

Current status and trend analysis of chronic heart failure research based on CNKI database and CiteSpace

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Abstract. Purpose: Chronic heart failure (CHF) is a serious cardiac disease and has become a common and high-incidence disease worldwide. This study aims to investigate the current status and trends of research on CHF over the past decade (2013-2023), in order to understand the latest developments in this field and future research directions. Methods: Using the China National Knowledge Infrastructure (CNKI) as the data source, visual analysis software CiteSpace 5.5 R1 was employed to visualize and analyze CHF-related research, exploring authors, institutions, keywords, and development trends of relevant studies. Results: A total of 1907 articles were included. Visual analysis revealed that research authors were relatively dispersed, with few collaborative publications. The collaboration among main research teams was insufficient, and the main research institutions were also relatively dispersed. Hot keywords included chronic heart failure, heart failure, chronic congestive heart failure, cardiac function, quality of life, prognosis, ventricular remodeling, brain natriuretic peptide, etc., forming nine clusters. Conclusion: The publication volume of CHF over the past decade showed a trend of gradual decrease followed by an increase. The impact of cardiac function on patients' prognosis and quality of life has received relatively high attention in the field of chronic heart failure.

Keywords: Chronic heart failure, current status, trend analysis, CNKI database, CiteSpace

1. Introduction

Chronic Heart Failure (CHF) is one of the most common cardiovascular diseases in the 21st century. Globally, the incidence of CHF is on the rise. In populations, the prevalence of CHF is approximately 2%, with an annual incidence of around 0.4%. CHF is more common in elderly patients and is an important health issue affecting aging societies. Over 50% of newly diagnosed CHF patients have other cardiovascular diseases, while over 30% of newly diagnosed cardiovascular disease patients have CHF [1]. During CHF, abnormalities in heart rate and rhythm, loss of cardiac contractile function, and abnormal activation of neurohormonal mechanisms can all affect cardiac function. During CHF, the sympathetic nervous system and the renin-angiotensin-aldosterone system are activated, leading to increased secretion of norepinephrine and angiotensin II, exacerbating cardiac remodeling and accelerating the deterioration of cardiac function [2]. During the development of CHF, accompanied by myocardial remodeling and ventricular reconstruction, both electrical and structural remodeling processes are prone to induce the occurrence and development of other cardiovascular diseases [3]. The combination of CHF with other cardiovascular diseases is one of the therapeutic challenges in the field

of cardiovascular medicine, and with the increasing aging population, related research is receiving more and more attention [4]. In this study, we used the visualization software CiteSpace 5.5 R1 to construct a knowledge map of CHF-related research, including network analysis of institutional cooperation, citation journal analysis, keyword co-occurrence analysis, and analysis of literature co-citations, in order to derive the frontiers, hotspots, and development trends in this field. We hope this research can provide valuable references for CHF researchers and promote further development in CHF research.

2. Data Source and Research Methods

2.1. Data Source

The search was conducted using the China National Knowledge Infrastructure (CNKI) as the data source, with the search theme set as “Chronic Heart Failure.” The time range for the search was from 2013 to 2023. The document sources included SCI, EI, CSSCI, CSCD, and Peking University Core Journals. After the search, a total of 2055 documents were retrieved. To ensure the representativeness of the sample literature and the validity of the analysis results, meta-analyses, systematic reviews, reviews, and literature that did not match the research content were excluded. Finally, 1907 articles were determined as research samples, converted into CNKI download format, and saved in RefWorks format for identification and analysis by CiteSpace software.

2.2. Research Methods

CiteSpace 5.5 R1 and Excel software were used to conduct bibliometric and visualization analysis of CHF-related research from aspects such as publication time, authors, countries and institutions, and keywords, revealing the research hotspots and development trends in this field. The time span was set from 2013 to 2023, and different parameters were set for different node types to draw the knowledge map.

3. Results

3.1. Analysis of Annual Publication Volume

Since 2013, the annual publication volume of CHF has shown a downward trend, reaching 137 in 2022. This may be due to reduced demand for new research due to advances in treatment methods. After 2018, it fluctuated up and down, with a slight decrease in 2022, possibly influenced by researchers' attention to the COVID-19 pandemic. By 2023, the publication volume reached 171, reflecting renewed attention to CHF research and remaining a global public health issue. Trends may be influenced by new discoveries and technological developments. This reflects the gradual decrease and subsequent increase in the intensity of CHF research during this period. It signifies renewed attention to the importance of CHF by researchers, indicating it remains an important global public health issue. This trend may change with new research findings or technological developments. See Figure 1.

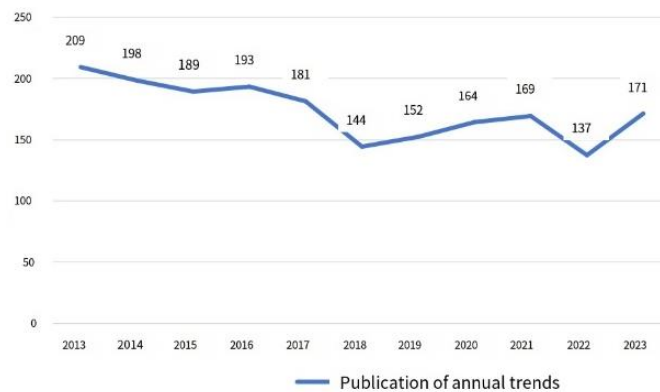


Figure 1. Changes in the Number of CHF Research Literature Publications from 2013 to 2023

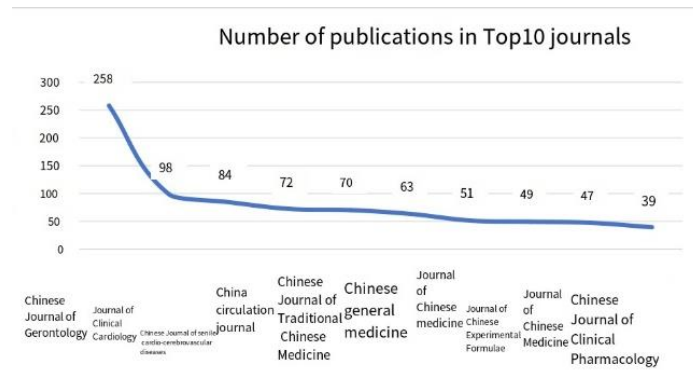


Figure 2. Distribution of Top 10 Journal Sources for CHF from 2013 to 2023

3.2. Analysis of Publishing Journals

According to the data provided by CNKI, we have compiled statistics on the top 10 journals by publication volume, as shown in Figure 2. These journals have collectively published 831 academic papers related to CHF. These papers primarily focus on the current and future development trends in the field of CHF and lead the latest research hotspots. The publication volume of these top 10 journals accounts for 43.58% of the total, indicating a relatively concentrated trend. It is worth noting that the papers published in these top 10 journals not only focus on the basic research of CHF but also cover various aspects such as clinical applications and treatment strategies. This comprehensive research perspective not only enhances our understanding of CHF but also provides more possibilities for its treatment.

3.3. Analysis of Institutions and Authors in CHF Research

Table 1. High-Productivity Institutions for Chronic Heart Failure Publications from 2013 to 2023

Frequency	Year of First Appearance	Institution
14	2015	Shengjing Hospital of China Medical University
12	2020	First Clinical Medical College, Shandong University of Traditional Chinese Medicine
9	2022	School of Traditional Chinese Medicine, Hunan University of Chinese Medicine
4	2013	Department of Cardiology, Nanfang Hospital, Southern Medical University
4	2018	Department of Cardiology, Affiliated Haikou Hospital, Xiangya School of Medicine, Central South University
3	2013	Department of Cardiology, Minzu Hospital, Hubei Minzu University
3	2022	School of Nursing, Tianjin Medical University
3	2022	School of Nursing, Nanjing Medical University; Department of Cardiology, The First Affiliated Hospital of Nanjing Medical University
3	2014	Department of Cardiology, The First People's Hospital of Yunnan Province
3	2022	Chengde Medical College

(1) Research Institutions

Analyzing the publishing institutions provides insights into the composition of researchers and the distribution of academic resources in the field, thereby understanding the institutions that are genuinely concerned about CHF research. Table 1 reveals the top 10 research institutions that published studies on CHF from 2013 to 2023. Shengjing Hospital of China Medical University leads with 14 publications. Following closely is the First Clinical Medical College of Shandong University of Traditional Chinese Medicine with 12 publications. Additionally, the School of Traditional Chinese Medicine, Hunan University of Chinese Medicine, published 9 papers. These data reflect the level of activity and influence of these institutions in the field of CHF research.

(2) Core Authors

To identify core authors, we typically focus on those who have published articles as first authors or independent authors. According to Price’s law, we conducted statistical analysis of CHF literature from 2013 to 2023 and found that the maximum number of publications N_{pmax} by first authors (including independent authors) was 25. Therefore, the minimum number M_P of publications for candidates for core authors in CHF research is calculated as:

$$M_P = 0.749\sqrt{N_{Pmax}} = 0.749 \times 5 = 3.745$$

According to Price’s law, the number of papers published by core authors should account for about 50% of the total papers. Calculating based on this ratio and rounding off, we designate authors who have published 4 or more papers as core authors. Among the 1907 selected documents, a total of 44 authors meet this criterion, and they have collectively published 385 papers, accounting for 20.19% of the total selected literature. Due to space limitations, only the top ten authors with the highest number of publications are listed (as shown in Table 2).

Table 2. Author Publication Quantity Table

No.	Author	Number of Papers
1	Xian Shaoxiang	25
2	Zhu Mingjun	19
3	Wang Lingjun	19
4	Wang Wei	17
5	Zhao Huihui	13
6	Wang Juan	13
7	Li Bin	12
8	Hu Zhixi	12
9	Dai Guohua	12
10	Sun Guozhen	11

To gain a deeper understanding of the collaboration between authors, we created a co-authorship knowledge map, as shown in Figure 3. Node size represents the number of publications by each author, while the lines indicate co-authorship, with thicker lines representing higher collaboration frequency. According to the map, Xian Shaoxiang has published 25 papers, followed by Zhu Mingjun and Wang Lingjun with 19 papers each, and Wang Wei with 17 papers. Zhao Huihui and Wang Juan each have 13 papers, indicating they are key contributors. However, the map exhibits a star-like distribution with limited collaboration. There is minimal collaboration among the top five authors, highlighting the need to strengthen collaboration between teams to facilitate knowledge exchange and advance CHF research.

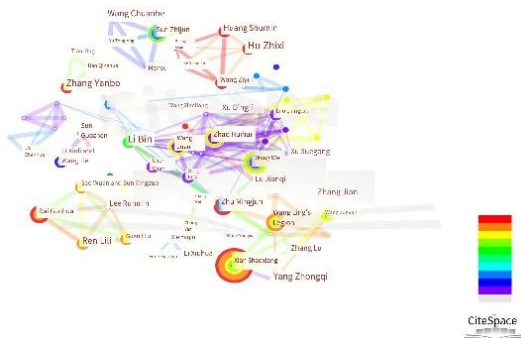


Figure 3. Co-authorship Knowledge Map

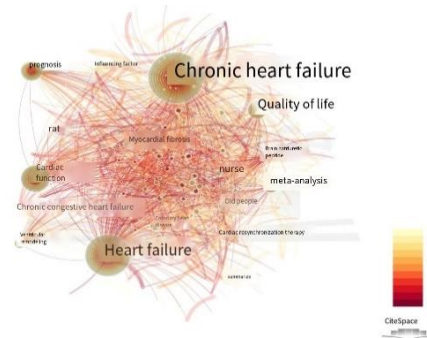


Figure 4. Co-occurrence Network Map of Key Concepts in the CHF Field from 2013 to 2023

3.4. Analysis of Research Hotspots and Trends

(1) Co-occurrence of Keywords and Analysis of High-frequency Words

Keywords are highly condensed and summarized representations of document content. Keyword analysis allows us to track research hotspots in the field of CHF. In CiteSpace, we set the time span as “2013-2023” and utilized the pathfinder algorithm along with pruning sliced networks and pruning merged networks to obtain the co-occurrence network map of keywords, as shown in Figure 4. In the graph, nodes represent keywords, with their size indicating frequency of occurrence, and lines representing co-occurrence strength, with more lines indicating higher strength. A total of 560 nodes and 2121 lines were obtained, with a network density of 0.0136, indicating a rich and extensive research content in CHF. Keywords cover topics such as cardiac function, quality of life, prognosis, ventricular remodeling, brain natriuretic peptide, including meta-analyses and the elderly.

Table 3. High-frequency Keywords in Chronic Heart Failure from 2003 to 2023

Frequency	Centrality	Year	Keywords
1101	1.3	2013	Chronic Heart Failure
511	0.53	2013	Heart Failure
173	0.08	2013	Cardiac Function
84	0.02	2013	Quality of Life
79	0.04	2013	Prognosis
49	0.01	2013	Meta-analysis
44	0.04	2013	Chronic Congestive Heart Failure
40	0.02	2014	Ventricular Remodeling
39	0.01	2013	Brain Natriuretic Peptide
35	0.01	2014	Elderly Population

By conducting statistical analysis on the frequency and centrality of the top 10 keywords, we compiled a list of the top 10 high-frequency keywords in CHF (see Table 3). The most frequent keywords are “cardiac function,” followed closely by “quality of life” and “prognosis,” indicating significant attention to these topics. The core keyword time zone map further analyzed the research focus and trends in various time periods from 2013 to the present. As shown in Figure 5, research on chronic heart failure has shifted from focusing on the disease itself to studying its complications, mechanisms, and medications.

Top 25 Keywords with the Strongest Citation Bursts

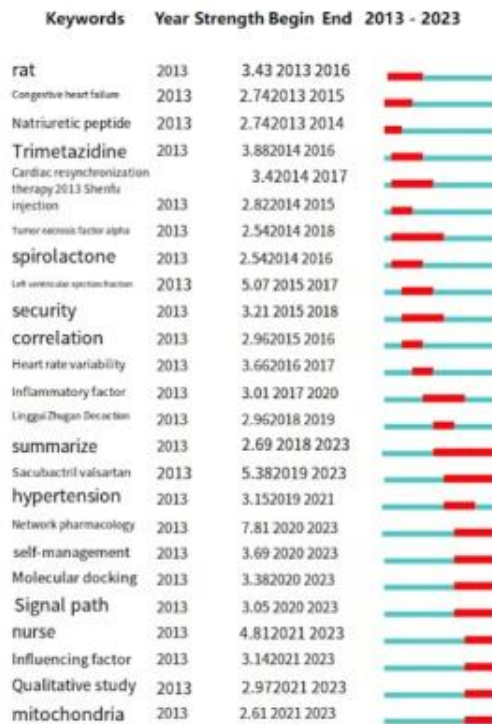


Figure 8. Keyword Emergence in CHF Research from 2013 to 2023

(3) Analysis of Research Trends

In this study, we utilized the time zone view function of CiteSpace to delve into the developmental trajectory of CHF research from 2013 to 2023. The graph displays the development and importance of keywords, as depicted in Figure 7. Notably, patient quality of life is significant in research, indicating its importance, while cardiac resynchronization therapy represents a treatment method, with its position and size indicating its significance. Prognosis indicates researchers' interest in treatment outcomes and survival rates. Since 2013, cardiac function, quality of life, and prognosis have been research hotspots. Signal pathways and RAS inhibition drugs have been recent research hotspots. On the other hand, "mutation words" reflect significant changes in the frequency and occurrence of keywords during specific time periods. Mutation intensity reflects the frequency of keyword changes and the degree of attention. Using CiteSpace's burst detection calculation tool, we plotted the top 25 mutation rate keywords from 2013 to 2018, as shown in Figure 8. The results indicate that from 2013 to 2018, research focused on mouse animal experiments, cardiac resynchronization therapy, tumor necrosis factor-alpha, and some traditional Chinese medicine. From 2018 to 2023, treatment directions shifted towards sacubitril valsartan, network pharmacology, and mechanism orientation towards signal pathways, qualitative research, and mitochondria. Since 2020, research has focused on self-management and nursing care in CHF, indicating that modern research is more concerned with patient prognosis and quality of life.

4. Discussion

CHF research has made significant progress since the early 20th century. Early studies focused on etiology and clinical manifestations, revealing coronary heart disease, hypertension, and typical symptoms such as fatigue and dyspnea [5]. Technological advancements have driven research into molecular mechanisms, uncovering the close association between changes in myocardial cell metabolism, apoptosis, fibrosis, and heart failure [6]. Approximately 26 million patients worldwide,

with China accounting for 8 million, emphasize the importance of research in improving quality of life and safety [7]. Research areas cover cardiac physiology, pathology, imaging, etc., utilizing methods such as animal models and prospective clinical research to explore treatment strategies and drug targets, aiming to provide reliable evidence for clinical practice [8]. Studies have revealed multiple signaling pathways and molecular regulatory mechanisms, such as RAAS system activation, enhanced inflammatory responses, and increased free radical production. Clinical data analysis shows that 60% of patients have abnormal RAAS activation, leading to myocardial fibrosis and worsening cardiac function [9]. 30% of patients have enhanced inflammatory responses, indicating their importance in pathogenesis. Increased free radical production exacerbates oxidative stress and cell damage. Treatment strategies include beta-blockers to improve cardiac function, aldosterone antagonists to reduce myocardial fibrosis, and cardiac transplantation and resynchronization therapy to improve survival rates [10].

In recent years, significant progress has been made in CHF research. Studies have found that myocardial cell apoptosis and inflammatory responses are crucial for disease development, providing a basis for treatment strategies. New drugs such as ARNI and SGLT2 inhibitors have shown excellent efficacy in reducing heart failure recurrence and mortality [11]. Future research will focus on genetic factors, utilizing artificial intelligence for prediction and prevention, as well as cardiac regenerative medicine, to achieve personalized medical care and disease prevention [12]. In summary, CHF research is moving towards multidisciplinary integration and comprehensive research. Future research will focus on in-depth exploration of pathogenesis, development of new treatment methods, and realization of personalized medical care. These advancements will provide more accurate and effective methods for the prevention and treatment of CHF.

5. Conclusion

In this study, we used CiteSpace 5.5R1 software to conduct visual analysis of 1907 relevant documents on chronic heart failure from 2013 to 2023, summarizing research over the past 10 years. We found that the number of publications in this field showed a trend of gradual decrease followed by an increase. This suggests that chronic heart failure has once again attracted the attention of researchers and is expected to continue to develop. Regarding the authors of the studies, there are numerous dispersed authors, with little collaboration among the top five authors in terms of publication. The level of collaboration between the main research teams is still insufficient, and the main research institutions are also relatively dispersed, indicating the need for further strengthening of cross-team and cross-institution collaboration. Through keyword analysis, we found that there is a high level of attention to the impact of cardiac function and patient prognosis and quality of life in the field of chronic heart failure. Trend analysis of research indicates that studies on chronic heart failure have shifted from focusing on the disease itself to studying the complications, mechanisms, and drugs for heart failure. Analysis of the treatment direction of research shows that early research on chronic heart failure mainly focused on mouse animal experiments, cardiac resynchronization therapy, tumor necrosis factor-alpha, and some traditional Chinese medicine. In recent years, research directions in treatment mainly focused on sacubitril valsartan and network pharmacology, while the research direction in mechanisms mainly focused on signal pathways, qualitative research, and mitochondria. Research directions from 2020 to the present mainly focus on self-management and nursing care for chronic heart failure.

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