Research article

Research hotspots and trends in biological agents for psoriasis: Visualization and bibliometric analysis

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A B S T R A C T

Psoriasis is a global health concern, and biological therapies have proven to be highly effective in treating psoriatic patients in many countries. We performed a bibliometric analysis of current research on biological agents for the treatments of psoriasis, investigating research patterns and public interest in this area. We conducted a thorough review of articles on biological agents for psoriasis in the Web of Science Core Collection spanning from 2000 to 2022. Our study involved examining the distribution of these articles based on publication year, affiliations, countries, authors, and journals. To visualize this data effectively, we employed bibliometric tools like CiteSpace and the R package bibliometrix. Our analysis encompassed 8,047 publications. The number of papers published sharply increased from 2009, either reaching its peak in 2022 or not yet reaching it. The United States (n = 2,292), Kristian Reich (n = 166), and *British Journal of Dermatology* (n = 368) emerged as the top countries, author, and journal, respectively, in terms of publication productivity. The burst references predominantly focused on evaluating the safety and efficacy of biological treatments. The keyword citation network identified 11 clusters, with research themes revolving around "double blind", "efficacy", "therapy", "safety", and "psoriatic arthritis" were the research focuses. Additionally, potential future research areas such as "multicenter," "drug survival," and "severity" were emphasized.

This study sheds light on the evolving research landscape and public interest in biological agents for psoriasis. The results suggest rapid expansion in this field, with the United States at the forefront. Enhanced international collaboration is recommended, and forthcoming research endeavors may concentrate on predicting treatment outcomes and adverse effects. Researching new biological agents, broadening the indications for biological agent treatment, and creating personalized treatment plans may pave the way for further research.

1. Introduction

Psoriasis is a long-lasting autoimmune condition that impacts a considerable number of individuals in the general population [1]. The occurrence of psoriasis differs across different regions, with higher prevalence rates observed in Europe and North America (3–4%), while lower rates are seen in Asia and Africa [2]. The disease is more common in high income countries and in regions with

older populations [3]. The emergence of psoriasis is influenced by a blend of genetic and environmental triggers. Various treatment options have been developed for psoriasis, including topical creams, phototherapy, and systemic medications. These conventional therapies often show limited efficacy and present serious side effects. [4].

In recent years, biological agents have emerged as a promising therapeutic approach, offering a more targeted approach to managing the disease. Biologics are specifically engineered to target certain molecules in the immune system that are involved in the progression of psoriasis, such as tumor necrosis factor-alpha (TNF-α), interleukin-12 (IL-12), interleukin-23 (IL-23), and interleukin-17 (IL-17), and can reduce inflammation and severity of psoriasis by blocking these molecules.

Bibliometric analysis is a quantitative method used to analyze the literature on a particular topic. It can be used to identify and display the most influential articles, institutions, and countries in a particular field. Moreover, utilizing visualization techniques on a large sample size can offer valuable insights into research gaps and future directions [5]. In this research, we performed a thorough bibliometric analysis to shed light on current research topics and popular public concerns in biological agents for treating psoriasis.

2. Results

2.1. Overview of publications

A total of 8,047 articles were retrieved on this topic (including 1858 review articles and 6189 research papers), with an average of 35.09 citations per item. The bar chart in Fig. 1a illustrates the yearly distribution of publications over time. Between 2000 and 2007, there was a consistent growth in the number of publications without any distinct research patterns, followed by a period of stability. Subsequently, there was a significant surge in publications from 2008 to 2020, with minimal fluctuations in the last two years. Fig. 1b shows the total cumulative number of publications as a plot. From 2000 to 2009, there was a relatively slow increase in the cumulative number of publications, with a sharp increase from 2009 onwards, potentially reaching its peak in 2022 or in the near future.

Regarding geographical distribution, a total of 8,047 documents were published across 98 countries and regions. The study categorized these documents by country and represented the spatial distribution through a heatmap (Fig. 2). Table 1 displays the top 10 most productive countries. The United States has the highest number of publications among all countries (2292 publications), far surpassing Italy (786 publications) and China (775 publications). In terms of citations, the United States was significantly ahead of Italy and China, which had notably fewer citations per publication. According to the country collaboration map (Fig. 3), it is evident that the USA leads in collaborating with 73 countries in publishing articles, followed by Germany with 64 countries and Italy with 56 countries. The most common countries to collaborate with the USA include Canada (458 articles), Germany (405 articles), and the United Kingdom (342 articles).

2.2. Analysis of prominent organization and public sources

In terms of prominent organizations and public sources, universities and research institutions were the most common among the top 30 prolific organizations. (Fig. 4). The most prolific organization was University of California System (428 publications), followed by the Icahn School of Medicine at Mount Sinai (303 publications) and the Johnson & Johnson (257 publications). Half of the top 10 productive institutions (University of California System, Icahn School of Medicine at Mount Sinai, Johnson & Johnson, Harvard University, Eli Lilly) were from the United States. Icahn School of Medicine at Mount Sinai and Tufts Medical Center from the USA were ranked the strongest co-operations.

Our research involved a thorough examination of 950 journals focused on biologics therapy for psoriasis. Through this examination, we were able to identify the top 10 most productive journals and compile their impact factor and h-index in Table 2. The *British*
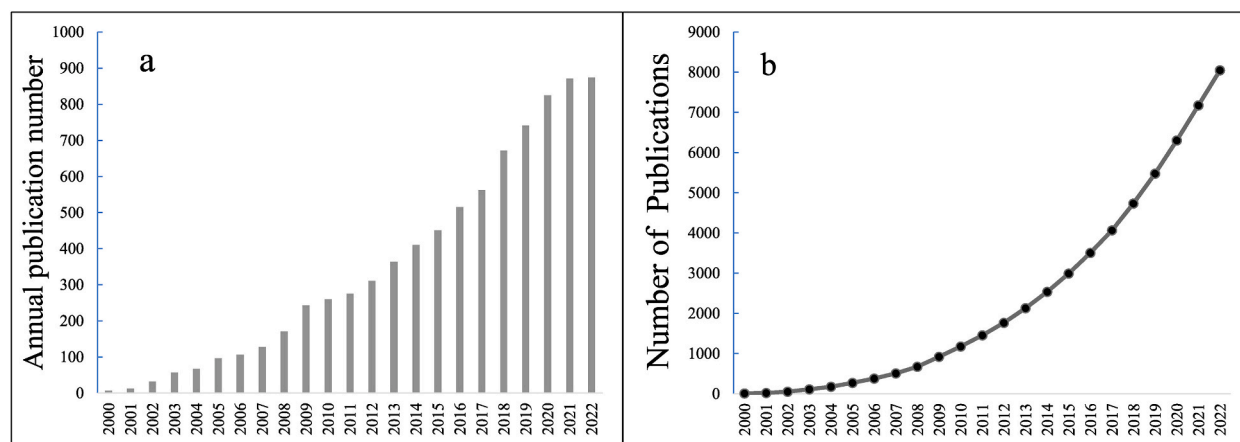

Fig. 1. Distribution of publications over the years. (a) The annual number of publications and (b) the cumulative number of publications on biological therapies for psoriasis.
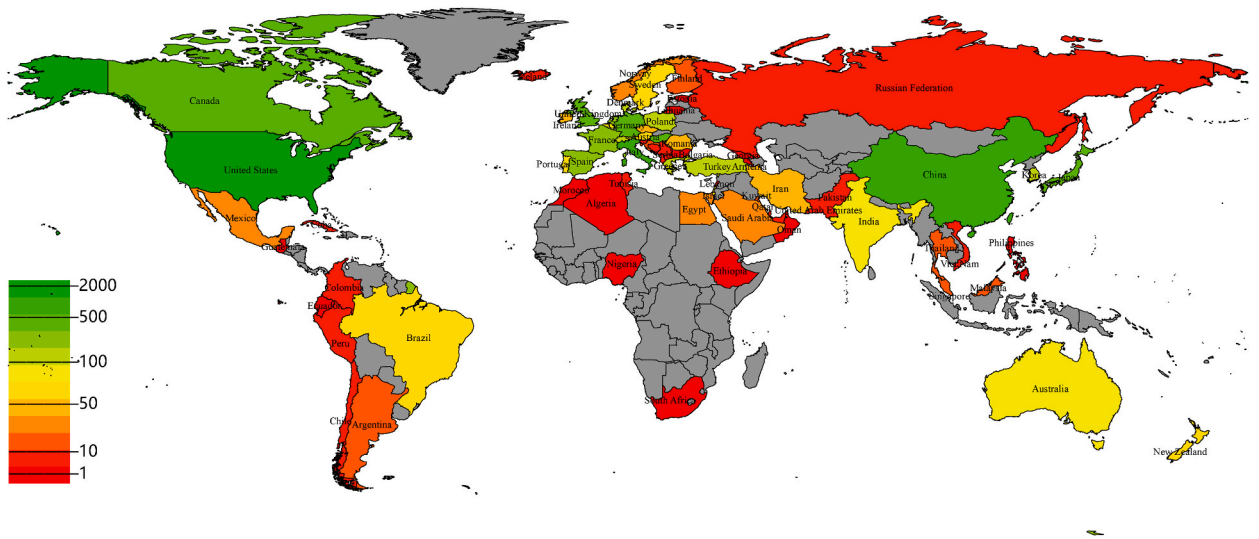
Fig. 2. The global distribution of publications is represented geographically, using a green-to-red gradient to indicate the varying number of publications. Countries with no publications are depicted in gray. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

Table 1
Top 10 most productive countries and regions.

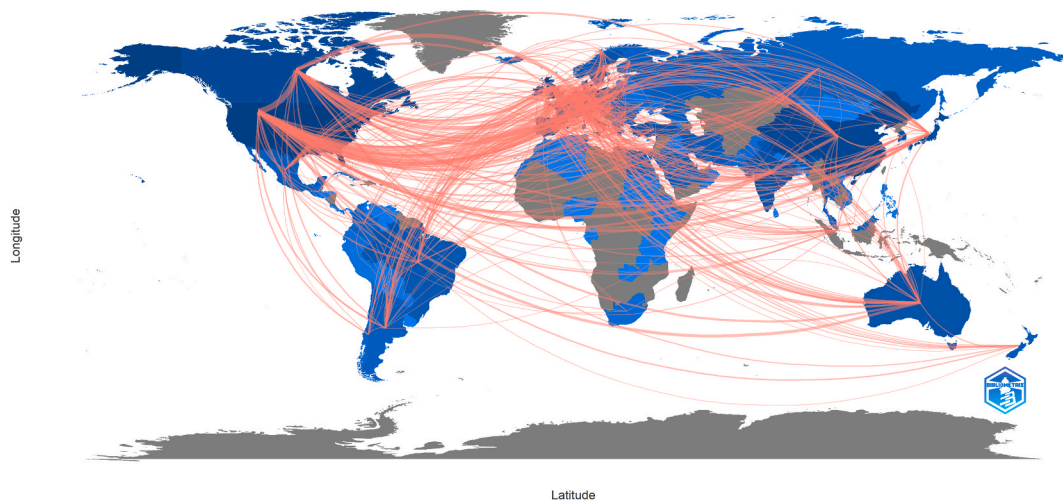| Rank	Country/region	Publications	Citations	Citations per publication
1	United States	2292	120,526	52.60
2	Italy	786	16,275	20.70
3	China	775	12,629	16.30
4	Germany	506	21,594	42.70
5	Japan	402	10,252	25.50
6	England	376	19,264	51.20
7	Canada	354	14,871	42.00
8	Spain	297	6232	21.00
9	France	234	9478	40.50
10	Netherlands	192	10,092	52.60

Country Collaboration Map

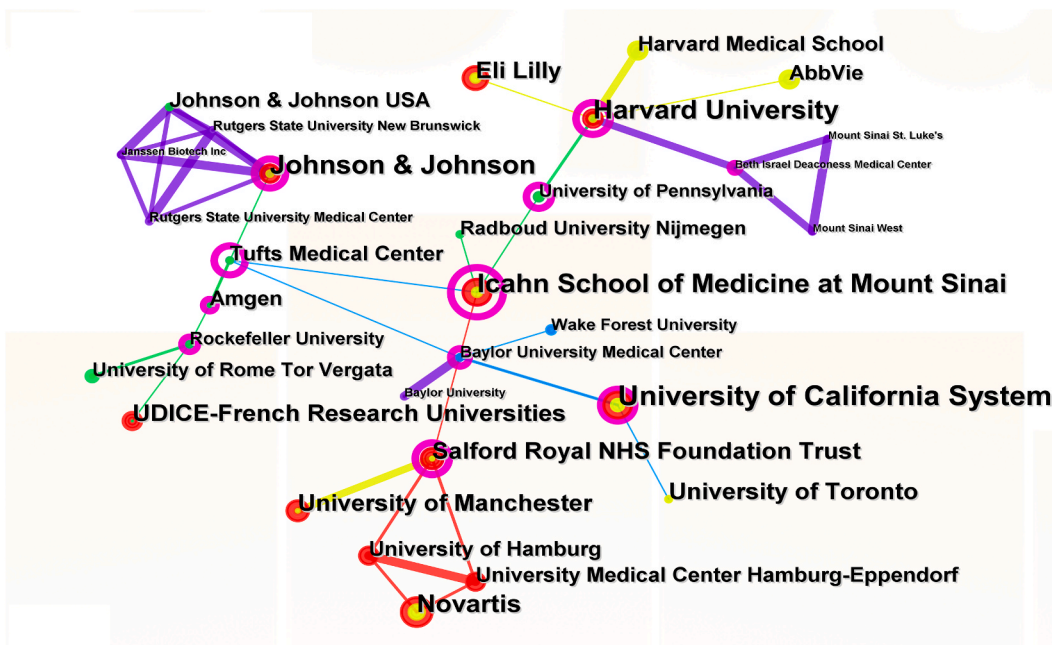**Fig. 3.** Country collaboration map.

Fig. 4. Coauthorship analysis of organizations.

Journal of Dermatology, with an impact factor of 11.113 and 368 publications, was found to be the most productive journal in this field. *The Journal of Dermatological Treatment* (363 publications, IF 3.23) and the *Journal of The European Academy of Dermatology and Venerology* (312 publications, IF 9.228) were the second and third most productive journals, respectively. Our results indicate that the *British Journal of Dermatology* holds the highest influence in the realm of biologics therapy for psoriasis. It is worth noting that all 10 journals included in our analysis were from developed countries in Europe and America.

2.3. Core authors

Our study analyzed the works of 26,466 authors and assessed their productivity by considering the quantity of published total citations, documents and H-index, presented these findings in Table 3 and Fig. 5, which illustrate the authors' production over time. Our analysis identified Kristian Reich from Germany as the prolific author in this area, having published 166 articles and received 8,317 citations. Alice B Gottlieb, a professor at the Icahn School of Medicine at Mount Sinai, closely followed with 162 publications and 6,928 total citations. Steven R Feldman from Wake Forest University also had a strong publication record, with 158 publications and 3,277 total citations. Notably, five of the top 10 cited authors were affiliated with institutions in the United States, indicating the country's prominent role in this research area.

2.4. Keywords and burst terms analysis

A co-occurrence map that displays the relationships between keywords based on how often they appear together in the dataset. In

Table 2
Top 10 most prolife journals.

Rank	Journal	Publications	h-index	Impact factor (2022)	JCR[a]
1	*British Journal of Dermatology*	368	75	11.113	Q1
2	*Journal of Dermatological Treatment*	363	32	3.23	Q2
3	*Journal of The European Academy of Dermatology and Venerology*	312	50	9.228	Q1
4	*Journal of The American Academy of Dermatology*	284	79	15.487	Q1
5	*Dermatologic Therapy*	267	28	3.858	Q2
6	*Journal of Dermatology*	184	32	3.468	Q2
7	*Journal of Investigative Dermatology*	183	75	7.59	Q1
8	*Journal of Drugs in Dermatology*	181	27	1.608	Q4
9	*Dermatology And Therapy*	157	19	3.661	Q2
10	*Dermatology*	121	32	5.197	Q1

[a] JCR, Journal Citation Reports.

Table 3

Top 10 core authors by number of publications.

| Rank	Authors	Organizations	Publications	Local Citations	h-index
1	Kristian Reich	University Medical Center Hamburg-Eppendorf (Germany)	166	8317	56
2	Alice B Gottlieb	Icahn School of Medicine at Mount Sinai (USA)	162	6928	58
3	Steven R Feldman	Wake Forest University (USA)	158	3277	36
4	Christopher E M Griffiths	Salford Royal NHS Foundation Trust (UK)	133	5572	44
5	L Puig	Hospital Universitari Arnau de Vilanova (España)	127	3796	38
6	Andrew Blauvelt	Oregon Medical Research Center (USA)	124	4853	43
7	Alan Menter	Baylor Scott & White University (USA)	122	7165	49
8	James G Krueger	The Rockefeller University (USA)	117	6224	62
9	Richard B Warren	University Medical Center Hamburg-Eppendorf (Germany)	113	1611	34
10	Kim A Papp	K Papp Clinical Research and Probity Medical Research (Canada)	104	6387	44
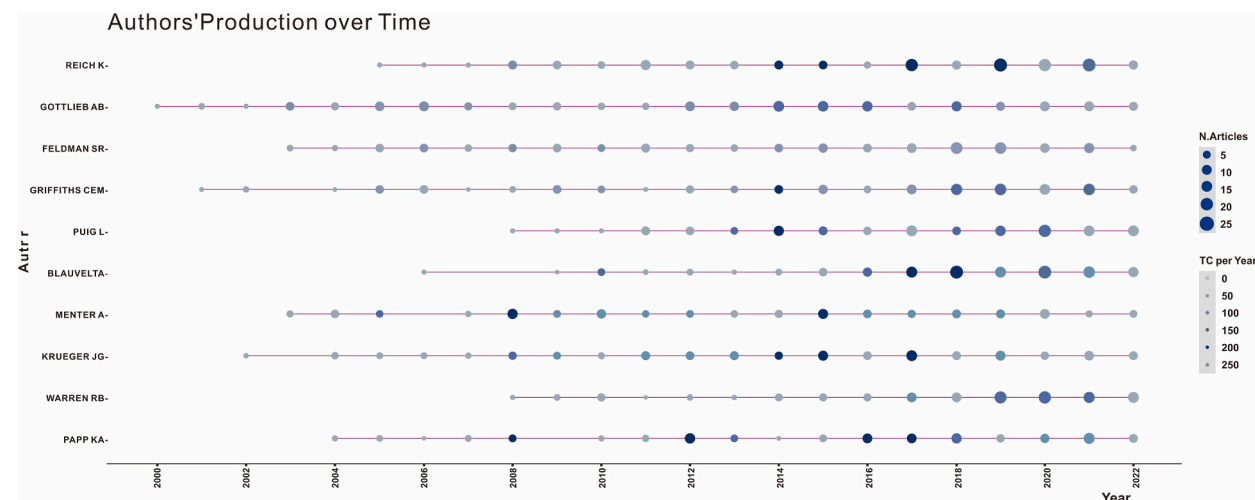
Fig. 5. Overlay visualization of the top ten authors' productions over time.

Fig. 6, the overlay visualization showcases the top 104 co-occurrence keywords. The most frequently appearing keywords include "double blind" (n = 1740), "efficacy" (n = 1312), "therapy" (n = 1101), "safety" (n = 1080), and "psoriatic arthritis" (n = 743). Fig. 7 depicts a timeline map of keywords with a frequency exceeding 5 from 2000 to 2020. The arrangement of each keyword in the time bar reflects the time it first appeared, revealing the evolution trends and inheritance relationship between them. The keywords appeared from 2000 to 2004 are: "keratinocyte", "T cell", "dendritic cell", "necrosis factor alpha", "infliximab" and "etanercept"; 2005–2009: "IL-23", "adalimumab", "Interleukin 12/23 monoclonal antibody", "placebo-controlled trial"; 2010–2014: "IL-17", "ustekinumab", "clinical response"; 2015–2019: "prevalence", "secukinumab"; 2020–2022: "brodalumab", "drug survival", "guselkumab" and "ixekizumab".

In Table 4, the top 10 keywords showing the most significant frequency bursts are listed, with the red bars highlighting the duration of these bursts. During the period from 2000 to 2015, mechanism- and trial-related keywords such as "Tumor necrosis factor" and "interleukin 12/23 monoclonal antibody" exhibited strong frequency bursts, indicating sustained research interest in possible mechanisms and clinical applications. Nevertheless, over the past two years, the trending keywords have transitioned towards phrases like "multicenter," "drug survival," and "severity," suggesting a change in researchers' interests.

2.5. Keyword cluster analysis

The clusters of keywords are representative of groups of keywords that are related to each other. During the network analysis, the keywords were segregated into 11 distinct clusters. Each of these clusters has a silhouette value that is greater than 0.8, indicating a strong correlation between the keywords within each cluster [6]. As shown in Fig. 8, #0 mainly represented keywords related to IL 12/23 clinical trials, included "interleukin 12/23 monoclonal antibody"; "placebo-controlled trial"; "double blind"; "phase III trials" and "severe psoriasis". #1 mainly represented keywords related to the diseases treated with biologics such as "psoriatic arthritis", #3 and #10 included combination therapies recommendation or monotherapy-controlled trials as the early stage of research into biologics, included "recommendation" and "photochemotherapy". #4, #6 and #9 represented biologics therapeutic mechanisms, including "dendritic cell", "skin inflammation", "T cells", "IL-17" and "IL-23". #5 and #7 related to outcomes and the evaluations of therapies, such as "efficacy", "safety", "quality of life", "economic burden" and "patient-reported outcomes". #8 included the names of TNF-a biologics, such as "adalimumab" and "etanercept".
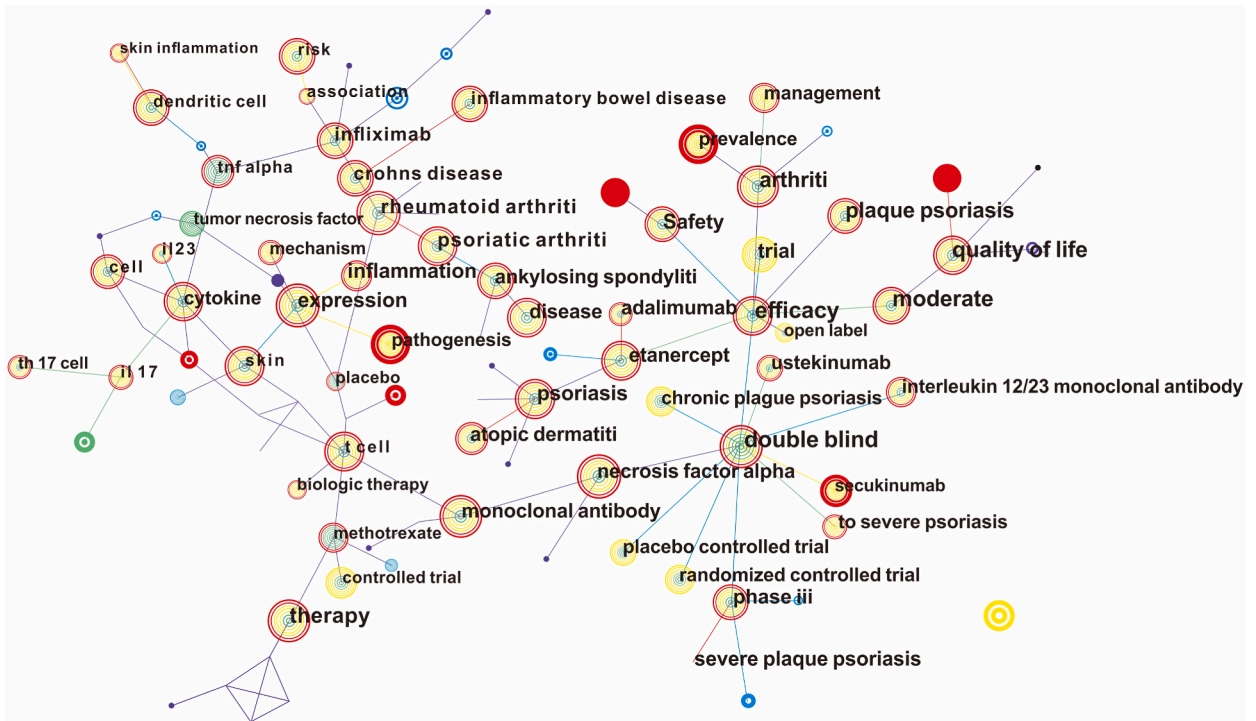
Fig. 6. Co-occurrence analysis of keywords.

Fig. 7. Keyword time zone map (2000–2022).

Table 4
The top 10 key words with the strongest citation bursts.

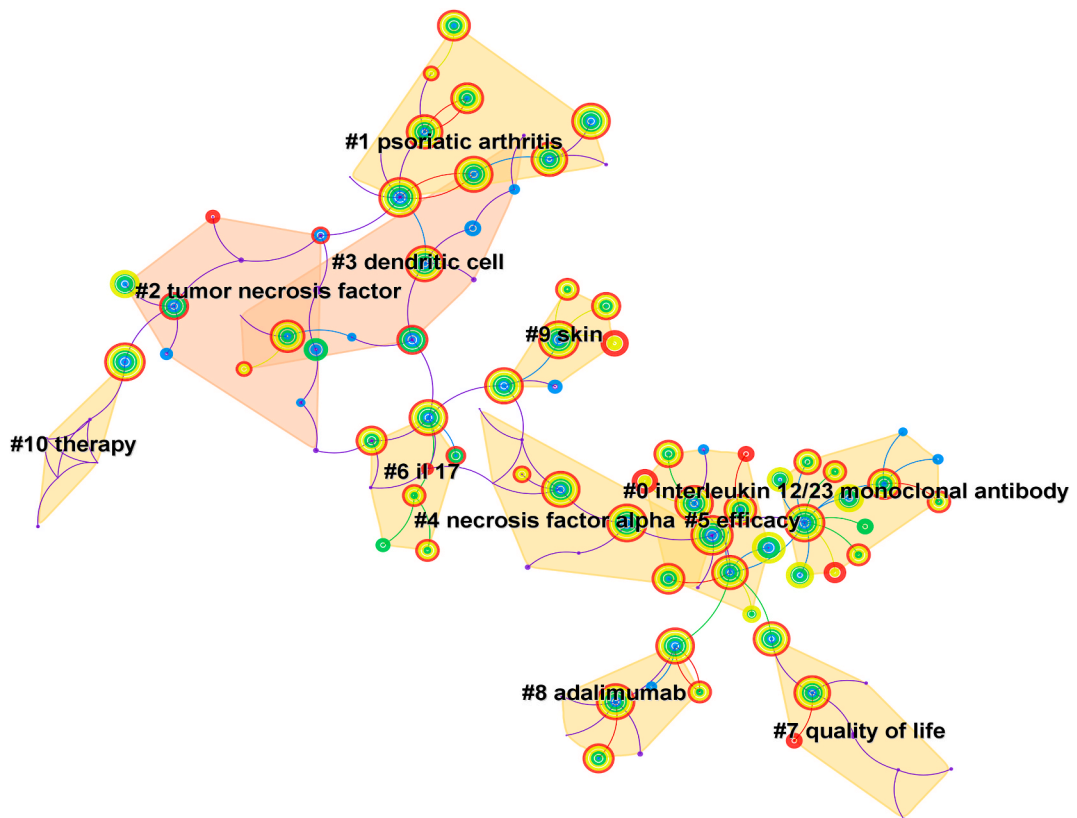| Keywords	Strength	Begin	End	2000–2022
tumor necrosis factor	54.74	2000	2014	
randomized trial	25.01	2002	2009	
interleukin 12/23 monoclonal antibody	46.88	2007	2014	
infliximab	27.5	2005	2014	
clinical response	26.9	2010	2014	
secukinumab	30.09	2015	2022	
interleukin 17	28.41	2015	2019	
multicenter	35.94	2020	2022	
drug survival	32.57	2020	2022	
severity	26.7	2020	2022	

Fig. 8. Cluster analysis of key words.

2.6. Publications citation analysis

The top 10 most cited documents were identified and are presented in Table 5. The local citations for these documents ranged from 397 to 788. The article [7] published in *the New England Journal of Medicine* in 2014 was ranked first. All of the top 10 articles were clinical trials. The majority of these articles found their home in prestigious journals such as *the New England Journal of Medicine* and *the Lancet*. This observation underscores the dominance of these two journals in the realm of medical research, particularly in the dissemination of high-quality research.

2.7. Burst references

Table 6 presents the top 10 high-impact references. The article "Etanercept in the treatment of psoriatic arthritis and psoriasis: a randomised trial" [7] had the earliest burst beginning year, which was 2000. Among the 10 articles, only one review article, "Psoriasis" [1], was published on *the New England Journal of Medicine*, while the remaining nine articles are clinical trial articles. Ref. [7] published in *Lancet* 2008, had the highest burst strength of 132.73. It is noteworthy that all these articles experienced a prolonged burst duration of more than 5 years. The latest articles have focused on secukinumab [9] and guselkumab [10].

3. Discussion

Psoriasis is a complex immune-mediated condition influenced by various factors, where the pathogenesis hinges on the intricate interplay between intrinsic and adaptive immunity orchestrated by immune cells like T cells, dendritic cells, and macrophages. Notably, TNF-α, IL-12, IL-23, and IL-17 emerge as pivotal immune regulators in the context of psoriasis. The advent of biological therapies targeting these specific molecules has transformed the landscape of psoriasis treatment, providing precise and highly effective interventions with an improved safety profile. The realm of psoriasis treatment has been reshaped by biological agents, ushering in targeted and potent therapies with enhanced safety parameters. Presently, the US Food and Drug Administration (FDA) has sanctioned four classes of biologic agents for managing moderate-to-severe psoriasis: TNF inhibitors (etanercept, certolizumab pegol, adalimumab, infliximab), IL-17 inhibitors (secukinumab, ixekizumab, brodalumab), IL-12/23 inhibitors (ustekinumab and briaki-numab), and IL-23 inhibitors (guselkumab, risankizumab, tildrakizumab).

TNF inhibitors were the initial biological drugs authorized for treating psoriasis. While they are very efficient in managing moderate-to-severe plaque psoriasis, they come with potential serious adverse effects, such as a heightened susceptibility to infections and cancers. [11,12].

IL-12/23 inhibitors target two cytokines involved in the immune response in psoriasis. Ustekinumab has been found to be more effective than high-dose etanercept in psoriasis subjects, reducing the likelihood of severe infections and cancers. [13].

IL-17 inhibitors offer a valuable treatment option. These inhibitors specifically target IL-17A, a cytokine pivotal in the development of psoriasis. They demonstrate greater effectiveness in improving skin conditions for individuals with moderate to severe psoriasis compared to IL-12/23 inhibitors, while maintaining a similar safety profile [14].

Other promising biological agents for psoriasis treatment include IL-23 inhibitors, which target a cytokine involved in the differentiation and activation of T cells in psoriasis. Guselkumab has shown superior long-term efficacy compared to secukinumab [15].

This study collected a total of 8,047 bibliographies and identified three distinct periods of development in this field. From 2000 to 2008, there was a relatively small annual output of publications, showing a steady linear growth trend. The number of newly published papers during this period remained below 200, with minimal growth each year. In the next period, from 2009 to 2017, saw a rapid increase in publications related to biologics therapy, accompanied by significant theoretical advancements. The yearly publication count rose to over 200 but did not surpass 600. The third phase, covering the years 2018–2022, experienced a substantial increase in annual publications, exceeding 600, indicating a maturation in the theoretical domain of this field. The publication numbers have continued to rise, establishing the topic as a burgeoning area of interest. We anticipate that the realm of biological therapy for psoriasis will further evolve in the forthcoming years. Enhanced insights into the pathogenesis of psoriasis and the ongoing progress in biotechnology may steer future investigations towards personalized medicine: customizing treatment regimens according to the genetic makeup and immune profiles of each patient.

America was found to be the dominant country in this research field, almost all core documents co-authored with US institutions [4, 7,9,16–19] (Table 5). While countries like Italy and China have a significant number of publications, they have not yet become dominant due to citation limitations. On the other hand, countries such as Germany, England, and various European nations have a strong scientific foundation in this field, contributing to their high publication rates. It is noteworthy that half of the top 10 most productive organizations and authors are based in the USA, indicating its leading position in research. The United States also engages in extensive collaborations with other countries, further solidifying its influence in this research domain. To enhance inter-state and international collaboration, it is imperative to prioritize partnerships among Asian nations. The exploration of biologic agents for psoriasis treatment is a worldwide, cooperative undertaking, with the United States at the forefront of this research sphere. While the levels of input from various nations and regions may differ, joint endeavors are pivotal in propelling scientific advancements and enhancing the well-being of patients. With the deepening of global research collaboration, we can anticipate the emergence of more innovative and efficacious treatment approaches in the future, offering improved therapeutic choices for individuals with psoriasis.

Quantitative indicators, like the h-index, total citations, and average citations per publication, are fluid metrics that develop in tandem with the advancement of research. They serve as valuable tools in pinpointing significant projects, offering crucial benchmarks for evaluating the impact of individuals and research institutions. Among the top ten high-yield authors, Kristian Reich and Richard B

Table 5
The top 10 most highly cited publication.

Rank	Title	Source	Publication year	Local citation
1	Secukinumab in plaque psoriasis–results of two phase 3 trials [9]	*NEW ENGL J MED*	2014	788
2	Efficacy and safety of ustekinumab, a human interleukin-12/23 monoclonal antibody, in patients with psoriasis: 76-week results from a randomised, double-blind, placebo-controlled trial (PHOENIX 1) [7]	*LANCET*	2008	744
3	Efficacy and safety of ustekinumab, a human interleukin-12/23 monoclonal antibody, in patients with psoriasis: 52-week results from a randomised, double-blind, placebo-controlled trial (PHOENIX 2) [7]	*LANCET*	2008	711
4	Etanercept as monotherapy in patients with psoriasis [16]	*NEW ENGL J MED*	2003	560
5	Infliximab induction and maintenance therapy for moderate-to-severe psoriasis: a phase III, multicentre, double-blind trial [31]	*LANCET*	2005	554
6	Adalimumab therapy for moderate to severe psoriasis: A randomized, controlled phase III trial [17]	*J AM ACAD DERMATOL*	2008	487
7	Guidelines of care for the management of psoriasis and psoriatic arthritis: Section 1. Overview of psoriasis and guidelines of care for the treatment of psoriasis with biologics [4]	*J AM ACAD DERMATOL*	2008	430
8	A global phase III randomized controlled trial of etanercept in psoriasis: safety, efficacy, and effect of dose reduction [34]	*BRIT J DERMATOL*	2005	420
9	Comparison of ixekizumab with etanercept or placebo in moderate-to-severe psoriasis (UNCOVER-2 and UNCOVER-3): results from two phase 3 randomised trials [18]	*LANCET*	2015	417
10	Phase 3 Studies Comparing Brodalumab with Ustekinumab in Psoriasis [19]	*NEW ENGL J MED*	2015	397

Table 6
The top 10 references with the strongest citation bursts.

References	Strength	Begin	End	2000–2022
Leonardi CL, 2003 [16]	123.66	2003	2014	
Chaudhari U, 2001 [30]	99.64	2001	2009	
Mease PJ, 2000 [8]	97.9	2000	2009	
Leonardi CL, 2008 [7]	132.73	2008	2019	
Papp KA, 2008 [32]	125.91	2008	2019	
Reich K, 2005 [31]	106.12	2005	2014	
Nestle FO, 2009 [1]	106.24	2010	2019	
Leonardi C, 2012 [33]	94.22	2012	2019	
Langley RG, 2014 [9]	103.97	2015	2022	
Blauvelt A, 2017 [10]	93.3	2017	2022	

Warren from the University Medical Center Hamburg-Eppendorf, which is ranked in the top 30 institutions in terms of high productivity and strong collaboration. Fig. 5 shows that L Puig, Richard B Warren, and Andrew Blauvelt have been publishing more actively in the last two years, hinting at their potential to lead the field in the future. These analyses of activity provide profound insights into the field's dynamics and trends, offering invaluable guidance for identifying future research collaborations and shaping pertinent scientific policies.

Identifying prominent journals in a specific field can aid scholars in constructing scientific accomplishments and accessing the direction of manuscript submission [20]. *The British Journal of Dermatology* is regarded as the most influential journal in the field, among the most prolific journals, based on both the total number of publications and its Impact Factor. In 2022, the *British Journal of Dermatology* published numerous articles [21–29] that primarily focused on assessing the safety, effectiveness, and recurrence of biological agents in treating psoriasis.

The chronological evolution of the burst references covers various aspects: the evaluation of safety and efficacy of TNF-α antibodies (Etanercept or infliximab) [8,16,30,31]; the effectiveness and therapeutic regimens for psoriasis with IL12/23 monoclonal antibody [8,16,30,31]; anti-interleukin-17 monoclonal antibody observational studies on the effectiveness evaluation of chronic plaque psoriasis treatment [9,33]; comparative studies of the biological treatment [10], including different clinical trials that use double-blind

and placebo-controlled methods to verify the effectiveness of biological agents in the induction and maintenance regimen of psoriasis or psoriatic arthritis. Later, different therapeutic regimens were evaluated, and some literature compared the dosage, regimens, incidence of side effects, the long-term effectiveness and tolerability of various biological agents in managing psoriasis [32]. The gathering and examination of literature afford us a glimpse into the present landscape of biological treatments for psoriasis. It is anticipated that additional clinical investigations pertaining to the enduring impacts, safety profiles, and cost-efficiency of biological agents will surface in the forthcoming days. Concurrently, research utilizing real-world data is poised to gain prominence, playing a pivotal role in enhancing patient care strategies and fine-tuning therapeutic protocols.

To investigate research trends, this present study analyzed keywords and burst terms, revealing a significant shift in focus. Overall, we can observe shifts in research trends and public interest in two primary areas: 1) from initial studies on the mechanisms of biological therapies, including changes in immune molecules, to subsequent translational medicine and clinical research; and 2) progressing from early biological advancements, like TNF-α, to later advancements, such as IL12/23 and IL-17 blockades. The research focus has gradually moved from mechanisms to effectiveness and side effects, signaling a development in theory and the exploration of the use of biological agents. We suggest that academics in this field direct their attention towards the following areas in the forthcoming years: delving into the possibilities of personalized medicine, gathering and scrutinizing real-world data, exploring strategies for combination therapy, and assessing the cost-effectiveness of biologics to guarantee the sustainability of healthcare resources.

4. Strengths and limitations

This study represents the first attempt to evaluate the research trends and impact of biologic therapy for psoriasis using bibliometric analysis. To ensure the accuracy of our results, we employed both CiteSpace and the R package bibliometrix for extracting data, conducting bibliometric analysis, and creating visualizations. Our study provides a comprehensive analysis of the research output and impact of this field based on a large number of quantitative publications and citations, which eliminates the potential bias that may be present in subjective evaluations. Additionally, key players were identified in the field to assist researchers and clinicians in identifying potential collaborators and experts.

While our study provides valuable insights into the field, it is important to note its limitations. Our analysis is confined to publications listed in the WoS Core Collection database, potentially omitting pertinent publications with lower citation counts and non-English literature studies that could be cataloged in databases like PubMed, Scopus, and other esteemed sources. Moreover, bibliometric analysis is limited in its capacity to assess the quality of individual studies, as citation metrics are influenced by time and recent articles may not have accrued enough citations simply because of their recent publication date. Additionally, bibliometric studies can only provide general information and rely on quantitative measures that may not fully capture the complexity of the topic. Factors such as patient preferences, the author's viewpoint and clinical judgment, and important details about specific studies cannot be accounted for in bibliometric analysis. Meanwhile, our research does not exclude publications with high citation counts. While high citations may indicate the influence of a literature, they may also reflect specific trends or fads rather than current emerging areas. Over-reliance on such literature could potentially skew the analysis results.

5. Conclusion

Our bibliometric analysis provides researchers with a valuable tool in comprehending trends and public interest in biological therapies for psoriasis. This research has observed a growing concern in recent years, with the USA contributing the most to this field, and the *British Journal of Dermatology* being the most influential journal. In conclusion, our bibliometric analysis highlights the importance of biological therapies for psoriasis and the need for further research in this field. Strengthening international collaboration, investigating long-term safety and efficacy, identifying biomarkers, exploring new agents, expanding indications, and creating personalized treatment strategies are crucial for advancing the treatment of psoriasis and enhancing patient results.

6. Materials and methods

6.1. Data retrieval

A comprehensive review of pertinent articles and reviews published in English was carried out through a systematic literature search using the Web of Science Core Collection. The search encompassed the period from 2000 to 2022 and was finalized on March 15, 2023. The search terms utilized were "biological agents" and "psoriasis." The search methodology is outlined in Supplementary 1. Two researchers (SY-L and SL) independently performed the initial data search and resolved any discrepancies that arose. Unpublished studies were not sought or incorporated in the review. The search strategy details can be found in Supplementary 1.

6.2. Data analysis and extraction

The study conducted a bibliometric analysis and visualized publications on biologics for psoriasis by examining the distribution of publication year, country and region, organization, journal, core authors, keywords, and key references. Data analysis and extraction were carried out using the bibliometrix package in R (version 4.2.3, R Foundation), while visualization was performed using CiteSpace (version 5.7, Drexel University) and ArcGIS 10.2. The bibliometrix package was utilized to analyze the distribution of countries, journals, core authors, and citations, while CiteSpace was employed for analyzing and visualizing citation bursts, co-authorship, and

co-occurrence.

Data availability statement

Sharing research data helps other researchers evaluate your findings, build on your work and to increase trust in your article. We encourage all our authors to make as much of their data publicly available as reasonably possible. Please note that your response to the following questions regarding the public data availability and the reasons for potentially not making data available will be available alongside your article upon publication.

Has data associated with your study been deposited into a publicly available repository?

No.

Please select why. Please note that this statement will be available alongside your article upon publication.

The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author.

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CRediT authorship contribution statement

Si-Yu Long: Writing – original draft, Visualization, Methodology, Formal analysis. **Lin Shang:** Writing – review & editing, Visualization, Methodology, Formal analysis. **Siqi Zhao:** Methodology, Data curation. **Huijuan Shi:** Investigation, Data curation. **Yan-Ling He:** Writing – review & editing, Supervision, Conceptualization.

Declaration of competing interest

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

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e31054.

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