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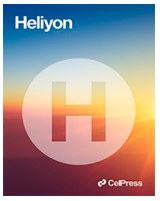

Research article

Research trends on traditional Chinese medicine and acute pancreatitis: A bibliometric analysis from 2007 to mid-2023

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A R T I C L E I N F O

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A B S T R A C T

Background: Traditional Chinese Medicine (TCM) is a unique medical system of historic significance, holding substantial influence within China and beyond. In recent years, the efficacy of TCM in treating acute pancreatitis has been substantiated. Despite over two decades of development in this domain, a bibliometric analysis illustrating TCM's role in acute pancreatitis remains scarce. Objective: This study aims to conduct a comprehensive analysis of findings in the field of acute pancreatitis and TCM using machine learning and text-analyzing methodologies. The intent is to provide scientific and intuitive support to researchers and clinicians. Methods: We searched the Web of Science Core Collection database for publications and related literature from 2007 to mid-2023. Tools such as Excel, Citespace V, and Vosviewer were utilized for bibliometric analysis. That included assessing published and cited counts, co-authorship mapping, co-citation analysis, burst detection, and keyword analysis. Results: The study revealed a fluctuating growth trend in the number of publications and citations since 2007. As many as 147 institutions from 13 countries, with a total of 756 authors, have published 202 papers in 76 academic journals. Sichuan University in China and Tang Wenfu have been recognized as the most influential national institution and author. The most frequently published journal is "Pancreas", while the most cited is the "World Journal of Gastroenterology". Commonly used single herbs in this field include Baicalin, Emodin, Rhubarb, and Salvia miltiorrhizae. Frequently used herbal formulations include Da chengqi decoction, Chaiqin chengqi decoction, and Qing yi decoction. Current research hotspots primarily surround concepts like hmgb1, nf-kappab, nfr2, oxidative stress, exosomes, nlrp3, pyroptosis, etc. Potential future research themes could relate to pharmacology, reducing hmgb1, inflammatory response, cell activation, Qing Yi-decoction, etc. This review holds significant guiding importance for clinical and scientific research into TCM treatment for acute pancreatitis in the future.

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1. Introduction

Traditional Chinese Medicine (TCM) is a time-honored medical system that has been widely used in the field of health across many countries in Asia. It emphasizes a holistic perspective, preventive awareness, and the recognition of individual differences in the treatment process. TCM aims to achieve balance between the individual and the environment, relying on natural medicines or specialized instruments and the body's ability to self-heal, in order to maintain overall health [1]. TCM encompasses treatment methods such as acupuncture, herbal medicine, cupping, massage, and qigong, which are widely used for disease prevention and treatment. During the COVID-19 pandemic, TCM was combined with conventional medicine in Wuhan hospitals, and it showed promising results [2]. TCM has also been extensively studied for its anti-tumor effects, with herbs like Danshen and Huangqi demonstrating anti-cancer properties [3]. Research has explored the potential of TCM in treating cardiovascular diseases, diabetes, and immune system disorders [4]. Acupuncture has been proven effective in managing chronic pain and migraines [5]. Inspired by TCM, Tu Youyou discovered artemisinin as an active compound for anti-malarial treatment, leading to significant progress in malaria control [6]. TCM's effectiveness, safety, and holistic approach have made it popular globally [7]. In recent years, more countries have recognized TCM as a complementary or alternative therapeutic method [8]. Current research focuses on safety, efficacy, and mechanisms of action [9]. Comparative trials have shown that TCM has fewer side effects compared to Western medicine in treating rheumatoid arthritis [10]. There is also interesting research into using Chinese herbal medicine to alleviate depression symptoms [11]. Along with various internal diseases, TCM has been widely utilized in the management of acute pancreatitis.

Acute pancreatitis is a severe inflammatory disease caused by factors like gallstones, alcohol, and medication abuse [12]. In this condition, the digestive enzymes produced by the pancreas become activated within the organ, leading to damage to the organ itself and affecting multiple organs, resulting in serious complications and potentially life-threatening situations [13]. Symptoms typically include intense upper abdominal pain that may radiate to the back, as well as nausea, vomiting, fever, accelerated heart rate, and abdominal distension. The mortality rate ranges from 1 to 5%, with increasing incidence in Europe and America [14]. Globally, the incidence is around 30–40 cases per 100,000 people annually [15]. The treatment cost for acute pancreatitis is high, averaging at 19, 778 euros, especially for severe cases requiring prolonged intensive care unit stays [16]. Recurrent acute pancreatitis increases the risk of developing chronic pancreatitis, and survivors experience reduced long-term quality of life [17–19]. Core events in acute pancreatitis pathogenesis include pathological calcium signaling, mitochondrial dysfunction, premature activation of proteolytic enzymes, endoplasmic reticulum stress, impaired unfolded protein response, and impaired autophagy [20–22,24–27[20–22,24–27, 23]. Inhibition of nuclear factor-kappaB activation, NLRP3 inhibition, restoration of mitochondrial and/or autophagic function, ORAI1 inhibition, inhibition of the RIP1-RIP3 pathway, TNF-alpha inhibition, autophagy pathway inhibition, TLR4 expression suppression, and oxidative stress inhibition have emerged as potential targets or pathways for acute pancreatitis treatment [28–35]. Current treatments for acute pancreatitis include fluid resuscitation, infection control, pain management, and nutritional support [36]. Chinese herbal medicine has shown positive impact in improving inflammation, alleviating complications, shortening disease duration, relieving pain, and improving survival rates in acute pancreatitis [37–39]. The use of TCM in acute pancreatitis has gained significant attention. The specific targets or pathways of TCM in managing acute pancreatitis are gradually being elucidated. With the expansion of clinical application and the rapid development of biomedical technology, it is important to comprehensively summarize and consolidate the research and application of Chinese medicine in acute pancreatitis treatment to better understand the current status and trends of research. Previous studies utilizing bibliometric analyses have covered various aspects of acute pancreatitis, including etiology, pathogenesis, diagnosis, treatment methods (including both Western medicine and traditional Chinese medicine), and potential complications. However, there has been a lack of detailed bibliometric analysis specifically focused on the application of traditional Chinese medicine (TCM) in the context of acute pancreatitis. This lack includes both quantitative and qualitative studies, as well as a limited understanding of key research topics, leading contributors, and future directions in this specific area. In contrast, this article concentrates on the application of TCM in the treatment of acute pancreatitis, providing a narrower scope that allows for a more in-depth understanding of specific research trends and hotspots within this particular field of medical study. By comprehensively summarizing and consolidating the existing research, this study aims to offer valuable insights and guidance to both clinicians and researchers. Furthermore, it seeks to explore the potential benefits of combining traditional Chinese medicine with modern biomedical approaches in the treatment of acute pancreatitis.

Bibliometric analysis is a powerful interdisciplinary tool that utilizes mathematical and statistical methods to evaluate and monitor the progress of specific disciplines [40]. It provides an objective assessment of research quality, identification of research trends and hotspots, and ranking of academic communities and individuals, making it an important tool for researchers, policy makers, and institutions [41]. This study aims to conduct a 15-year longitudinal observation (2007–2023) of the research and application of Chinese medicine in acute pancreatitis treatment. By analyzing authorship, publications, keywords, and citation counts, research trends in specific fields can be identified. This can assist researchers and policy makers in identifying emerging research areas and allocating resources accordingly [42]. Assessing research productivity through citation analysis can evaluate the impact of research in specific areas, helping researchers and institutions evaluate the quality and significance of individuals and departments, and make informed decisions on collaboration, funding, and recruitment [43]. By analyzing country, institution, and co-authorship networks, potential collaborations can be identified, promoting research in specific fields [44]. Analyzing publication and citation counts can evaluate research performance, assisting researchers and institutions in making informed decisions on promotion, tenure, and funding [45]. By identifying research gaps and strengths in a specific field, evidence-based decision-making can be facilitated, assisting policy makers in determining funding priorities, research agendas, and regulatory policies [46].

2. Materials and methods

2.1. Data collection

We utilized the Expanded Science Citation Index Database (WoS) to obtain literature data. We retrieved and downloaded all documents published between 2007 and 2023 from the WoS Core Collection (WoSCC) database on May 10, 2023, to minimize variations in citation numbers and studies. The search keywords employed were: TOPICS=(Chinese Traditional medicine or Chinese Traditional Medicine or Chinese herbal or Chinese Traditional herbal or TCM or Chinese Decoction or Chinese Medicine or Traditional Chinese Herbal Medicine) AND TOPICS=(Acute Pancreatitis or Acute pancreatic inflammation or Pancreatic acute inflammation or Severe acute pancreatitis). We restricted the language to English and included only research articles and reviews. To ensure objectivity, two authors (LWP and GW) independently assessed study quality, extracted data carefully, and compared the findings to avoid bias. In case of any discrepancies, a consensus decision was reached through the involvement of a third investigator (ZX). The data was saved and stored in download_txt format. The titles, abstracts, and keywords of the 294 studies were manually screened and filtered. Where necessary, full texts were further reviewed. We excluded online publications or retracted papers, as well as letters, books, unrelated articles, studies with incomplete or inconsistent data, and those specifically addressing chronic pancreatitis. The articles will be included if they meet the following criteria: (1) Focusing on traditional Chinese medicine and acute pancreatitis; (2) Published in English and indexed in the Web of Science Core Collection; (3) Studying human populations, mice, or rats with interventions using traditional Chinese medicine; (4) Published between 2007 and 2023. The following articles will be excluded if they fall into the following categories: (1) Irrelevant types such as online publications, retractions, letters, or books; (2) Articles that are not related to the research topic; (3) Studies with incomplete or unconsolidated data; (4) Studies specifically targeting chronic pancreatitis , Through the above steps, we finally identified 202 suitable studies.

2.2. Data acquisition

Two authors conducted an independent analysis of a text file containing 202 studies on Traditional Chinese Medicine (TCM) and acute pancreatitis. The following metrics were extracted: publication count, citation frequency, institutions, countries, authors, journals, references, keywords, journal impact factors for the year 2021, and H-index. The files were imported into VOSviewer and Citespace for co-authorship, co-occurrence, and co-citation analysis. Excel was used for calculating publication count, citation frequency, journal impact factors, and H-index. The total number of publications was measured by the metric (NP) to assess productivity. The total citation count excluding self-citations was represented as (NC) to denote impact, while (AC) was used to indicate the average citations per year. The H-index was employed to evaluate academic contributions and predict future scientific achievements.

2.3. Data analysis

VOSviewer (version 1.6.19) , was used to create, visualize and explore a collaborative network map of institutions , countries, authors , journals, and keywords, with each point representing a country/region, author , journals,or keywords the number of publications determining the size of the point, and the number of collaborations determining the strength of the links between the points. CiteSpace (version 6.2. R2) is a visual analysis of temporal trends of keywords , references. R (version 4.3.2) is used to plot a Lotka plot and a Zipf's graph.

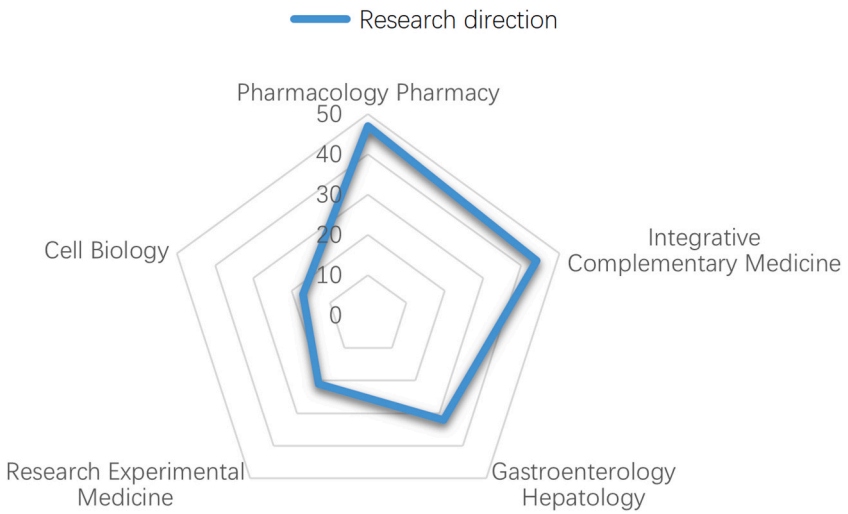

Fig. 1. Title:The primary research directions in this field.

3. Result

3.1. Research direction

In this study, we identified five key areas of research relating to Traditional Chinese Medicine (TCM) and Acute Pancreatitis. Fig. 1 was constructed using the search results from the Web of Science. By employing the "Analysis Results" feature, we were able to classify the sources of the documents and their associated fields. These specific fields include Pharmacology & Pharmacy, Integrative & Complementary Medicine, Gastroenterology & Hepatology, Research & Experimental Medicine, as well as Cell Biology. As shown in Fig. 1, pharmacological investigations of TCM are the most outstanding area of study. TCM is also frequently utilized as an alternative or complementary treatment for pancreatitis. The digestive system plays a critical part in these lines of research. Furthermore, experimental and cell studies are crucial components of the research in this particular area.

3.2. General data

The total NP and NC within a specific time period can objectively and quantitatively reflect the overall development trend of a research field. Based on the defined search terms, a total of 202 articles were screened, consisting of 165 original articles (81.68%) and 37 reviews (18.31%). These 202 publications received a total of 1409 citations without self-citations, with an average of 93 citations per year and an H-index of 23. Using Price's Law, we calculated the percentage fit of the exponential growth curve for publications from 2007 to 2022, resulting in an R^2 value of 0.532. The relatively low R^2 could suggest potential uncertainty or complexity within this specific area. Other factors might also be influencing the output of publications. Although the R^2 value is not high, a certain growth trend can still be observed. As shown in Fig. 2, the number of publications has generally continued to increase from 2007 to 2022, although the growth trend is not very pronounced. After publishing only 2 articles in 2007, the publication count gradually increased with occasional decreases, eventually stabilizing after 2019. It peaked in 2022 with 25 publications. The 2023 decline is likely due to publications that have not yet been included in the year, and our study only counts publications through May 2023, not the actual decline in publications. The total citation count of research on TCM and AP has shown fluctuations over the years (Fig. 2). The years 2017 and 2019 were notably peak years with high-cited article outputs. Considering that recently published articles require time to accumulate citations, the total citation count may continue to grow. Overall, both the publication count and citation count in the field of TCM and AP have shown an upward trend, indicating the increasing research attention and the continuous rise in the research value of TCM in the treatment of AP.

3.3. Citation and cocitation

Table 1 presents the top ten highly cited papers in the field, along with detailed information about the authors, journals, citation counts, and publication years."Effect of Emodin on Endoplasmic Reticulum Stress in Rats with Severe Acute Pancreatitis" by Wu, Li. Published in INFLAMMATION, cited 48 times, This study demonstrated through animal experiments that emodin can alleviate pancreatic injury and suppress inflammatory response by inhibiting the expression of the ER stress sensor IRE1α and its downstream molecules [47]."Up-regulation of Toll-like receptor 4 was suppressed by emodin and baicalin in the setting of acute pancreatitis" by Li, Zongfang. Published in BIOMEDICINE & PHARMACOTHERAPY, cited 45 times , This study concludes that the combined use of emodin and baicalin can reduce pancreatic injury, alleviate lung injury, and suppress toll-like receptor 4 (TLR4) expression in acute

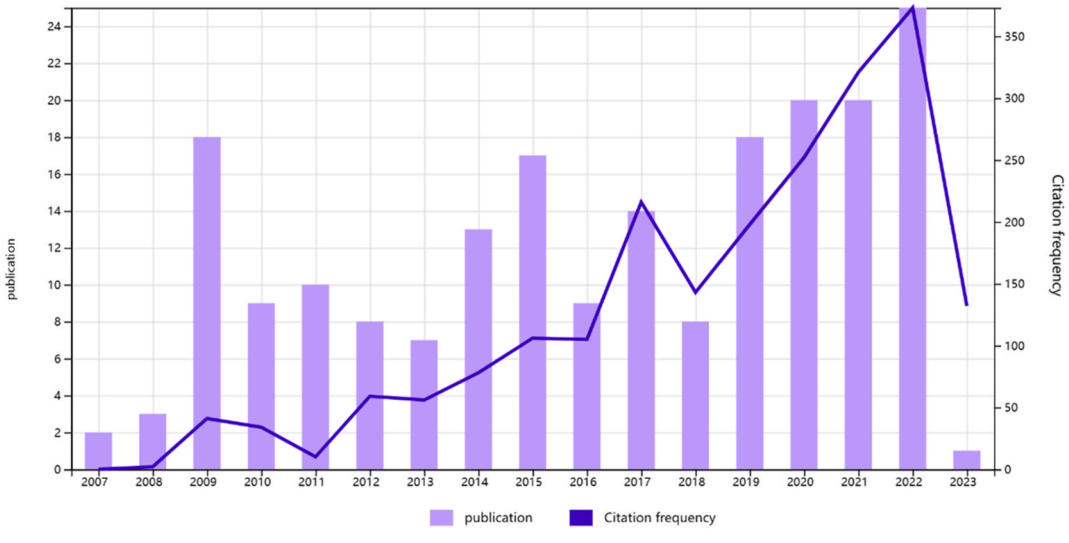

Fig. 2. Title:The number or publications and citations per year.

Table 1
The top 10 most cited articles in the field of Chinese traditional medicine and acute pancreatitis research from 2007 to 2023.

Rank	Author	Journal	Title	Citations	Year
1	Wu, Li	INFLAMMATION	Effect of Emodin on Endoplasmic Reticulum Stress in Rats with Severe Acute Pancreatitis	48	2013
2	Li, Zongfang	BIOMEDICINE& PHARMACOTHERAPY	Up-regulation of Toll-like receptor 4 was suppressed by emodin and baicalin in the setting of acute pancreatitis	45	2009
3	Ma, Ran	BIOMEDICINE &PHARMACOTHERAPY	Calycosin alleviates cerulein-induced acute pancreatitis by inhibiting the inflammatory response and oxidative stress via the p38 MAPK and NF-kappa B signal pathways in mice	43	2018
4	Yao, Wei-Yan	MOLECULAR MEDICINE REPORTS	Emodin has a protective effect in cases of severe acute pancreatitis via inhibition of nuclear factor-kappa B activation resulting in antioxidation	38	2015
5	Zhang, Min-Jie	WORLD JOURNAL OF GASTROENTEROLOGY	Treatment of abdominal compartment syndrome in severe acute pancreatitis patients with traditional Chinese medicine	38	2008
6	Xiang, Hong	FRONTIERS IN PHARMACOLOGY	Chinese Herbal Medicines Attenuate Acute Pancreatitis: Pharmacological Activities and Mechanisms	36	2017
7	Gao, Zhenming	DRUG DESIGN DEVELOPMENT AND THERAPY	Emodin Protects Against Acute Pancreatitis-Associated Lung Injury by Inhibiting NLPR3 Inflammasome Activation via Nrf2/HO-1 Signaling	35	2020
8	Liu, Xiao	JOURNAL OF ETHNOPHARMACOLOGY	Investigation on the spectrum-effect relationships of Da-Huang-Fu-Zi-Tang in rats by UHPLC-ESI-Q-TOF-MS method	34	2014
9	Zhang, Jing-Wen	WORLD JOURNAL OF GASTROENTEROLOGY	Therapeutic effect of Qingyi decoction in severe acute pancreatitis-induced intestinal barrier injury	33	2015
10	Chen, Zhuoan	CELLULAR PHYSIOLOGY AND BIOCHEMISTRY	Dachengqi Decoction Attenuates Inflammatory Response via Inhibiting HMGB1 Mediated NF-kappa B and P38 MAPK Signaling Pathways in Severe Acute Pancreatitis	30	2015

pancreatitis (AP) [48]."Calycosin alleviates cerulein-induced acute pancreatitis by inhibiting the inflammatory response and oxidative stress via the p38 MAPK and NF-kappa B signal pathways in mice" by Ma, Ran. Published in BIOMEDICINE & PHARMACOTHERAPY, cited 43 times , This study indicates, based on animal experiments and biochemical analysis, that an isoflavone derived from Radix astragali may have anti-inflammatory and antioxidant effects through the p38 MAPK and NF-κB signaling pathways, potentially preventing acute pancreatitis [49]. These studies investigate the effects of emodin, baicalin, and calycosin on inflammation, oxidative stress, and other molecular pathways related to pancreatitis. They contribute significantly to our understanding of how traditional

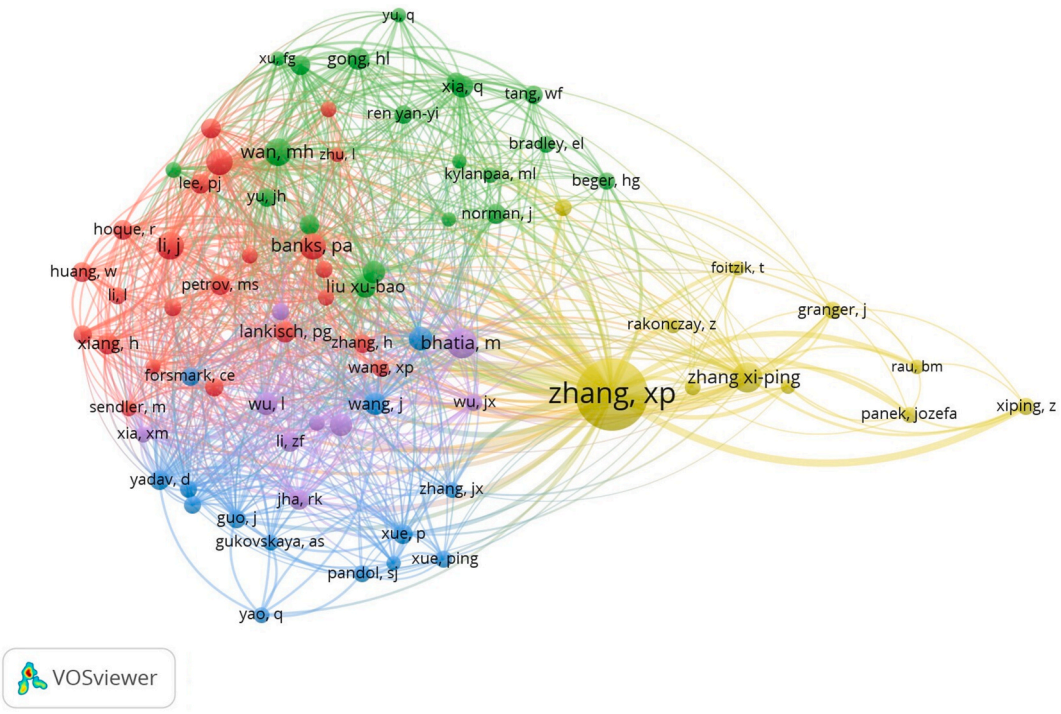

Fig. 3. Title:The co-citation analysis of authors in the field.
Description:Dots represent authors, with larger dots indicating a high number of co-citations or association strength, clusters are marked using different colors and links represent cooperation between authors. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

Chinese medicine may provide potential treatment options for acute pancreatitis.In author co-citation analysis, 77 authors met the threshold, with the minimum citation count for authors set at 10. Fig. 3 illustrates 5 clusters based on the co-citation relationships among authors, with different colors representing the different associations. Each cluster represents a collaborative network of authors who are closely co-cited. In this Figure, Zhang Xi Ping stands out as the most strongly related author within the yellow cluster and also has the highest number of citations among all the authors in that cluster. Similarly, within the purple, green, red, and blue clusters, Mohit Bhatia, Wan Mei Hua, Li Juan, and Wang Jia respectively emerge as the authors with the highest relatedness. This suggests their roles as core authors in the field and their academic influence. These insights can be valuable for selecting research partners, allocating research resources, understanding the direction of disciplinary development, and identifying research hotspots.

3.4. Institution

A total of 147 institutions have contributed to the field, with 20 of these establishments publishing over 4 papers each. Table 2 encapsulates the top 10 most influential entities in the field of Traditional Chinese Medicine (TCM) treatment for Acute Pancreatitis (AP). Sichuan University tops the list with the highest NP value of 70, followed by Liverpool University and Zhejiang Chinese Medical University, both with a score of 22. As for the AC index, Nanjing University of Chinese Medicine leads with a score of 20.25, while Dalian Medical University with 14.12 and Hangzhou First People's Hospital with 11.57 trail behind. When the minimum threshold requirement for the number of documents and citations for an institution is set at 5, all 147 institutions meet this standard, indicating collaborative relationships existing amongst them. Fig. 4 showcases two clusters based on co-citation relationships among these institutions, with varying colors representing distinct co-citation associations. Within the red cluster, Sichuan University stands out as the most influential entity, earning the most co-citation count with 69 documents. In contrast, in the green cluster, Hangzhou First People's Hospital is highlighted with 21 documents co-cited, ranking second. In conclusion, based on this analysis, Sichuan University and Hangzhou First People's Hospital hold substantial influence and prominent academic standing in the AP treatment field using TCM.

3.5. Countries/Regio

These publications originate from 13 countries/regions, and Table 3 presents the top 5 influential countries/regions along with their NP, NC, H-index, and average citation (AC) per item. China has the highest NP percentage (96.5%, 195/202), followed by England (10.8%, 22/202) and New Zealand (6.4%, 13/202). The top three countries also have the highest NP, NC, and H-index values. Setting the minimum document and citation count for a country at 1, 12 out of the 13 countries meet the threshold, with 1 countries not collaborating with any other country and therefore not shown in the graph. The overlay visualization in Fig. 5 illustrates the collaboration among 11 countries. China has collaborations with multiple countries, particularly New Zealand and England. China leads in terms of publication and citation count, indicating its significant contribution in this field. England and New Zealand occupy the second and third positions, respectively, highlighting their importance in the research of TCM and pancreatitis. The map also reveals that Sweden has been one of the early contributors in researching on TCM for pancreatitis, while Poland has emerged as a recent player in this field. Although there is extensive international collaboration in this field, it is important to note that research on TCM and pancreatitis is still largely limited to China. To promote the development of this field, researchers should actively seek international collaborations.

3.6. Author and coauthorship

Over 756 authors have published articles in this field. Among them, 88 authors have contributed at least 4 papers to this research area. Based on the square root law of authors we estimate the number of productive authors to be 28, The top 10 authors in Table 4 represent about one-third of the total number of prolific authorsTable 4 summarizes the top 10 most active or prolific authors. Xia Qing (Sichuan University) has the highest number of publications (NP = 41), followed by Tang Wenfu (Sichuan University, 33) and Huang, Wei (Sichuan University, 25). Xia Qing has the highest number of publications (41), but Tang Wenfu is the author with the most

Table 2
The top 5 most productive institutions in the field of Chinese traditional medicine and acute pancreatitis research from 2007 to 2023.

Rank	Affiliation	NP	NC	AC	H-index
1	Sichuan University	70	528	7.54	14
2	Liverpool University	22	100	4.55	5
3	Zhejiang Chinese Medical University	22	231	10.5	9
4	Hangzhou First People's Hospital	21	243	11.57	10
5	Dalian Medical University	17	240	14.12	9
6	Zhejiang University	17	204	12	9
7	Royal Liverpool University Hospital	15	59	3.93	4
8	University of Auckland	12	45	3.75	4
9	Shanghai University of Traditional Chinese Medicine	9	97	10.78	4
10	Nanjing University of Chinese Medicine	8	162	20.25	6

(NP stands for the total number of publications , NC represents the total citation count , AC is the abbreviation for average citations per year).

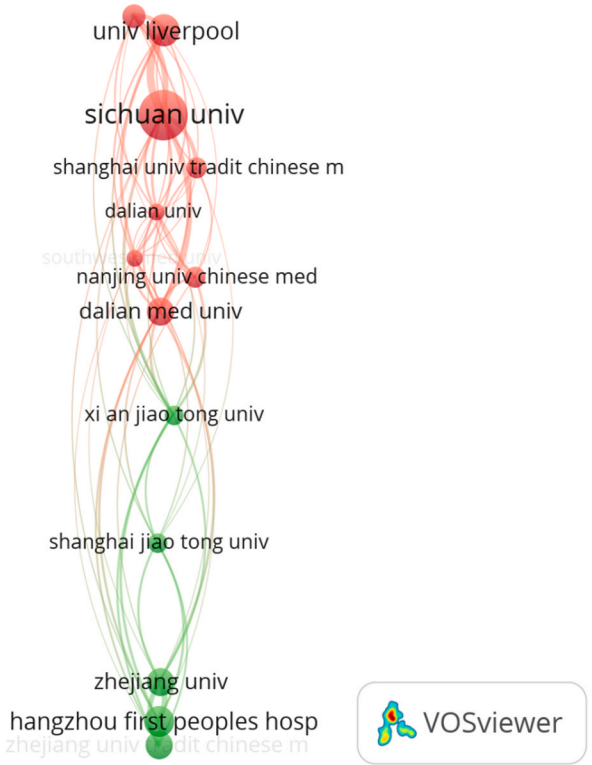

Fig. 4. Title: The cooperation network of institutions in the field.
Description: Dots represent institutions, with larger dots indicating a high number of publications or association strength, clusters are marked using different colors and links represent cooperation between institutions. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

Table 3
Top most 5 productive countries/regions in the field of Chinese traditional medicine and acute pancreatitis research from 2007 to 2023.

Rank	Country	NP	NC	AC	H-index
1	China	195	1968	10.09	23
2	England	22	100	4.55	5
3	New Zealand	13	45	3.46	4
4	USA	4	77	19.25	4
5	Germany	2	11	5.5	2

(NP stands for the total number of publications，NC represents the total citation count，AC is the abbreviation for average citations per year).

significant impact (AC = 11.21, H index = 13). According to Lotka's Law, we have plotted the Lotka plot for the number of publications contributed by authors in this field. In Fig. 6, we can observe the relationship between authors and the number of articles they have published. It also indicates that in this research field, a minority of individuals will generate the majority of the output. Among the 756 authors, 64 authors meet the criteria with a minimum of 4 publications and citations. One author does not collaborate with others, remaining 63 authors are displayed on the map. The overlay visualization map (Fig. 7) depicts clustering based on author co-authorship relationships, with different colors representing different collaboration connections. Darker clusters represent earlier years, while lighter clusters represent more recent years. Our report reveals that Tang Wenfu, Xia Qing, and Wan Meihua are the top three authors with the strongest collaboration relationships, with publication counts of 27, 20, and 20, respectively. Their average publication years were primarily in 2016 and 2017, indicating their longstanding, active research involvement in the fields of Traditional Chinese Medicine and acute pancreatitis. Additionally, Huang Wei ranks fourth in terms of collaboration strength, with an average publication year in 2019 and 11 publications, signifying Huang Wei as a rising star with significant influence in the field. Furthermore, Huang Lei, with an average publication year in 2012, is one of the key early researchers in the field, making remarkable contributions. Authors such as Yang Jingyu, Han Chenxia, Jiang Kun, Deng Lihui, Li Tingting, Wen Yongjian, Sutton Robert, and Jintao have an average publication year of 2020, while authors Du Dan and Fu Xianhui have an average publication year of 2021. Hu Qian represents authors with an average publication year in 2022, indicating their active involvement as major researchers in the field. In conclusion, the research contributions in the field of Traditional Chinese Medicine and acute pancreatitis come primarily from these

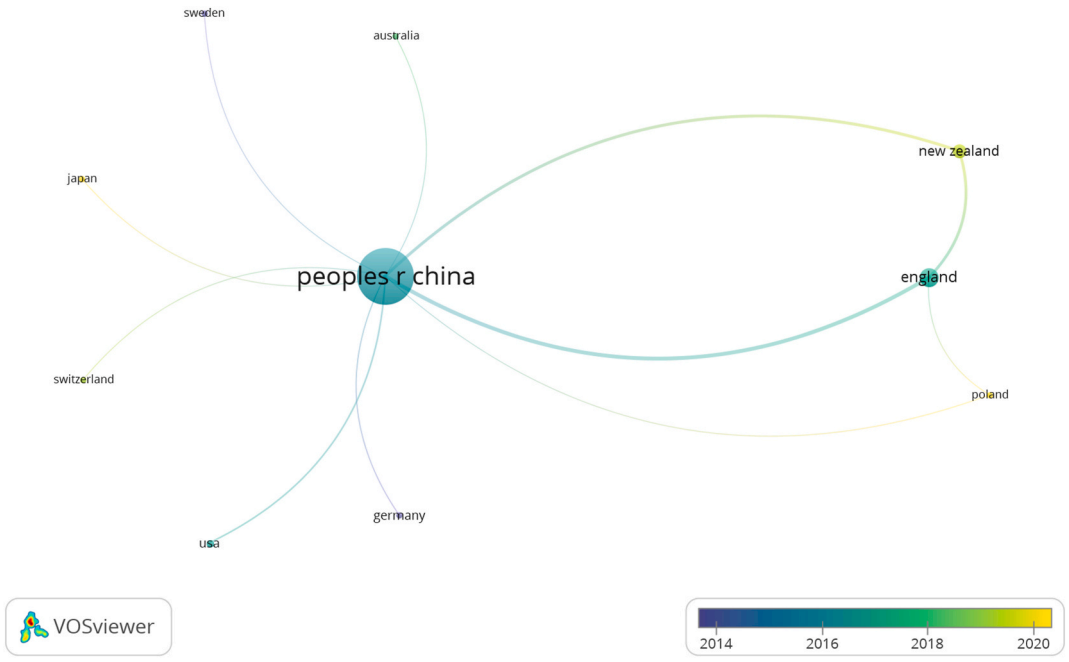

Fig. 5. Title: The cooperation network of countries regions in the field.
Description: Dots represent countries, with larger dots indicating a high number of publications or association strength. Clusters are marked using different colors, and links represent cooperation between countries. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

Table 4
The top 10 active authors in the field of chinese traditional medicine and acute pancreatitis research from 2007 to 2023.

Rank	Author	Affiliation	Country	NP	NC	AC	H-index
1	Xia, Qing	Sichuan University	China	41	220	6.9	10
2	Tang Wenfu	Sichuan University	China	33	293	11.21	13
3	Huang, Wei	Sichuan University	China	25	120	5.6	6
4	Wan, Meihua	Sichuan University	China	25	198	9.16	10
5	Zhang Xiping	Hangzhou First People's Hospital	China	22	217	11.5	10
6	Xue, Ping	Sichuan University	China	20	128	8.15	9
7	Li, Jing	Sichuan University	China	19	219	12.95	11
8	Zhang, Jiong	Sichuan Provincial People's Hospital	China	17	163	10.47	9
9	Sutton, Robert	Sichuan University	China	15	51	3.87	4
10	Du, Dan	Sichuan University	China	14	37	3.5	4

(NP stands for the total number of publications，NC represents the total citation count，AC is the abbreviation for average citations per year).

collaborating author teams. Their collaborative research spans multiple years and continues to explore the field.

3.7. Journals and Co-citation journals

A total of 76 academic journals have published papers on the treatment of acute pancreatitis with traditional Chinese medicine. Among them, 31 journals have published two or more articles. Table 5 lists the top 10 most prolific journals, their publishers, publication counts, citations, average citations, H-index, and impact factors (IF). The most prolific journal is PANCREAS with 22 publications, followed by EVIDENCE-BASED COMPLEMENTARY AND ALTERNATIVE MEDICINE (16) and WORLD JOURNAL OF GASTROENTEROLOGY (16). Despite being ranked third in terms of publication count, WORLD JOURNAL OF GASTROENTEROLOGY has the highest IF (4.30), highest citations (232), and highest H-index (9) among the ten journals. Therefore, we can preliminarily conclude that this journal is a Bradford Core journal and the most influential journal in this field. Fig. 8 displays the network graph of co-citation journals and clusters. Each journal in the visualization has a different size, representing its citation frequency. Among the co-citation journals, 73 journals meet the threshold, with a minimum citation count set at 20 for one journal. As shown in the figure, the World Journal of Gastroenterology has a co-citation count of 497, which is the highest among the listed journals. The Pancreas has a co-citation count of 246, Gastroenterology 189, Gut 140, Gastrointestinal and Liver Physiology 88, and the American Journal of Physiology 75. These journals are highly cited in the field and exhibit a high co-citation strength, indicating a strong correlation and

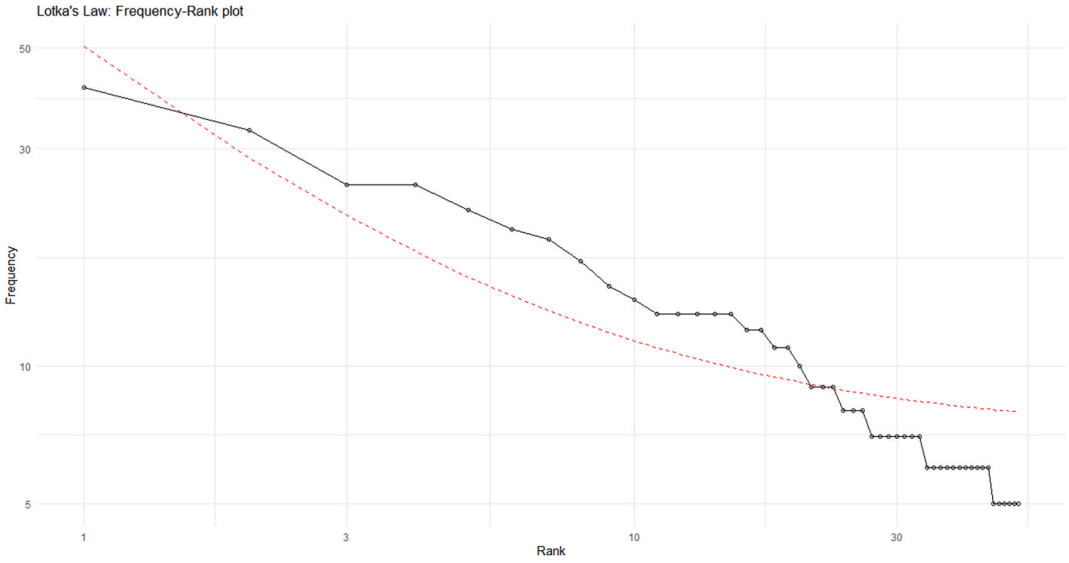

Fig. 6. Title: Author Productivity-Lotka plot
Description: The horizontal axis (x-axis) represents "Rank," which is arranged based on the number of articles published by each author. The vertical axis (y-axis) represents "Frequency," which is the number of articles published by each author. There are two lines on the plot: the black dots represent the actual publication records of each author, and the red dashed line represents the prediction of Lotka's Law. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

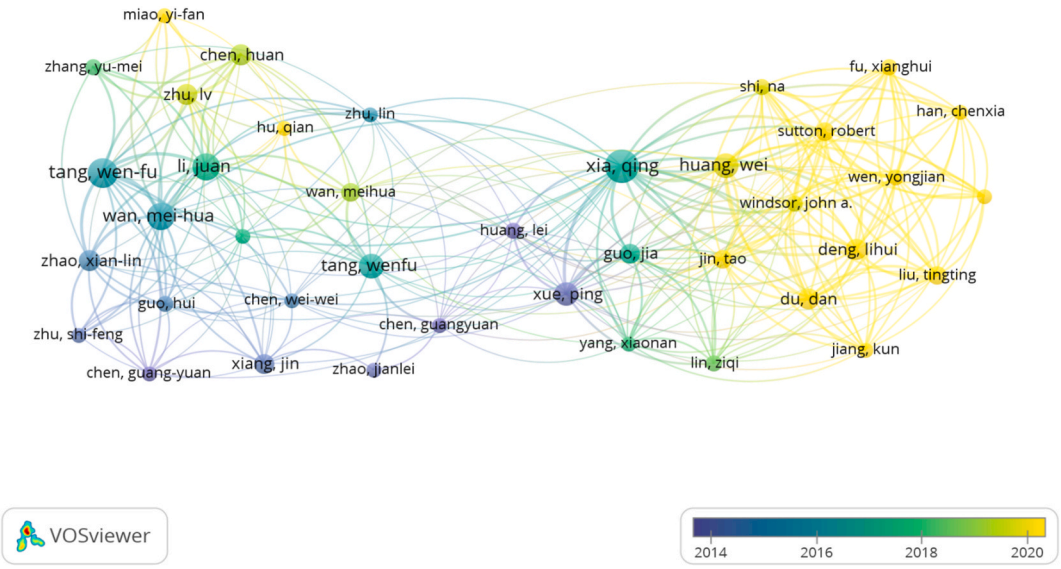

Fig. 7. Title: The cooperation network of authors in the field.
Description: Dots represent authors, with larger dots indicating a high number of publications or association strength. Clusters are marked using different colors, with darker clusters representing earlier years and lighter clusters representing more recent years. Links represent cooperation between authors. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

significant impact on advancing research in the field.

3.8. References Co-citation analysis

Fig. 9 displays a time-axis view of the co-citation clustering of literature. Each horizontal line is arranged from left to right in chronological order. The corresponding clustering labels, which are based on topics or keywords and generated via an algorithm, are shown on the right side, with the number of included publications decreasing from top to bottom. Each circle represents a publication, with larger circles representing publications with higher co-citation frequencies ， The left side of the horizontal line shows the earlier

Table 5
The top 10 leading journals in the field of Chinese traditional medicine and acute pancreatitis research from 2007 to 2023.

Journal	NP	NC	AC	H-index	Journal IF(2022)
PANCREAS	22	52	2.36	3	2.90
EVIDENCE-BASED COMPLEMENTARY AND ALTERNATIVE MEDICINE	16	99	6.19	7	2.65
WORLD JOURNAL OF GASTROENTEROLOGY	16	232	14.5	9	4.30
INFLAMMATION	10	159	15.9	7	5.10
FRONTIERS IN PHARMACOLOGY	9	79	8.78	4	5.60
CHINESE JOURNAL OF INTEGRATIVE MEDICINE	7	64	9.14	5	2.90
JOURNAL OF ETHNOPHARMACOLOGY	7	113	16.14	6	4.40
BIOMEDICINE & PHARMACOTHERAPY	5	129	25.8	4	7.50
HEPATOBILIARY & PANCREATIC DISEASES INTERNATIONAL	5	96	19.2	5	3.30
MOLECULAR MEDICINE REPORTS	5	77	15.4	4	3.40

(NP stands for the total number of publications，NC represents the total citation count，AC is the abbreviation for average citations per year).

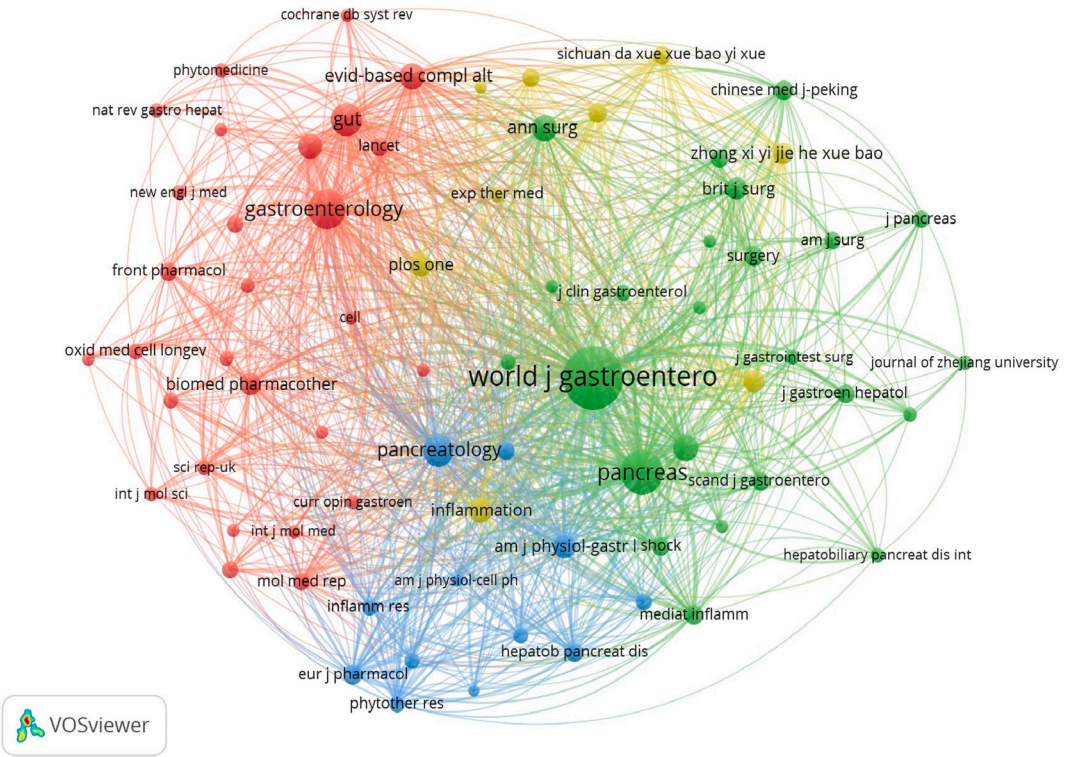

Fig. 8. Title: The cooperation network of journals in the field.
Description: Dots represent journals, with larger dots indicating a high number of publications or association strength, clusters are marked using different colors and links represent cooperation between journals. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

publication period, and the right side shows the later publication period. The lines connecting the circles represent co-citation relationships. These 14 clusters represent different topics. From Fig. 9, we can clearly observe the development of different topics over time and the publication of literature. Early research included terms such as severe acute pancreatitis, tissue pharmacology, Salvia miltiorrhizae (Danshen), ATPase mRNA expression, and protective effects. Therefore, these areas have been studied for a long time. However, it is evident that in recent years, there are fewer publications directly related to these topics, indicating that researchers may be conducting more studies on new influences. Mid-term studies include topics such as pancreas protection, taurocholate-induced vacuole formation, integrative diagnosis, and spectrum-effect relationship; this indicates a new direction for the study of acute pancreatitis. Currently, the overall development of network pharmacology is progressing rapidly. Dachengqi decoction is a major prescription that has received significant attention in the literature and is frequently cited. Important recent topics include the reduction of HMGB1-induced inflammatory responses and activation-mediated acinar cell research. The aforementioned analysis reveals the contribution of historical literature to acute pancreatitis research across different time periods, demonstrating the evolution and development of the research field. This is of critical importance in understanding the historical context and current trends of Traditional Chinese Medicine and acute pancreatitis literature. Furthermore, it serves as a valuable tool for identifying potential

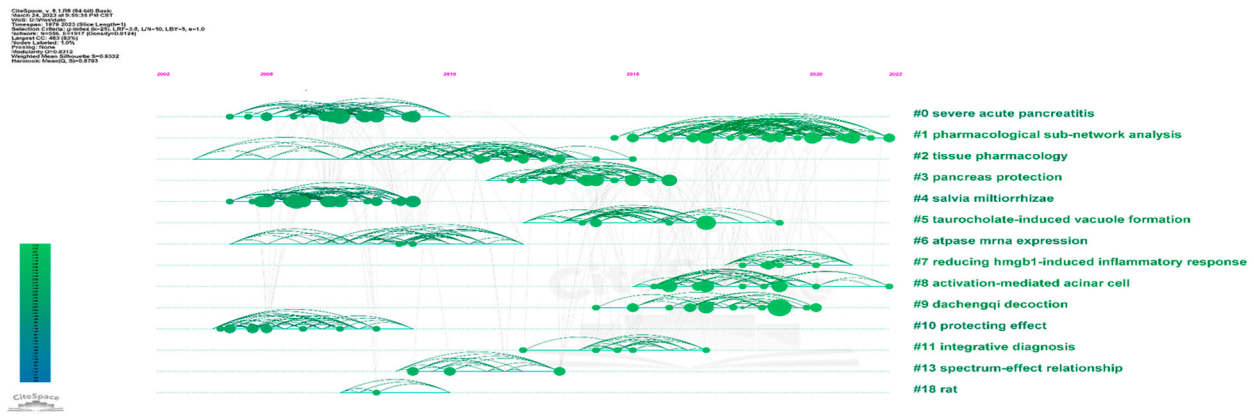

Fig. 9. Title: Timeline view of reference co-citation.
Description: Cluster names are arranged vertically based on topics or keywords. The node's position on the horizontal axis represents the time of its first occurrence, and the lines connecting the nodes represent co-citation connections. The size of each node is determined by the number of co-citations.

directions for future research.

3.9. References with citation burst

In the field of bibliometrics, references with citation bursts, which receive frequent citations from other studies within a specific period, are another important measure, signifying their recognition and impact within the academic community. The significance of citation bursts lies in their potential to identify research hotspots, influential papers, and track the evolution of research themes. Fig. 10 lists the top 25 references with the strongest citation bursts. Among these references, the citation bursts can be divided into three distinct stages. The first stage occurred between 2008 and 2011, and all of the references in this stage were authored by Zhang Xiping. Within this stage, there are 8 highly cited references, and interestingly, 6 of them are authored by Zhang Xiping. The second stage witnessed a burst in citations from 2013 to 2019, with Marja-Leena Kylänpää initiating the burst, followed by Jing-Wen Zhang. A total of 10 references experienced a citation burst during this mid-term stage. The third stage, initiated by Jun Li, began in 2018 and continued until 2023. Within this stage, 8 references exhibited citation bursts. It is worth noting that as of 2023, 6 references continue to experience citation bursts, indicating their recent and sustained attention in the academic community.

Top 25 References with the Strongest Citation Bursts

References	Year	Strength	Begin	End	2007 - 2023
Zhang XP, 2007, WORLD J GASTROENTERO, V13, P5079, DOI 10.3748/wjg.v13.i38.5079, DOI	2007	4.63	2008	2012	
Zhang XP, 2008, DIGEST DIS SCI, V53, P581, DOI 10.1007/s10620-007-9868-3, DOI	2008	4.51	2009	2012	
Zhang Xi-Ping, 2006, HEPATOBILIARY PANCREAT DIS INT, V5, P501	2006	3.88	2009	2010	
Xiping Z, 2007, MEDIAT INFLAMM, V2007, P0, DOI 10.1155/2007/72361, DOI	2007	3.88	2009	2010	
Zhang Xi-ping, 2007, JOURNAL OF ZHEJIANG UNIVERSITY-SCIENCE B, V8, P888, DOI 10.1631/jzus.2007.B0888, DOI	2007	3.88	2009	2010	
Granger J, 2005, SHOCK, V24, P45, DOI 10.1097/01.shk.0000191413.94461.b0, DOI	2005	3.44	2009	2010	
Zhang XP, 2007, WORLD J GASTROENTERO, V13, P717, DOI 10.3748/wjg.v13.i5.717, DOI	2007	3.44	2009	2010	
Zhang XP, 2007, J PANCREAS, V8, P704	2007	3.21	2009	2011	
Kylanpaa ML, 2010, WORLD J GASTROENTERO, V16, P2867, DOI 10.3748/wjg.v16.i23.2867, DOI	2010	3.21	2013	2014	
Wu L, 2013, INFLAMMATION, V36, P1020, DOI 10.1007/s10753-013-9634-y, DOI	2013	2.97	2014	2017	
Zhao JL, 2013, J PHARMACOL SCI, V122, P118, DOI 10.1254/jphs.13037FP, DOI	2013	4.3	2015	2018	
Wan MH, 2012, CHINESE MED J-PEKING, V125, P1941, DOI 10.3760/cma.j.issn.0366-6999.2012.11.019, DOI	2012	3.13	2015	2017	
Wang J, 2012, PLOS ONE, V7, P0, DOI 10.1371/journal.pone.0040160, DOI	2012	3.13	2015	2017	
Banks PA, 2013, GUT, V62, P102, DOI 10.1136/gutjnl-2012-302779, DOI	2013	3.13	2015	2017	
Wan B, 2014, SCAND J GASTROENTERO, V49, P1375, DOI 10.3109/00365521.2014.958523, DOI	2014	3.78	2017	2018	
Yao WY, 2015, MOL MED REP, V11, P1416, DOI 10.3892/mmr.2014.2789, DOI	2015	3.23	2017	2018	
Zhang JW, 2015, WORLD J GASTROENTERO, V21, P3537, DOI 10.3748/wjg.v21.i12.3537, DOI	2015	3.04	2017	2019	
Li J, 2017, WORLD J GASTROENTERO, V23, P3615, DOI 10.3748/wjg.v23.i20.3615, DOI	2017	3.09	2018	2023	
Xiang H, 2017, FRONT PHARMACOL, V8, P0, DOI 10.3389/fphar.2017.00216, DOI	2017	3.57	2019	2023	
Lee PJ, 2019, NAT REV GASTRO HEPAT, V16, P479, DOI 10.1038/s41575-019-0158-2, DOI	2019	7.53	2020	2023	
Forsmark CE, 2016, NEW ENGL J MED, V375, P1972, DOI 10.1056/NEJMra1505202, DOI	2016	3.72	2020	2021	
Zhang CL, 2017, EVID-BASED COMPL ALT, V2017, P0, DOI 10.1155/2017/5864945, DOI	2017	3.18	2020	2021	
Moggia E, 2017, COCHRANE DB SYST REV, V0, P0, DOI 10.1002/14651858.CD011384.pub2, DOI	2017	3.1	2020	2023	
Wen YJ, 2020, PHYTOMEDICINE, V79, P0, DOI 10.1016/j.phymed.2020.153328, DOI	2020	3.47	2021	2023	
Xia SL, 2019, INFLAMMATION, V42, P2129, DOI 10.1007/s10753-019-01077-z, DOI	2019	3.47	2021	2023	

Fig. 10. Title: Top 25 references with the strongest citation bursts.
Description: The blue bar represents the timeline, while the red bar indicates the start and end year, as well as the duration of the citation burst for each reference. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

3.10. Keywords Co-occurrence and bursts analysis

Through the law of the square root of the keyword's author, we can estimate that there are approximately 20 high-frequency keywords. According to Zipf's Law, we have plotted the Zipf graph for high-frequency keywords in Fig. 11. The blue line represents the regression line obtained through the least squares method. The line is fitted based on the logarithmic scale of the actual data, representing the trend between the occurrence frequency of keywords and their ranking. The R^2 value of 0.939 indicates that the fitted model has a high quality. The prominent keywords in Fig. 12A are basically consistent with those in Fig. 11, but the former emphasizes the strength of the association of prominent keywords.

When the minimum occurrence of a keyword was set to 2, 81 out of the 415 keywords met the threshold. These 81 keywords are displayed in the map. Keywords represent the research content of the literature and represent the main themes of the articles. When a keyword has a high frequency of occurrence, it reveals the distribution of research topics and the hotspots and trends in the field of research. The overlay visualization map (Fig. 12A) displays the collaborative relationship clustering based on keyword co-occurrence. Different colors represent different collaboration relationships. Darker clusters represent earlier years, while brighter clusters correspond to more recent years. It displays the hotspots in the research field of Traditional Chinese Medicine and acute pancreatitis. From the map, it can be observed that the identified keywords can be divided into multiple clusters, representing the prominent themes in this research field. We analyzed the top ten keywords with association strength and some emerging keywords according to different clusters in Fig. 12A. Acute severe pancreatitis, acute pancreatitis and traditional Chinese medicine are the most prominent keywords in this field, with the highest association strength, ranking first, second and third respectively. "Apoptosis" has an average publication year of 2013 and ranks fourth in keyword co-occurrence strength, indicating that it is a traditional hotspot in the field of traditional Chinese medicine and acute pancreatitis. "Rats" has an average publication year of 2010 and ranks fifth, indicating that rats have been the main subjects of research in the field of traditional Chinese medicine and pancreatitis since the early stages. "Baicalin" ranks sixth in terms of relevance, "emodin" ranks tenth, while "rhein" "rhubarb" and "salvia" also hold prominent positions, emphasizing the significance of these single herbal medicines in the field of traditional Chinese. "inflammatory mediators," and "obstructive jaundice" rank 7th, 8th, respectively, indicating that these three are the research focuses in this field. The association strength of "octreotide" ranks ninth, and "dexamethasone" is also a prominent keyword in the ranking of Western medicines, which may be a commonly used combination drug in this field. The co-occurrence of "da chengqi-decoction" is 16 times, with an average publication year of 2015. Similarly, "chaiqin chengqi-decoction" has a co-occurrence of 13 times, with an average publication year of 2015. These findings indicate that they are key prescriptions in the field of traditional Chinese medicine and pancreatitis research in recent years. Additionally, "qing yi-decoction" appears 9 times, with an average publication year of 2019. On the other hand, "xuebijing injection" only appears twice but has an average publication year of 2021. This suggests that these two decoctions are newly emerged commonly used prescriptions in this field. "Trl4," "pharmacokinetics," "icam1," "aquaporins," "oxidative stress" are keywords that appear frequently

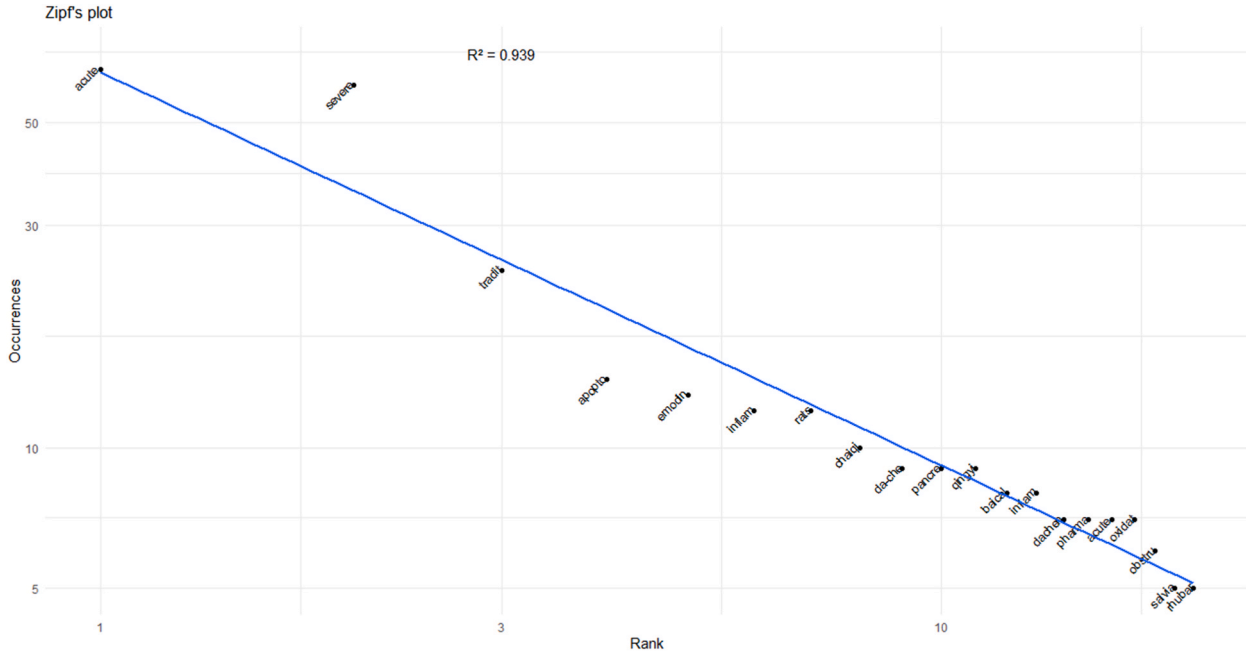

Fig. 11. Title: High-frequency keywords -Zipf graph
Description: The x-axis represents the ranking of the keywords, and the y-axis represents the co-occurrence frequency of the keywords. The blue line is the regression line obtained through the least squares method. It is fitted based on the logarithmic scale of the actual data, representing the trend between the occurrence frequency of keywords and their ranking. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

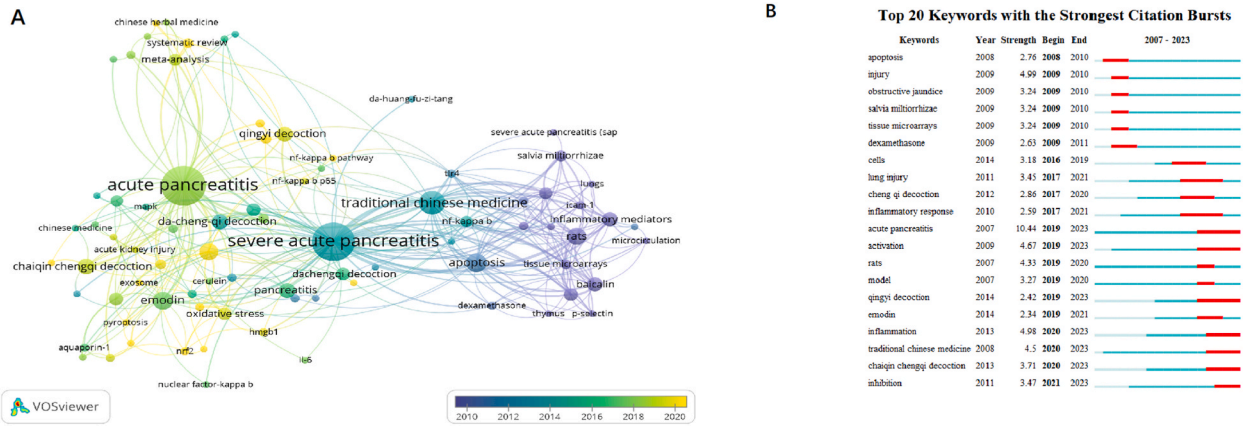

Fig. 12. Title: The visualization analysis of keywords in this field and the analysis of keyword citation bursts.
Description: (A) Dots represent keywords, with larger dots indicating higher frequency or association strength. Clusters are marked using different colors, and links represent co-occurrence between keywords. Dark clusters represent earlier periods, while light clusters represent later periods.(B) A blue bar represents the time period in which the keyword appeared, while a red bar represents the interval in which the keyword experienced a burst. The bars indicate the start year, end year, and duration of the burst. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

and have longer publication years, indicating that they are traditional research hotspots in this field. From the map, it can also be seen that "acute lung injury," "kidney injury," and "network pharmacology" are keywords with relatively late average publication years and high ranks, indicating that they are emerging research directions in recent years. "Molecular docking," "hmgb1," "nf-kappab," "nfr2," "oxidative stress," "exosome," "nlrp3," "inflammasome," and "pyroptosis" have publication years concentrated in recent years, indicating that they are current hot targets, pathways, or mechanisms in this field. Keyword burst analysis includes two attributes, burst strength and duration, which indicate the rapid changes of keywords over time and can serve as markers for the development of research paths. Keyword burst analysis was performed using CiteSpace software. Most cluster keywords and their synonyms also appeared in Fig. 12B, and the burst time of keywords roughly matched the time displayed in the keyword clustering view. The first keyword, "apoptosis," burst in 2008, and the keyword with the highest burst strength was "acute pancreatitis," followed by "injury," "lung injury," "Salvia miltiorrhizae," and "obstructive jaundice." More than half of the keywords have continued to burst in recent years, indicating that they are currently the focus of research. The above provides a comprehensive research overview, identifies salient topics, highlights historical and current hotspots, and reveals emerging research directions and practices in the field. It provides valuable insights to researchers, practitioners and policymakers by mapping key research trends and areas that may require further investigation and exploration.

4. Discussion

Over the past few decades, traditional Chinese medicine (TCM) has been used as an effective therapeutic agent to alleviate acute pancreatitis (AP) in Asian countries. TCM has the potential to interact with multiple molecular targets involved in the pathogenesis of AP [50]. Combining TCM with Western medicine in the treatment of AP has shown clearly noticeable therapeutic effects, including rapid onset of action, reduction of inflammation factors, improvement of intestinal mucosal barrier function [51]. Enhancing our understanding of TCM application in AP is crucial for drug discovery and clinical research, as it plays a vital role in alleviating symptoms, controlling complications, and reducing mortality rates. Unlike previous research, the study by Wenjie Sun and his team provides a comprehensive summary of the recent status and developmental trends of AP research, whereas this paper focuses specifically on the research regarding the application of Traditional Chinese Medicine (TCM) in AP treatment [52]. Sun's research points out that universities and research institutions in high-output countries, such as China, the United States, and India, are very active in conducting AP research. Meanwhile, the results of keyword co-occurrence and clustering emphasize the research on AP classification, mortality rate, and risk factors. On the other hand, this study presents significant research themes such as severe acute pancreatitis, traditional Chinese medicines, cell apoptosis, and the therapeutic efficacy of specific TCM formulas. Similarly, in Xujuan Luo's research, severe acute pancreatitis and necrotizing pancreatitis are essential themes of acute pancreatitis research, showcasing the general research trends, hotspots, and gaps in the field through text analysis and visualization [53]. This study emphasizes the substantial guiding significance of TCM in treating acute pancreatitis and provides strong support for future clinical and scientific work. In summary, although previous documents have conducted macro-level analysis of the current status of AP research, there are significant differences in research goals, methods, and outcomes compared to this paper. Therefore, this study aims to fill this gap by analyzing the current situation of TCM research in AP treatment from 2007 to 2023 through methods such as publication volume analysis, citation analysis, co-citation analysis, collaborative authorship analysis, burst detection, and keyword analysis.

4.1. Research directions and trends of TCM in AP treatment

The article first elaborates on five main research areas: pharmacology and pharmacy, integrated complementary medicine, gastroenterology and hepatology, experimental medical research, and cell biology. These fields not only showcase the various applications of traditional Chinese medicine (TCM) in the treatment of acute pancreatitis, but also reveal potential alternative therapeutic methods. Additionally, the article identifies an important trend: the research on TCM treatment for acute pancreatitis is on the rise, with the overall increase in the number of publications and citation frequency. This indicates that the importance of TCM in the research field of acute pancreatitis treatment is increasingly recognized, and its value is being acknowledged globally. In summary, the article provides valuable insights into the research direction, disciplinary investigation, and development trends of TCM in relation to acute pancreatitis, offering inspiration to researchers. In future studies, more emphasis should be placed on generating high-quality research outcomes to promote the application of TCM in this field, thereby providing more effective treatment methods for patients with acute pancreatitis.

4.2. International collaboration and productivity representative

Sichuan University ranks the highest in publication output, with strong connectivity to other institutions within academic clusters. Both Sichuan University and Hangzhou First People's Hospital have extensive collaborations with other institutions, suggesting their significant influence and academic standing in the field of Traditional Chinese Medicine (TCM) treatment for acute pancreatitis. Examining these collaborative relationships may reveal potential academic trends and partnership opportunities to provide valuable insights for researchers. However, it is important to be aware of geographical distribution imbalances, which limit exchanges and cooperation between regions, posing challenges to the field's development. Researchers should strive to improve this distribution and eliminate geographical barriers to promote a global perspective in studies. China contributes the most to this field, holding the highest number of publications and citations. The England and New Zealand follow closely, playing crucial roles in TCM and pancreatitis research. China has the strongest connectivity with multiple countries, collaborating extensively with New Zealand and the England. Sweden is an early participant in the field, while Poland is a more recent contributor. Despite widespread international collaborations, TCM and pancreatitis research remain primarily limited to China. For the field to develop further, more countries and regions are encouraged to participate. Cross-border collaboration should be promoted to conduct comparative research, exploring the advantages of different research methods and therapies. Tang Wenfu, Xia Qing, and Wan Meihua are the authors with the highest level of collaboration, and their publication quantity also ranks at the forefront. Tang Wenfu's research focuses on pharmacokinetics, organ damage, inflammatory responses, and TCM mechanisms in treating acute pancreatitis [54,55]. Zhang Xi Ping, with the highest co-citation frequency, investigates the inhibitory effect of baicalin on TNF-α levels in blood, and the induction of apoptosis in multiple organs as a treatment for acute pancreatitis, as well as the inhibitory effect of Salvia miltiorrhizae injection on ICAM-1, TLR4, NF-kappa B expression and Bax protein regulation to protect SAP or OJ rat organs [56,57]. Revealing key author teams in the field can help identify potential partnership opportunities and strengthen existing networks to advance research and development. Analyzing the publication years and activity level of authors in the field offers insights into the area's development, emerging trends, and potential future directions. The report also highlights newly influential researchers who may greatly contribute to future TCM and acute pancreatitis research. Their research results can contribute to a better understanding of TCM applications in acute pancreatitis treatment and provide valuable guidance for the field's further development and refinement. Although the report emphasizes collaborative relationships among authors, more in-depth research and broader analyses are needed to gain a comprehensive understanding and guidance. Meanwhile, TCM and acute pancreatitis is a complex issue involving multiple disciplines and areas, and interdisciplinary collaboration may promote the field's development and lead to more comprehensive research outcomes.

4.3. Journal and reference Co-citation and burst detection

Among the top 10 journals publishing research on herbal medicine and acute pancreatitis, five have impact factors (IF) greater than 5. The number of articles published in journals with an IF greater than 5 accounts for 18.3% of the total articles included in this study. Based on the journal collaboration network analysis,the World Journal of Gastroenterology is the most commonly cited and highly associated journal in the field of gastroenterology. It belongs to the Bradford Core journal and has close collaboration with many other journals. It has made significant contributions to the development of traditional Chinese medicine in the treatment of acute pancreatitis. The timeline view of co-cited references provides insights into the dynamic changes and trends of different reference clusters over time. In Fig. 9, clusters 2 (tissue pharmacology), 4 (Salvia miltiorrhizae), 6 (ATPase mRNA expression), and 10 (protective effect) represent the earliest research, while clusters 1 (network pharmacology), 7 (reducing HMGB1-induced inflammatory response), and 8 (activation-mediated acinar cell) represent recent hotspots. This suggests that research in this field has progressed from a macro and superficial stage to a more specific and detailed stage, with the mechanism of action and pathways of TCM expanding in practice. The use of specific treatment targets such as HMGB1 and acinar cells has enabled research in acute pancreatitis prevention, diagnosis, and treatment. Furthermore, in Fig. 9, "Dachengqi Decoration" is the only cluster named after a TCM decoction, and "Salvia miltiorrhizae" is the only cluster named after an herbal medicine. This indicates that Dachengqi Decoration and Salvia miltiorrhizae are highly regarded in this field and commonly used in the treatment of acute pancreatitis. Fig. 10 lists the top 25 most frequently cited references. The first major citation burst comes from an article published by Zhang Xiping et al., in 2007. Their research confirmed that baicalin and octreotide may protect the kidneys of rats with severe acute pancreatitis by inhibiting inflammatory mediators and inducing cell apoptosis [58]. The strongest citation burst comes from a paper published by Peter J. Lee et al., in 2019, a review of acute pancreatitis.

This paper discusses key cellular processes in the latest pathogenesis of acute pancreatitis, such as the pathological elevation of Ca2+ concentration in acinar cells, a central event in acute pancreatitis that mediates pro-cell death and pro-inflammatory pathways [59]. It also emphasizes the pathophysiological mechanisms and clinical management of acute pancreatitis. The longest citation burst comes from a paper published by Jun Li et al., in 2017. This paper lists commonly used decoctions or single Chinese medicinal herbs in the treatment of acute pancreatitis. Research has found that the main formulas for treating acute pancreatitis are Dachengqi decoction, Qingyi decoction, Chaiqinchengqi decoction, Dahuangfuzi decoction, and Huoxueqingyi decoction. The primary single Chinese medicinal herbs include Rheum, Salvia miltiorrhizae, Natrii sulfas, Baicalein, Ligustrazine, and Resveratrol. These decoctions or traditional Chinese medicines work in the treatment of acute pancreatitis in a variety of ways [60]. The co-citation analysis of references presents a timeline view that tracks the development of traditional Chinese medicine in treating acute pancreatitis, showcasing the evolution of different research topics over time. This facilitates an understanding of historical and current research trends and serves as a guide for future research directions. It reveals a recent shift towards new directions, with pancreatic protection, tauroursodeoxycholic acid-induced vesicle formation, and comprehensive diagnosis emerging as new hotspots. The article also identifies frequently cited references from other studies during specific periods through burst analysis, highlighting their significant impact on the academic community. The analysis of citation bursts uncovers research hotspots, influential papers, and tracks the evolution of research topics. Although Traditional Chinese Medicine (TCM) has made progress in the treatment of acute pancreatitis, related research is not yet published in international high-impact factor journals. This lack might be influenced by various factors such as research quality, methods, and international acceptance levels. Both historical and recent studies have identified the potential of some TCM and traditional remedies, like Dachengqi Decoction and Danshen, in treating acute pancreatitis. However, there's considerable fragmentation in the research topics. Refining and optimizing these medicines, discovering more effective active ingredients, enhancing efficiency, reducing side effects, and determining drug dosage control for specific pathological conditions remain significant challenges. While promising therapeutic targets such as HMGB1 and acinar cells have been identified, the current task is to translate these findings into practical clinical treatments and conduct randomized controlled trials to validate the efficacy and safety of these drugs. More attention should be placed on standardization and quality control of medicines in treating acute pancreatitis to ensure consistent and safe treatment outcomes. Thus, establishing strict quality control standards and a standardization system is urgently needed in this field. In summary, many challenges persist in the research field of TCM and acute pancreatitis treatment. Significant ongoing efforts are required to improve research quality, deepen theoretical studies, advance clinical practice, improve efficacy evaluation, and strengthen exchanges and cooperation with relevant fields.

4.4. Keyword analysis and research hotspots

The keywords co-occurrence analysis provides insights into the structure and dynamics of specific research areas. By identifying the most frequently occurring keywords and their co-occurrence patterns, researchers can better understand key concepts and themes driving research in this field. Furthermore, it helps researchers identify emerging trends and areas of interest. In terms of keyword frequency, we found that "acute pancreatitis" and "severe acute pancreatitis" are prominent keywords, along with "traditional Chinese medicine". The most prominent keywords related to TCM decoctions are "Dachengqi Decoction," "Chaiqin Chengqi Decoction," and "Qingyi Decoction." The most frequently mentioned single Chinese medicinal herbs are Baicalin, emodin, rhubarb, Salvia miltiorrhizae. The current hot topics include molecular docking, HMGB1, NF-kappa B, Nrf2, oxidative stress, exosome, NLRP3 inflammasome, and pyroptosis. From the keyword clustering analysis and keyword burst analysis, it can be observed that the research in this field has evolved from an initial stage to a more detailed and refined stage. The mechanisms and pathways of herbal medicine in pancreatic inflammation have also gradually expanded, with the discovery of more treatment targets. The various modes of action of herbal medicine in the prevention and treatment of acute pancreatitis are interconnected. Recent evidence suggests that pathological elevation of Ca2+ concentration in acinar cells is a central event in acute pancreatitis. Baicalin can enhance cell viability, inhibit cytosolic Ca2+ concentration, and significantly improve intracellular vesicle and IP96 mRNA expression [61]. Impaired autophagy leads to premature activation of pancreatic proteases; thus, normal autophagic function is a prerequisite for acinar cell survival [62]. In a controlled experiment using Acanthopanax and 3-methyladenine to observe the therapeutic effects on acute pancreatitis, both treatment groups showed a lower number of autophagosomes and autolysosomes in pancreatic acinar cells compared to the control group, indicating that Acanthopanax may reduce pancreatic injury by reducing autophagic damage [63]. The endoplasmic reticulum (ER) has the ability to process and clear proteins. When it is damaged, ER stress leads to a protective cellular response, triggering apoptosis and exacerbating pancreatic necrosis [64]. Chaiqin Chengqi Decoction has been shown to alleviate ER stress proteins and apoptotic cell death, protecting against TNF-α and IL-6-induced HK-2 cell injury [65]. In gallstone pancreatitis, exposure of duct cells to bile acids leads to duct cell injury and subsequent exposure of acinar cells to bile acids, causing cell damage and death [66,67]. Emodin can alleviate pancreatic duct cell injury induced by ATP by inhibiting P2X7/NLRP3 signaling, thereby reducing the severity of acute pancreatitis [68]. Duct cell injury can mediate the infiltration of immune cells to the injured site [69]. NADPH oxidase in neutrophils promotes oxidative stress and increased intracellular activation of pancreatic proteases [70]. Dachengqi Decoction treatment inhibits neutrophil-mediated inflammation through targeting the HMGB1-TLR-4-IL-23-IL-17A signaling pathway, improving pancreatic microcirculatory dysfunction induced by SAP [71]. Inflammasome activation increases the production of pro-inflammatory cytokines [72]. Emodin effectively protects rats from AP-associated lung injury by inhibiting NLRP1 inflammasome activation through the Nrf3/HO-2 signaling pathway [73]. Toll-like receptors (TLRs) activate the NF-κB pathway, which mediates the expression of pro-inflammatory cytokines and chemokines [74]. Chaiqin Chengqi Decoction suppressed NK1R internalization and NF-kappa B signal pathway activation in isolated pancreatic acinar cells [75]. Keyword co-occurrence and frequency analysis provide clinicians with major prescriptions or individual herbs in the field of Traditional Chinese Medicine (TCM) for treating acute

pancreatitis. Some examples are the classical formulas: “Dachengqi Tang,” “Chaiqin Chengqi Tang,” emerging formulas: “Qingyi Tang, ” and commonly used herbs such as Baicalin, emodin, rhubarb, and Salvia miltiorrhiza. These keywords enable doctors to understand the herbs and TCM formulas commonly used in today’s clinical practice, helping them provide more personalized and effective treatment to patients. This not only assists clinicians in guiding clinical decisions and optimizing treatment plans, but also ensures that clinical practice keeps pace with the latest research advancements. A comprehensive description of the various mechanisms of action of medicinal herbs in the prevention and treatment of pancreatitis offers clinicians more treatment ideas and options. The burst analysis of keywords reveals the changing trends over time, serving as markers of the evolution of research paths for clinicians. Clinicians can identify emerging research directions and practices in recent years through keyword burst analysis, thereby acquiring the latest research findings promptly to inform their clinical practice. In addition, policymakers can formulate related policies and standards based on these analytical results, promoting the standardized application and further research of TCM in treating acute pancreatitis. Currently, Western medicine mainly focuses on symptomatic treatment for acute pancreatitis, while some Chinese herbal decoctions and formulas have a multi-pathway effect in combating pancreatic injury and improving pancreatic necrosis. The research on the mechanism of Traditional Chinese Medicine (TCM) treatment for pancreatitis has made progress, but there are still some issues that need to be addressed. Firstly, various herbal formulas and herbs are used in the treatment of acute pancreatitis, but there is a lack of standardized treatment protocols, leading to variations in clinical practice. Although there have been advances in the mechanism research of TCM for acute pancreatitis, further exploration is needed to identify specific treatment targets and reveal the precise mechanisms of TCM. Currently, there is insufficient integration between TCM and Western medicine in the field of acute pancreatitis, and clear guidelines and operational norms are lacking. This leads to fragmented treatment patterns. In the future, it is recommended to establish more unified and standardized treatment protocols for TCM treatment of acute pancreatitis, clarify the usage specifications, and dosage of various herbal medicines and establish relevant guidelines. In-depth research should be conducted on the mechanisms of TCM in the pathogenesis of acute pancreatitis, inflammation regulation, and cellular protection to identify specific targets and approaches for TCM treatment. Collaborative research between TCM and Western medicine should be strengthened, and a combined treatment model and guidelines should be established to improve the overall therapeutic efficacy of acute pancreatitis.

4.5. Limitations

Our study has several limitations. Firstly, due to the limitations of CiteSpace and Vosviewer software, we only selected the core collection from the WoSCC database for paper retrieval. Secondly, the content included does not cover online publications, retractions, letters, or books, which may result in omissions and biases. Thirdly, we only included papers published in English, which may introduce language bias. Additionally, there may be some keywords that were overlooked during the search process. Lastly, we only retrieved articles published in the past fifteen years to reflect the current status of the field. Therefore, for a more comprehensive bibliometric study, utilizing a mixed database that includes non-English papers and is not limited by publication year, could provide a broader perspective on the research trends related to traditional Chinese medicine and acute pancreatitis. The above-mentioned content represents the limitations discussed in the bibliometric analysis paper.

5. Conclusion

Our study analyzed the state of research on Traditional Chinese Medicine (TCM) applications in treating Acute Pancreatitis (AP). Key focus areas included pharmacology, complementary medicine, gastroenterology, experimental medicine, and cell biology. The increasing research interest and publication value indicate the growing significance of TCM in AP treatment. Prominent stakeholders include institutions like Sichuan University, Zhejiang Chinese Medical University, and the University of Liverpool, with China, the UK, and New Zealand playing central roles in research production. Noteworthy authors such as Tang Wenfu, Xia Qing, and Wang Meihua have made multiple contributions in this field. Prominent platforms for disseminating TCM-AP research include the “World Journal of Gastroenterology,” “Pancreas,” and “Gastroenterology.” Research topics evolve over time, focusing on severe AP, TCM, apoptosis, specific TCM combinations, network pharmacology, and HMGB1-induced inflammatory responses. The identification of significant references demonstrates their academic influence. Molecular docking, HMGB1, NF-κB, Nrf2, oxidative stress, exosomes, and NLRP3 inflammasome are prominent research hotspots, highlighting key elements and pathways in TCM-AP research. In conclusion, this study outlines the research prospects of TCM in the treatment of AP while emphasizing the need for clinical trials to explore its efficacy.

Data availability statement

Has data associated with your study been deposited into a publicly available repository?
Response：Yes.
Has data associated with your study been deposited into a publicly available repository?
Response：Web of Science. The data is too large to provide individually.

CRediT authorship contribution statement

Wang-peng Lan: Writing – original draft. **Wen Guo:** Methodology, Data curation, Conceptualization. **Xin Zhou:** Methodology, Formal analysis, Data curation. **Zhi Li:** Writing – review & editing.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:Li reports financial support was provided by Zhi. Zhi L reports a relationship with Southwest Medical University that includes: funding grants.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e25659.

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