Research article

Global research status of intrahepatic cholestasis of pregnancy: A bibliometric analysis of hotspots, bursts, and trends

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ABSTRACT

Background: Research on intrahepatic cholestasis of pregnancy (ICP) has recently gained attention. However, no bibliometric analysis was performed in the ICP research field. Therefore, the present study aimed to use bibliometric analysis to analyze the current research hotspots and identify global research status in ICP to reference for future research directions.

Methods: We comprehensively searched the Web of Science Core Collection (WoSCC) database from its inception to December 31, 2023. Articles and reviews related to ICP were downloaded as plain text file records. We used the VOSviewer and Citespace to perform the bibliometric analysis and visualization. The main bibliometric features were tabulated and calculated.

Results: A total of 1092 documents, including 921 original articles and 171 reviews, were identified in WoSCC. These publications were published in 395 journals by 4751 authors from 1250 institutions and 61 countries/regions. The global publication numbers exhibited a gradual upward trend. China, the United States, and the United Kingdom were top contributors to scientific research on ICP. King's College London, London Imperial Coll Sci Technol & Med, and Sichuan University were the most productive institutions. Catherine Williamson had published the most papers and received the most total citations. The most productive journal was *Journal of Maternal-Fetal & Neonatal Medicine*. The most cited paper was Beuers et al. in the *Journal of Hepatology* (2009). Citation burst terms showed that "risk factors" and "perinatal outcomes" were hotspots. "Inflammation", "risk factors", "perinatal outcomes", and "bile acid" have gained attention in more recent research.

Conclusion: The present study comprehensively summarizes the global research status and research trends in ICP. Our study identifies hotspots, collaborative networks, and trends that will provide new insights and guidance for further research in the field.

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1. Introduction

Intrahepatic cholestasis of pregnancy (ICP) is the most common liver disorder in pregnancy and has adverse neonatal and maternal outcomes [1]. ICP usually develops in the third trimester of pregnancy and is characterized by elevated serum bile acid levels and pruritus [2]. Although the clinical symptoms of ICP may resolve rapidly after delivery, it confers risk to the fetus, including spontaneous preterm delivery, fetal cardiac dysfunction, and stillbirth [3,4]. The pathogenesis of ICP is multifactorial, and due to the lack of experimental research data related to pathogenesis, the specific etiology is still unclear [5]. The reported incidence of ICP has been estimated to range from 0.3 % to 15 % among different ethnic and geographic groups [6]. Ursodeoxycholic acid (UDCA) is the first-line treatment for ICP to reduce the risk of preterm birth [7].

Noticeably, great interest has been paid to ICP research, and the annual publications on ICP are steadily increasing. Systematic reviews, meta-analyses, and clinical guidelines have provided an in-depth synthesis of specific research questions on ICP in recent years [8,9]. Nevertheless, a study is needed to assess the global research status, hotspots, and trending topics of ICP from a bibliometric perspective.

Bibliometrics is a widely recognized method that enables an objective and comprehensive evaluation of knowledge carriers through statistics and mathematics [10]. The bibliographic analysis gives clinicians and researchers an overview of the research status and reveals the evolution trend. Moreover, bibliometrics is crucial for identifying the research focuses and future trends in a specific field [11]. Therefore, bibliometrics has gained popularity among researchers and scholars since its introduction in 1969 [12]. To our knowledge, no bibliometric studies on ICP have been conducted to date. Therefore, the current study aimed to perform a bibliometric analysis to evaluate the global research status of ICP and identify current research hotspots and trends.

2. Methods

The Chengdu Women's and Children's Central Hospital Ethics Committee waived ethical approval, considering the present study was a bibliometric analysis. Our study was performed by following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline [13] and the reporting method described by Donthu et al. [14] to combine the quantitative and qualitative assessments. The principal goal was to produce a science mapping of how research on ICP has evolved and identify the hotspots, burst terms, and trends. Hotspots and burst terms refer to keywords with strong citation bursts during a particular period. This study employs burst detection to analyze the burst terms and hotspots and reveal the emerging research trends of the ICP.

2.1. Data source and search strategy

We conducted a comprehensive literature search of the Web of Science Core Collection (WoSCC) from January 1, 1970 to December 31, 2023. The WoSCC contains more than 61 million records from around the world and is the most comprehensive database for bibliometric analysis [15]. The combinations of the following entry terms and Medical Subject Headings (MeSH) terms were used: 'Intrahepatic Cholestasis of Pregnancy', 'Pregnancy related cholestasis', 'Recurrent intrahepatic cholestasis of pregnancy', 'Cholestasis, Pregnancy-Related', 'Pregnancy-Related Cholestasis', 'Obstetric Cholestasis', 'Cholestasis, intrahepatic of pregnancy', 'Familial intrahepatic cholestasis of pregnancy', 'Familial recurrent intrahepatic cholestasis of pregnancy', 'ICP'. The **Supplementary file** (*Appendix S1*) showed the detailed search strategy. The publication type was limited to 'Article' and 'Review article', and no other filters were applied. We exported the plain text file records containing cited references and full records for further analysis. Duplicates were excluded automatically with CiteSpace (version 6.2.4). Two researchers (LX and ML) performed the literature search independently to ensure the reliability of the results.

2.2. Exclusion and inclusion criteria

We included studies that met the following criteria: (1) Articles involving intrahepatic cholestasis of pregnancy; (2) Article type: Original article or Review.

Exclusion criteria were as follows: (1) Article type: meeting abstract/proceeding paper, letter/correspondence, editorial, opinion/comment, correction/erratum, retraction, book, patent, dissertation, news; (2) Early Access was also excluded because the specific publication year and date information was missing.

2.3. Bibliometric analysis and visualization

The VOSviewer (Leiden University's Centre for Science and Technology Studies, version 1.6.19) and Citespace (version 6.2.4) software were used to perform the bibliometrics and visualization analysis [16]. The co-occurrence, co-authorship, co-citation, and bibliographic-coupling networks were constructed and visualized by the VOSviewer software tool. The size of the circles indicates the number of publications in the co-authorship analysis network [17]. The co-authorship networks evaluated the collaborative relationships between authors, institutions, and countries/regions [18]. The co-occurrence network shows the frequency of how variables appear together [19]. Three visualizations of the co-occurrence (overlay, network, and density visualization) used keywords that appeared more than five times to identify significant terms in ICP research.

CiteSpace produces several important metrics, with temporal metrics such as citation bursts, structural metrics such as modularity,

centrality, and silhouette score, as well as a combination of both, namely, the sigma metric [20]. This study used CiteSpace to analyze burst terms, citation bursts, timelines of keywords, and dual-map overlay with a 5-year time slice. This study used burst terms and citation bursts to identify keywords that experienced high citation bursts during a particular period. The dual-map overlay was constructed to evaluate the patterns of connections and movements within multiple disciplines [21]. The impact factors of the journals were extracted from the 2022 Journal Citation Reports (data were extracted from WOSCC in plain text files). The publication trends and the sum of times cited were charted annually.

3. Results

3.1. Study selection and descriptive analysis of included studies

The initial search in WoSCC resulted in 1453 articles. Three hundred and sixty-one records were excluded, including 187 meeting abstracts, 31 proceeding papers, 59 letters, 51 editorials, 12 early access, 9 book chapters, 2 news items, 9 corrections and 1 retraction. Finally, a total of 1092 documents were included in the further study (*Supplementary file*, *Appendix S2*).

Of the 1092 documents, 921 (84.34 %) were original, and 171 (15.66 %) were review articles. One thousand forty-three articles were written in English, and the rest were written in non-English. The highest numbers of published articles were in the field of Obstetrics Gynecology (n = 400, 36.63 %), followed by Gastroenterology Hepatology (n = 254, 23.26 %) and Medicine General Internal (n = 128, 11.72 %). The treemap chart of WOS categories is presented in the *Supplementary file*, *Appendix S3*.
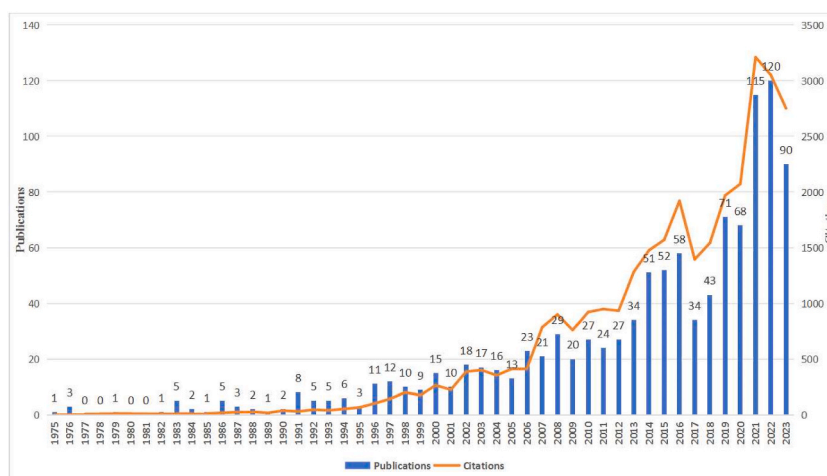
3.2. The trend of global publications and citations

Fig. 1 shows the earliest relevant article published in 1975 and the largest number (n = 118) of articles issued in 2022. Between 2011 and 2022, global publications experienced a gradual upward trend, with occasional years lacking new contributions (e.g., 2017, 2018). A more significant increase in publications occurred in 2021 and 2022. The first citation occurred in 1976, the most cited document (1149 times) is a review article published in 2015 [5], and the year with the most citations was 2021 (n = 3210). The 1092 eligible articles were cited 31,006 times, with an average citation of 28.39.

3.3. Co-authorship analysis

When the two authors co-write an article, they form a co-authorship relationship. We used the VoSviewer to produce the author collaboration map. A total of 4751 authors were involved in ICP research. Ninety-five authors with more than 5 papers formed the 5 clusters (Fig. 2A). The different colors stand for different clusters of authors. Most of the researchers in Cluster 1 (red color) were from the King's College London, University of Gothenburg, and the University of Salamanca. Prof. Hanns-Ulrich Marschall was the central figure in Cluster 1. These researchers collaborated closely with Cluster 3 (blue color), led by Prof. Catherine Williamson. Cluster 3 had the largest node (Catherine Williamson) and the most active coauthors in the field. Cluster 2 (green color), led by Prof. Ulrich Beuers of Amsterdam University Medical Centers, consists of researchers from Friedrich-Alexander-University of Erlangen-Nuremberg and Kaunas University of Medicine. The item density visualization map shows that the yellow color of the points are those productive authors in the ICP area (Fig. 2B). The overlay visualization indicates some authors have a quick growth in the number of papers published recently, such as Caroline Ovadia. Specific information can be obtained from the *Supplementary file*, *Appendix S4*.

The top three authors who published the highest number of studies were Catherine Williamson, Hanns-Ulrich Marschall, and

Fig. 1. The trend of publications and citations regarding ICP over time.
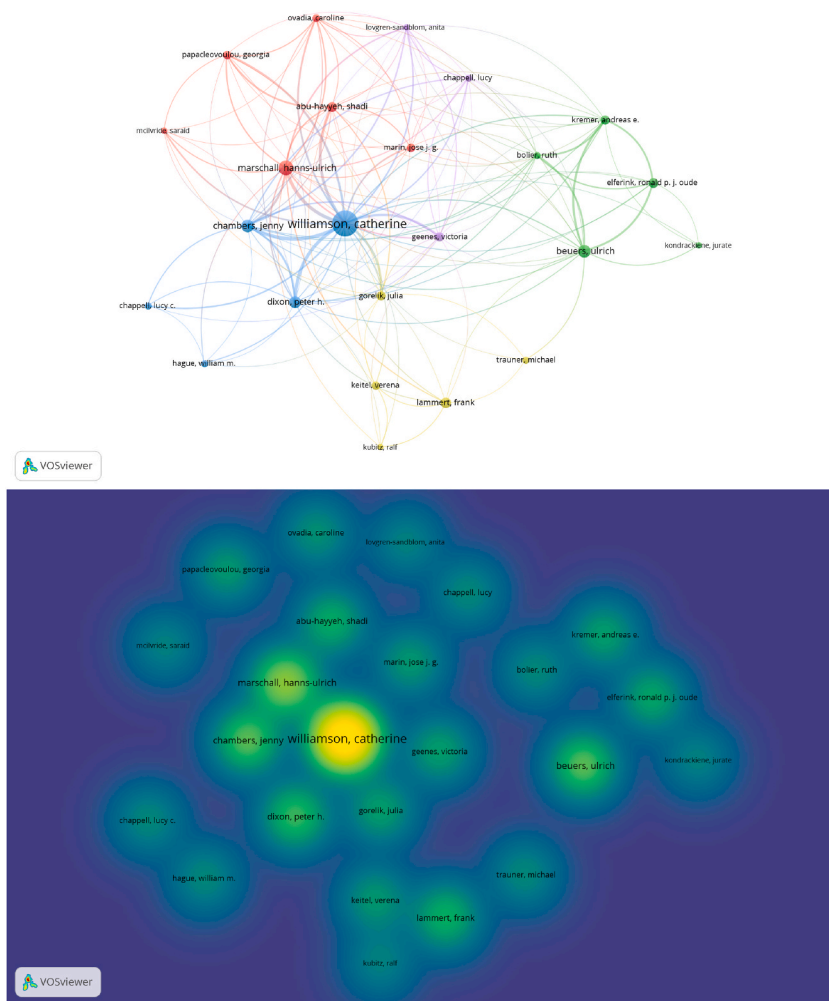
Fig. 2. Fig. 2(A). Network map of co-authorship among authors who published more than 5 articles; Fig. 2(B). Item density visualization of co-authorship among authors who published more than 5 articles.

Humberto Reyes, with 71, 30, and 29 articles, respectively. The above findings are shown in Table 1.

4. Distribution of countries and institutions

4.1. Countries

The publications on ICP were conducted by 1250 institutions in 61 countries/regions. Most of the studies were published by five

Table 1
Top 10 authors in terms of number of documents.

Rank	Author	Affiliation	Documents	Citations	H-index
1	Catherine Williamson	King's College London	71	4464	57
2	Hanns-Ulrich Marschall	University of Gothenburg	30	915	67
3	Humberto Reyes	University of Chile	29	1584	19
4	Yong Shao	The First Affiliated Hospital of Chongqing Medical University	18	311	24
5	Jenny Chambers	Imperial College London	16	994	16
6	Ulrich Beuers	Amsterdam University Medical Centers	16	2730	71
7	José Ribalta	University of Chile	15	1088	15
8	Peter Hendy Dixon	King's College London	14	887	32
9	Frank Lammert	Saarland University Medical Centre	12	1641	70
10	Shadi Abu-Hayyeh	Imperial College London	11	553	16

countries: China (n = 279), the United States (n = 162), the United Kingdom (n = 135), Turkey (n = 83), and Germany (n = 64). The remaining countries/regions had less than 62 publications, showing regional differences in the degree of research on ICP. Table 2 shows the top 15 countries/regions for publications in the ICP area. In contrast, The United Kingdom had the highest citations (TC = 7081), followed by the United States (TC = 5116), Germany (TC = 4217), and Sweden (TC = 3562). Although China had the most publications, the average citations is lower than in other countries/regions.

A total of 30 countries/regions had more than 5 documents formed the collaboration map (Fig. 3A and B). The network visualization map revealed the close collaborations between countries/regions. For example, China collaborates closely with the United States and Denmark. Sweden has active cooperation with United Kingdom and Australia. The overlay visualization map revealed that China, Turkey, and Denmark had increased publications in recent years (Fig. 3C). The international collaborations between countries are shown in Fig. 3D. Strong collaborations between countries/regions lead to thicker connecting lines between nodes. Obviously, China has robust national cooperation with the USA. The United Kingdom has a strong collaboration with Sweden and the Netherlands.

4.2. Institutions

Of the 1278 institutions, 88 had more than 5 publications, which formed the 14 main clusters (***Supplementary file***, *Appendix S5*). The ***Supplementary file***, *Appendix S6* shows the top 10 institutions in terms of publications in the ICP research field. King's College London has produced the highest number of ICP articles (n = 56), followed by the Imperial College of Science, Technology and Medicine (n = 38) and then Sichuan University (n = 34). The ***Supplementary file***, *Appendix S7* summarized the counts and total citations of the top 10 productive institutions in detail. The Imperial College of Science, Technology and Medicine, King's College London, and University of Chile were the most prominent institutions regarding the counts and total citations. Notably, University of Chile published 25 papers with striking citations of 1923.

4.3. Analysis of journals and bibliographic-coupling

The citation analysis of sources revealed that 395 journals were involved in ICP research. Forty-eight journals published at least 5 articles, which formed 4 clusters in the citation visualization map (Fig. 4A). The top five most productive journals were the *Journal of Maternal-Fetal & Neonatal Medicine* (n = 40, 3.66 %), *Hepatology* (n = 32, 2.93 %), *BMC Pregnancy and Childbirth* (n = 24, 2.16 %), *Journal of Hepatology* (n = 22, 2.02 %), and the *American Journal of Obstetrics and Gynecology* (n = 20, 1.78 %). The top 15 productive journals are shown in Table 3. Eight of the top 15 productive journals were cited more than 400 times. *Hepatology* (TC = 3816) was the most cited journal, followed by *Journal of Hepatology* (TC = 3075), *Gastroenterology* (TC = 1498) and *American Journal of Obstetrics and Gynecology* (TC = 1320). Six of the top 15 journals related to ICP have an impact factor greater than 5, and 7 journals were in the Q1 JCR division.

In addition, *Hepatology* (n = 3533), *Gastroenterology* (n = 1831), and *American Journal of Obstetrics and Gynecology* (n = 1744) generated the top 3 co-citations (Fig. 4B). The bibliographic coupling map showed the active journal coupling relationship divided into three clusters (Fig. 4C).

The dual-map overlay showed relationship distribution among journals, with the citing journals cluster on the left and the cited journals cluster on the right. The two main green trajectories were Medicine/Medical/Clinical to Health/Nursing/Medicine (z = 5.96, f = 4861) and Molecular/Biology/Genetic (z = 4.03, f = 3358), respectively (Fig. 4D). The main trajectories showed the article published in Health/Nursing/Medicine and Molecular/Biology/Genetic is mainly cited by literature in Medicine/Medical/Clinical journals.

Table 2
Top 15 countries/regions by number of publications in ICP research.

Rank	Countries/regions	Documents, n(%)	Citations
1	China	279, (25.55)	2925
2	United states	162 (14.84)	5116
3	United Kingdom	135 (12.36)	7081
4	Turkey	83 (7.60)	863
5	Germany	64 (5.86)	4217
6	Italy	61 (5.59)	2001
7	Finland	51 (4.67)	1664
8	France	49 (4.49)	2207
9	Netherlands	46 (4.21)	2786
10	Sweden	45 (4.12)	3562
11	Australia	35 (3.21)	1520
12	Chile	33 (3.02)	2449
13	Poland	31 (2.84)	477
14	India	28 (2.56)	120
15	Switzerland	26 (2.38)	2462
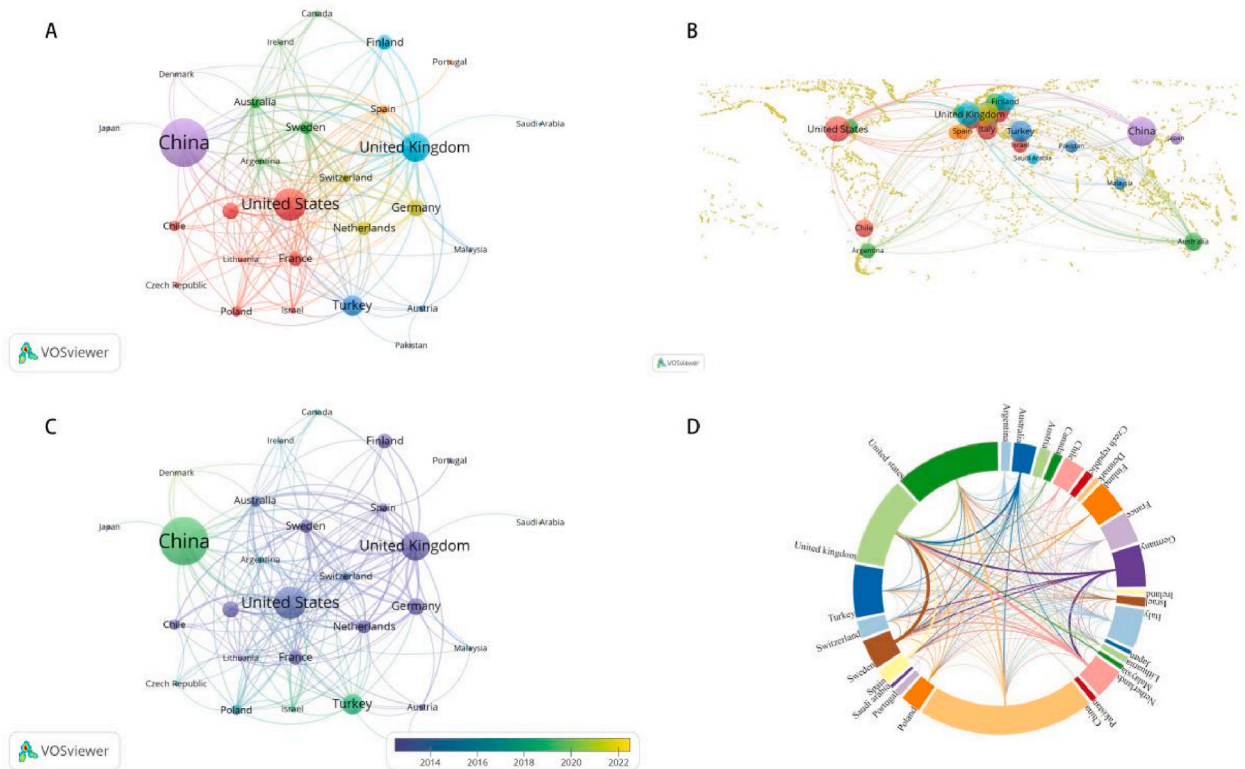
Fig. 3. Fig. 3(A). Network map of co-authorship among countries who had more than 5 articles; Fig. 3(B). Network map of scientific cooperation among countries; Fig. 3(C). Item density visualization of co-authorship among countries who had more than 5 articles; Fig. 3(D). The international collaboration map of ICP research.

4.4. Citation of documents and Co-citation analysis of cited references

The top 10 most cited documents in ICP are shown in the ***Supplementary file***, *Appendix S8*. Of the 10 most-cited articles, four were original articles, and six were reviews. The citation analysis showed that the top 10 documents had over 250 citations. The most cited document (n = 1149) was a clinical practice guideline published in 2009 about managing cholestatic liver diseases [5]. The second most cited document was an original article that assessed the connections between bile acid levels and neonatal complication rates in ICP [22]. The item density of document citations showed the Top 3 cited references were "Beuers, 2009, J HEPATOL", "Glantz, 2004, HEPATOLOGY" and "Paumgartner, 2002, HEPATOLOGY" (***Supplementary file***, *Appendix S9A*). The co-citation analysis showed 4 main thematic research clusters comprising 257 publications co-cited at least 20 times (***Supplementary file***, *Appendix S9B*). Cluster 1 (red color) included references focused on the increased serum bile acid levels and adverse perinatal outcomes. Cluster 2 (green color) included papers published before 2000 and were descriptive studies focused on the perinatal outcomes of ICP. Cluster 3 (blue color) explores the pathogenesis of ICP in the molecular genetic analysis. Cluster 4 (yellow color) is mainly about the diagnosis, management, and drug therapy of ICP.

4.5. Co-occurrence of keywords and burst keyword

A total of 71 keywords, which had a minimum number of 20 co-occurrences, formed the network visualization (Fig. 5A). The top 3 co-occurrence keywords were "intrahepatic cholestasis of pregnancy" (n = 905), "ursodeoxycholic acid" (n = 254), and "obstetric cholestasis" (n = 201). The co-citation of keywords identified five clusters: cluster #0 obstetric cholestasis, cluster #1 intrahepatic cholestasis of pregnancy, cluster #2 mdr3 gene, cluster #3 bile acid, cluster #4 ursodeoxycholic acid (Fig. 5B). The silhouette suggested that the five clusters were highly credible (S1 = 0.989, S2 = 0.97, S3 = 0.926, S4 = 0.92, and S5 = 0.918). These 5 clusters focus on the risk factors, diagnosis, treatment, outcomes, and mechanisms of ICP. As shown in Fig. 5B and timeline map (Fig. 5C), the Cluster #0 ranged from 1994 to 2010 and is related to the management of obstetric cholestasis. The primary keywords were "intrahepatic cholestasis", "pregnancy" and "management". Cluster #1 ranged from 1994 to 2019 and is mainly about the risk factors, diagnosis and outcomes of ICP. The primary keywords were "intrahepatic cholestasis of pregnancy", "risk", "diagnosis" and "outcomes". Cluster #2 explores the mechanisms of ICP in a molecular level. The primary keywords were "mdr3 gene", "primary biliary cirrhosi" and "familial intrahepatic cholestasis". Cluster #3 is related to the etiology of ICP. The primary keywords were "bile acids", "progesterone metabolites", and "liver disease". Cluster #4 ranged from 1995 to 2009 and focused on the treatment of ICP. The primary keywords were
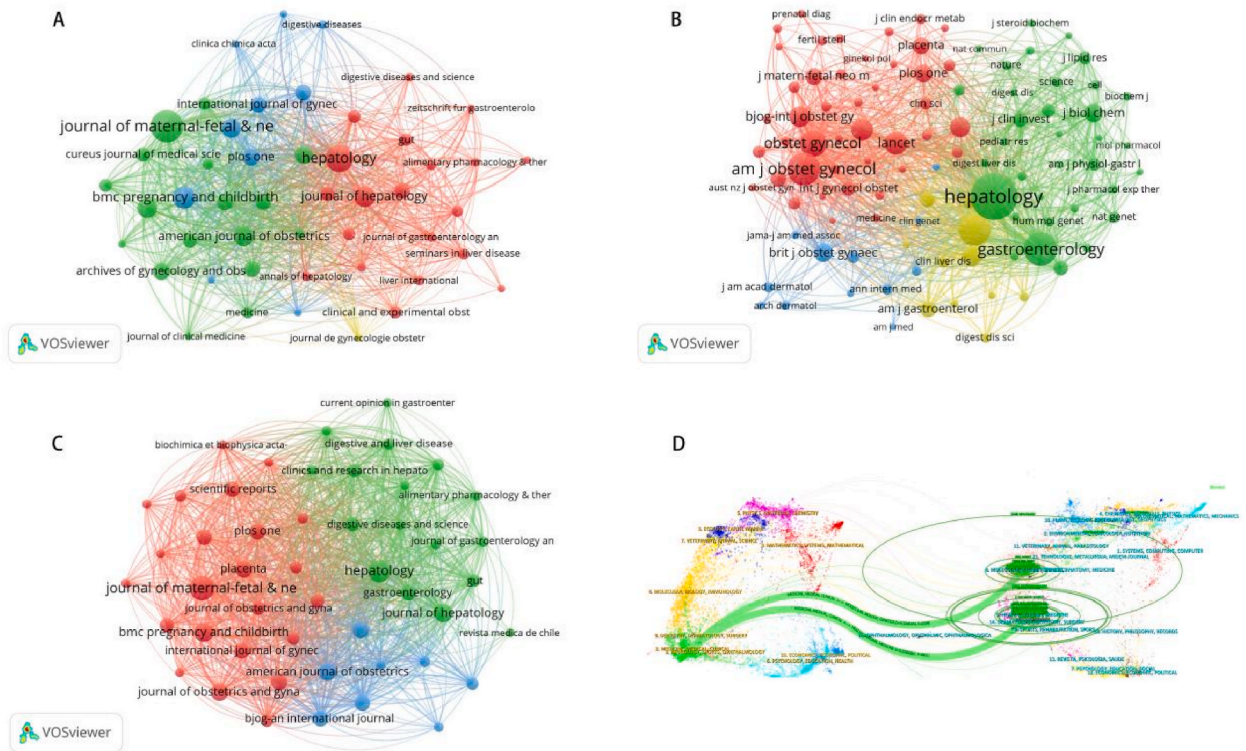
Fig. 4. Fig. 4(A). Network map of citation among journals who had more than 5 articles; Fig. 4(B). Network map of co-citation among journals who had more than 5 articles; Fig. 4(C). Bibliographic-coupling of sources; Fig. 4(D). The dual-map overlay of journals related to ICP research.

Table 3
Top 15 journals by number of publications in ICP research.

Rank	Journals	Documents, n(%)	Citations	Average citations	IF-2022, JCR Quartile
1	Journal of Maternal-Fetal & Neonatal Medicine	40 (3.66 %)	430	10.75	1.8, Q3
2	Hepatology	32 (2.93 %)	3816	119.25	13.5, Q1
3	BMC Pregnancy and Childbirth	24 (2.16 %)	347	14.46	3.1, Q2
4	Journal of Hepatology	22 (2.02 %)	3075	139.77	25.7, Q1
5	American Journal of Obstetrics and Gynecology	20 (1.78 %)	1320	66.00	9.8, Q1
6	Journal of Obstetrics and Gynaecology Research	20 (1.78 %)	146	7.30	1.6, Q4
7	Placenta	19 (1.74 %)	389	20.47	3.8, Q2
8	Acta Obstetricia et Gynecologica Scandinavica	18 (1.65 %)	230	12.78	4.3, Q1
9	Archives of Gynecology and Obstetrics	16 (1.47 %)	246	15.38	2.6, Q3
10	BJOG-an international journal of obstetrics and gynaecology	15 (1.37 %)	876	58.40	5.8, Q1
11	Ginekologia Polska	15 (1.37 %)	60	4	1.3, Q4
12	Obstetrics and Gynecology	15 (1.37 %)	729	48.60	7.2, Q1
13	Plos One	15 (1.37 %)	521	34.73	3.7, Q2
14	Scientific Reports	15 (1.37 %)	343	22.87	4.6, Q2
15	Gastroenterology	14 (1.28 %)	1498	107.00	29.4, Q1

IF=Impact Factor, JCR = Journal Citation Reports.

"ursodeoxycholic acid" and "randomized controlled trial".

To further reflect the hotspots and trends in ICP research, we performed keyword citation bursts using Citespace (Fig. 5D). Intrahepatic cholestasis of pregnancy (31.92) had the highest burst strength, followed by Outcomes (19.9) and risk (13.77). In addition, "familial intrahepatic cholestasis" and "mdr3 gene" had the longest duration of emergence, with a span of 13 years. While keywords such as "risk" (2019–2023), "outcomes" (2020–2023), "inflammation" (2017–2023) and "bile acid" (2020–2023), have been used more recently, indicating that these keywords have gained more attention to become research trends in the future.

5. Discussion

In the present study, we performed a bibliometric analysis to evaluate the global research status of ICP and identify the research

Fig. 5. Fig. 5(A). Co-occurrence of keywords; Fig. 5(B). Clusters of keywords; Fig. 5(C). Timeline of keywords; Fig. 5(D). Citation bursts analysis of keywords.

hotspots, burst citations, and development trends. To our knowledge, this is the first bibliometric analysis to report the publication landscape, identify the main contributors, and assess the collaboration on the ICP topic using the WoSCC database.

The annual publications of a topic can reflect the development of research in a particular field. Our results show that research on the ICP area has developed and gradually increased over the past 48 years. According to the annual publications, we can divide the growth trend of ICP-related research into three periods. The annual publications before 1995 were initially published in single digits, indicating that the research on ICP is scarce. From 1996 to 2010, research in this field was still in its early stages, with an average annual publication of 16.8 papers. From 2011 to 2022, the annual publications have grown rapidly, with an average annual publication of 58.2 papers, indicating that the research on ICP is explosive and that related research has gained more attention. The number of published papers accounted for 64 % of all publications in the last decade. The future trend looks promising and blossoming, with a significant surge in interest over the past three years (2021–2023). One possible explanation for the growing interest is the rising incidences of ICP during the last three decades [23,24].

Among the top 10 authors, Catherine Williamson from the Department of Women and Children's Health, King's College London, has published extensive papers related to ICP. Catherine Williamson is a leading clinical researcher in maternal medicine and mainly focus on the maternal and fetal etiology, and outcomes of a common liver disease of pregnant women, ICP [25]. In 2005, Catherine Williamson demonstrated ATP8B1 gene mutations in ICP [26]. In 2007, she identified 4 novel heterozygous FXR variants in ICP [27]. More recently, in 2021, she published a review in the Lancet, finding the risk of stillbirth is increased in women with ICP and singleton pregnancies when serum bile acids concentrations are 100 μmol/L or more [28]. Hanns-Ulrich Marschall is the second most productive author from the University of Gothenburg. With expertise in liver diseases, Marschall has made significant contributions to the field of ICP. Furthermore, the top 10 productive authors had robust collaboration with each other. Among both top 10 most prolific authors and co-cited authors, Catherine Williamson, Hanns-Ulrich Marschall, Jenny Chambers, and Peter Hendy Dixon had high total link strength with other authors. Strengthening cooperation with these top scholars is a good choice for research.

The development of ICP research has been uneven among countries/regions. China, the USA, and the UK are major countries conducting research on ICP. The top 3 countries published 560 articles, accounting for over half of the total publications. In addition, most of the top 15 productive countries are high-income countries, which may be related to the country's degree of economic development and funding support. Moreover, the UK led international collaborations, with UK-centered international partnerships covering all the positions among the top 10 countries in terms of publications. Four of the top 10 productive institutions are located in China, followed by UK (n = 2), Sweden (n = 2), Chile (n = 1), and the Netherlands (n = 1). We noticed the USA, which ranked 2nd in terms of the number of publications, had no institution in the top 10. It is worth noting Chile had a good performance on the ICP research considering the epidemiological relevance [29]. Although some countries have cooperative relations, the breadth and intensity of cooperation between institutions are not ideal. For example, there is only a small amount of collaboration between institutions in China. Furthermore, the lack of literature on ICP in Africa could be due to the low incidence rate in this area [30].

Journal analysis can help find the core journals in this field [31]. Of the top 15 journals by number of publications, Q1 JCR division journals account for 46.7 %, and 6 journals have an impact factor greater than 5. The publishers of the top 15 journals are all from developed countries, which make the high productivity sense. Furthermore, although China contributed significantly to ICP research, none of the top 10 ranked journals were Asian publishers. There is a need to establish and develop journals with international influence in Asia. Most of the top 15 journals were in the "Obstetrics & Gynecology" and "Gastroenterology & Hepatology" category, and only two journals were in the "Multidisciplinary Sciences" category. Most ICP studies are published in clinically related journals, indicating that more effort is needed to improve basic research. The dual-map overlay showed similar results, the articles published in Molecular/Biology/Genetic are mainly cited by literature in Medicine/Medical/Clinical. The most productive journal was *Journal of Maternal-Fetal & Neonatal Medicine*. *Hepatology*, *American Journal of Obstetrics and Gynecology*, and *Journal of Hepatology* were among the most prominent journals regarding the citations and co-citations, as articles with high citations are often published in journals with a higher impact factor and tend to frequently co-cite with each other.

The total citations could be one of the reliable indicators to evaluate the influence of a scholarly publication [32]. Highly cited publications may reflect the essential topics in the study field. The ten most cited publications identified in the ICP research area were published from 1999 to 2014, with six reviews and four articles. Only 4 studies directly related to ICP were in the top 10 cited references, and the remaining 6 were about cholestatic liver disease or chronic pregnancy disease. The most cited publication was a clinical guideline for managing of cholestatic liver diseases (including ICP) [5]. The second-most cited reference was Glantz et al., who explored the relationships between bile acid levels and fetal complication rates in ICP [22]. This study emphasized the relationships between the increased fetal complications risk and high bile acid levels (> or = 40 μmol/L). The third cited paper, authored by Paumgartner et al., summarizes the therapeutic mechanisms of UDCA in cholestatic liver disease [33]. In general, the top 10 cited references mainly focus on the pathogenesis, diagnosis, treatment, and perinatal outcomes of ICP, thereby laying a solid foundation for the field. Interestingly, the top 3 co-cited references happen to be the top 3 cited studies. Most of the top 10 cited references were based on international collaborations, suggesting that extensive international collaborations will be conducive to the development of the field and the overall improvement of research level.

Keyword co-occurrence shows the most prominent keywords in ICP research published in the WoSCC database. The top 3 occurring words were "intrahepatic cholestasis of pregnancy", "ursodeoxycholic acid", and "obstetric cholestasis", which is most common in titles, abstracts, and keywords on research centered on ICP. Through the analysis of keyword clustering, we found that the risk factors, treatment, perinatal outcomes, and underlying mechanisms of ICP are the primary focus of the field. Timeline map showed developmental pathways in ICP research. Papers published before 2000 were mainly descriptive studies (e.g., case series, case-control, cross-sectional), focusing on maternal and fetal outcomes. Those papers formed the cluster #0 obstetric cholestasis and cluster #1 intrahepatic cholestasis of pregnancy, related to epidemiology, diagnosis, management, and perinatal outcomes of ICP [34,35]. From 1995 to 2009, many clinical trials were performed to investigate the optimal drug therapy for ICP [36,37]. Those papers focus on the treatment of ICP formed the Cluster #4 ursodeoxycholic acid. From 2004 to 2019, several population-based studies were carried out to evaluate the increased bile acid levels and adverse pregnancy outcomes [4,22,38]. Those papers related to the etiology of ICP formed the Cluster #3 bile acids. Cluster #2 MDR 3 genes included studies investigating the genetic etiology of ICP, mainly about the genetic predisposition, multidrug resistance 3 gene (MDR3) variation, ABCB11 mutations, and bile salt export pump (BSEP) [39,40].

Keywords with citation bursts represent emerging topics within a specific research field, as researchers have frequently cited these references in recent years [41]. According to the keyword citation bursts, "intrahepatic cholestasis of pregnancy" (31.92), "outcomes" (19.9) and "risk" (13.77) had the highest burst strength, indicating that perinatal outcomes and risk factors for developing ICP or adverse outcomes were hotspots in the field. Meanwhile, "risk" (2019–2023), "outcomes" (2020–2023), "inflammation" (2017–2023), and "bile acid" (2020–2023) have been widely discussed recently and will probably be the future trends. Collectively, the study of ICP covers a wide range of subjects, including exploring the mechanisms involved, evaluating the risk factors, developing treatments, and improving the outcomes.

6. Limitations

Our study has several limitations. First, only articles and reviews indexed in the WoSCC database were included, which caused potential biases. Some documents and journals are not indexed in the WoSCC database. However, this will not have a substantial impact on overall trends, considering that the WoSCC is the most widely used database for scientometric analysis and covers the vast majority of studies. Second, early access articles were not included because the specific publication year and date information was missing. This process may cause the omission of some information. Third, citation or co-citation analysis focuses only on highly cited publications and ignores recent publications. Nevertheless, the present study will help researchers understand the global research status, hot spots, and trends of ICP and identify areas where further research is still needed.

7. Conclusions

In summary, our study provided a comprehensive overview of the ICP-related research from a bibliometrics perspective. The annual publications increasing significantly in recent years indicate research on ICP has received growing attention. The present study identified the most productive researchers, institutions, and journals involved in ICP research worldwide. Strengthening the cooperation among different countries/regions will contribute to the further development of this field. Our study summarizes the global research status and identifies hotspots, collaborative networks, and trends, which will provide new insights and guidance for further research in the ICP field.

Ethics approval and consent to participate

The Chengdu Women's and Children's Central Hospital Ethics Committee waived ethical approval, as this was a pure bibliometric study.

Consent for publication

Not applicable.

Data availability statement

The data associated with this study have not been deposited into a publicly available repository. The data associated with this study will be made available on request.

CRediT authorship contribution statement

Jianghui Cai: Writing – review & editing, Writing – original draft. **Mi Tang:** Writing – review & editing, Writing – original draft, Funding acquisition. **Yi Deng:** Writing – review & editing, Writing – original draft. **Liling Xiong:** Resources, Funding acquisition, Data curation. **Mengqiu Luo:** Resources, Data curation. **Cheng Huang:** Visualization, Software. **Li Yang:** Visualization, Software. **Xiao Yang:** Writing – review & editing, Supervision, Funding acquisition, Conceptualization.

Declaration of competing interest

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e33940.

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