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Review article

Global acute-on-chronic liver failure trends during 2012–2022: A bibliometric study

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ABSTRACT

Introduction: Acute-on-chronic liver failure (ACLF) is a clinical syndrome with high short-term mortality. ACLF has been increasingly studied in recent years; however, a bibliometric analysis of the entire ACLF field has not been conducted. This study assesses current global trends and hotspots in ACLF research.

Materials and methods: The core Web of Science database was searched for all ACLF-related publications conducted during 2012–2022. The data included information on the author, country, author keywords, publication year, citation frequency, and references. Microsoft Excel was used to collate the data and calculate percentages. VOSviewer software was used for citation and density visualization analysis. Histogram rendering was performed using GraphPad Prism Version 8.0 and R software was used to supplement the analysis.

Result: A total of 1609 ACLF-related articles from 67 different countries were identified. China contributed the most literature, followed by the United States. However, Chinese literature only had the 4th highest number of citations, indicating that cooperation with other countries needs to be strengthened. The Journal of Hepatology had the highest number of ACLF-related citations. Prognosis was one of the most common author keywords, which may highlight current research hotspots. Bacterial infection was a common keyword and was closely related to prognosis.

Conclusion: This bibliometric analysis suggests that future research hotspots will focus on the interplay among bacterial infection, organ failure, and prognosis.

1. Introduction

Acute-on-chronic liver failure (ACLF) is a distinct clinical syndrome characterized by an intense inflammatory response, single or multiple organ failure, and high mortality within 28 days [1]. Compensated, decompensated, and non-cirrhotic chronic liver diseases lead to the development of type A, type B, and type C ACLF, respectively [2]. Many factors promote the progression of chronic liver disease to ACLF, including bacterial infections, excessive drinking, varicosity hemorrhage, and liver disease flares [3]. Systemic inflammatory syndrome is an important pathological mechanism driving this transformation. ACLF patients in different geographic

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regions have different clinical and pathological characteristics. Thus, diagnostic criteria for the disease are not uniform worldwide. The disease has several treatment options, including organ support, predisposing factor, and complication therapies, but no specific medications are available to address ACLF pathogenesis [4]. In recent years, more research has focused on developing new treatment strategies due to the extremely high short-term mortality rate of this condition. However, research is complex and variable because of the diversity and intricacies of ACLF etiology, predisposing factors, diagnosis, and treatment options.

There is an urgent need for new methodologies to analyze the high number of research studies at the macro and micro levels and to characterize the relationships between them. Bibliometrics is a statistical method that integrates large amounts of research data, including authors, journal, citation frequency, author, reference, and publication year. This analytic method can identify research trends and the geographical distribution of a disease or drug treatment, providing a high level of reference information [5]. Bibliometrics analysis has been widely used in clinical research, including studies of liver disease [6–8] but has not been used for ACLF. The current study summarizes the basic information of ACLF-related research conducted from 2012 to 2022 including the author, the country of publication, the number of citations and key words using bibliometrics analysis. The aim is to visualize the basic information of ACLF literature in recent ten years and explore new research trends and identify possible ACLF-related research hotspots for future study.

2. Materials and Methods

2.1. Search strategy

The Web of Science core database, which provides the most comprehensive information on bibliometric software requirements [9], was arbitrarily searched for ACLF-related studies conducted between 2012-01-01 and 2022-08-01. Considering that there is a large amount of literature on ACLF in 2022, we took the day of search as the last day for data inclusion. The search strategy included: TS= (acute-on-chronic liver failure*) OR TS= (ACLF) OR TS= (Failure, Acute-On-Chronic Liver) OR TS= (Failures, Acute-On-Chronic Liver) OR TS= (Liver Failures, Acute-On-Chronic Liver) OR TS= (Liver Failure, Acute-On-Chronic). Using this strategy, a total of 2647 documents were retrieved. Of these, 1015 documents including meeting abstracts, conference papers, online articles, revisions, retractions, and editorials were excluded, along with 23 non-English articles. A total of 1609 documents composed of 1344 articles (83.5 %) and 265 reviews (16.5 %), were included in the study (Fig. 1). The selected search publications were exported into Excel and text. The content included the study title, abstract, authors, literature type, and references. The journal impact factors (IF), available in Journal Citation Reports 2021 (Clarivate Analytics), were also included.

2.2. Data analysis

Microsoft Excel was used to arrange and sort the data. The most frequently cited papers and the countries or authors with the highest number of citations were summarized. GraphPad Prism Version 8.0 (San Diego, CA, USA) was used to draw bar graphs. VOSviewer (Version 1.6.6, the Centre for Science and Technology Studies of Leiden University) was used for citation analysis and density visualization based on author, country, journal, and author keywords. Pajek software was used to adjust and configure the drawings. R software was used for the supplementary analysis of the content that could not be analyzed using VOSviewer. All selected software are commonly used and reliable for bibliometric analysis [10].

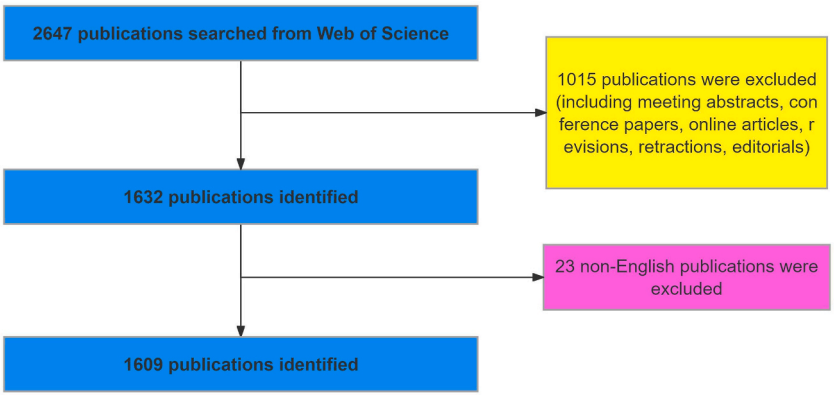

Fig. 1. The selection process of the retrieved publications.

3. Results

3.1. Analysis of the annual publication volume and the number of citations

The annual publication volume of ACLF-related articles increased between 2012 and 2021 and the upward trend became increasingly apparent over time (Fig. 2A). The volume was highest in 2021 (n = 301, 18.7 %) and decreased in 2022, likely because the search ended in August of that year. The number of citations per article increased significantly over the study period (Fig. 2B).

Considering the different types of literature, we analyze reviews and articles separately. Of all the articles, 1148 (85.4 %) were cited at least once, 573 (42.6 %) were cited at least 10 times, and 40 (3.0 %) were cited at least 100 times. Of all the reviews, 238 (89.8 %) were cited at least once, 133 (50.2 %) were cited at least 10 times, and 14 (5.3 %) were cited at least 100 times. The most cited article, entitled "Acute-on-chronic liver failure is a distinct syndrome that develops in patients with acute decompensation of cirrhosis" was published in Gastroenterology and cited 1543 times. The top 10 cited articles are shown in Table 1. The most cited publications, both articles and reviews, have Spanish authors. In the article, six articles were co-authored by authors from multiple countries, but in the review, only two articles were co-authored by authors from multiple countries.

3.2. Analysis of author and author source

A total of 6727 authors were involved in the 1609 retrieved publications. Of these, 205 (2.6 %) published at least 10 articles. Rajiv Jalan, published the highest number of articles (n = 84, 5.2 %), followed by Vicente Arroyo (n = 67, 4.2 %), and Jonel Trebicka (n = 64, 4.0 %). The top 20 most published and most cited authors are shown in Table 2. Articles published by Rajiv Jalan had the highest number of citations (n = 7854), followed by Vicente Arroyo (n = 7569), and Pere Gines (7,178). Country analysis of the corresponding authors found that only a small percentage of Chinese authors collaborated with foreign authors (Fig. 3).

A total of 1940 institutions participated in the development of 1609 articles. The top 10 prolific institutions are shown in Table 3. The most active institution was Capital Med University in China, followed by Zhejiang University in China and the University of Barcelona in Spain. Co-author analysis of 49 institutions with at least 1000 citations found that while institutions from several countries have collaborated extensively, there has been very little collaboration between Chinese institutions and those in other countries (Fig. 4A).

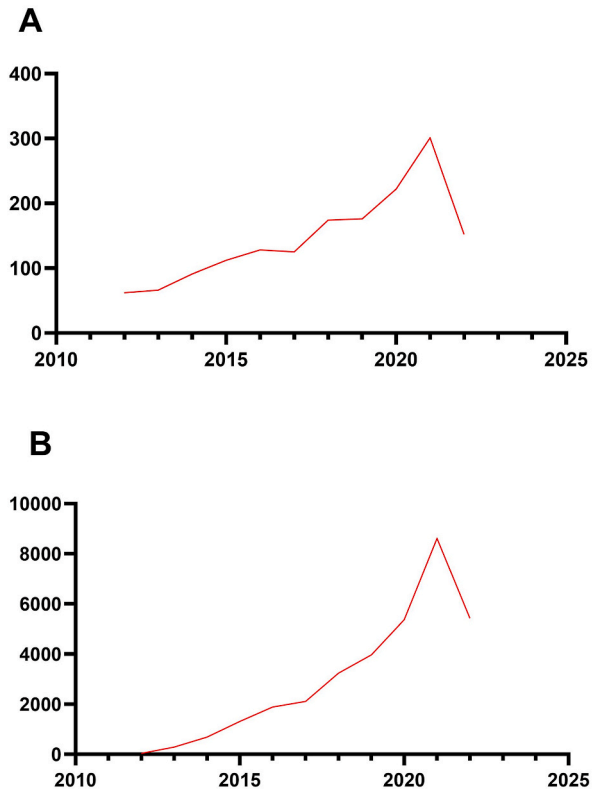

Fig. 2. ACLF-related publications. (A) Annual number of publications. (B) Annual number of publication-specific citations.

Table 1
Top 10 ACLF-related citations.

Typle	Number	Title	Author	Source title	Year	Cited by	Country	Average annual citations
Article								
	1	Acute-on-Chronic Liver Failure Is a Distinct Syndrome That Develops in Patients With Acute Decompensation of Cirrhosis	Moreau, Richard et al.	GASTROENTEROLOGY	2013	1517	Spain, France, England, Italy, Belgium, Germany	168.56
	2	Altered profile of human gut microbiome is associated with cirrhosis and its complications	Bajaj, Jasmohan S et al.	JOURNAL OF HEPATOLOGY	2014	558	USA	69.75
	3	Bacterial infections in cirrhosis: A position statement based on the EASL Special Conference 2013	Jalan, Rajiv et al.	JOURNAL OF HEPATOLOGY	2014	519	Spain, England, Switzerland, USA, France, Italy, Austria, Belgium, Germany	64.88
	4	Development and validation of a prognostic score to predict mortality in patients with acute-on-chronic liver failure	Jalan, Rajiv et al.	JOURNAL OF HEPATOLOGY	2014	490	USA, Spain, France	61.25
	5	Systemic Inflammation in Decompensated Cirrhosis: Characterization and Role in Acute-on-Chronic Liver Failure	Claria, Joan et al.	HEPATOLOGY	2016	350	Spain, Austria, Netherlands, France, England, Austria, Italy, Germany, Belgium	58.33
	6	Clinical Course of acute-on-chronic liver failure syndrome and effects on prognosis	Gustot, Thierry et al.	HEPATOLOGY	2015	338	Spain, Belgium, Italy, Germany, France, England, Ireland, Austria, Switzerland	48.29
	7	Extracorporeal albumin dialysis with the molecular adsorbent recirculating system in acute-on-chronic liver failure: The RELIEF trial	Banares, Rafael et al.	HEPATOLOGY	2013	310	Spain, Belgium, Denmark, England, Germany, France, Austria, Italy, Switzerland	34.44
	8	Survival in Infection-Related Acute-on-Chronic Liver Failure Is Defined by Extrahepatic Organ Failures	Bajaj, Jasmohan S et al.	HEPATOLOGY	2014	301	USA	37.63
	9	ACG Clinical Guideline: Alcoholic Liver Disease	Singal, Ashwani K et al.	AMERICAN JOURNAL OF GASTROENTEROLOGY	2018	299	USA	74.75
	10	Acute-on-chronic liver failure: an update	Hernaez, Ruben et al.	GUT	2017	293	USA	58.60
Review								
	1	Cirrhosis-associated immune dysfunction: Distinctive features and clinical relevance	Albillos, Agustin et al.	JOURNAL OF HEPATOLOGY	2014	558	Spain	69.75
	2	Acute-on chronic liver failure	Jalan, Rajiv et al.	JOURNAL OF HEPATOLOGY	2012	401	England, Spain, USA, France	40.10
	3	Acute-on-chronic liver failure: A new syndrome that will re-classify cirrhosis	Arroyo, Vicente et al.	JOURNAL OF HEPATOLOGY	2015	261	Spain, France, England	37.29
	4	Human serum albumin, systemic inflammation, and cirrhosis	Arroyo, Vicente et al.	JOURNAL OF HEPATOLOGY	2014	255	Spain	31.88
	5	Liver - guardian, modifier and target of sepsis	Strnad, Pavel et al.	NATURE REVIEWS GASTROENTEROLOGY & HEPATOLOGY	2017	222	Germany	44.40
	6	Child-Pugh Versus MELD Score for the Assessment of Prognosis in Liver Cirrhosis: A Systematic Review and Meta-Analysis of Observational Studies	Peng, Y et al.	MEDICINE	2016	205	China	34.17
	7	Acute liver failure	Stravitz, R. Todd et al.	LANCET	2019	202	USA	67.33
	8	Acute-on-chronic liver failure: terminology, mechanisms and management	Sarin, Shiv K et al.	NATURE REVIEWS GASTROENTEROLOGY & HEPATOLOGY	2016	175	India	29.17

(*continued on next page*)

Table 1 (*continued*)

Typle	Number	Title	Author	Source title	Year	Cited by	Country	Average annual citations
	9	Clinical states of cirrhosis and competing risks	D'Amico, Gennaro et al.	JOURNAL OF HEPATOLOGY	2018	153	Italy	38.25
	10	Acute-on-Chronic Liver Failure	Arroyo, Vicente et al.	NEW ENGLAND JOURNAL OF MEDICINE	2020	148	Spain	74.00

Table 2
(A) Top 20 authors with the most publications; (B) Top 20 authors with the most citations.

Number(A)	Author	Documents	Country	Number(B)	Author	Cited by	Country
1	Jalan, Rajiv	84	England	1	Jalan, Rajiv	7854	England
2	Arroyo, Vicente	67	Spain	2	Arroyo, Vicente	7569	Spain
3	Trebicka, Jonel	64	Germany	3	Gines, Pere	7178	Spain
4	Sarin, Shiv Kumar	61	India	4	Moreau, Richard	6971	France
5	Moreau, Richard	59	France	5	Angeli, Paolo	5296	Italy
6	Juan, Li	58	China	6	Pavesi, Marco	5004	Italy
7	Gines, Pere	55	Spain	7	Gustot, Thierry	4739	Belgium
8	Angeli, Paolo	43	Italy	8	Bernardi, Mauro	4687	Italy
9	Yu, Chen	42	China	9	Trebicka, Jonel	4656	Germany
10	Zhongping, Duan	38	China	10	Saliba, Faouzi	4546	France
11	Hai, Li	38	China	11	Laleman, Wim	3902	Belgium
12	Fernandez, Javier	37	USA	12	Wendon, Julia	3860	England
13	Zhiliang, Gao	36	China	13	Alessandria, Carlo	3734	Italy
14	Lanjuan, Li	36	China	14	Durand, Francois	3623	France
15	Pavesi, Marco	34	Italy	15	Gerbes, Alexander	3521	Germany
16	Kai, Wang	34	China	16	Cordoba, Juan	3116	Spain
17	Maiwall, Rakhi	33	India	17	Fernandez, Javier	3116	USA
18	Yu,Zhang	33	China	18	Zeuzem, Stefan	3067	Germany
19	Jinhua, Hu	32	China	19	Albillos, Agustin	2875	Spain
20	Ning, Qin	31	China	20	Domenicali, Marco	2639	Italy

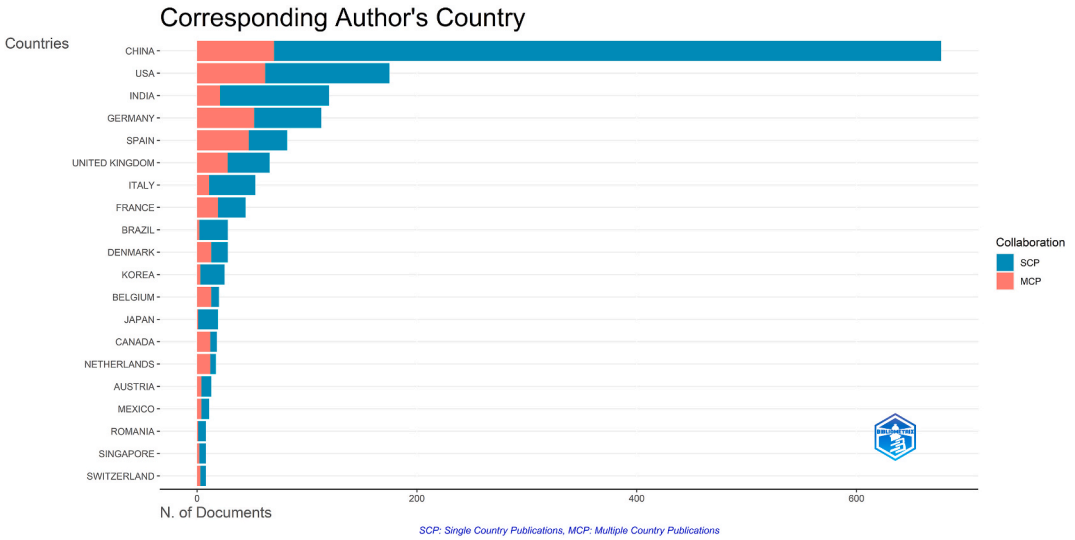

Fig. 3. Corresponding authors by country. SCP represents intra-country collaboration while MCP represents inter-country collaboration.

3.3. Analysis of publications by country and journal

The retrieved publications were developed by researchers from 67 different countries covering five continents, of which Europe participated in the highest number (Fig. 5). Forty countries had published at least five ACLF-related articles and extensive cooperative exchanges had already taken place between these countries (Fig. 4B). China produced the highest number of publications (n = 699),

Table 3
Top 10 organizations with the most publications.

Number	Organization	Documents	Country
1	Capital Med University	156	China
2	Inst Liver & Biliary Sci	153	India
3	Zhejiang University	135	China
4	University of Barcelona	121	Spain
5	University of College London	118	England
6	Sun Yat Sen University	105	China
7	Hosp Clin Barcelona	84	Spain
8	University of Padua	79	Italy
9	Shanghai Jiao Tong University	78	China
10	Hop Beaujon	77	France

followed by the United States (n = 258) and Germany (n = 188) (Fig. 6A). However, articles from countries with the highest number of publications were not necessarily highly cited. Articles in which Spain participated were cited the highest number of times (n = 11,132 times) followed by England (n = 9883) and France (n = 9067), while China, the country with the highest number of published articles, was cited only 8298 times (Fig. 6B).

A total of 1609 publications were retrieved from 378 journals, of which 39 published at least 10 articles (Fig. 7). The Journal of Hepatology published the highest number of ACLF-related articles (n = 88, 5.5 %), followed by Liver International (n = 73, 4.5 %) and Hepatology International (n = 64, 4.0 %) (Fig. 8A). The top 10 most prolific journals differed from the top 10 cited journals. The top three most cited journals were the Journal of Hepatology, Hepatology, and Gastroenterology (Fig. 8B). The top 10 cited journals and their 2021 impact factor (IF), a common measure of a journal's influence, are shown in Table 4. As indicated, the IF values did not align with the top ten cited articles.

3.4. Analysis of author keywords

In the 1609 retrieved articles, 2372 different author keywords appeared, 67 of which appeared at least 10 times. The most frequently occurring author keyword was "acute-on-chronic liver failure" (n = 492), followed by "cirrhosis" (n = 259), "prognosis" (n = 158), "liver failure" (n = 124) and "hepatitis b virus" (n = 124). Density visualization analysis found that there were fewer treatment-related keywords, of which liver transplantation was the most common (Fig. 9).

The 67 author keywords that appeared at least 10 times were analyzed by year. In addition to the keywords related to the disease itself, the keywords that appeared in recent years included "bacterial infection," "spontaneous peritonitis," "epidemiology," "liver transplantation," "COVID-19," "ascites," "sepsis," "coagulation," and "portal hypertension." Three of the keywords, bacterial infection, sepsis, and spontaneous peritonitis, were related to bacterial infection (Fig. 10A). Using the keyword "bacteria*" as the criterion, 58 of 1609 screened articles were obtained. Of the author keywords used in these articles, 10 appeared five or more times. Spontaneous bacterial peritonitis was the most frequently studied bacterial infection type in recent years, and prognosis was the keyword most closely associated with bacterial infection with the exception of ACLF itself (Fig. 10B).

4. Discussion

Acute-on-chronic liver failure (ACLF) is an acute liver injury syndrome that develops from chronic liver disease and has high short-term mortality. The prevalence of ACLF in patients with decompensated cirrhosis can be as high as 35 %, while the 90-day mortality rate can reach 58 % [11]. As a result of its high short-term mortality and global prevalence, ACLF-related research has increased dramatically in recent years. The current study assessed international trends in ACLF research and identified an increase in related studies from 2012 to 2021. These findings suggest that research on ACLF has not yet reached a bottleneck and future studies of this research hotspot should be expected.

China has published the highest number of ACLF-related studies, indicating that this country is making continuous breakthroughs in the field. However, Chinese studies only had the 4th highest number of citations This may be because many Chinese clinicians conduct research for promotional rather than personal reasons, often viewing research as a burden. The goal of scientific research should be to better understand a disease. Thus, Chinese researchers should consider placing more focus on the quality rather than the number of studies they publish. Of the top 10 cited countries, six, including the top three, were located in Europe. The prevalence of ALCF in Europe has reached 39 %, second only to South Asia [12]. In addition, the amount of research conducted in a particular area is often associated with the economic environment of the region. Europe tends to have a higher economic level than South Asia, explaining why its contribution is among the best.

Visual information was used to characterize distinguished teams. As expected, while the top 20 published articles involved several Chinese authors, the top 20 cited articles had no authors from China. Many of the authors in the top 20 publications and those with the highest number of citations were European. American authors were not prominent in either. This may be because the incidence and mortality of ACLF are lower in the United States than in other regions. Country analysis of the corresponding authors also showed that a much larger number of Spanish and other European authors collaborated with research teams from other countries than Chinese authors. International cooperation can deepen understanding of diseases, especially those involving widespread global pandemics.

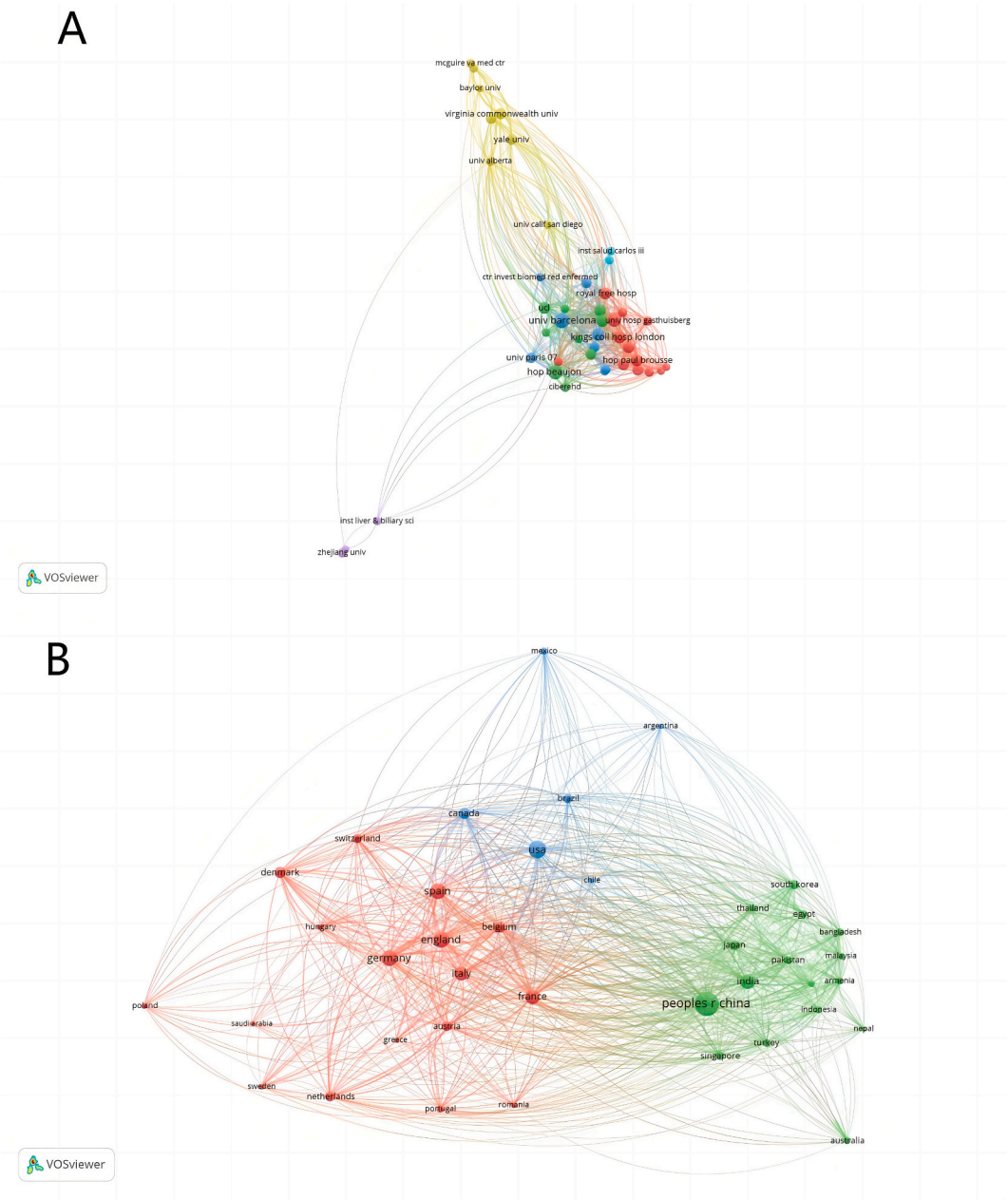

Fig. 4. (A) Co-author analysis of 49 organizations with articles cited at least 1000 times. The size of the circle indicates the number of publications and the distance between circles indicates the strength of the connection. Different colors represent institutions from different regions. Purple represents institutions from Asia (primarily China), yellow represents those from the Americas (primarily the United States), and red, blue, and green represent those from Europe. **(B) Citations from 40 countries with five or more published articles.** The size of the circle indicates the number of publications, and the number of lines indicates the number of connections between them. Red represents European countries, blue represents American countries, and green represents Asian, Oceanian, and African countries.

Thus, Chinese scientists should consider strengthening their relationships with foreign researchers. Future research on ACLF should be conducted on an international level. An analysis of institutions found that universities were most heavily involved in publishing research studies. The institution that published the highest number of ACLF-related studies was Capital Med University in China. While four of the top 10 published institutions were Chinese, they had little exchange with other countries. These findings illustrate that China is heavily focused on ACLF research, but also needs to strengthen its international cooperation.

Journal selection is the most important aspect of manuscript publishing. The Journal of Hepatology had the highest number of ACLF-related publications and citations so is clearly a top journal in this field. While IF is a strong indicator of journal quality, the current study found that some journals with low IF had multiple publications and citations. This finding suggests that article evaluation

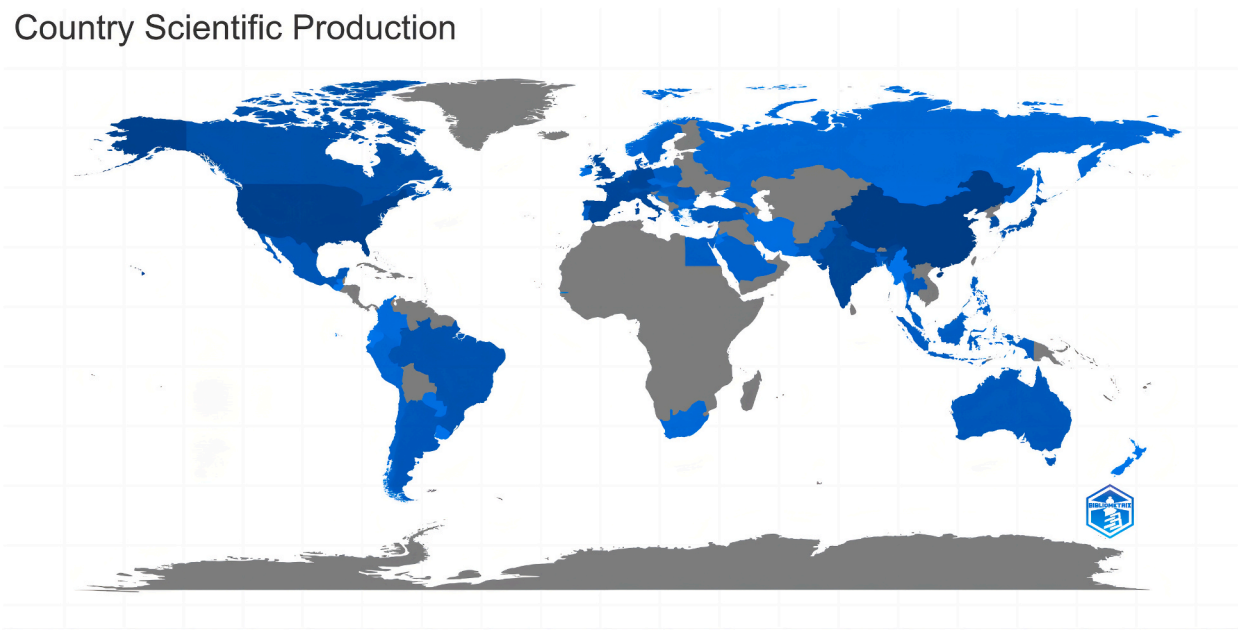

Fig. 5. ACLF-related publication distribution by country. Darker colors represent a higher number of published papers.

may be biased if the IF is the only criterion used. Since IF is heavily influenced by journals, some journals with lower IF scores may also publish high-quality articles that are cited more [13]. The current study used the number of citations to assess each article's influence; however, this method still has limitations, including self-citation. While IF or citation number alone may not be sufficient for determining the influence of an article, they may effectively complement each other [14]. It is our opinion that a new criterion based on the quality of the manuscript itself should be considered.

Highly cited articles often reflect current research hotspots and trends. We analyzed the citations of articles and reviews respectively. It is worth noting that the number of citations of articles is generally higher than that of reviews, but the proportion of reviews with high citations is slightly higher than that of articles. We think that this is because the publication time of the review is relatively late, and the research on ACLF in the world is still in different upward trends. In addition, the annual citations of the 10 most-cited papers also indicate that the citation rate of the review is not low, which indicates that the current research on ACLF is still a hot spot, and more reviews are needed to summarize. The most cited article, entitled, "Acute-on-chronic liver failure is a distinct syndrome that develops in patients with acute decompensation of cirrhosis" defined ACLF diagnostic criteria in different regions [15]. Guidelines are the most authoritative form of definition for a disease, but they were not the most frequently cited in our results. We think that there are two reasons for this: one is that ACLF is a relatively new hot research area, and the world's understanding of it is not enough; the other is that ACLF has regional differences, and there is no unified definition and standard at present. Due to regional differences in ACLF, diagnostic criteria differ considerably by country. A recent US guideline summarizes three major diagnostic criteria from the Asian Pacific Association for the Study of the Liver (APASL), the European Association for the Study of the Liver - Chronic Liver Failure (EASL-CLIF), and the North American Consortium for the Study of End-Stage Liver Disease (NACSELD) [16]. The most cited article sets the stage for ACLF diagnostic criteria. In addition, almost all of the top ten cited reviews mentioned the definition of ACLF, and four of the top ten cited articles discussed the definition of ACLF. This suggests that unifying the definition of ACLF and improving the accuracy of its diagnosis may be the direction of future research. Three of the top 10 cited articles also assessed the effect of bacterial infections on disease [17–19], and one of the top 10 cited reviews also Specifically assessed it [20]. Bacterial infection and ACLF are closely associated and current studies suggest that infection may help to induce the transformation of liver cirrhosis into ACLF. However, little is known about the role of bacterial infection after disease progression to ACLF. Future research should focus on the types of bacteria that contribute to disease pathogenesis.

In addition to ACLF itself, prognosis, cirrhosis, liver failure, and hepatitis b virus were the most common author keywords. Cirrhosis is the pre-stage for most ACLF and is likely to share features of the disease. Hepatitis B infection is a cause of ACLF that is common in China, explaining the high frequency of this keyword. Exploring the etiology and pre-disease status of ACLF can optimize the prediction of ACLF occurrence, which is also a potential future research direction. The prediction of the occurrence of ACLF varies according to the etiology, and the accuracy of the prediction can be improved by adding the etiological school number into the prediction [21]. In addition, considering the limitations of a single indicator, we believe that multi-dimensional assessment of ACLF occurrence is also one of the hot spots of research. For example, when exploring the influence of inflammation on ACLF occurrence, the recovery effect of regeneration on ACLF is also considered. Liver failure is also a feature of the disease. Importantly, ACLF is a disease that involves multiple organ failure and should be considered a focus of research. While some studies have incorporated the characteristics of ACLF-associated organ failure into treatment prognosis [22,23], most have evaluated the quantitative rather than the type

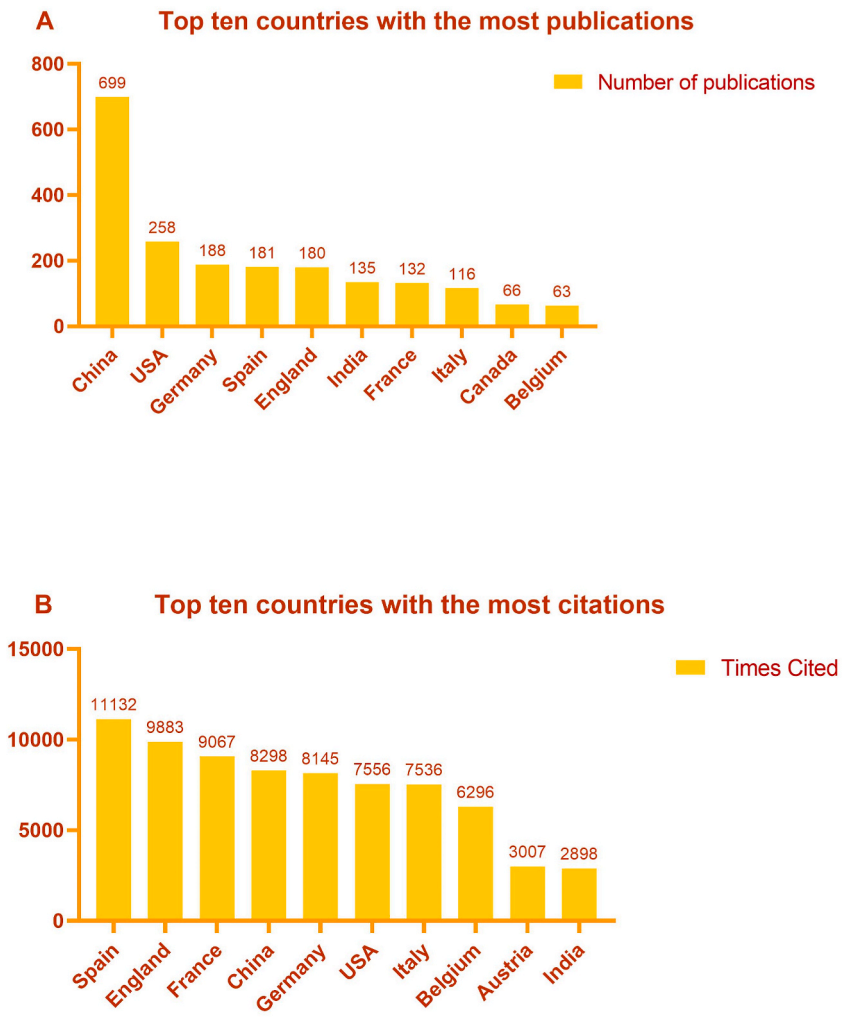

Fig. 6. (A) Top ten countries with the most publications; (B) top ten countries with the most citations.

characteristics of organ failure. After analyzing the author keywords by year, we focused on those used in recent years. Three keywords were associated with bacterial infection, indicating that this is a hot topic in ACLF research. This is consistent with our previous analysis of highly cited articles. Screening bacterial infection-related studies for associated keywords identified spontaneous bacterial peritonitis as a common type of bacterial infection and prognosis as a potential research direction. These findings suggest that future research is likely to focus on the association between bacterial infection, organ failure, and disease prognosis. This may include a study of the related indicators of bacterial infection and the number and types of organ failure included in an assessment of prognosis.

This study identified very few manuscripts that focused on specific ACLF treatments. To date, liver transplantation (LT) remains the only effective cure; however, this condition has many limitations. First, liver availability remains limited. Second, the prognosis of patients undergoing liver transplantation may vary greatly depending on disease severity [24,25]. Therefore, determining the effective population of liver transplantation and judging the timing of liver transplantation may also be a potential hot spot in this field of research. Our results suggest that prognosis is a high-frequency keyword in this field, which is not in conflict with the conclusion. In fact, the prognostic study of liver transplantation includes the assessment of the condition and the judgment of the timing of treatment, which we believe is the trend of future research. In addition, some studies have shown the effectiveness of artificial livers for the treatment of ACLF [26]. The key factor affecting its efficacy is the degree of liver regeneration. Our team has previously paid attention to the influence of liver regeneration related indicators, alpha fetal protein, in predicting disease prognosis [27,28], but other predictable markers of liver regeneration will also need to be explored. In the future, more liver regeneration indicators can be mined, which will be beneficial to the treatment of diseases and the prediction of disease prognosis. The results of the keyword analysis suggested that the treatment of bacterial infections, especially those involving the intestine, should be an additional focus of future research. It is important to note that while antibiotics can delay the progression of decompensated cirrhosis to ACLF, overuse can disrupt the intestinal microenvironment [29]. As a result, treating bacterial infections remains controversial. Future studies are needed to explore the feasibility and effectiveness of these treatment methods and multi-regimen treatments may help to improve the

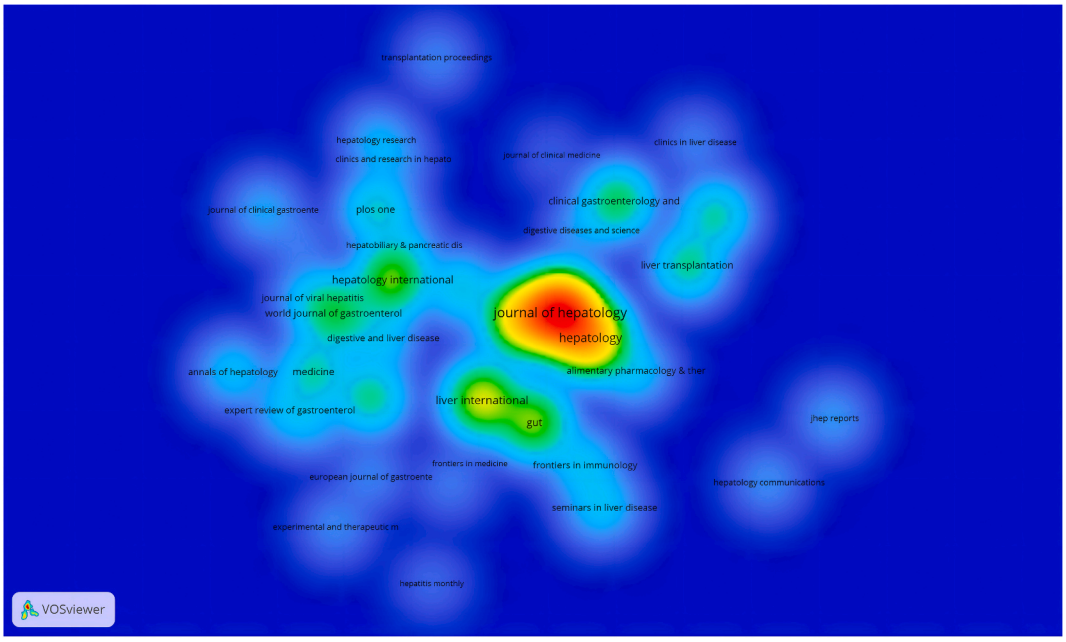

Fig. 7. Density visualization of 44 journals with 10 or more publications. Darker fonts and colors indicate a higher number of citations.

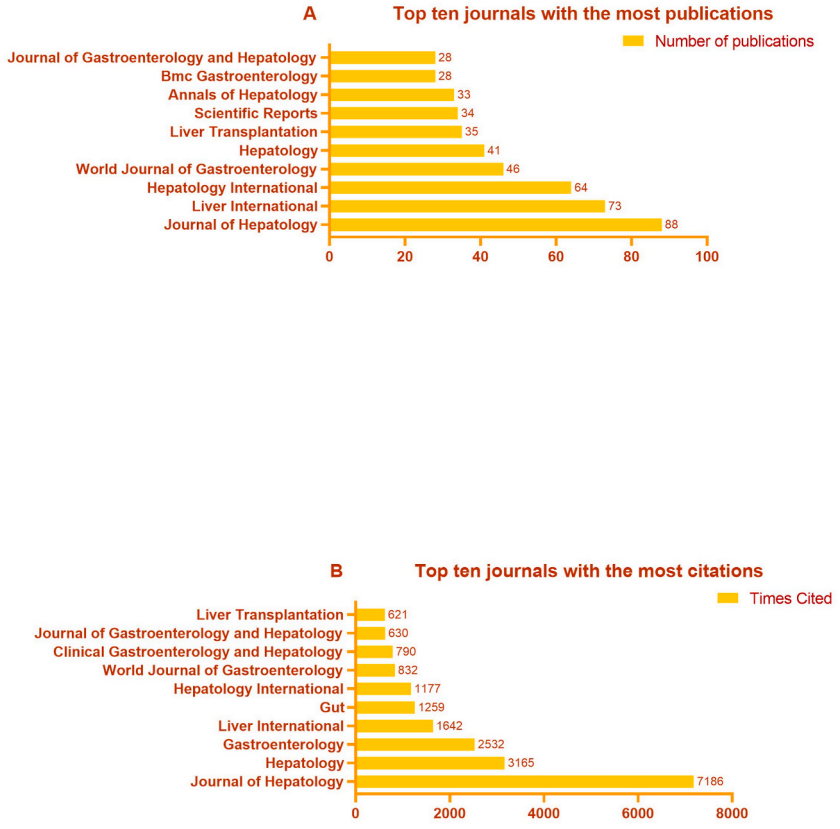

Fig. 8. (A) Top 10 journals with the most publications. (B) Top 10 journals with the most citations.

Table 4
Top 10 journals with the most citations.

Number	Journal	Documents	Cited by	IF
1	Journal of Hepatology	375	7153	30.083
2	Hepatology	333	3353	17.298
3	Gastroenterology	52	2751	33.883
4	Liver International	80	1649	8.754
5	Hepatology International	66	1377	9.029
6	Gut	46	1280	31.793
7	World Journal of Gastroenterology	51	883	5.374
8	Clinical Gastroenterology and Hepatology	26	770	13.576
9	Journal of Gastroenterology and Hepatology	70	622	4.369
10	Liver Transplantation	57	619	6.112

IF, impact factor.

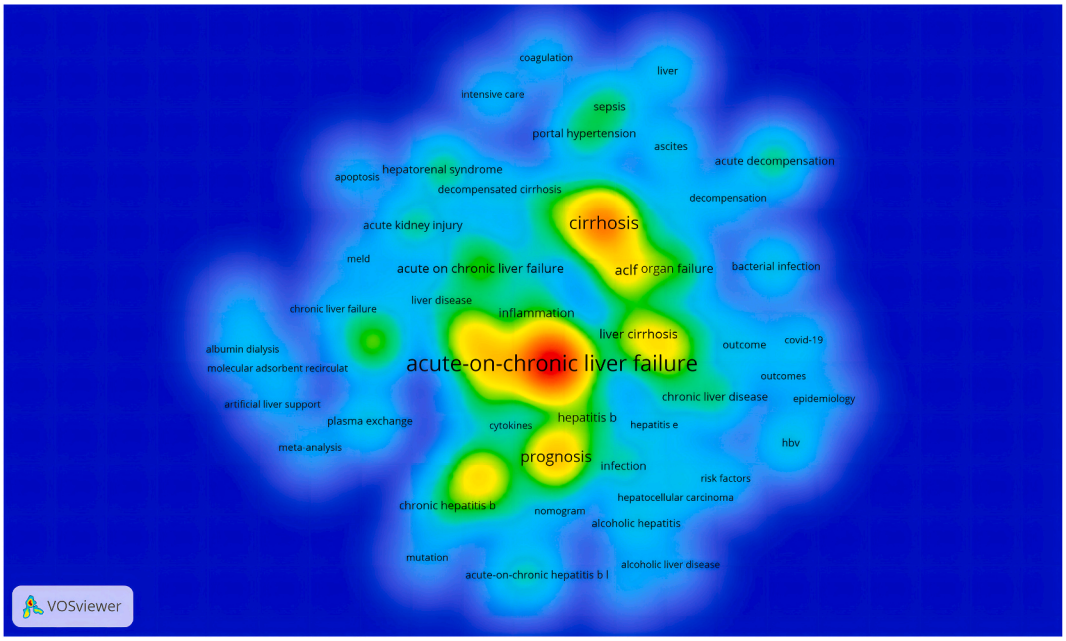

Fig. 9. Density visualization of 70 author keywords that appeared 10 or more times. Darker fonts and colors indicate a higher number of appearances.

prognosis and survival rate of ACLF patients.

To the best of our knowledge, this is the first bibliometric study to analyze ACLF-related research trends and hotspots, providing an important reference for future researchers. However, this study does have some limitations. First, only publications from the Web of Science were included, thus relevant articles not available in this database may have been left out. Second, only articles and reviews were assessed and all non-English papers were excluded. While some literature may have been kept out of this analysis, however, these exclusions helped to ensure the heterogeneity of the literature to a greater extent.

5. Conclusion

This study found that China has published the largest number of ACLF-related papers but needs to invest more in the quality of its manuscripts. ACLF research will need to focus on developing a unified definition of the disease for use on a global scale. Combined with the keyword and high-frequency article analysis, three additional future research directions should be considered: 1) the role of bacterial infections during ACLF, 2) the influence of organ failure and bacterial infection on ACLF prognosis, and 3) additional treatment options for ACLF, including use of the artificial liver.

Data availability statement

The data in this paper has been uploaded as supplementary materials.

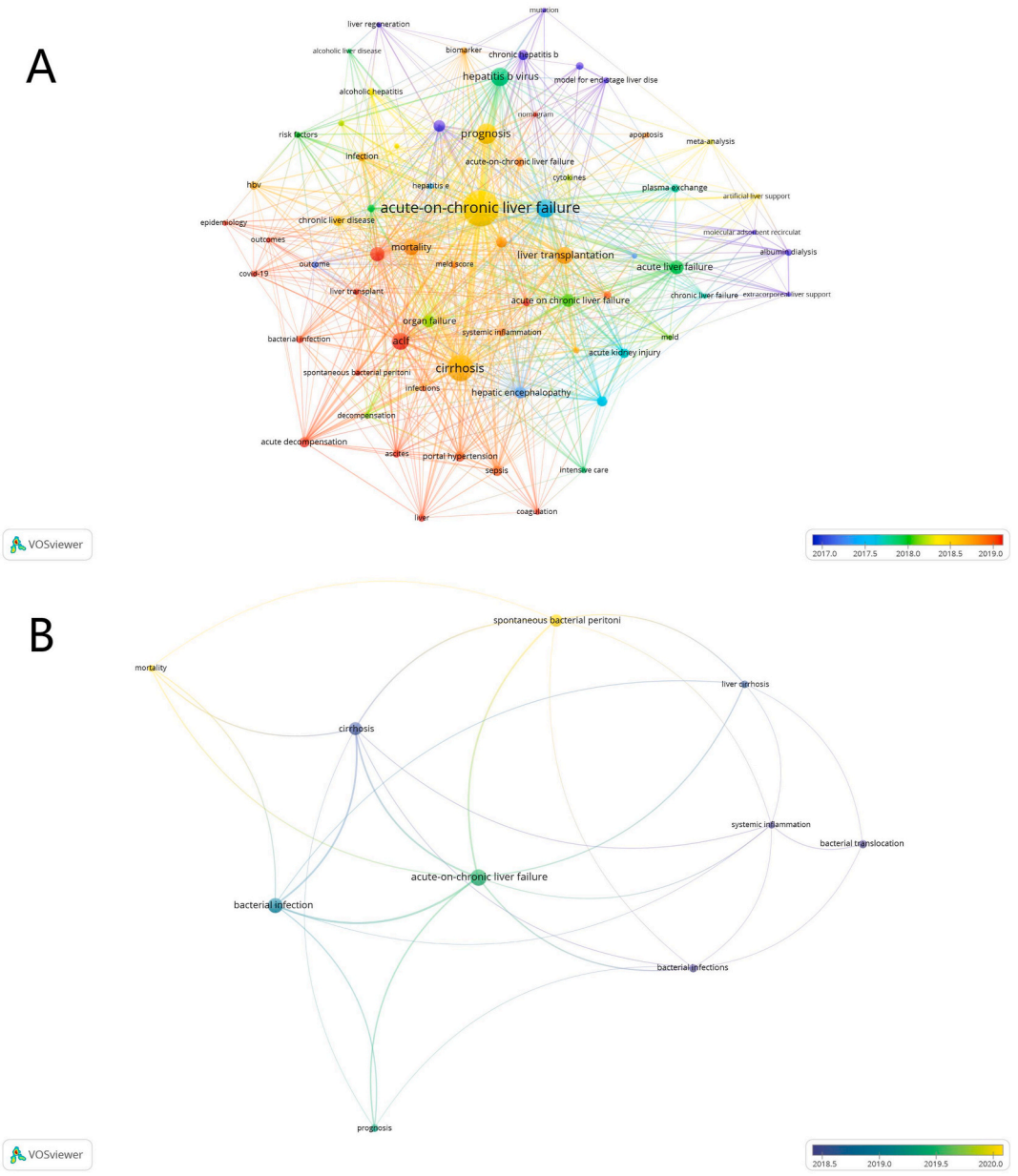

Fig. 10. (A) Co-occurrence frequency analysis of 67 keywords. The redder the color, the more recent the keyword; the larger the circle, the more associated the keyword is with other keywords; the closer the circles, the stronger the connection between the keywords. **(B) Co-occurrence frequency of 10 author keywords related to bacterial infections.** The larger the circle, the more frequent the author keyword; the more yellow the color, the more recent the author keyword; the closer the distance between two circles, the stronger the connection between the author keywords.

CRediT authorship contribution statement

Cheng-zhi Bai: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Juan Ren:** Writing – original draft, Validation, Supervision, Data curation. **Xue Zhang:** Writing – original draft, Validation, Conceptualization. **Yi-yang Hu:** Writing – original draft, Validation, Software. **Xiao-ping Wang:** Writing – original draft, Validation. **Xiao-wei Tang:** Validation, Supervision, Conceptualization. **Shan-hong Tang:** Writing – review & editing, Writing – original draft, Validation, Supervision, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e25791.

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