Original article

Mapping the Scientific Research on Health Literacy

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Abstract

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Introduction: Health literacy includes skills required to make informed personal and social health decisions. Due to the increasing importance of health literacy, it is vital to investigate the quantitative and thematic publication process in this field. This study aims to investigate the publication process and draw a scientific map of articles in health literacy.

Methods: The current research is a descriptive-analytical one. Scientometric techniques were used for anlayzing health literacy publications from 2012 to January 23, 2023 in the PubMed database. RStudio and VOSviewer software were used for data analysis.

Results: In the 12 years under review, 8,242 documents in the field of health literacy have been published. 27,193 authors and 1,588 journals contributed to the publication of these documents. Seven hundred four authors contributed to single-author papers, and 26,489 contributed to multi-author papers. International participation in this area was 11.95%. Wolf MS, Osborne RH, and Paasche-Orlow MK are the most contributing health literacy researchers. America-China registered the most scientific cooperation pairs. The International Journal of Environmental Research and Public Health has published the most health literacy articles among the journals. The research trend in 2013-2014 was toward teaching and educational principles and methods.

Conclusion: Researchers in the field of health literacy pay special attention to the issue of scientific cooperation. In the reviewed articles, COVID-19 is one of the prominent topics that coincide with the issue of health literacy.

Introduction

Health literacy is a set of skills everyone needs to make informed decisions for their health. Improving health literacy leads to increased potential to make informed decisions during illness, reduced health threats, increased disease prevention, enhanced safety, improved quality of life, and improved quality of care. Limited health literacy has multiple consequences in various health areas, such as lack of access to appropriate health services, less inclination to seek treatment, poor medication

adherence, increased emergency department visits, longer hospital stays, and increased mortality rates, and has a significant impact on the use of health care services (1). Sufficient health literacy increases the effectiveness of medical counseling, health promotion, and self-care programs. Additionally, health literacy is crucial in individuals' willingness and engagement in screening programs, making them more active in managing their illness (2).

The criterion for determining countries' global position and authority and the basis for their comprehensive development relies on the level of knowledge production, research achievements, and their applications in enhancing global standards. Therefore, emphasizing research and increasing research activities in any country leads to development and progress and brings true self-sufficiency and independence to that country. Researchers attribute the advancement of science to communication systems and emphasize that the rapid growth of science in the world requires the exchange of information and scientific communication among researchers worldwide (3). Publishing research results is an important part of the scientific method. Each article in a journal is part of a permanent scientific record. Most journals are highly specialized and publish scientific articles in various scientific fields (4). In today's world, visualizing information through graphic representations on social networks is one of the main techniques that demonstrate intellectual relationships and the structure of scientific knowledge. This new approach enables the analysis of traditional domains and provides a key tool for studying the interaction and evolution of science based on its disciplines and specialties. This particular approach, compared to visualization, also known as the illustration and mapping of knowledge and information, ultimately leads to creating a map of specialization, a subject area, a field, or a set of field (5). One of the trends in scientometrics is the study of the structure and dynamics of science. Knowledge maps are an effective method for representing the optimal state of science. The knowledge map is capable of identifying the resources and flow of knowledge, as well as its limitations and deficiencies, and by determining its main areas, it provides the necessary information about each subdomain to research managers. The scientific areas in these maps are determined based on scientists' activity level, and empty spaces indicate unworked or unknown scientific domains.

In such cases, different scientific domains' growth, integration, or separation can be observed over time (6).

Given the importance of health literacy in promoting individual and community health and considering the crucial role of scientific research in enriching this field, awareness of the quantitative and qualitative growth trends and the thematic content of articles in this area can provide valuable information for decision-making at both micro and macro levels for planners, policymakers, and decision-makers in the health sector. Therefore, this study aims to investigate the quantitative growth trends, scientometric indicators, and the thematic content of health literacy articles based on the Medline database data.

Methods

The present research is a descriptive-analytical and practical study and has utilized the techniques of bibliometrics and scientometrics. In this study, the trend and co-occurrence analysis of terms, among the most commonly used methods in bibliometrics and scientometrics, has been employed. Scientometrics is a scientific field that provides the basis for evaluating scientific domains and comparing production factors (countries, institutions, and authors). Therefore, assessing and evaluating domains is one of the main objectives of this field (7). The target audience for this research includes 8,242 published documents (citable records in Medline) on health literacy. The data for this research were collected from the Medline database. The reason for choosing this database is that it is one of the most important components of PubMed, the largest database in the field of medical sciences, which can be easily retrieved through MeSH. This is because all the documents in Medline have been indexed with MeSH terms, and it is easy to find all the articles placed under that term using these terms. The advanced search section of the PubMed database was used to retrieve the initial records for this research. The search strategy was selected by limiting the advanced search section of the PubMed database of "Health Literacy" to the MeSH Terms. This search strategy retrieved 8,242 documents, all of which were extracted from this database in the format of Pubmed.txt on January 23, 2023 (Figure 1).

Bibliometrix and VOSviewer software were used for data analysis. Bibliometrix is a tool for comprehensive scientific mapping and an open-source tool for quantitative research in scientometrics and bibliometrics, designed by Massimo Aria & Corrado (8). RStudio software was used to obtain

bibliographic information related to the research process, scientific collaboration networks of countries, institutions and authors, most productive countries, institutions, authors, and journals, as well as the publication trends of authors and thematic areas of health literacy based on time intervals. VOSviewer, designed exclusively for drawing bibliometric maps, was developed by Van Eck & Waltman with the support of Leiden University in the Netherlands (9). The network visualization of co-occurring terms was also facilitated by the capabilities and functionalities of VOSviewer software.
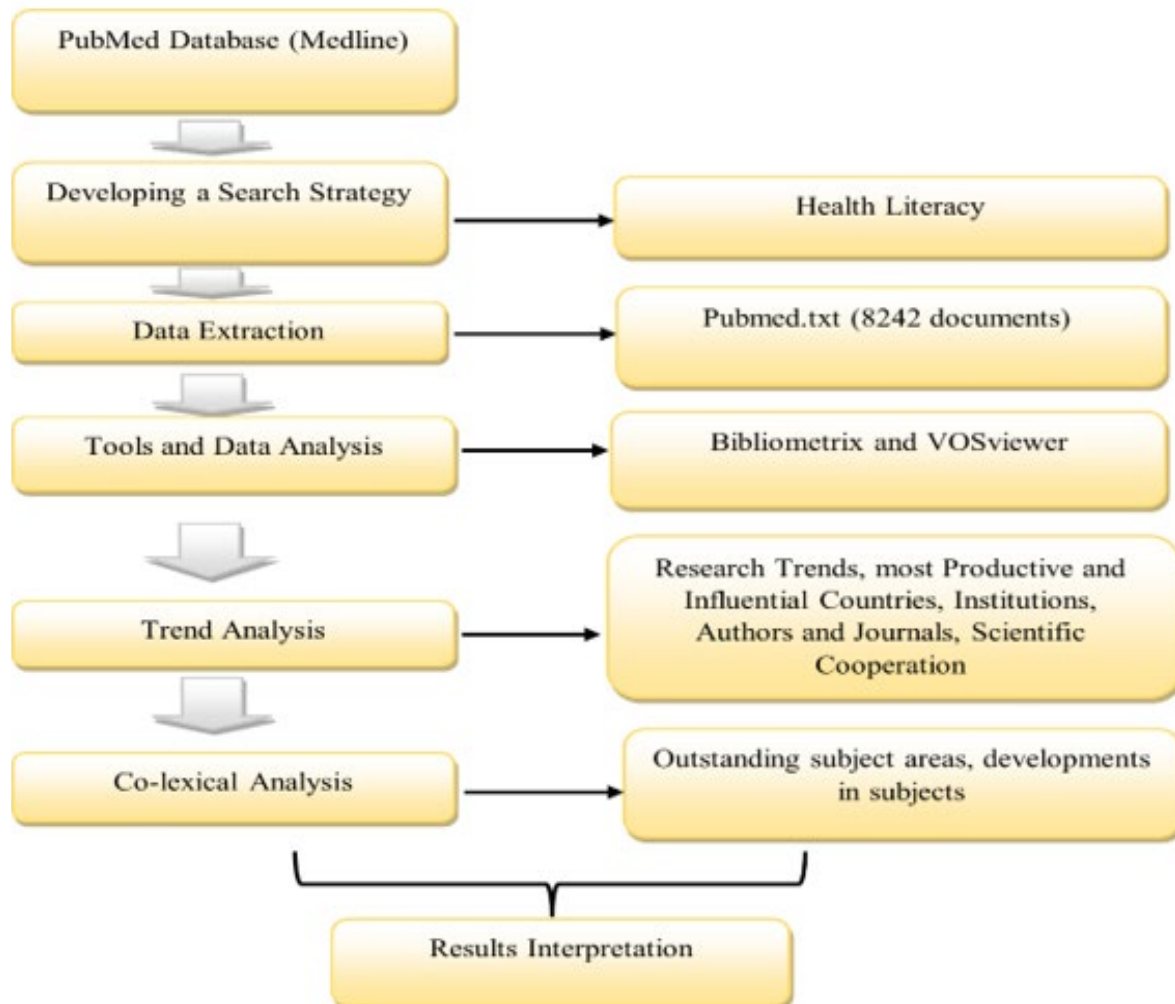

Figure 1. Research execution process (data collection source, analysis process, and analysis tools)

Results

As shown in Table 1,2,3 a total of 8,242 documents on the subject of health literacy have been published in the desired period in 1,588 journals, with 27,193 authors contributing to the publication of these documents. Considering the number of single-authored documents (n = 704, 8.54%) and the number of documents written in collaboration (n = 7,583, 91.46%), researchers in this field pay special attention to scientific collaboration. Worth mentioning that international collaboration in this field has been 11.95%.

Table 1. Summary of published articles on health literacy

Description	Results
TimeSpan	2012 - 2023
Documents	8,242
Sources	1,588
Author's keywords	9,246

Table 2. Status of single authorship and multiple authorship of published articles on health literacy

Authors	
Authors	27,193
Authors of single-authored documents	704 (8.54 %)
Authors of multi-authored documents	26,489 (91.46 %)

Table 3. Collaboration status of authors of published articles on health literacy

Authors Collaboration	
Single-authored documents	704 (8.54%)
Multi-authored documents	7,538 (91.46%)
Documents per author	0.303%
Authors per document	3.29%
Co-authors per documents	4.98%
International co-authorships	11.95%

Considering the time period under review, the increasing trend of publications has been well observed since the year of examination (2012) until now. The classification of publications based on two time periods also indicates that 42.49% (3,502) of publications belong to the period of 2012-2017, while the remaining 57.51% (4,740) of publications are related to recent years (2018 until now), confirming the increase in publications in recent years (Figure 2).

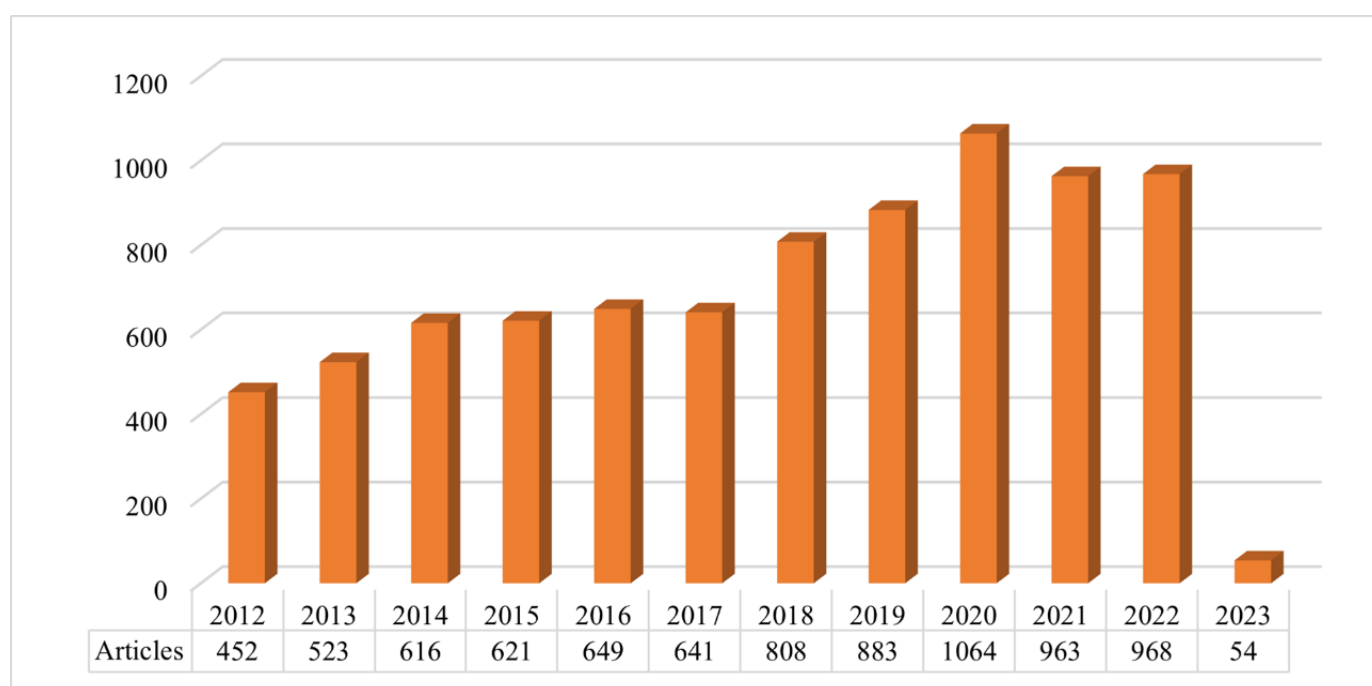|	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Articles	452	523	616	621	649	641	808	883	1064	963	968	54

Figure 2. The timeline for document publication on health literacy

Table 4 lists countries that have published the most health literacy publications. Regarding the number of published articles, the United States had the highest number of scientific publications, with 29.19% during the examined period, and was the main leader in scientific production in this field. Following that, Australia, China, Germany, Canada, and the Netherlands were other leading countries in this field, ranking next. According to the findings, Iran is Asia's third most productive country, with 522 published articles, and the tenth most productive country in the world.

Table 4. Most productive countries in the field of health literacy

#	Country	Article	% of 26807
1	USA	7,825	29.19
2	Australia	3,465	12.92
3	China	2,896	10.80
4	Germany	1,464	5.46
5	Canada	1,450	5.40
6	Netherlands	1,036	3.86
7	Italy	688	2.56
8	Japan	570	2.12
9	Norway	534	1.99
10	Iran	522	1.94

Figure 3 represents the geographical distribution network of participating countries in health literacy worldwide. The dark blue color indicates a high number of documents for each country, the light blue color indicates a low number of documents for each country, and the gray color represents countries without documents. The orange lines and links on the map indicate a wide range of collaborations (10). Authors and researchers from 127 countries collaborated scientifically in studies related to this field. Based on the geographical map of scientific collaboration in this field, it can be argued that the United States-China, United States-Australia, Australia-China, United States-Canada, and United States-Germany have recorded the highest number of scientific collaborations.
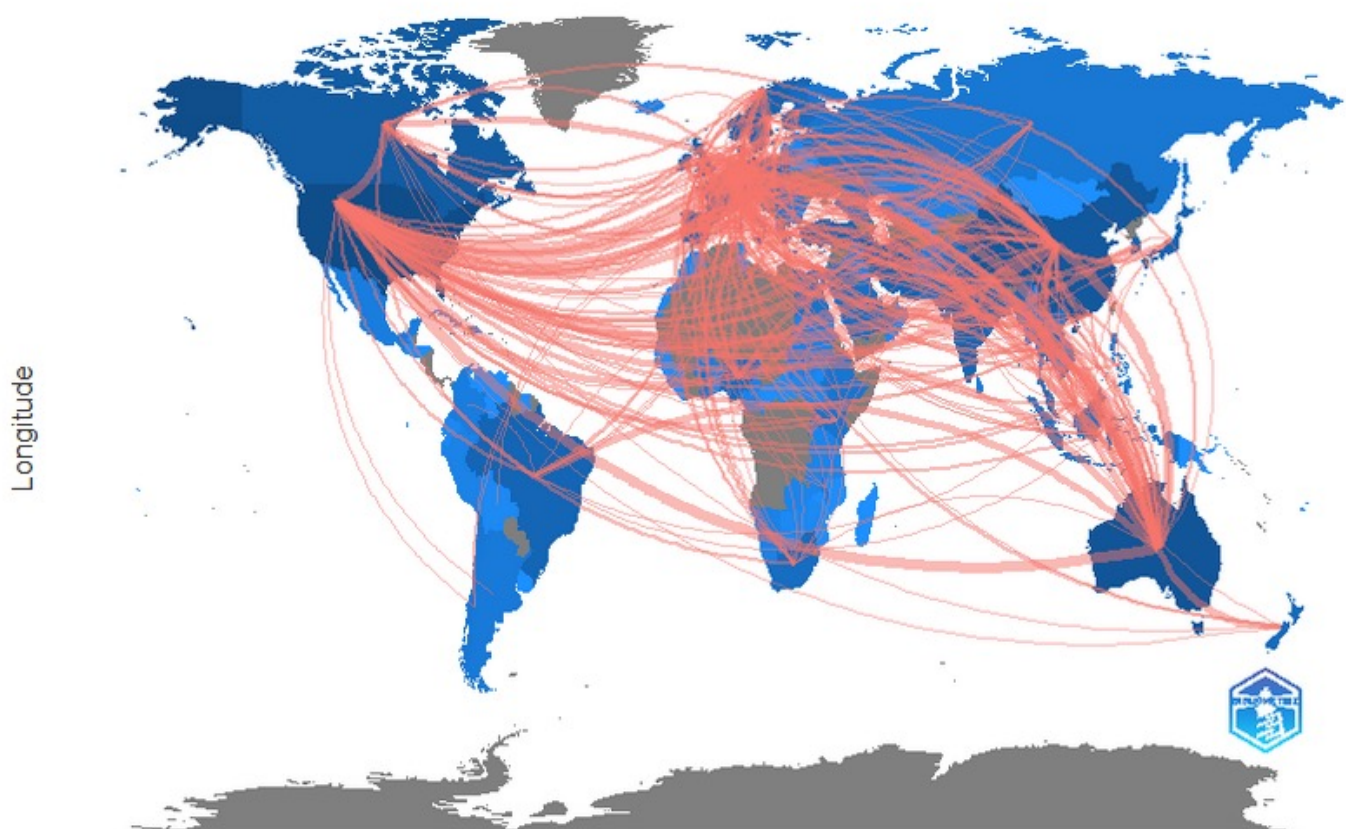

Figure 3. Geographic distribution and scientific collaboration of countries in health literacy

Table 5 presents a list of researchers who have published the most articles in the field of health literacy. Professor Wolf MS, with 97 articles, and Professor Osborne RH, with 70 articles, are researchers who have published over 50 articles on health literacy. On the other hand, according to the Articles Fractionalized index, Professor Wolf MS, with 15.04 articles, and Professor Osborne RH, with 13.26 articles, have obtained the highest scores in this field.

Table 5. Most productive researchers in the field of health literacy

#	Authors	Articles	Articles Fractionalized
1	Wolf MS	97	15.04
2	Osborne RH	70	13.26
3	Mccaffery KJ	50	8.17
4	Paasche-Orlow MK	47	11.01
5	Kripalani S	46	8.81
6	Okan O	44	7.73
7	Schillinger D	42	8.65
8	Sørensen K	41	10.40
9	Nutbeam D	39	8.43
10	Bailey SC	38	6.11

Figure 4 depicts the network of collaboration among researchers in health literacy. In the network, nodes represent authors, and the links between each node indicate scientific communications among researchers. The size of the nodes indicates the number of their publications (11). Generally, the network includes researchers who have collaborated on at least ten documents. As visible in the network, researchers such as Wolf MS from Northwestern University in the United States, Osborne RH from Winburne University of Technology in Australia, and Paasche-Orlow MK from Boston University School of Medicine in the United States have the highest number of publications and communications in this field. This can be observed well from their nodes' size and labels' prominence.
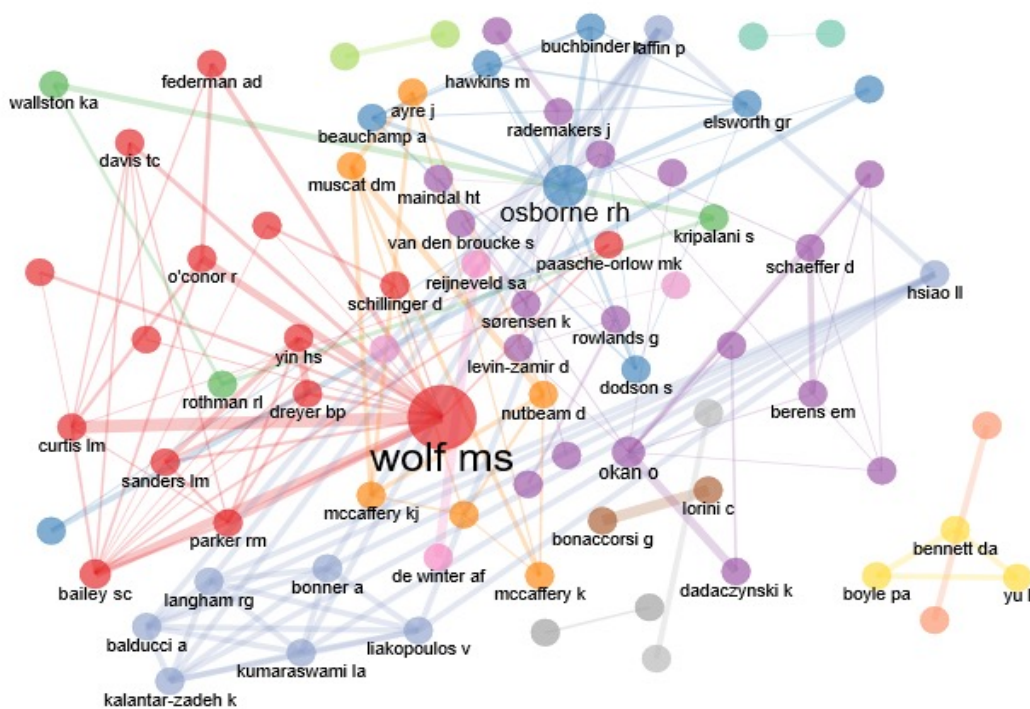

Figure 4. Network of scientific collaboration among researchers in health literacy

The publishing trend of the most productive authors is shown in Figure 5, indicating the start and end years of a researcher's scientific activity. The red lines represent the start and end of a researcher's scientific activity, and the bubbles represent publications, with the size of the bubbles indicating the number of collaborations (12). Wolf MS has published the most in health literacy for 11 years. Osborne RH, the second most productive researcher in this field, started his activity in 2013 and has continued his work until 2022.
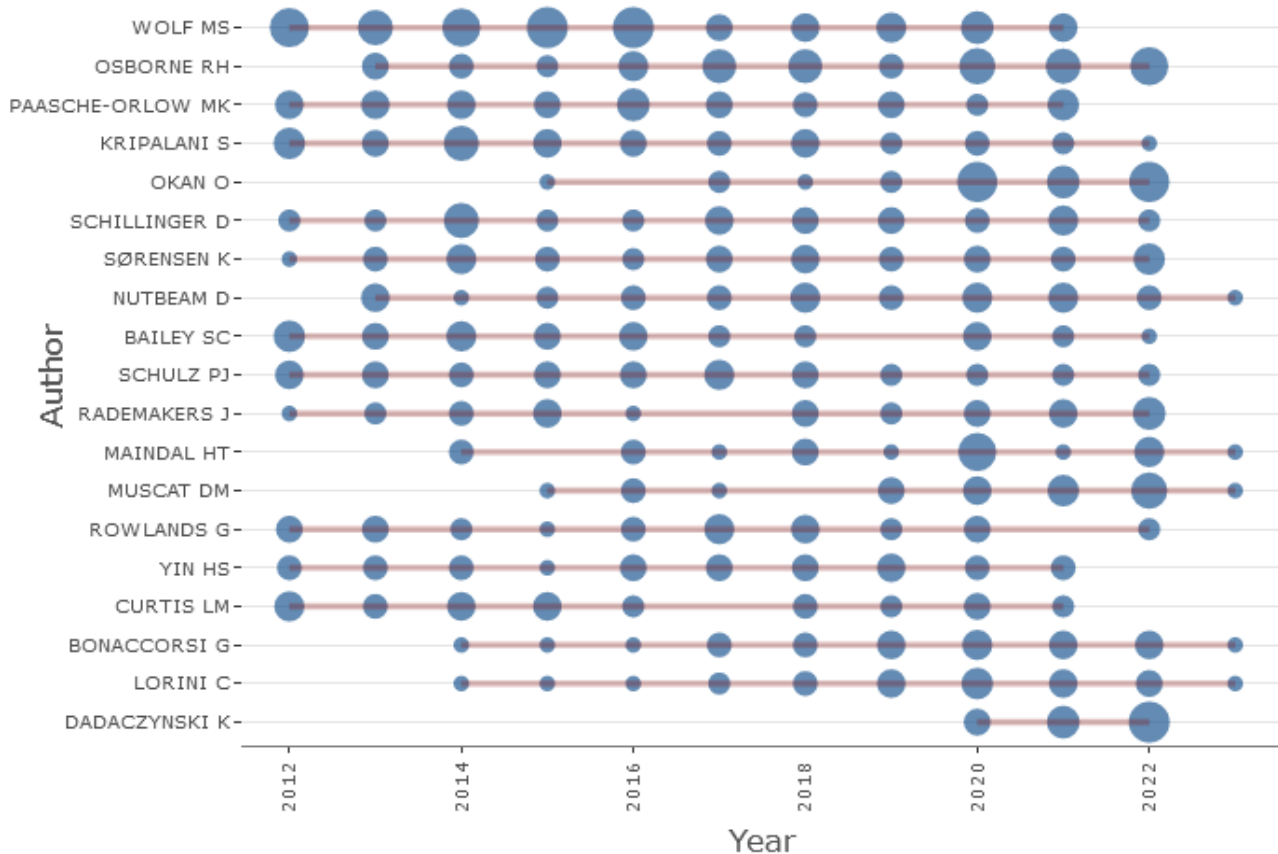

Figure 5. Publication status of the most prolific authors over time in health literacy

As visible in Table 6, The University of Sydney from Australia ranked first with 565 articles, followed by the University of California from the United States with 520 articles, and Deakin University from Australia with 203 articles. Generally, based on the results of Table 6, Australia, with four institutions/universities, and the United States, with three universities, have allocated the highest number of productive institutions in this field to themselves.

Table 6. Most productive institutions in the field of health literacy

#	Affiliation	Articles	Country
1	The University of Sydney	565	Australia
2	University of California	520	USA
3	Deakin University	203	Australia
4	Northwestern University	198	USA
5	Vanderbilt University Medical Center	193	USA
6	Monash University	189	Australia
7	Central South University	181	China
8	Harvard Medical School	176	USA
9	Taipei Medical University	175	Taiwan
10	University of Melbourne	146	Australia

As shown in Figure 6, the network density of collaboration between institutions is very weak, and it can be said that the network lacks the necessary coherence because there are few communications between institutions in the network, and most nodes are only scattered with two collaborations in the network. In other words, the University of Sydney in Australia, the University of California in the USA, and Deakin University in Australia have the highest number of publications in the field of health literacy, which is well reflected in the size of these institutions and the prominence of their labels. On the other hand, Monash University and Deakin University have the highest level of scientific collaboration. In other words, the University of Sydney leads the scientific leadership in the red cluster. The University of California also leads the scientific leadership in the blue cluster, and Deakin University leads the scientific leadership in the orange cluster. The University of Melbourne leads the practical leadership in the pink cluster, and Northwestern University in the purple cluster is among the leading institutions that have been able to take scientific leadership from it.
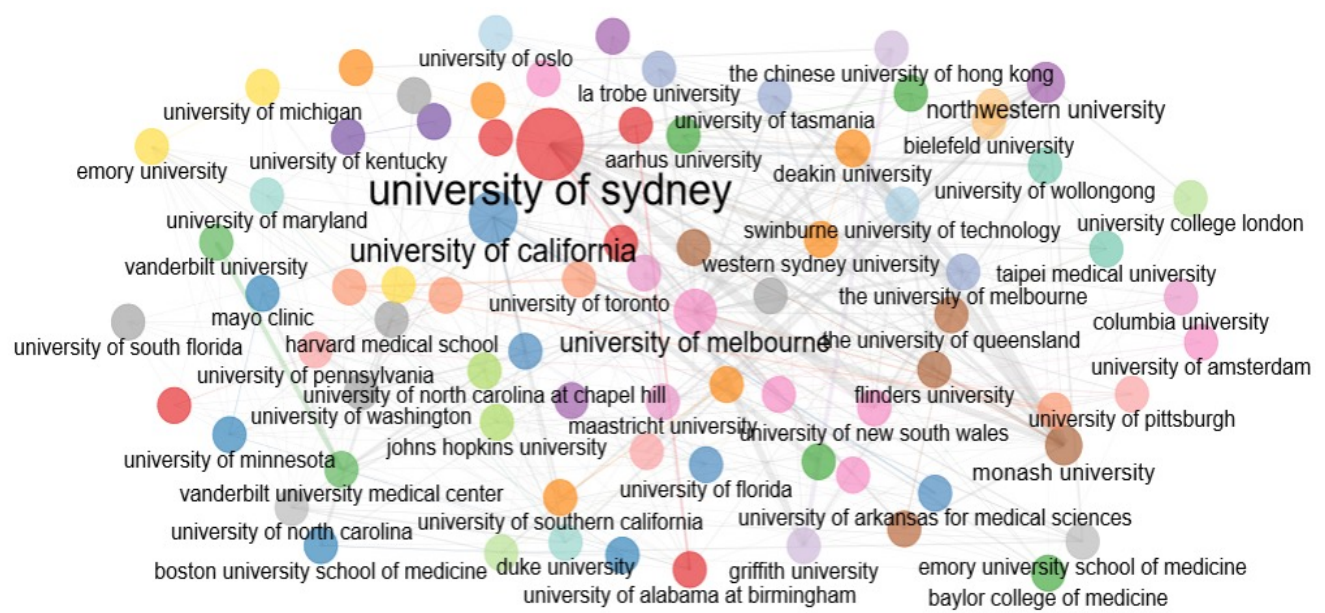

Figure 6. Scientific collaboration network in the field of health literacy

Among the journals published, the International Journal of Environmental Research and Public Health published the most scientific research with 426 documents, followed by Patient Education and Counseling with 244 documents. Most journals publishing scientific research in health literacy are among the top 50% (Q2) and 25% (Q2) in quality in this area (Table 7).

Table 7. Most productive journals in the field of publishing articles in health literacy

#	Journals	Articles	IF	Q
1	International Journal of Environmental Research and Public Health	426	4.614	1
2	Patient Education and Counseling	244	3.467	2
3	Journal of Health Communication	205	2.742	2
4	BMC Public Health	199	4.135	2
5	PLOS One	159	3.752	2
6	Journal of Medical Internet Research	133	7.077	1
7	Studies in Health Technology and Informatics	131	-	-
8	BMJ Open	129	3.007	2
9	Health Literacy Research and Practice	101	-	-
10	Health Promotion International	92	3.734	1

Figure 7 and Table 8 represent a co-occurrence network in health literacy. This network consists of 327 nodes and eight clusters. The co-occurrence rate of key terms was considered to be 10. The size of the nodes indicates a high frequency of key terms. Additionally, nodes of the same color in the network indicate the proximity of concepts within that cluster.

As observed in the network, most nodes are red, green, blue, and yellow, indicating the proximity of these concepts to health literacy. It should be noted that the links between nodes represent the co-occurrence frequency of these key terms. The thicker the link, the higher the co-occurrence frequency (13).
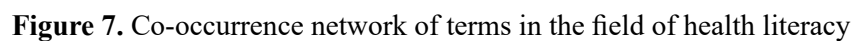

Figure 7. Co-occurrence network of terms in the field of health literacy

Table 8. Summary of key terms in each cluster in the health literacy field

| Cluster	Cluster size	Key terms
Red	45	Health Literacy, Medication Adherence, Education, Adherence, Nursing, Heart Failure, Breast Cancer, Decision-Making, Chronic kidney Disease, Cancer Screening
Green	40	Self-efficacy, Food Literacy, Children, Physical Activity, Psychometrics, Nutrition, Physical Literacy, Nutrition Literacy, Reliability, Validation, Obesity
Blue	34	Health Promotion, Health Disparities, Social Determinants of Health, Self-Care, Parents, Social Support, Community Health, Health Care, Health Status, Women's Health, Health Behaviors
Yellow	33	Communication, Self-Management, Cancer, Quality of Life, Quantitative Research, Shared Decision Making, Primary Health Care, patient Participation, Information, Oncology, Patient-Centered Cancer, Prostate Cancer
Purple	32	Covid-19, E-Health Literacy, Health Information, E-Health, Social Media, Digital Health Literacy, Vaccination, Pandemic, Corona Virus, Vaccine Hesitancy, Infodemic, Sars-cov-2
Cyan	30	Patient Education, Readability, Internet, Health Communication, Health Equity, Vulnerable populations, Consumer Health Information, Understandability, Barriers, Patient Engagement, Organizational Health Literacy, Patient Education Materials
Orange	28	Mental Health Literacy, Mental Health, Health Education, Depression, Stigma, Adolescent, Intervention, Help-seeking, Anxiety, Schizophrenia, Mental illness, Media Literacy, Stress, Depression Literacy

Table 8. Summary of key terms in each ... (continued)

Cluster	Cluster size	Key terms
Pink	23	Public Health, Primary Care, Prevention, Diabetes, Empowerment, Type 2 Diabetes, Epidemiology, Health Policy, Health Informatics, Preventive Medicine, Information Technology

The co-occurrence network consists of eight clusters, with the red cluster being the largest with 45 members, the green cluster with 40 members, and the blue cluster with 34 members. In other words, the keywords Health Literacy, Self-efficacy, and Health Promotion were most prevalent in these three clusters. The results related to the co-occurrence network and Table 6 indicate that the purple cluster is more associated with COVID-19-related topics, while the pink cluster refers to public health, prevention, and healthcare topics.

Figure 8 shows the process of topics based on the keywords used in articles in the field of health literacy in the period under review. The nodes represent the thematic areas, and the size of each node also indicates its frequency in the network. The most common keywords are Humans, Health Literacy, Female, Male,

Middle Aged, Aged, Health Knowledge, Surveys and questionnaires, and Cross-sectional studies. The research trend in health literacy shows that during 2012, researchers' attention in this field was focused on dentistry, and the presence of thematic areas such as health education, dental, dentist-patient relations, and dentists indicates the same. The research trend in 2013-2014 has been more focused on teaching and educational methods, and the high frequency of thematic areas such as mathematics, teaching/ methods, data collection, educational measurement/ methods, and pamphlets compared to other topics in this field indicates the same. Finally, from 2020 to 2021, keywords such as COVID-19, SARS-COV-2, and Students, along with topics like Quality of Life and Mental Health, have been prominent.
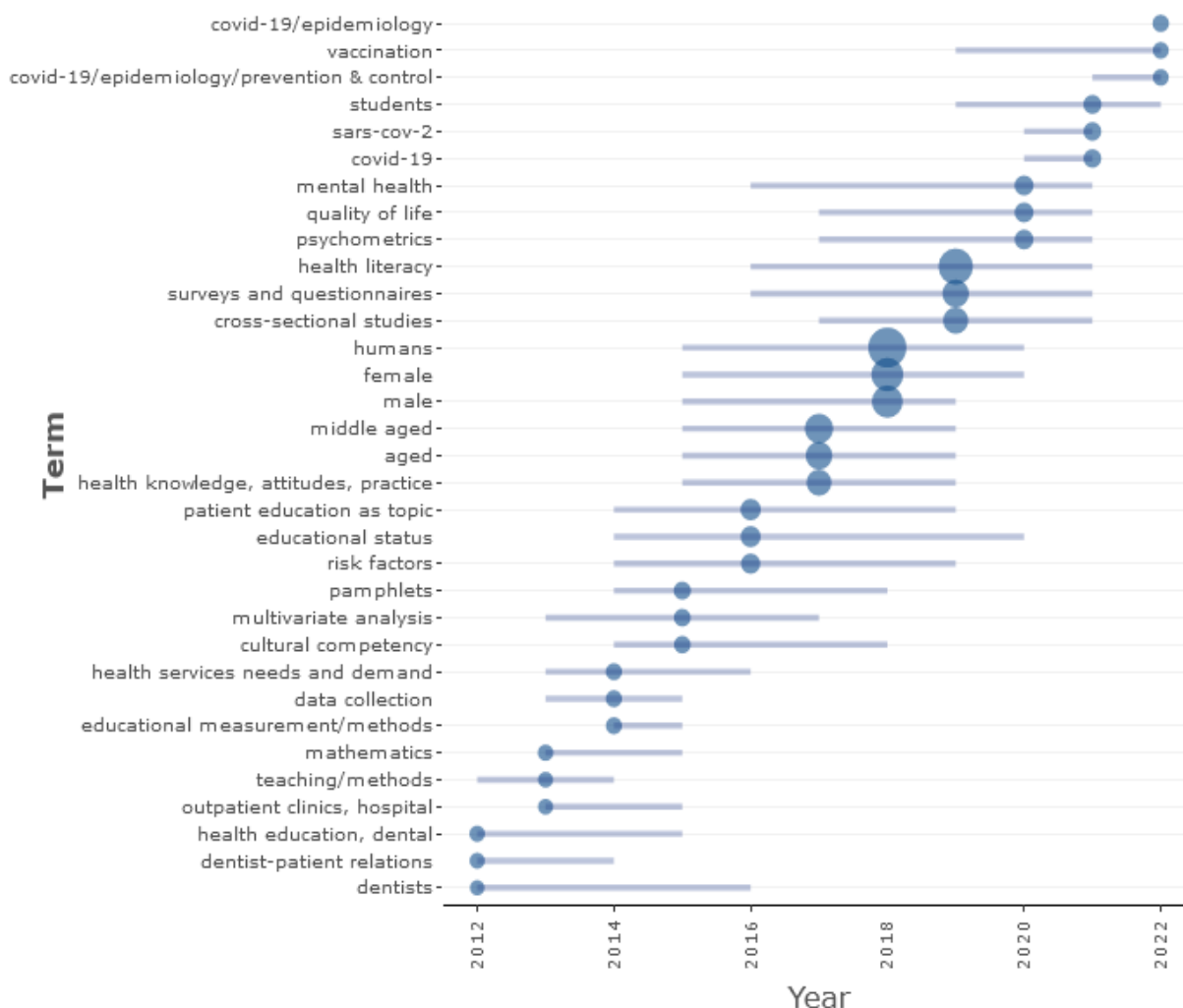
Figure 8. The prominent thematic areas in health literacy based on the temporal perspective

Discussion

Research findings indicate that 27,193 authors have published their findings in this field in 1,588 journals. It is predicted that the number of publications in health literacy will at least double by 2030 compared to 2022. Furthermore, the results related to collaboration status show that single-authored documents account for 8.54% and documents resulting from scientific collaboration account for 91.46%, indicating the special attention of researchers in this field to scientific collaboration. The findings of this research are consistent with the findings of Gholampour et al., who conducted a study on publications related to mega-events (14). These researchers pointed out the high percentage of authors' attention to multi-author documents. Research with multiple authors seems to be expected to produce higher-quality articles, as the thinking and knowledge of multiple individuals can lead to better outcomes.

In the present study, more than 90% of publications related to health literacy have been in the form of scientific collaborations, and less than 10% of single-author publications have been allocated to themselves, indicating the attention of researchers in this field to group publications. The research trend in health literacy during the examined period shows increased production in this area. Additionally, the distribution of publications in two intervals shows that 42.49% of publications belong to the time interval of 2012-2017 and the remaining 57.51% to recent years (2018-present), indicating an increase in recent years. The results of the present study are consistent with the results of the research by Gholampour, Gholampour & Noroozi in the field of highly cited articles; San et al. in the field of oral and dental health literacy, Gholampour et al. in the field of mega events; and Janooy & Abdi in the field of media and information literacy (11, 14-17). In the mentioned studies, researchers have referred to the increase in publications in recent years. In the present study, the trend of publications in recent years has also been increasing. In general, a high level of health literacy has numerous social benefits for individuals and society. For this reason, health literacy is closely related to individuals' ability to use health information and services and have greater control over their health as members of society. Therefore, perhaps one of the reasons for the increase in scientific productions in this field reflects the interest and attention of the academic community to this research area, as well as the demands of governments and the general public from the academic community to address the issue of health literacy.

The USA publishes the highest percentage of publications in health literacy, with 29.19%. Following that, Australia, China, Germany, Canada, and the Netherlands were other leading countries in this field. Worth mentioning that Iran, with the publication of 522 articles, is the third most productive country in Asia and the tenth most productive country in the world that has shown interest in the field of health literacy. The presence of Iran among the leading countries in this field can be argued in a study conducted by Tavousi et al. (18) in 2015, indicating that health literacy in Iran is very low, with about half of the population having low health literacy. He also highlighted that the level of health literacy is lower among the elderly, housewives, and individuals with low education. Perhaps one of the reasons for the attention of the Iranian academic community to the issue of health literacy is the prioritization of literacy in drawing the comprehensive scientific map of the country (19). It is necessary to mention that the USA is at the forefront of most scientific fields, and in this study, the USA also had the highest number of publications in the field of health literacy. Therefore, the results of this study are consistent with the results of the studies by Gholampour et al., Janooy & Abdi, San et al., Gholampour, and Gholampour & Noroozi. The structure of scientific collaboration between countries in health literacy has shown that authors and researchers from 127 countries have collaborated in studies related to this field. Based on the geographical map of scientific collaboration in this field, it can be argued that the United States, China, Australia, Canada, and Germany have recorded the highest number of scientific collaborations. Therefore, it can be concluded that these countries were among the prominent countries in this field, and researchers from other countries had a strong inclination to collaborate with them. In the study by Gholampour et al. and San et al. (14, 16) the United States was identified as one of the leading countries in scientific production. In the present study, the United States also ranked first by a significant margin, thus confirming the findings of Gholampour et al., San et al., and the present study. Perhaps one of the reasons for the United States' leadership in health literacy is that the American Medical Association has included health literacy in its nursing program (20-21). Considering that the articles in the field of health literacy in Iran are in an intermediate state, strengthening this subject and

implementing it in Iranian society can improve the lack of literacy of the past and move towards national progress in health literacy.

Results related to the most prolific authors over time showed that Wolf MS, the director of the Department of Medicine, Institute for Public Health and Medicine (IPHAM), and the Center for Applied Health Research on Aging at Northwestern University, has had the highest scientific activity in the field of health literacy for over 11 years. The University of Sydney in Australia, the University of California in the United States, and Deakin University in Australia ranked first to third in the number of scientific publications in this field. In line with the structure of scientific collaboration between institutions in this field, the density of the network of institutions is very weak, and it can be said that the network lacks the necessary coherence, and most nodes are only scattered in the network with two collaborations. In other words, Monash University and Deakin University have registered the highest level of scientific collaboration in this field. The results of the most prolific institutions based on clusters showed that the University of Sydney had scientific leadership in the red cluster. The University of California had scientific leadership in the blue cluster, and Deakin University had scientific leadership in the orange cluster. The University of Melbourne had practical leadership in the pink cluster, and Northwestern University in the purple cluster is among the leading institutions that have been able to take scientific leadership in this cluster.

Furthermore, scientific findings in this field were published in 1,588 journals. Based on their impact factor, the scientific status of these journals showed that only three journals did not receive an impact factor score, while the rest obtained an impact factor score. Additionally, the status of the journals, based on the Q score, indicates that most published documents in this field were based on the results of Table 5 in journals that are among the top 50% (Q2) and 25% (Q1) in terms of quality. In the field of health literacy, eight clusters of terms were formed. Cluster 1 referred to the issue of health literacy. Cluster 2 examined the topics of literacy and nutrition-related issues. Cluster 3 focused on the issue of community health and individual health. Cluster 4 addressed issues related to cancer and healthcare. Cluster 5 examined COVID-19 and healthcare. Cluster 6 focused on patient education. Cluster 7 addressed mental health literacy and issues related to stress and anxiety. Cluster 8 emphasized the topic of public health

and healthcare. The trends in health literacy topics showed that researchers' attention in this field was focused on dentistry-related topics in the early years. The research trend in 2013-2014 has been toward teaching and educational principles and methods. However, with the COVID-19 pandemic, studies in this field, like other fields, have been affected by this virus. Additionally, the keyword "Students" has been prominent among other terms in the period of 2020-2021, which can be attributed to the concerns of society and families about this group's susceptibility to COVID-19 or the impact of studying performance with this virus.

Conclusion

In any society, the acquisition of health knowledge is a crucial factor in enhancing the health and well-being of its inhabitants, and it holds immense significance. The people of a community are equipped with knowledge about how to stay healthy, undoubtedly resulting in fewer blunders that pose a risk to the wellbeing of the community. Knowing about research in the health literacy area is a scientific way to prevent increasing costs and a sick society.

Moreover, global research on health literacy can lead society and individuals to research with pure and first-hand data. By knowing the countries and authors working in the field of health literacy, one can trust the health information in this collection more and obtain more reliable information. Besides, when a publication recieve more citations, it can be understood that it contains original data. In general, the study and review of research in the field of health literacy shows the dos and don'ts that are crucial in people's decision-making.

Declarations

Acknowledgement

Conflicts of Interests

The authors stated no conflicts of interest.

Ethical statement

ethics code IR.UMSHA.REC. 1401.870 and project number: 140111119757.

Authors' contributions

All the mentioned authors have voluntarily and hardworking collaborated in the present research.

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