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ORIGINAL RESEARCH

# A Bibliometric Analysis of Medication Compliance in Children with Asthma

Jing Zhao[1], Yu Ding[1], Zhiyuan Wang[2], Guo Kou[1], Sen Xu[1], Jing Tai[1], Chunrui Zhang[1], Ying Guo[1], Jun Yang[1]

[1]Department of Pediatric Intensive Care, Nanyang Second People's Hospital, Nanyang, Henan, 473012, People's Republic of China; [2]Department of Pediatric Intensive Care, The First Affiliated Hospital of Xinxiang Medical College, Xinxiang, Henan, 453100, People's Republic of China

Correspondence: Jun Yang, Department of Pediatric Intensive Care, Nanyang Second People's Hospital, No. 66, Jianshe East Road, Wancheng District, Nanyang, Henan, 473012, People's Republic of China, Tel +86 18503772257, Email yangj2024j@163.com

**Objective:** Bibliometrics was used to visualize the literature data of the current study on medication compliance in children with asthma, which can provide reference for improving the medication compliance of children with asthma.

**Methods:** Using the bibliometrix package in R4.4.1, all the research literatures related to the medication compliance of children with asthma in the WOS core database were used, and the data visualization analysis of the retrieved research literatures was carried out.

**Results:** A total of 285 research literatures on medication compliance in children with asthma were screened out. The earliest related research was published in 2009, and reaching its peak in 2019. The number of publications and citations related to medication compliance in children with asthma in the United States ranked first. J Allergy Clin Immun has 1043 citations in related journals. The analysis of cumulative publication volume shows that from 2009 to 2024, Journal of Asthma has the largest cumulative publication volume. Halterman Js is the most authoritative. The most frequently used keyword in these articles is "asthma". Statistical analysis of the high-frequency keywords in the literature on medication compliance in children with asthma showed that the top three high-frequency words were medication adherence, followed by unplanned children and childhood asthma.

**Conclusion:** The study on medication compliance in children with asthma was first published in 2009, and the research heat increased year by year. The most authoritative author in the field of medication compliance in children with asthma is Halterman Js. Journal of Asthma magazine is interested in the research field of medication compliance in children with asthma.

**Keywords:** children, asthma, medication adherence, bibliometrics

## Introduction

Bronchial asthma (asthma) is a heterogeneous disease characterized by chronic airway inflammation. It has a history of respiratory symptoms such as wheezing, shortness of breath, chest tightness and cough, with variable expiratory airflow limitation. Respiratory symptoms and intensity can change over time.[1] Asthma is a global disease. At present, there are about 300 million asthma patients in the world, and the prevalence rate is between 1% and 13%.[2] According to the 2014 edition of Global Initiative for Asthma (GINA), long-term inhaled corticosteroids are still the preferred treatment for asthma, but the level of asthma control in life is still far from the standard required by GINA. The main reason is that children cannot inhale enough drugs in time. According to foreign literature, the proportion of children with asthma who can adhere to long-term inhaled corticosteroids standard treatment varies from 18% to 65%, but most of them are less than 50%;[3] the proportion of inhaled hormone standardized treatment in children with asthma in China is only 6%, and most of them stop inhaled treatment after symptom relief.[4] According to statistics, most children in China can not be standardized treatment,[5] and in patients with inhaled corticosteroids, compliance is less than half.[6]

It has been reported in the literature that most children cannot be performed according to the treatment plan formulated by GINA, which is the main influencing factor of poor treatment compliance in children.[7,8] These include: worry about the side effects of glucocorticoids, doubts about inhalation therapy and drug effects, forgetting of various reasons, children's treatment does not cooperate, failure to master the correct inhalation method leads to poor efficacy,

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economic reasons and some iatrogenic factors.[9] The results of the asthma best control study (GOAL) showed that 50% of asthma patients achieved complete control and 80% of patients achieved partial control after one year of grading and maintenance treatment according to GINA.[10] It can be seen that the improvement of treatment compliance is beneficial to the improvement of asthma control level and clinical efficacy. Foreign surveys have found that only half of asthma patients are completely controlled and partially controlled, and only 18% of them are completely controlled.[11,12]

With the exponential growth of research literature in the field of medication compliance in asthmatic children, traditional literature review methods have limitations in systematically sorting out the law of knowledge evolution, identifying core research clusters and international cooperation dynamics. In recent years, scholars at home and abroad have paid more and more attention to the application of bibliometrics and knowledge map visualization technology to study and analyze literature data. In the environment of explosive growth of various research papers, it is particularly important to use scientific methods to summarize and analyze massive literature information. Bibliometrics, as an interdisciplinary method integrating statistics, information science and data visualization technology, can objectively reveal the research hotspots, academic influence distribution and knowledge dissemination path in the field through quantitative analysis and knowledge map construction. Through quantitative analysis of literature and drawing visual scientific maps, it can fully and detailedly display the knowledge network and development status of a certain research field. For example, high-frequency keyword clustering can identify unexplored intervention blind spots, and international cooperation network analysis can provide empirical evidence for cross-border policy collaboration.[13] Therefore, more and more medical researchers have begun to use this method to conduct statistical analysis of medical literature. The Web of science (WOS) database is the most authoritative database in the world. It contains core academic papers in various fields including medicine and is an important data source for bibliometric analysis. The development of software such as VOSviewer and CiteSpace and software packages such as Bibliometrix provide important tools for bibliometrics. VOS viewer and CiteSpace are visualization software developed by the University of Leiden in the Netherlands and Professor Chaomei Chen, a Chinese-American. Bibliometrix is a software package based on R language developed by Dr. Massimo Aria and others in Italy.[14]

Traditional reviews mostly focus on the analysis of clinical intervention effects, but lack systematic review of global research trends, core cooperation networks and knowledge evolution paths. For example, the relevance of regional challenges to global research hotspots has not been explored in depth. Although the application of bibliometrics in the medical field is gradually increasing, the study of compliance in children with asthma still relies on small-scale clinical data, and there is a lack of evidence based on large-scale literature data to support cross-border policy collaboration. This study integrated the global 28-year research data for the first time through bibliometric methods, aiming to fill the above gaps: reveal the imbalance of knowledge structure in the field, and provide a data-driven decision-making framework for regional intervention strategies. Therefore, this study will summarize the relevant information about the main core institutions and authors in this field, conduct in-depth analysis of all the literature collected and collated, and carry out systematic data mining. Based on the visual knowledge map, the research status of medication compliance in children with asthma will be displayed intuitively and vividly, and the research upsurge in this field will be displayed. Looking forward to the future development trend of this field, it will provide information support for promoting the medication compliance behavior of children with asthma and improving the clinical nursing system of children with asthma in China.

## Research Data and Methods
### Data Source
The literature on medication compliance in children with asthma was derived from Science citation Index Expanded (SCI-expand) in the WOS core database. All English literatures were retrieved with the keywords of "asthma", "children", "child" and "Medication adherence". The release date was set to end on October 1, 2024. The literature type was set to be original research, that is, "Article" or "Review Article". The search results were stored in text format, and the information of countries, institutions, authors and publication time of all literatures were included. Repetitive papers, conference papers, reports and incomplete information are excluded.

## Descriptive Analysis

The bibliometrix package in R 4.4.1 was used to analyze the annual number of publications related to medication compliance in children with asthma, as well as the number of relevant publications and related citations of countries, institutions, authors, journals and literatures. The data analysis of high-frequency keywords also used the bibliometrix package, which was visually presented as a word cloud map and a tree map.

## Collaborative Network Analysis and Keyword Co-Occurrence Analysis

The bibliometrix package in R4.4.1 was used to analyze the cooperation relationship between the authors of the literature on medication compliance in children with asthma and to draw the cooperation network, time axis and density map, and to analyze and draw the keyword co-occurrence network map. The larger the number of related posts is, the larger the node is, the closer the node is, the wider the connection is, and the node shows the same color to indicate similar types or close cooperation.

# Results

## Global Annual Publication

After searching and screening in the WOS website, 285 English literatures related to medication compliance in children with asthma were obtained, and there was no repeated literature. Finally, 285 English literatures related to medication compliance in children with asthma were included for analysis.

The research on medication compliance of children with asthma in Web of science was first published in 2009. Since 2011, the number of related publications has increased rapidly. In 2012, 2014, 2019 and 2023, there were four peaks respectively, and the overall number of publications showed a fluctuating increase. The number of related papers peaked at 30 in 2019, and the number of related papers had declined in the following two years, but the direction of heat is still high, which had great research value and development potential (Figure 1).

## Countries (Regions) Issued and Cited

The number of publications, the number of single country publications (SCP), the number of multiple country publications (MCP) and the number of citations related to medication compliance in children with asthma in the countries (regions) of the corresponding authors were counted. A total of 29 countries (regions) contributed to this research field
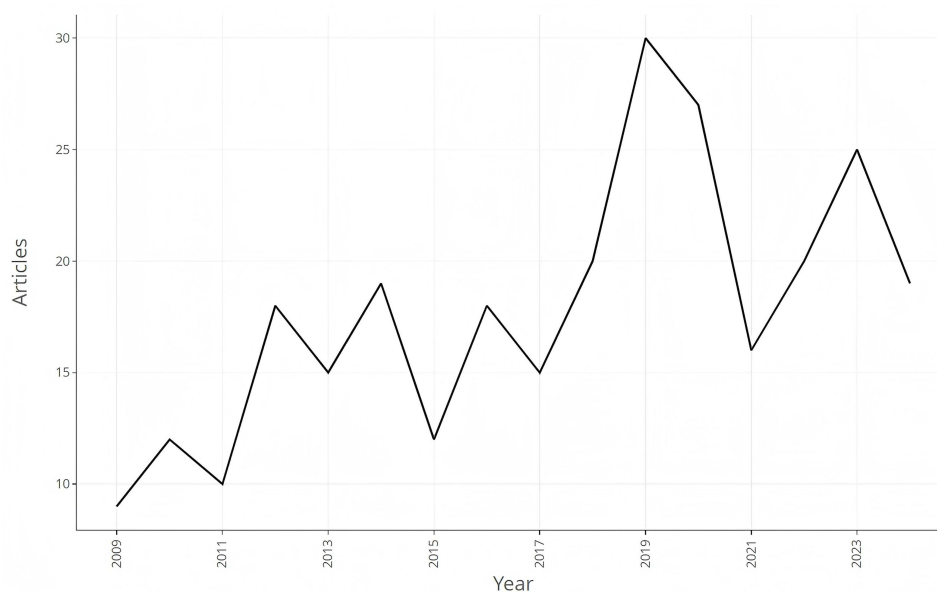


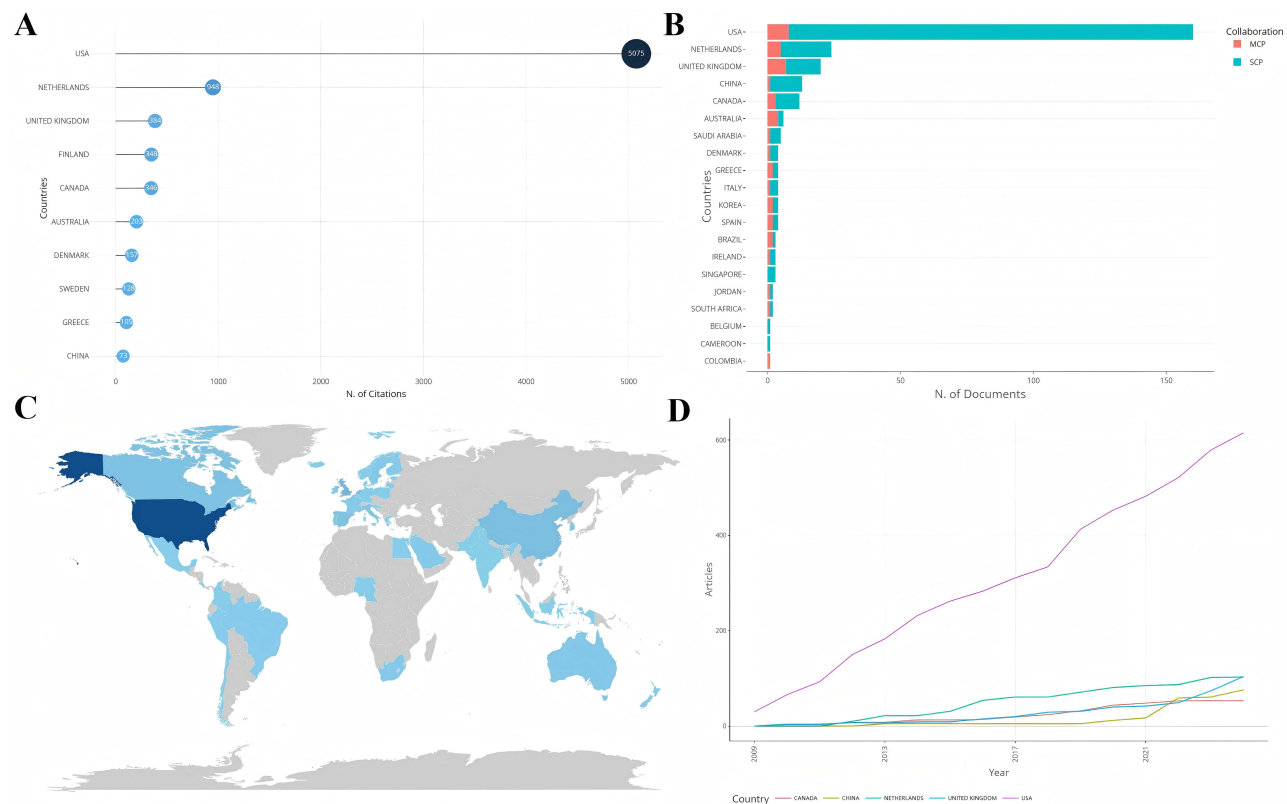**Figure 1** Literature on medication compliance in children with asthma.

**Figure 2** The publication and citation of countries. (**A**) the top ten countries cited in the relevant literature; (**B**) SCP and MCP publications; (**C**) national distribution map; (**D**) The cumulative growth of the article over time.

(see Figure 2 for the map of national publications, the deeper the color, the more articles). Table 1 is the top ten countries in terms of the number of related publications. Among them, the United States ranks first with 160 related publications, and China ranked fourth with 13 related publications. Figure 2A shows the top ten countries in terms of relevant citations, with the United States ranking first (relevant citations: 5075) and the Netherlands ranking second (948). Chinese related publications ranked fourth in the world, while the number of citations ranked only 10, indicating that Chinese international recognition and influence in this research field still need to be improved. Most of the documents

**Table 1** The top ten countries in the number of related publications

| Rank | Country | Reference | SCP | MCP | MCP Ratio (%) |
|------|---------|-----------|-----|-----|---------------|
| 1 | America | 160 | 152 | 8 | 5.0 |
| 2 | Netherlands | 24 | 19 | 5 | 20.8 |
| 3 | United Kingdom | 20 | 13 | 7 | 35.0 |
| 4 | China | 13 | 12 | 1 | 7.7 |
| 5 | Canada | 12 | 9 | 3 | 25.0 |
| 6 | Australia | 6 | 2 | 4 | 66.7 |
| 7 | Saudi Arabia | 5 | 4 | 1 | 20.0 |
| 8 | Denmark | 4 | 3 | 1 | 25.0 |
| 9 | Greece | 4 | 2 | 2 | 50.0 |
| 10 | Italy | 4 | 3 | 1 | 25.0 |

published by countries with the highest number of publications, such as the United States, the Netherlands and the United Kingdom, were SCP. The MCP ratio showed that countries such as Australia had more cooperation with other countries around the world (Figure 2B, 2C and Table 1). The cumulative growth of the article over time showed that the United States had the fastest growth rate and was much higher than other countries (Figure 2D).

## Periodicals Published and Cited

Statistical analysis was performed on journals that published literature on medication compliance in children with asthma. The top ten journals with relevant citations are shown in Figure 3A, of which J Allergy Clin Immun ranked first with 1043 local citations. The analysis of the journals with the largest number of articles on medication compliance in children with asthma showed that Journal of Asthma had the largest number of articles related to the topic of this study, and 56 articles were published in this journal (Figure 3B). The analysis of the influence of each journal showed that Journal of Asthma had the highest influence (H index is 17, Figure 3C). The cumulative number of articles published in each journal was analyzed. The results showed that from 2009 to 2024, the cumulative number of articles published by Journal of Asthma was the first, which was much higher than that of other journals (Figure 3D); The results of Bradford's Law curve show that a small number of journals have published a large number of relevant research articles, which is consistent with the distribution of Bradford's Law (Figure 3E).

## Citation of Articles

The citations of literatures related to medication compliance in children with asthma were statistically analyzed, and the top 10 articles are shown in Figure 4. Among them, the top three articles in the global cited ranking were from the journals of Am J Resp Crit Care (493 times), Eur Repir J (348 times), Resp Med (348 times) (Figure 4A); the top three local cited articles were from journals: Eur Respir J (44 times), J Allergy Clin Immun (31 times), Curr Allergy Asthm R (29 times), see Figure 4B; The most frequently cited literature in each article was Mcquaid El, 2003, J Pediatr Psychol, V28, P323, DOI 10.1093/PEPSY/JSG (Figure 4C); the citation cluster analysis of each article showed that it is mainly divided into three categories (Figure 4D).

## Issuance of Agency Papers

A total of 518 institutions had contributed to this field. The top ten institutions are shown in Figure 5A, and the top five are JOHNS HOPKINS UNIVERSITY (33), UNIVERSITY OF ROCHESTER (33), HARVARD UNIVERSITY (25), UNIVERSITY OF GRONINGEN (23), UNIVERSITY OF MASSACHUSETTS SYSTEM (21). The trend of the number of papers published by the top 5 institutions over time is shown in Figure 5B. Among them, JOHNS HOPKINS UNIVERSITY, HARVARD UNIVERSITY and UNIVERSITY OF ROCHESTER were the first to publish papers, and the number of papers gradually increased over time.

## The Author's Posting Situation

A total of 1372 authors have contributed to this field. The top ten authors in the number of articles published are shown in Figure 6A, and the top three were HALTERMAN JS (10 articles), RHEE H (9 articles), FELDMAN JM (8 articles); in the ranking of local citations, JANSSENS HM ranked first with a citation frequency of 72 (Figure 6B). HALTERMAN JS ranked first in the author's influence ranking (H index) (Figure 6C); the changes in the number of papers published by the authors over time show that since 2012, more articles have been published by authors (Figure 6D); Figure 6E shows that most of the authors are from the United States, followed by the Netherlands and the United Kingdom. The most frequently used keyword in these authors "articles" is "asthma"; The results of the Lotka's Law curve showed that a small number of authors had published a large number of relevant research articles, which was consistent with the distribution of Lotka's Law (Figure 6F).

## Analysis of Author and Country Cooperation Network

A collaborative network analysis was conducted on the included authors. The results showed that there were a total of 10 cooperative groups, among which the intra-team cooperation of koster es, halterman js, feldman jm, etc. was the closest. The cooperation between the teams was relatively independent, and the cooperation between each other was less
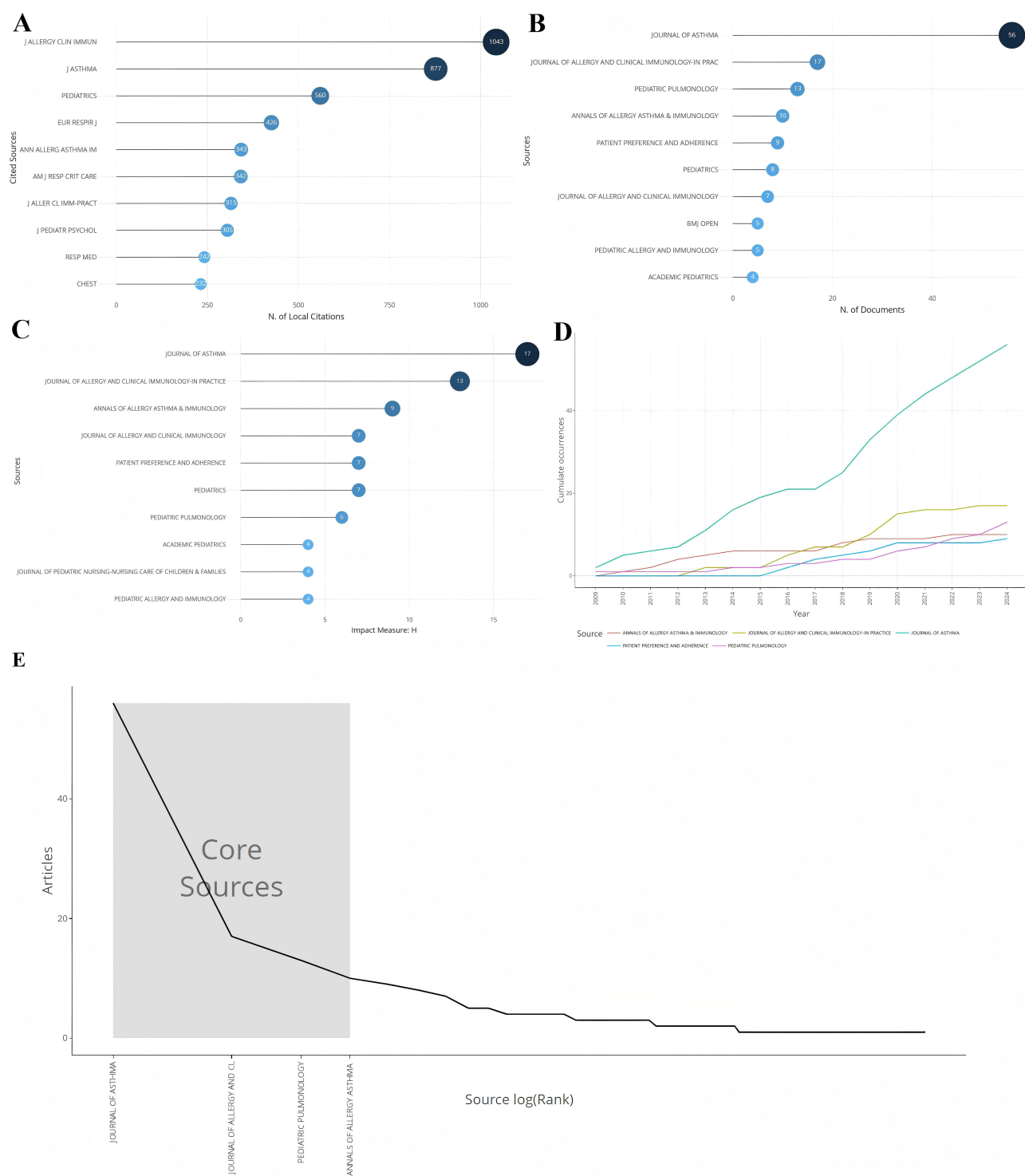
**Figure 3** Journals published and cited. (**A**) Citation ranking of each journal; (**B**) the number of publications in each journal; (**C**) the ranking of the influence of each journal; (**D**) The cumulative number of publications in each journal changes over time; (**E**) Results of Bradford's Law analysis.

(Figure 7A). The national cooperation map showed that the United States had the strongest connection with other countries. In this cooperation network centered on the United States, the United Kingdom, Australia, and Canada had the closest cooperation with the United States (Figure 7B).
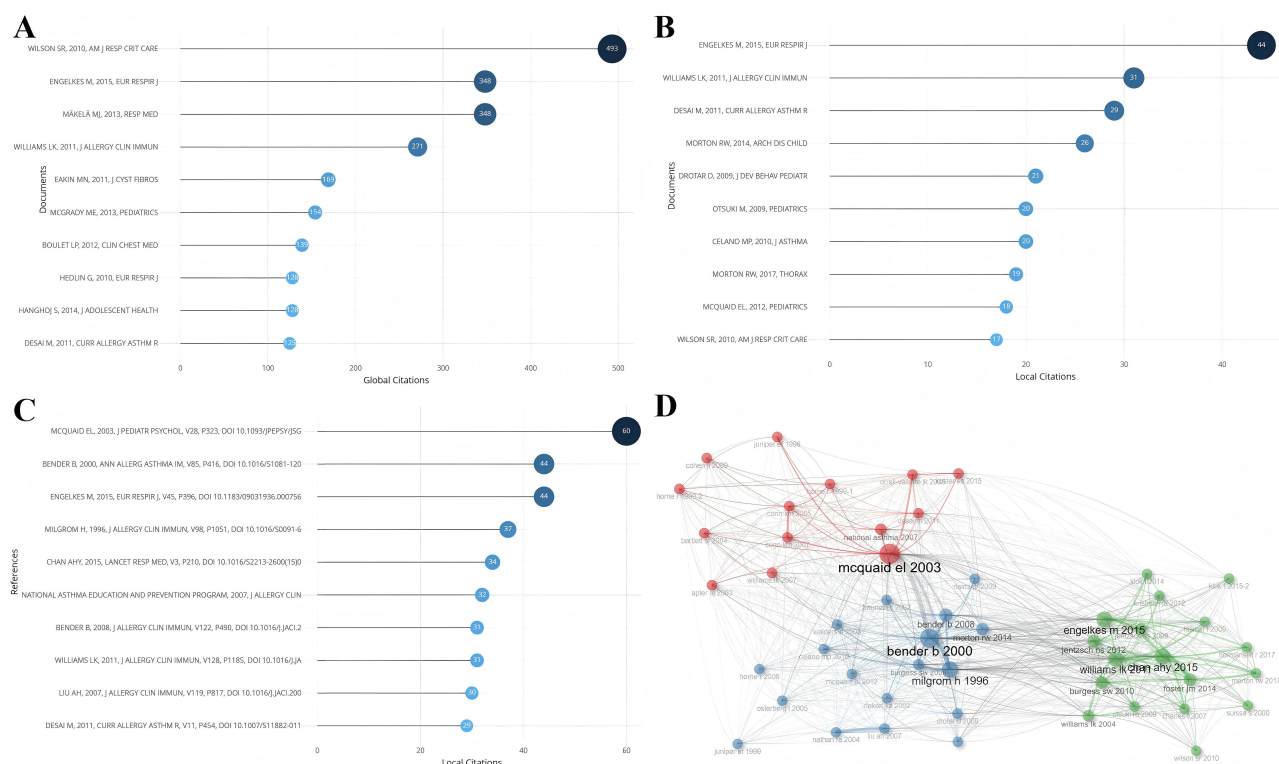
**Figure 4** (**A**) Ranking of the most cited articles in the world; (**B**) ranking of the most cited articles in the local; (**C**) the most cited literature in each article; (**D**) Citation network clustering analysis.
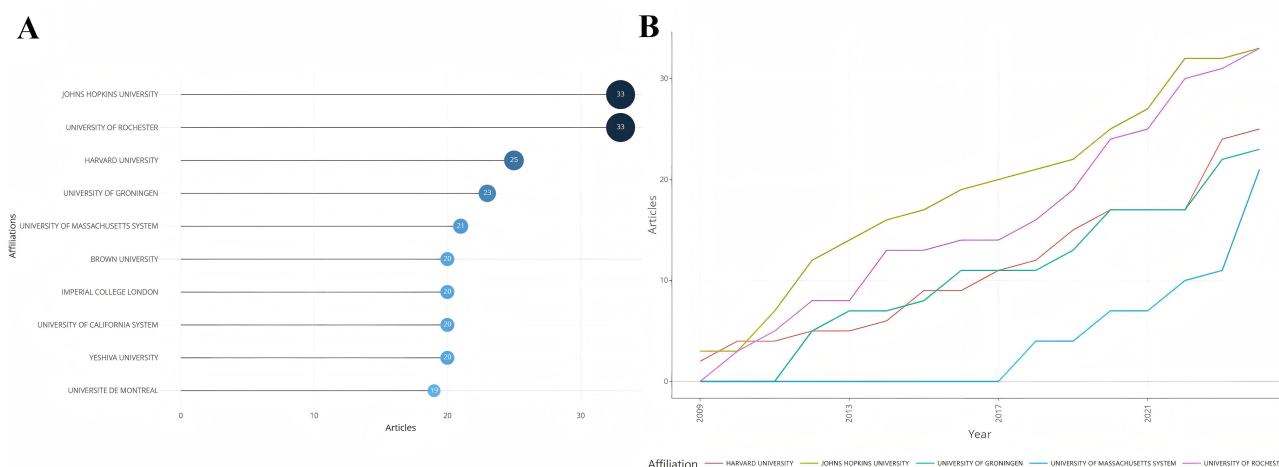


**Figure 5** The situation of institution publication. (**A**) Ranking the number of institutional publications; (**B**) The changes in the number of papers issued by the top 5 institutions over time.

## High-Frequency Keyword Analysis

Keywords were the extraction of key information from a literature. By understanding the high-frequency keywords in related research, the core and hot spots in this research field can be roughly inferred. The high-frequency keywords in the literature related to medication compliance of children with asthma were statistically analyzed, and the word cloud map (Figure 8A) and tree map (Figure 8B) were drawn. The larger the area of the keywords, the higher the frequency of occurrence. As shown in the figure, the top three high-frequency words were medication adherence (127 times, 10%), followed by unplanned children (124 times, 10%) and childhood asthma (61 times, 5%).
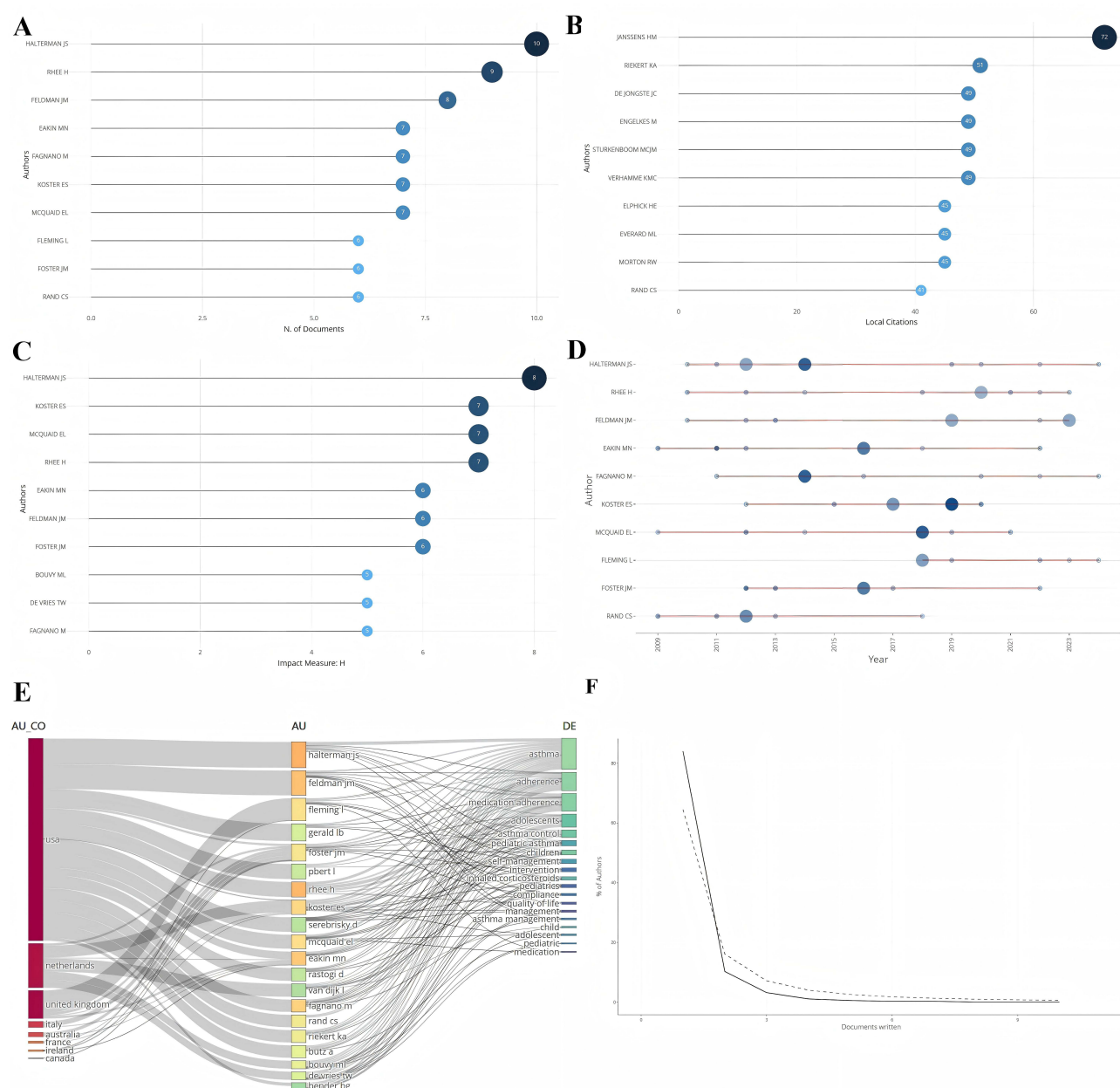
**Figure 6** The author's publication. (**A**) Ranking of the number of publications; (**B**) local citation ranking; (**C**) influence ranking (H index); (**D**) the change of the author's volume over time; (**E**) the author 's country and the keywords used in the article (the left side is the country name, the middle is the author name, and the right side is the keyword name); (**F**) Results of Lotka's Law analysis.

## Keyword Co-Occurrence Network

Co-occurrence analysis was performed on 670 keywords in the literature related to medication compliance in children with asthma. The co-occurrence network and clustering were divided into three categories, as shown in Figure 9. Clustering 1 namely children and medication adherence, etc.; cluster 2 was pediatric asthma, etc.; cluster 3 were impact, urban children, etc.

## Discussion

Bronchial asthma is a chronic airway inflammation as the core of the disease, characterized by airway hyperresponsiveness and allergic reactions, involving a variety of inflammatory cells mediated airway structural remodeling.[15] Glucocorticoid, as a core anti-inflammatory drug, forms a complex into the nucleus through cell receptor binding and
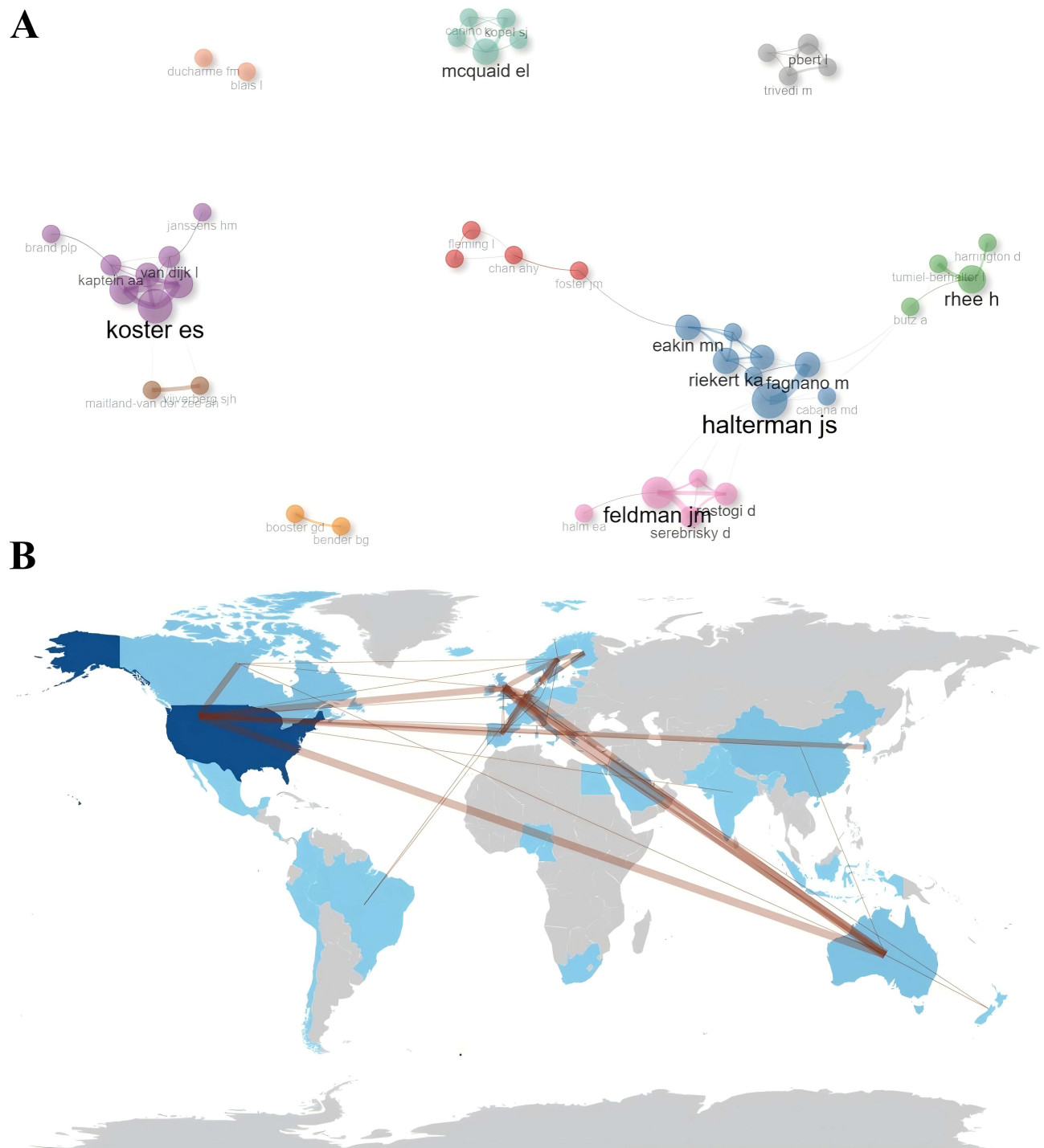
**A**



**B**



**Figure 7** (**A**) Author cooperation network diagram; (**B**) National cooperation network diagram.

regulates gene transcription: (1) inhibits inflammatory cell activation and cytokine/mediator production; (2) enhance the β2-adrenoceptor reactivity of airway smooth muscle; (3) Promote the synthesis of anti-inflammatory proteins, ultimately reduce airway hyperresponsiveness and achieve anti-inflammatory effects.[16]

The World Health Organization (WHO) has formulated the Global Initiative for Asthma (GINA), which proposes long-term, continuous, standardized and individualized treatment principles, and points out that the preferred method of asthma treatment is inhaled corticosteroids (ICS), which is the first-line drug for acute asthma attack and long-term

**Figure 8** High frequency keyword analysis. (**A**) Word cloud map; (**B**) Keyword tree diagram.

control of asthma, and long-term standardized inhaled corticosteroids can effectively control asthma. However, at present, both at home and abroad, asthma patients have low compliance with inhaled ICS treatment, and the longer the patient's treatment time, the lower the compliance. A survey of children with recurrent wheezing treated with inhaled glucocorticoids for 12 weeks showed that without intervention, the compliance of children with inhalation therapy at 4,8, and 12 weeks was 62.86%, 51.42%, and 40.00%, respectively. After a certain intervention, the compliance of the children was 86.67%, 76.67%, and 66.67%, respectively. Although the treatment compliance of the intervention group was slightly higher than that of the non-intervention group, the overall compliance was still low and showed a downward trend.[17,18]

ICS treatment compliance in children with asthma was affected by multiple factors: (1) treatment factors, patient factors, medical factors; (2) parents' concerns about the side effects of hormones often lead to only acute-phase medication. According to the survey,[19] only 66.6% of patients regularly use ICS, and more than 90% have cognitive misunderstandings. However, studies have confirmed that ICS works locally through the respiratory tract and has good

**Figure 9** Keyword co-occurrence network.

long-term safety. It is recommended to standardize follow-up, strengthen education, emphasize the local anti-inflammatory advantages of ICS and correct gargling to prevent oral fungal infection, which can effectively improve treatment compliance.

The United States' leading position in the number of publications and citations may be due to its long-term research investment, cross-agency cooperation networks, and policy tilt in child health research. In contrast, although China has a higher number of publications, the number of international citations is significantly lower. This may be related to the limitations of regional research topics, insufficient international cooperation (MCP ratio is only 7.7%), and language barriers. This difference suggests that developing countries need to strengthen transnational cooperation and enhance the global dissemination of research results.[20]

The co-occurrence of high-frequency keywords "medication adherence" and "unplanned children" revealed the core contradiction in the field: compliance, as a key indicator of asthma control, often fluctuates due to sudden symptoms. This contradiction highlights the shortcomings of current intervention strategies - over-reliance on technical means, while ignoring the dynamic management of family behavior. For example, the emergence of "unplanned children" indicates that adaptive interventions for emergencies have not yet formed a systematic research cluster.

The keyword clustering showed that the research hotspots had long been focused on "drug treatment technology", while social and cultural factors only appeared sporadically. This is consistent with the stagnation of global asthma control rate, suggesting that behavioral economics and public health perspectives need to be integrated in the future to develop a family-community linkage intervention model.

The high number of papers and H index of "Journal of Asthma" reflect its status as an authoritative platform in the field, but its research topics focus on clinical intervention, which may ignore the impact of structural factors on compliance. In contrast, "J Allergy Clin Immun" was cited the first, but it focused more on pathological mechanisms than on practical strategies. This discipline preference may lead to the disconnection between research results and first-line nursing needs.

The findings of this study offer actionable insights for improving asthma management in clinical practice and public health policy. First, the identification of "medication adherence" and "unplanned children" as dominant keywords

highlights the urgent need for personalized intervention strategies. Second, the fragmented international collaboration network underscores the potential for knowledge transfer between high-MCP countries and regions with limited resources. Adopting standardized protocols from the Netherlands could bridge gaps in low-MCP regions like China. Furthermore, the persistent misconceptions about ICS safety call for targeted educational campaigns using visual tools to demonstrate ICS's localized action and safety profiles.

At present, there are still many articles published every year on the medication compliance of children with asthma. The time of publication of the literature can reflect the academic research process and development speed in this field to some extent. According to the results of this study, it is reasonable to believe that the study of medication compliance in children with asthma will continue and dynamically, so this study has further significance and value.

Of course, influenced by some objective factors, this study also has some limitations. First of all, bibliometric analysis has high norms and standards for data. Therefore, in order to ensure the quality and integrity of the collected data, this study only selects the journal articles in the SCI index of the core collection of Web of science database, excluding other databases (such as Scopus), which will inevitably lead to the problem that the analysis data is not comprehensive enough. In addition, quantitative analysis needs to analyze and interpret the data, which requires researchers to have a more in-depth and comprehensive understanding of the field, otherwise there will inevitably be some subjectivity. In the future, we should expand data inclusivity by integrating non-English databases and grey literature to capture underrepresented regions, especially low- and middle-income countries. Developing AI-driven adherence tools that combine bibliometric insights with real-world behavioral data to predict high-risk cohorts and personalize interventions. Implementing policy-driven studies to evaluate the efficacy of national asthma registries and cross-border collaborations inspired by successful models like the GOAL trial. Addressing these priorities will transform fragmented research efforts into a cohesive, patient-centered framework for global asthma control.

## Conclusion

In summary, the results of this study show that the study of medication compliance in children with asthma was first published in 2009, and the research heat has increased year by year. The most authoritative author in the field of medication compliance in children with asthma is Halterman Js. Journal of Asthma magazine is interested in the research field of medication compliance in children with asthma. The most concerned topics in the study of medication compliance in children with asthma over the years were medication adherence, unplanned children and childhood asthma.

## Data Sharing Statement

All data generated or analysed during this study are included in this article. Further enquiries can be directed to the corresponding author.

## Ethics Approval and Consent to Participate

This study was conducted in accordance with the Declaration of Helsinki and approved by the ethics committee of Nanyang Second People's Hospital (LY20230101).

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## Disclosure

All of the authors had no any personal, financial, commercial, or academic conflicts of interest separately.

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