This finding aligns with previous studies (Yousefy & Malekahmadi, 2013), which have underscored the global leadership of North American institutions in medical library research. The upward trajectory of research output over the past three decades, particularly evident in the post-2000 period, correlates with the growing integration of information technology in healthcare (Senbekov *et al.*, 2020). This transformation has had far-reaching implications for the field of MLIS. The notable surge in research during 2008 coincides with advancements in digital health and medical informatics, thereby providing further support for the proposition that MLIS is undergoing a transition toward a domain that is more technology-centric. Furthermore, an additional study lends support to this observation, demonstrating that the publication of articles in the field of medical librarianship and information saw a significant increase beginning in 2010, with the highest number of articles being published in 2019. It is noteworthy that the most prominent research focus during this period was on "Patients' Use of Information Resources" (Dastani *et al.*, 2022). This is consistent with the user-centered focus identified in the third cluster of the general map based on time (Figure 3), which highlights topics such as clinical decision-making and the Cochrane Library. This underscores the growing importance of patient-centered care in MLIS research. The focus on patient information use reflects broader trends in healthcare, where the objective is to provide patients with accessible, high-quality information (Ramírez-Saltos *et al.*, 2023) and to enhance digital health literacy (Mulukuntla, 2020), with the aim of improving health outcomes.

The analysis further illustrates that the field of Information Science, Library Science has retained its centrality, accounting for over 60% of the research output. This underscores the enduring significance of traditional library functions even as new domains, such as health

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informatics and evidence-based practice, gain prominence. However, the presence of Public Environmental Occupational Health as one of the lower-ranked areas of research suggests that interdisciplinary integration, particularly in public health, may be underexplored. The preponderance of U.S.-based institutions, including the University of California System and the University of Washington (Yousefy & Malekahmadi, 2013), in the production of MLIS research highlights the institutional centralization of scientific output. However, the discovery that nearly half of the records lack affiliation data raises concerns about the transparency and accessibility of MLIS research. This could indicate deficiencies in data collection within the WoS database (Pranckutė, 2021) or shortcomings in the reporting practices of researchers. Similarly, the considerable number of articles lacking author names is problematic, as it impairs the ability to accurately assess individual contributions and hinders citation tracking. Future bibliometric studies may need to address this gap by promoting improved metadata curation and reporting standards and ensuring that authorship and affiliations are fully documented.

The substantial involvement of funding from U.S. government entities, including the NIH National Library of Medicine (NLM) and the National Institutes of Health (NIH), underscores the pivotal influence of federal financial support on the direction of MLIS research. A cluster analysis of the general map based on time reveals the evolution of research themes within MLIS, which has transitioned from a focus on traditional library functions (e.g., cataloging, indexing, and archiving) to more user-centered and technology-driven themes such as biomedical information ("Enhancing Library Impact through Technology," 2015). In addition, the application of technology has been shown to enhance the impact of libraries in a number of other areas, including clinical decision-making (Eloranta & Boman, 2022; Kvist & Hofmann, 2023; Wysocki *et al.,* 2023) and public health workforce development. Of particular note is the second cluster, which illuminates the burgeoning convergence between MLIS and digital technologies. It features terms such as "bioinformatics" and "broadband internet," which are identified as pivotal domains of advancement. This phenomenon mirrors global trends in healthcare informatics and the growing reliance on electronic resources and digital libraries in supporting clinical decision-making (Rundo *et al.,* 2020).

Moreover, the appearance of terms such as "clinical decision-making" and "confidence interval" in the third cluster highlights the field's growing emphasis on evidence-based healthcare. This is consistent with the findings of the study conducted by Phillips *et al.* (2022), which suggests that evidence-based medicine facilitates optimal healthcare decisions by integrating clinical expertise, research evidence, and patient preferences. The utilization of evidence-based resources, such as the Cochrane Library, enables medical librarians to deliver enhanced services (Esmaeilzad *et al.,* 2022), thereby indicating that MLIS is a pivotal factor in facilitating clinicians' access to superior quality research for the purpose of informed decision-making. The limited representation of non-Western countries, despite Iran's high level of achievement in this field (Siamian *et al.,* 2023) and its ranking sixth, indicates that MLIS research is still predominantly concentrated in developed regions. The expansion of MLIS research networks to encompass a more diverse range of geographic regions could enhance global health equity and facilitate the dissemination of healthcare knowledge in underserved communities. The emergence of a scientometric cluster dedicated to citation analysis and indexing (cluster 5) indicates that the field is undergoing a process of self-reflection, with scholars employing bibliometric techniques to assess the impact of MLIS research. This "scientometrics of scientometrics" indicates a maturation of the field, wherein MLIS professionals are not only providing information but also critically evaluating how information is used and cited. However, this area also presents an opportunity for growth, as improving citation analysis within MLIS could enhance the visibility and influence of the field in broader academic and healthcare conversations.

6. IMPLICATIONS FOR FUTURE RESEARCH AND PRACTICE

The findings from this study have several implications for the future of MLIS research and practice: As the field of MLIS continues to

converge with health informatics and digital technologies, future research should prioritize the development of more sophisticated tools for information retrieval, management, and dissemination in healthcare settings. This may entail investigating emerging technologies such as artificial intelligence and machine learning in the context of medical libraries. Furthermore, in light of the growing emphasis on evidence-based healthcare and the expanding role of medical libraries in clinical decision-making, there is a distinct opportunity for more profound interdisciplinary collaboration between MLIS professionals, healthcare practitioners, and technologists. Joint research initiatives could investigate strategies for further integrating library science into healthcare practice, particularly in the domains of patient education and public health. It is imperative that MLIS research be expanded to encompass a greater number of contributions from non-Western countries and underserved regions. This is the only way to guarantee that healthcare knowledge is distributed equitably. Subsequent studies could examine how medical libraries in developing countries are addressing local healthcare challenges and contributing to global health information networks.

7. CONCLUSION

The scientometric mapping and analysis of MLIS from 1990 to 2022 reveal a dynamic and evolving field, marked by significant growth and increasing specialization. The United States, Canada, and England are the top three countries in terms of scientific output in this field, with Iran ranking sixth. It is noteworthy that 2008 was the year with the highest production in this domain. The top-ranked "Research Area" is "Information Science, Library Science," with "Health Care Sciences Services" ranking second in its specialized field. The most prolific author in this field is "Bardyn Tania P," followed by "Burgard Daniel Eric." The initial cluster on this scientific map is concerned with professional and managerial tasks, the cataloguing, abstracting, and indexing of materials in medical libraries. The second cluster demonstrates the evolution of this scientific field towards technology and the utilization of the Internet in medical libraries. The third cluster illustrates the user-oriented nature of medical libraries, emphasizing the value and importance of users from children to adults, as well as current medical topics. The fourth cluster underscores the crucial role of organizational issues, especially those pertaining to the parent organization, in managing and delivering services for medical libraries. Moreover, the fifth cluster, the smallest on the scientometric map of librarianship and medical information, underscores the paramount importance of citation-related fields, such as citation databases. It also emphasizes the integration of scientometrics into the scientific realm of librarianship and medical information, underscoring the vital role of utilizing citations and citation databases to select core journals and evaluate scientific output.

The findings underscore the pivotal role of MLIS professionals in advancing healthcare, spanning traditional library management responsibilities to pioneering endeavors in bioinformatics and digital health services. Nevertheless, challenges persist, notably in the realms of methodological diversity, international collaboration, and transparency in research practices. By confronting these challenges, the MLIS field can perpetuate its indispensable contribution to the future of healthcare, nurturing innovation, interdisciplinary collaboration, and evidence-based practice.

Contribution statement

Saeid Shirshahi and Alireza Rahimi conceived of the presented idea. Reza Varmazyar and Hossein Ghalavand developed the theory and performed the computations. Saeid Shirshahi and Alireza Rahimi verified the analytical methods. Alireza Rahimi supervised the findings of this work. All authors discussed the results and contributed to the final manuscript.

Conflict of interests

The authors declare no conflict of interest related to this work.

Statement of data consent

The data generated during the development of this study has been included in the manuscript. ●

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