

## Publication Trends on Infective Endocarditis: Comprehensive Bibliometric Analysis and Visualization Between 1892 and 2022

### ABSTRACT

**Background:** In recent years, studies reported that the incidence of infective endocarditis (IE) has increased despite the decrease in rheumatic heart diseases, great advances in medical and surgical treatment methods, and prophylactic antibiotic therapies. However, there is no bibliometric analysis based on the visual mapping method in the literature. In the study, we aimed to analyze the hot topics in IE, the distribution of publications in terms of country, institution, journal, author, and their relationships by assessing IE articles published in the 130 years between 1892 and 2022.

**Methods:** Publications before 2023 were analyzed using the keywords "infective" and "endocarditis" in the Scopus database.

**Results:** Approximately 25% of the publications on IE were from the USA followed by Japan, France, and the UK. A total of 116 keywords were used at least 15 times and the keywords were categorized into 9 clusters by the VOSviewer program. The keywords used more than 100 times except "infective endocarditis" were "echocardiography," "mortality," "surgery," "Staphylococcus aureus," "cardiac surgery," "epidemiology," and "prognosis" 247, 191, 152, 142, 130, 122, and 119 times, respectively. To the best of our knowledge, the study is the most comprehensive study globally on IE with the widest time range including the visual mapping method.

**Conclusion:** Since our study reveals the changes in the literature related to infective endocarditis, we think that it will be a guide in planning new research studies. We believe that periodic repetition of bibliometric analyses and keyword mapping studies will contribute to the quantitative and qualitative development of scientific productivity globally.

**Keywords:** Infective endocarditis, bibliometric analysis, VOSviewer, bibliometric mapping

### INTRODUCTION

Infective endocarditis (IE) is a disease caused by infection of the endothelial surface of the heart and heart valves by microorganisms in the blood. Infective endocarditis is an infectious disease with a high risk of mortality and morbidity. In recent years, especially in developed countries, it has been reported that the incidence of IE is increasing despite the decrease in rheumatic heart diseases, great advances in medical and surgical treatment methods, and prophylactic antibiotic therapies.<sup>1-4</sup> Despite the improvement in blood culture and echocardiographic methods and sensitive diagnostic criteria, IE is still difficult to diagnose.<sup>5</sup> However, diagnosis and treatments of IE have significant developments and changes in terms of location, time, and population variables between 1892 and 2022. Developments in the field of health, new diagnostic and treatment methods, the increase in institutional and trained healthcare workforce opportunities, and advancements in the sharing of universal scientific experiences have had crucial effects on this situation.

The Duke criteria used in the diagnosis of IE were published in 1994<sup>6</sup> and revised by Li et al<sup>7</sup> in 2000. The Duke criteria used in the diagnosis of IE are divided into 3 as definite IE diagnostic criteria, probable IE diagnostic criteria, and non-IE diagnostic criteria.<sup>8</sup> In studies reported from developed countries, the incidence of IE

### ORIGINAL INVESTIGATION

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is approximately 6/100 000 (range between 1.5 and 11.5/100 000). Epidemiological findings have shown that the incidence of IE has increased in recent years and that this increase occurs particularly in the elderly.<sup>9</sup> Staphylococci and streptococci are the causative agents in approximately 80% of IE cases. Staphylococci (especially *Staphylococcus aureus*) are the most common causative agent in healthcare-associated IE cases, while streptococci are the most common community-acquired IE agent. Rarely, fastidious microorganisms may also be responsible for IE cases. Among these, HACEK bacteria have an important place.<sup>10</sup> It has been reported that HACEK bacteria are responsible for 3% of IE cases.<sup>11</sup> In endemic countries, *Brucella* spp. also can be a causative agent for IE.<sup>12</sup> In addition, the fungal microorganisms can be rare causative agents of IE; however, their mortality rate is more than 50%.<sup>12</sup> Therefore, fungal agents should be considered as causative agents, especially *Candida* and *Aspergillus* species.

The detection rate of the causative agent in IE cases varies between countries. In developed countries, this rate is over 90%. However, in developing countries, this rate is reported between 41% and 67%.<sup>9,12</sup> In addition, it is known that blood culture-negative IE cases are higher in developing countries than in developed countries. Therefore, more studies should be conducted on negative blood cultures in developing countries, their causes should be explained, and solutions should be proposed. This is possible not only through global IE guidelines but also through regional and center-specific IE guidelines.

Infective endocarditis remains an important cause of mortality and raises many questions in diagnosis, treatment, and disease management worldwide. This affects research studies and although the mortality rate is high, the contribution of developing countries to the literature remains limited. However, there is just 1 bibliometric study on IE in the literature<sup>13</sup> and there is no keyword visual mapping method-based study. To the best of our knowledge, our study includes

## HIGHLIGHTS

- Approximately 25% of the publications on infective endocarditis (IE) are from the USA, followed by Japan and France.
- France, Spain, and the USA dominate the list of the most productive institutions.
- We should draw attention that *Brucella* spp. may also be causative in endemic countries.
- It is important to support studies on IE in underdeveloped and developing countries and to present the data to the literature.
- The most used keywords were "echocardiography," "mortality," "surgery," "*Staphylococcus aureus*," "cardiac surgery," "epidemiology," and "prognosis" 247, 191, 152, 142, 130, 122, and 119 times, respectively.
- The guidelines are still the most popular publication on this subject as a result of the challenges of the diagnosis and the treatments of IE.

bibliometric data with the widest time range (130 years) including visual mapping method-based keyword analysis.

Bibliometric analysis is defined as a qualitative and quantitative research method used to evaluate the impact of researchers, study groups, institutions, countries, and journals on a specific topic.<sup>14</sup> Bibliometric data may help the evolution of a specific topic over the years and the factors contributing to it can be revealed. With network map analyses using bibliometric data, interactions between parameters such as keywords and collaborations related to the topics can be visualized. VOSviewer program visualizes the data obtained in bibliometric analysis studies with data mining method by converting them into network maps and helps to reveal the themes and collaboration models related to the subject.<sup>14,15</sup> The combined use of bibliometric and network mapping analyses helps to identify the topics studied in a specific topic, collaborations, changes over the years, and deficiencies related to the topic.<sup>16</sup> We believe that evaluating the changes in thousands of publications on IE over the years from the initiated point will shed light on the determination of future studies and the organization of health policies and funds.

As we mentioned above, there is no such comprehensive bibliometric analysis and keyword visual mapping method-based study on IE. Therefore, we aimed to analyze the hot topics in this field, the distribution of publications in terms of country, institution, journal, and author, and their relationships by evaluating IE articles published in the 130 years between 1892 and 2022.

## METHODS

Different databases can be used to search the data to be used in bibliometric analyses. Scopus database is a database developed by Elsevier by combining the features of Web of Science and PubMed, which allows a wider range and easier data analysis.<sup>15,17</sup> In our study, Scopus database was used because it has more advantages compared to other databases and provides more publication results. Visualization and mapping of the data obtained by bibliometric analysis is especially useful in determining the research areas related to the subject. The VOSviewer program, which we used to create network maps, is a popular application used to visualize the data obtained in bibliometric analysis studies with data mining method.<sup>16</sup> Publications before 2023 were analyzed using the keywords "infective" and "endocarditis" in the Scopus database. The year range selected for the analysis of the publications was 1892-2022. The final search query in Scopus was 'TITLE (infective AND endocarditis) AND (EXCLUDE (PUBYEAR, 2023)) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "re") AND (LIMIT-TO (SRCTYPE, "j"))).' The literature review was conducted on February 17, 2023, and all data were transferred from the database to Microsoft Excel 365 (Microsoft Corp., Wash, USA) on the same day to prevent bias due to daily database updates.

Quantitative and qualitative analysis of the data obtained were evaluated in terms of the number of publications, topic,

language, journal, country, authors, year, institution, and the most cited publications. The data collected by the bibliometric analysis were analyzed using the VOSviewer program to visualize keyword and collaboration links. Frequency, percentage, and arithmetic mean values of the collected data were calculated using the Microsoft Excel tool.

Our study was conducted in accordance with the Declaration of Helsinki revised in 2013. Since our study is a document review technique, ethics committee approval is not required. Ethical approval and informed consent are not needed for this study as this includes only a bibliographic analysis of published articles. We did not contact any author for further information about their publications. No artificial intelligence program was used in the production of the manuscript.

## RESULTS

In total, 8651 publications between 1892 and 2022 were found in the Scopus database. The inclusion and exclusion criteria are given in the flowchart in Figure 1.

The highest number of publications was 468 (7.14%) in 2022 (Figure 2). To show the changes in research productivity over

the last 20 years, the annual number of articles and the rates of increase in the annual number of articles by year are given in Table 1.

The most preferred language was English (n=5441; 82.98%), and this was followed by Japanese (n=250; 3.81%) and Spanish (n=228; 3.48%). The 15 most preferred languages are shown in Table 2.

The field with the largest share of articles obtained during the selected study period was "medicine" (n=6220; 94.86%). This was followed by "immunology and microbiology," "biochemistry, genetics and molecular biology," "pharmacology, toxicology, and pharmacy," and "dentistry" (Figure 3).

The distribution of publication frequency on the world map is shown in Figure 4. Approximately 25% of the publications on IE are from the United States of America (USA) followed by Japan, France, the United Kingdom, Spain, Italy, Germany, Germany, China, Türkiye, and India (Figure 5). When the regional distribution of publications is analyzed, North American and Western European countries stand out, while Africa and Central Asia have the least number of publications.

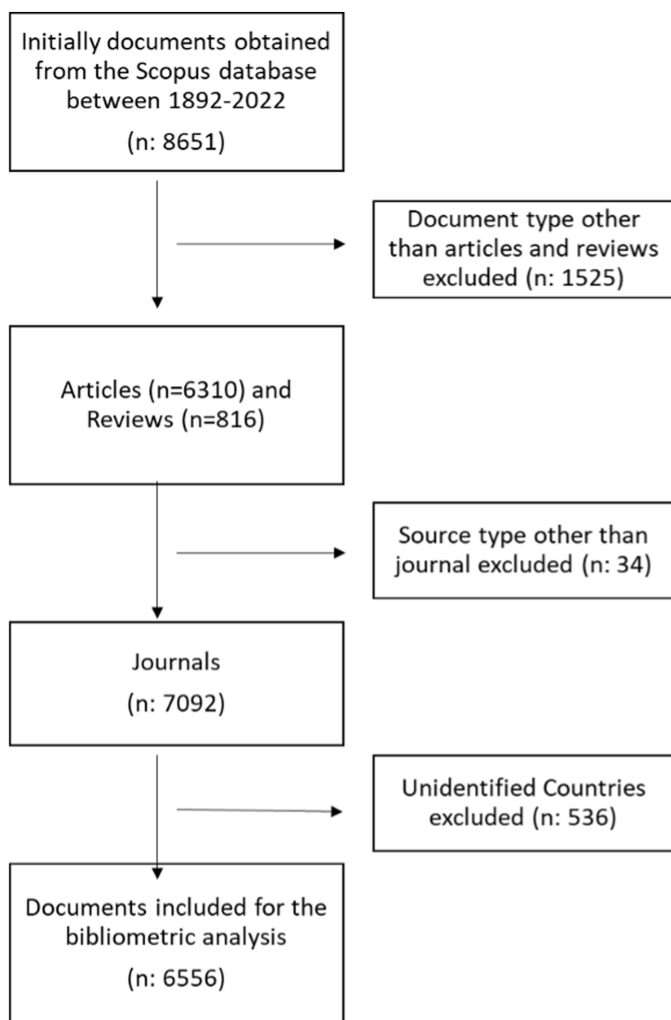
Hospital Clinic Barcelona from Spain ranks first in the list of institutions with the most publications, followed by Inserm and Hôpital Bichat-Claude-Bernard AP-HP from France. The list of institutions producing the most publications is given in Table 3. Five of the institutions in the top 10 are located in France, 3 in Spain, and 2 in the USA.

A total of 1421 (21.67%) publications were published in the top 20 journals listed in Table 4. The top 20 most preferred journals for publishing IE-related publications are presented in Table 4 along with their Scientific Journal Ranking (SJR) and Impact Factor (IF) values.

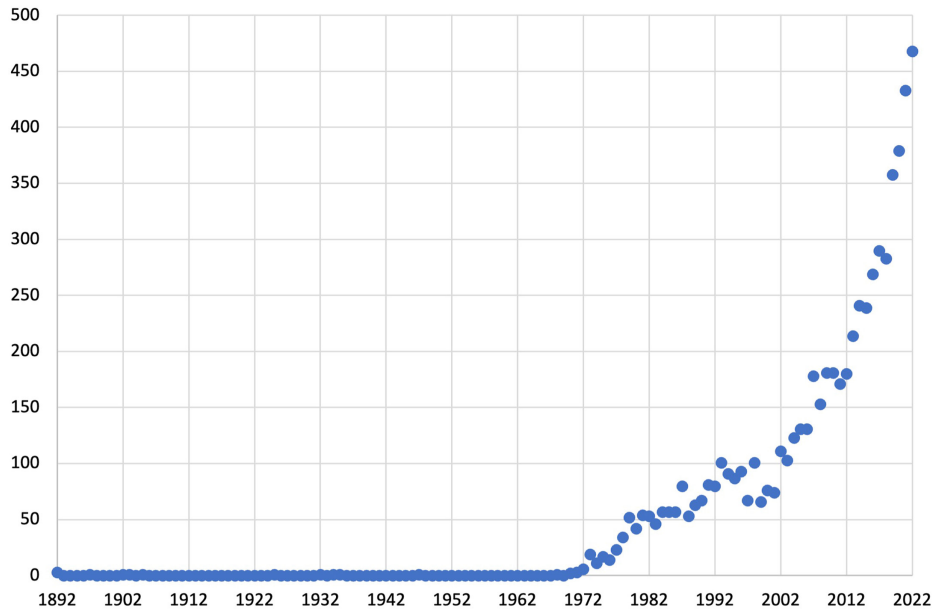
The top 10 most cited publications are shown in Table 5.<sup>6,7,18,19-25</sup> "Proposed modifications to the Duke criteria for the diagnosis of infective endocarditis"<sup>7</sup> published in *Clinical Infectious Diseases* is the most cited publication with 2868 citations. Three of the 10 most cited publications were published in *Circulation* and 2 in the *European Heart Journal*. Of the 10 most cited articles, 8 were guideline/consensus reports and 2 were original research articles.

Table 6 lists the top 10 authors who published the most articles on IE, their countries, and h-indexes. Habib, G. with 86, Hoen, B. with 83, and Delahaye, F. with 72 publications are the most prolific authors by the number of publications. Seven of the authors in the top 10 were from French institutions.

VOSviewer program was used for keyword analysis in our study. According to the frequency of the keywords used, the keywords used more than 100 times except "infective endocarditis" were "echocardiography" 247 times, "mortality" 191 times, "surgery" 152 times, "*Staphylococcus aureus*" 142 times, "cardiac surgery" 130 times, "epidemiology" 122 times, and "prognosis" 119 times. A total of 116 keywords were used at least 15 times, and the keywords were categorized into 9 clusters by VOSviewer. The clusters with the most used 5 keywords: (1) Clinical diagnosis of IE (red cluster):



**Figure 1. Flowchart of infective endocarditis research inclusion.**



**Figure 2. Hundred thirty years of increase in the number of publications.**

infective endocarditis, echocardiography, case report, mycotic aneurysm, transesophageal echocardiography; (2) Predisposing factors of IE (green cluster): infective endocarditis, *Staphylococcus aureus*, bacteremia, congenital heart disease, children; (3) Complications related heart valves (blue cluster): endocarditis, risk factors, aortic valve, mitral valve, outcome; (4) treatments of heart valve diseases (yellow cluster): vegetation, prosthetic valve endocarditis, mitral

valve repair, mitral valve replacement, aortic valve replacement; (5) antimicrobial therapy (purple cluster): diagnosis, antibiotic prophylaxis, prophylaxis, antibiotics, guidelines; (6) complications of IE (light blue): cardiac surgery, stroke, embolism, heart failure, valve replacement; (7) microbiological diagnosis (orange): complications, prosthetic valve, infective endocarditis, blood culture, Duke criteria; (8) causative agents (lilac): epidemiology, *Enterococcus faecalis*, rheumatic heart diseases, streptococci, Staphylococcus; (9) prognosis of IE (pink): mortality, surgery, prognosis, infection, pacemaker.

**Table 1. Annual Number of Articles and Rates of Increase in the Last 20 Years**

Year	Documents	%	Literature Growth Percentage
2022	468	7.14	0.08
2021	433	6.60	0.14
2020	379	5.78	0.06
2019	358	5.46	0.27
2018	283	4.32	-0.02
2017	290	4.42	0.08
2016	269	4.10	0.13
2015	239	3.64	-0.01
2014	241	3.68	0.13
2013	214	3.26	0.19
2012	180	2.75	0.05
2011	171	2.61	-0.06
2010	181	2.76	0.00
2009	181	2.76	0.18
2008	153	2.33	-0.14
2007	178	2.71	0.36
2006	131	2.00	0.00
2005	131	2.00	0.07
2004	123	1.88	0.19
2003	103	1.57	-0.07

The network map by keyword analysis is shown in Figure 6, and the network map covering the publications in the last 10 years and trends by years is shown in Figure 7.

**Table 2. Fifteen Most Preferred Languages**

Rank	Language	Number of Publications
1	English	5441
2	Japanese	250
3	Spanish	228
4	French	195
5	German	90
6	Chinese	87
7	Italian	80
8	Portuguese	80
9	Polish	72
10	Russian	58
11	Turkish	39
12	Czech	34
13	Korean	9
14	Dutch	8
15	Hebrew	7

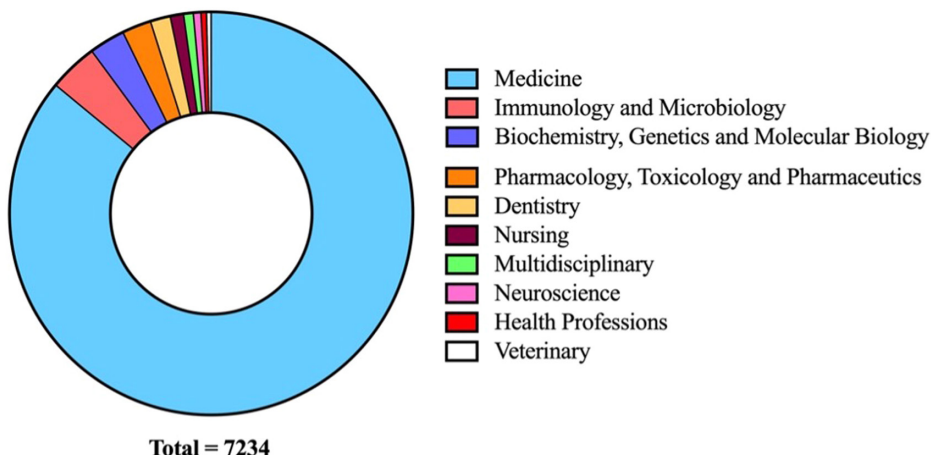


Figure 3. Distribution of publications to the research areas.

**DISCUSSION**

A total of 6556 publications on IE were published between 1892 and 2022, and the highest increasing rates were in the last 3 years (2022: 7.14; 2021: 6.6; 2020: 5.78). It is significant that these rates of increase coincided with the years when the COVID-19 pandemic and speculative discourses on the side effects of vaccines used during the pandemic were on the agenda.<sup>26-29</sup> Recently reported that the annual number of IE cases worldwide has exceeded 1 million and the number of deaths has exceeded 66 thousand.<sup>30</sup> Scientific databases such as PubMed, Scopus, and WoS show a dramatic increase in the number of articles published in recent years. The increasing importance of IE, which threatens public health, has made bibliometric studies on this subject and the determination of the relevant trends necessary.

As expected, English is the most preferred language in IE publications. When the countries that contribute most frequently to the literature are assessed, apart from the USA and the UK, non-native English-speaking countries such as Japan, France, Spain, Italy, Germany, China, and Turkey come to the fore, but English dominates the literature as the preferred language of publication. When the top 20 contributors to the IE literature were analyzed, 9 countries were from Europe, 7 from Asia, 2 from North America, one from South America, and 1 from Australia. Studies reporting the incidence of IE report that the highest increase in cases is in Western Europe and South American countries.<sup>29</sup> In line with the countries that produce publications most frequently, France, Spain, and the USA dominate the list of the most productive institutions. The study showed that

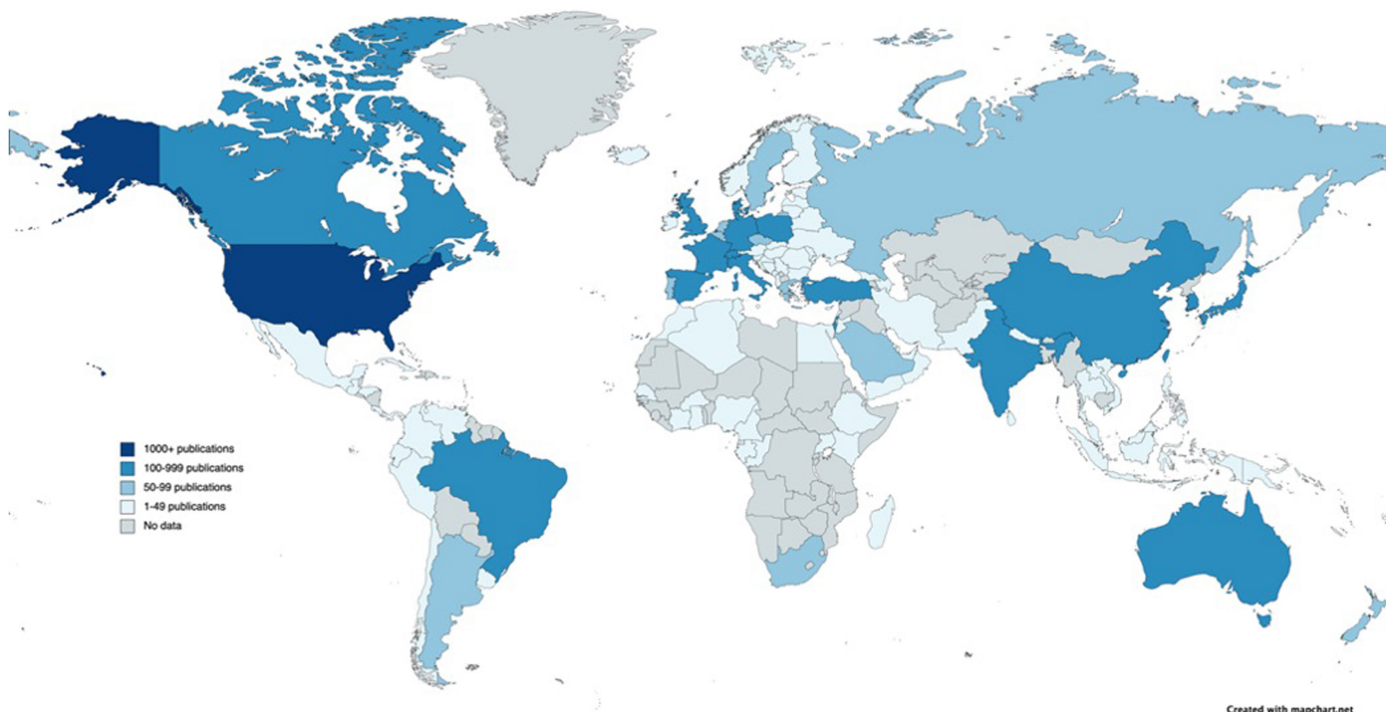
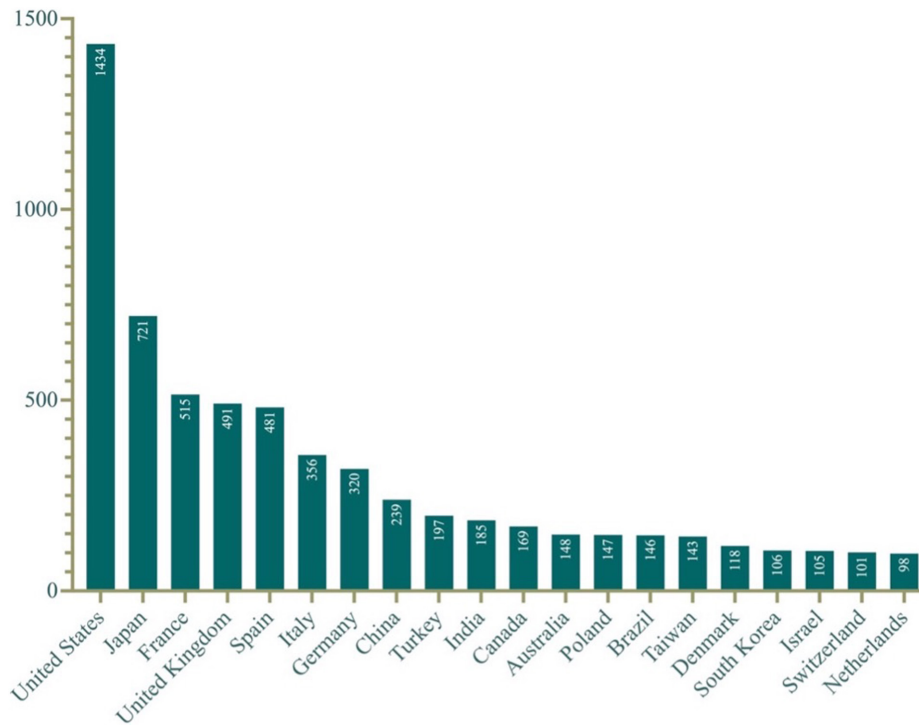


Figure 4. Distribution of publication frequency worldwide.



**Figure 5. Top 20 countries with the most publications.**

African countries are lagging behind in publications on IE. We think that it is important to support studies on this topic in the African region, where developing and undeveloped countries are more, and to present the data to the literature in order to solve the problem both regionally and globally. The incidence of IE is expected to be higher in developing countries. However, studies reporting incidence in many developing countries are not available. Therefore, it was demonstrated in our study that more research is needed in these countries. The lack of incidence studies may be related to the financial status of the country, the interest of researchers, and country strategies. In addition, IE may not be studied as a priority due to HIV, tropical diseases, and non-infectious diseases which are more common and have higher mortality than IE. Also, in some countries, IE diagnosis and reporting may not be possible due to limited access to health services. Nevertheless, the populations of countries have been increasing at different rates over the years.

Such variations underscore the necessity for a meticulous examination of the correlations between the number of publications and incidence rates.

When the countries of the 20 most productive journals were analyzed, the UK has 9 journals, the USA has 5, Japan has 2, Ireland, Germany, Spain, and Brazil have 1 journal each. It is noteworthy that none of the journals from France, Italy, China, and Turkey, which are among the 10 countries that contribute most frequently to the literature, are included in the list. *Kyobu Geka The Japanese Journal of Thoracic Surgery*, which publishes the most publications, is not indexed in WoS, while the journals with the highest IF are *Circulation* (39 918), *European Heart Journal* (35 855), and *Clinical Infectious Diseases* (20 999).

The most cited article was published in *Clinical Infectious Diseases* in 2000 and received 2868 citations. The other 2 articles with over 2000 citations were published in the *European*

**Table 3. Top 10 Productive Institutions**

	Affiliation	Country	Number of Publications	%
1	Hospital Clinic Barcelona	Spain	135	2.06
2	Inserm	France	126	1.92
3	Hôpital Bichat-Claude-Bernard AP-HP	France	106	1.62
4	Universitat de Barcelona	Spain	103	1.57
5	Mayo Clinic	United States	102	1.56
6	Duke University Medical Center	United States	88	1.34
7	AP-HP Assistance Publique - Hopitaux de Paris	France	85	1.30
8	Université Paris Cité	France	84	1.28
9	Hospital Universitari Vall d'Hebron	Spain	83	1.27
10	Hopital La Timone	France	80	1.22

**Table 4. Top 20 Preferred Journals**

Rank	Journal	Publications	CiteS-22	IF-22	Country
1	<i>Kyobu Geka The Japanese Journal of Thoracic Surgery</i>	122	N/A	N/A	Japan
2	<i>International Journal of Cardiology</i>	114	7	3.5	Ireland
3	<i>American Journal of Cardiology</i>	108	4.9	2.8	US
4	<i>European Heart Journal</i>	99	29.2	39.3	UK
5	<i>Clinical Infectious Diseases</i>	93	21.5	11.8	UK
6	<i>Annals of Thoracic Surgery</i>	77	5.6	4.6	US
7	<i>BMJ Case Reports</i>	74	1.2	0.9	UK
8	<i>Heart</i>	74	10.4	5.7	UK
9	<i>Journal of Heart Valve Disease</i>	74	N/A	N/A	UK
10	<i>European Journal of Clinical Microbiology and Infectious Diseases</i>	60	8.9	4.5	Germany
11	<i>Circulation</i>	59	42.1	37.8	US
12	<i>Revista Espanola De Cardiologia</i>	57	2.5	5.9	Spain
13	<i>American Heart Journal</i>	56	7.9	4.8	US
14	<i>Arquivos Brasileiros De Cardiologia</i>	56	2.9	2.6	Brazil
15	<i>European Journal of Cardio Thoracic Surgery</i>	56	5.9	3.4	UK
16	<i>BMC Infectious Diseases</i>	49	4.8	3.7	UK
17	<i>Internal Medicine</i>	49	1.9	1.2	Japan
18	<i>Clinical Microbiology and Infection</i>	48	16.5	14.2	UK
19	<i>Journal of Thoracic and Cardiovascular Surgery</i>	48	9.2	6	US
20	<i>Scandinavian Journal of Infectious Diseases (currently known as Infectious Diseases)</i>	48	5.0	5.8	UK

**Table 5. The Top 10 Most Cited Publications**

Rank	Title	Year	Journal	Cited by
1	Proposed modifications to the Duke criteria for the diagnosis of infective endocarditis <sup>7</sup>	2000	<i>Clinical Infectious Diseases</i>	2868
2	2015 ESC Guidelines for the management of infective endocarditis <sup>18</sup>	2015	<i>European Heart Journal</i>	2786
3	New criteria for diagnosis of infective endocarditis: utilization of specific echocardiographic findings <sup>6</sup>	1994	<i>The American Journal of Medicine</i>	2196
4	Prevention of infective endocarditis: Guidelines from the American Heart Association <sup>19</sup>	2007	<i>Circulation</i>	1973
5	Guidelines on the prevention, diagnosis, and treatment of infective endocarditis (new version 2009) <sup>20</sup>	2009	<i>European Heart Journal</i>	1643
6	Infective endocarditis in adults: Diagnosis, antimicrobial therapy, and management of complications: A scientific statement for healthcare professionals from the American Heart Association <sup>21</sup>	2015	<i>Circulation</i>	1592
7	Clinical presentation, etiology, and outcome of infective endocarditis in the 21st century The international collaboration on Endocarditis-prospective cohort study <sup>22</sup>	2009	<i>Archives of Internal Medicine</i>	1491
8	Infective endocarditis: diagnosis, antimicrobial therapy, and management of complications: a statement for healthcare professionals from the Committee on Rheumatic Fever, Endocarditis, and Kawasaki Disease, Council on Cardiovascular Disease in the Young, and the Councils on Clinical Cardiology, Stroke, and Cardiovascular Surgery and Anesthesia, American Heart Association <sup>23</sup>	2005	<i>Circulation</i>	1403
9	Infective endocarditis in adults <sup>24</sup>	2001	<i>NEJM</i>	1069
10	Changing profile of infective endocarditis: Results of a 1-year survey in France <sup>25</sup>	2002	<i>JAMA</i>	812

**Table 6. Top 10 Most Prolific Authors by the Number of Publications**

	Author	Number of Publications	%	Country	H-index
1.	Habib, G.	86	1,31	France	88
2.	Hoen, B.	83	1,27	France	70
3.	Delahaye, F.	72	1,10	France	58
4.	Baddour, L.M.	66	1,01	United States	74
5=	Duval, X.	64	0,98	France	55
5=	Selton-Suty, C.	64	0,98	France	46
7.	Wilson, W.R.	62	0,95	United States	75
8.	Raoult, D.	61	0,93	France	168
9.	Vilacosta, I.	57	0,87	Spain	50
10.	Casalta, J.P.	56	0,85	France	44

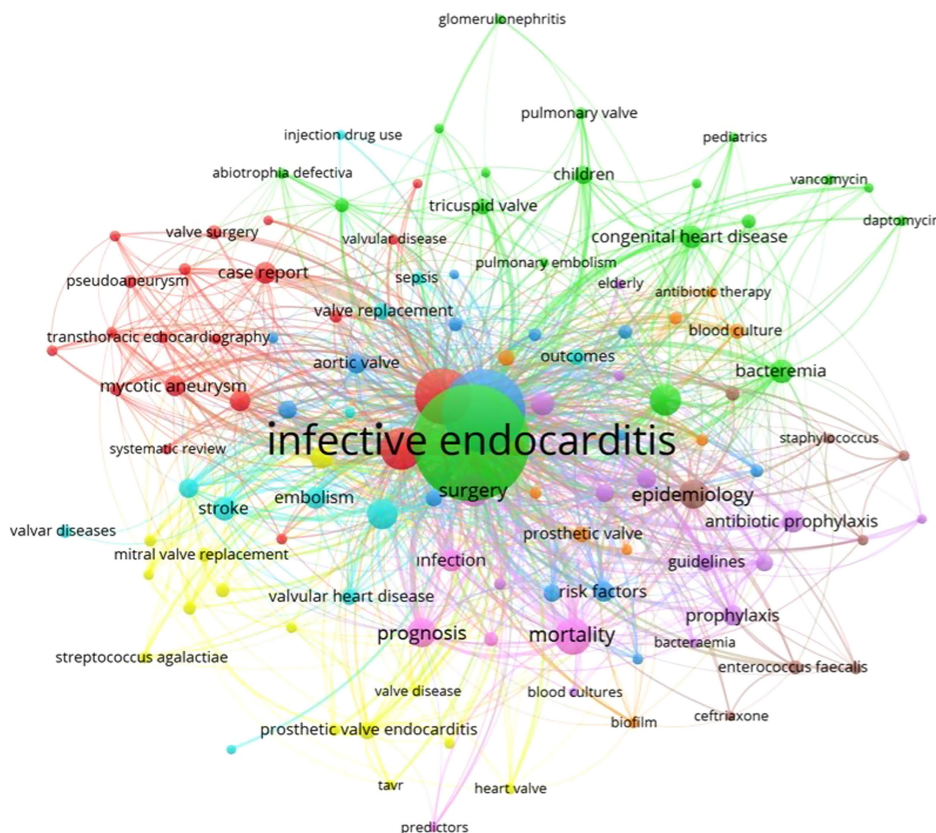
*Heart Journal* with 2786 citations and the *American Journal of Medicine* with 2196 citations. The 3 most cited articles were all consensus reports. That indicates the guidelines are still the most popular publications on this subject as a result of the challenges of the diagnosis and the treatments of IE. Our study shows that regional and local guidelines and original research studies are needed to eliminate difficulties in diagnosis and treatment.

**Clinical Diagnosis of Infective Endocarditis (in Red Cluster)**

The most prominent keyword in the red cluster in our study, echocardiography, is a non-invasive cardiac test that can assess the structure and motion of the myocardium, heart valves, pericardium, and great vessels and is the most popular non-invasive cardiac diagnostic test. In a study analyzing the most cited publications in the literature on echocardiography, it was found that most of the publications were related to left ventricle (LV) function, LV structure, and heart valve problems.<sup>31</sup> In our study, heart valve problems were also prominent. Similarly, some studies show that most of the echocardiography publications were from the USA. In our study, 3 of the 10 most cited publications (30%) were published in *Circulation*, similarly, in the study by Huang et al<sup>31</sup> it was reported that 39 of the 100 most cited echocardiography articles (39%) were published in *Circulation*.

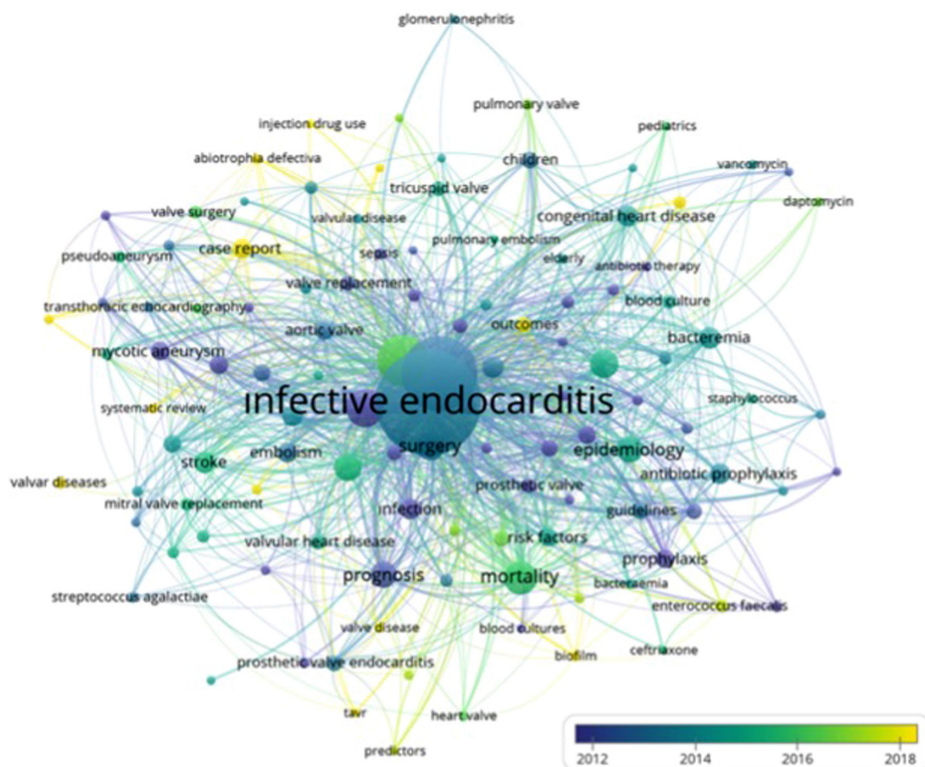
**Predisposing Factors and Causative Agents of Infective Endocarditis (in Green Cluster)**

Infective endocarditis is a serious complication occurring in 10%-25% of *Staphylococcus aureus* bacteremia, and *S. aureus* has been reported as the dominant causative pathogen in Europe and North America in recent years.<sup>32</sup> Although *Streptococcus agalactiae* and *Enterococcus faecalis* were also prominent in our study, *Staphylococcus aureus* was found to be the most frequently used keyword among bacterial agents. Rheumatic heart disease and congenital heart disease are common predisposing factors for IE. Other risk



**Figure 6. Network map by keyword analysis.**





**Figure 7. Overlay visualization of all keywords by years using VOSviewer.**

factors are prosthetic valves, degenerative valve disease, intravenous drug use, and human immunodeficiency virus infection. The proportion of IE cases caused by *Streptococcus* and *Staphylococcus* is increasing. In addition, the scarcity of IE studies in developing countries is striking.<sup>31,32</sup>

### Complications, Mortality, Surgery, and Prognosis (in Other Clusters)

Infective endocarditis remains to be a life-threatening disease with high morbidity and mortality and continues to be a hot topic of research in scientific studies. Although it was reported that the incidence has remained stable in many countries in recent years, it has increased in high-income countries such as the USA and the UK. Additionally, the prognosis of the disease is reported to be more unfavorable in women.<sup>33</sup> Surgical approaches in IE infections are very important, especially in critically ill patients such as immunosuppressed and intravenous drug/substance addicts. So, studies on IE mortality, prognosis, and surgical approaches remain popular.

The priority should always be the diagnosis, as IE has the risk of spreading to every tissue when the patient has IE suspicion.<sup>34</sup> The diagnosis can be difficult in most cases and may need a combined clinical examination, microbiologic evaluation, and echocardiographic evaluation. New microbiologic and imaging techniques are required, especially in cases with negative blood cultures. A multidisciplinary "endocarditis team" including specialists in infectious diseases, cardiology, and cardiac surgery is strongly recommended by current guidelines for the management of IE.

To the best of our knowledge, this study is the most comprehensive study globally on IE. Since our study reveals the

changes in the literature related to infective endocarditis, we think that it will be a guide in planning new research studies. We believe that periodic repetition of bibliometric analyses and keyword mapping studies will contribute to the quantitative and qualitative development of scientific productivity globally.

**Ethics Committee Approval:** The study was conducted following the Declaration of Helsinki revised in 2013. Since our study is a document review technique, ethics committee approval is not required.

**Informed Consent:** Informed consent is not needed for the study as this includes only a bibliographic analysis of published articles. We did not contact any author for further information about their publications.

**Peer-review:** Externally peer-reviewed.

**Author Contributions:** Concept – O.A., Y.E.M.; Design – O.A., Y.E.M.; Supervision – O.A., Y.E.M.; Resources – O.A., Y.E.M.; Materials – O.A., Y.E.M.; Data Collection and/or Processing – O.A., Y.E.M.; Analysis and/or Interpretation – O.A., Y.E.M.; Literature Search – O.A., Y.E.M.; Writing – O.A., Y.E.M.; Critical Review – O.A., Y.E.M.

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