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ORIGINAL RESEARCH

The Future Landscape of Endothelial Cells Research in Psoriasis: Bibliometric Analysis and Literature Review

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Background: Psoriasis is a global health concern as a chronic inflammatory skin disease. Endothelial dysfunction has been implicated in psoriasis pathogenesis.

Objective: This study aims to explore the scientific literature on the relationship between psoriasis and endothelial cells using bibliometric analysis, identifying research trends and public interest in this topic.

Methods: We analyzed articles on the topic of endothelial cells and psoriasis in the Web of Science (WoS) Core Collection from 1987 to 2022, examining their distribution by publication year, country, organization, author, and journal. We used bibliometric software, including CiteSpace and R package bibliometrix, to visualize co-authorship relations, keyword citation burst analysis, co citation networks, keyword time zone map, burst references and cluster analysis.

Results: Our analysis included 993 publications. The bibliometric analysis revealed a steady increase in the number of publications on psoriasis and endothelial cells over the past decade. The United States was the leading contributor to this field. The *Journal of Investigative Dermatology* was the most high-yield publication journal. Burst references analysis identified key articles that have significantly influenced the field, including studies on the role of endothelial dysfunction in psoriasis pathogenesis and the association between psoriasis severity and cardiovascular outcomes. 9 clusters were grouped in the key-word citation network. "Expression", "inflammation", "endothelial growth factor" and "angiogenesis" were the research focuses, while "cardiovascular disease", "atherosclerosis", "endothelial dysfunction", and "oxidative stress" might be the future research hotspots.

Conclusion: This bibliometric analysis sheds light on the growing acknowledgement of the involvement of endothelial cells in psoriasis, with the United States taking the lead. It also emphasizes the necessity for additional research to unravel the underlying mechanisms connecting psoriasis, endothelial dysfunction, and cardiovascular comorbidities. Ultimately, this research will contribute to the development of enhanced management strategies for psoriasis patients.

Keywords: bibliometric analysis, endothelial cells, psoriasis, inflammation, cardiovascular risk, molecular mechanisms

Introduction

Psoriasis, a chronic inflammatory skin disease, affects around 2–3% of the global population. It has been linked to an increased risk of cardiovascular disease.[1] A systematic review estimated the annual cost of psoriasis in the United States to be around $112 billion, with about 60% of the cost attributed to comorbidities.[2] The expense of treating cardiovascular diseases in psoriasis patients was significantly higher than in those without psoriasis.[3]

Endothelial cells, forming the innermost layer of blood vessels, are vital in maintaining vascular homeostasis.[4] These cells regulate blood flow and vascular permeability, as well as the recruitment and activation of immune cells.[5] In psoriasis, the dysregulation of endothelial cell functions contributes to the chronic inflammation and aberrant angiogenesis observed in affected skin lesions by secreting pro-inflammatory cytokines and chemokines.[6] Additionally, endothelial dysfunction is a characteristic of

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many cardiovascular diseases.[7] Researches suggested a connection between psoriasis and endothelial dysfunction, which may contribute to the increased risk of cardiovascular diseases in psoriasis patients.[8] The mechanisms behind this association remain unclear but could involve the production of pro-inflammatory cytokines, oxidative stress, and diminished nitric oxide bioavailability.[9,10]

The current research on endothelial cells and psoriasis aims to understand the complex interactions between these cells and other components of the skin, such as keratinocytes, immune cells, and fibroblasts. However, the precise roles of signaling molecules and interactions within the psoriatic microenvironment are still not fully understood. Additionally, the heterogeneity of endothelial cells in different vascular beds and their behavior during disease progression further complicate the research landscape.

Therefore, focusing on endothelial cells may represent a promising therapeutic strategy for psoriasis and its related comorbidities. This study intends to explore current trends and hot topics in research on this subject using bibliometric analysis.

Materials and Methods

Data Retrieval

A total of 993 documents were sourced from the WoS Core Collection and were included in the bibliometric analysis and visualization. The types of documents included were articles and reviews, and the language was limited to English. The search spanned from 1987 to 2022 and was completed on April 19, 2023. The search terms used were: TS = (endothelial cells) and TS = (psoriasis). Two researchers (SY-L and SL) independently conducted the initial data search and then identified any potential discrepancies.

Data Extraction and Analysis

The characteristics retrieved for publications on endothelial cell studies on psoriasis included the distribution of publication year, country and region, organization, journal, core authors, keywords, and key references. Bibliometric analysis and network visualization were conducted using CiteSpace (version 5.7, Drexel University) and the bibliometrix package in R (version 4.2.3, R Foundation). The bibliometrix package was utilized for data extraction and analysis of the distribution of countries, journals, core authors, and citations. The distribution of countries was visualized with ArcGIS 10.2. Other analyses, including keyword citation burst analysis, co-authorship analysis, co-occurrence analysis, and visualization were performed using CiteSpace.

CiteSpace is a JAVA-based citation visualization software primarily used to aid in visualizing and analyzing knowledge areas and emerging trends, including author and co-cited authors, journal and citation bipartite overlays, timeline or time zone view, keyword citation burst, and reference analysis. Co-occurrence analysis charts can display the frequency of co-occurrence between keywords in literature, which assists researchers in identifying themes and hotspots in their research field, as well as understanding the citation relationships and academic influence between literature. Citation network diagrams effectively illustrate the interconnection of references within literature, thereby assisting researchers in comprehending the academic significance and impact of certain works. Similarly, topic evolution graphs provide a visual representation of the progression of themes within a research field over time. This aids researchers in grasping the developmental trends and potential future trajectories of their area of study.

Results

Publication Outlines

A total of 993 articles were found on this subject with an average of 62.01 citations per article. The chronological distribution of these publications is depicted as a bar chart in Figure 1a. From 1987 to 1991, fewer than 10 papers were published each year. The annual publication count saw a gradual increase from 1992 to 1999, but fluctuated significantly without any discernible pattern. However, from 2000 to 2022, there was a noticeable upward trend in the number of publications, particularly after 2010 when the growth rate accelerated. Figure 1b presents a plot of the total cumulative number of publications, which clearly increased over time. Although the growth rate of the total number of publications

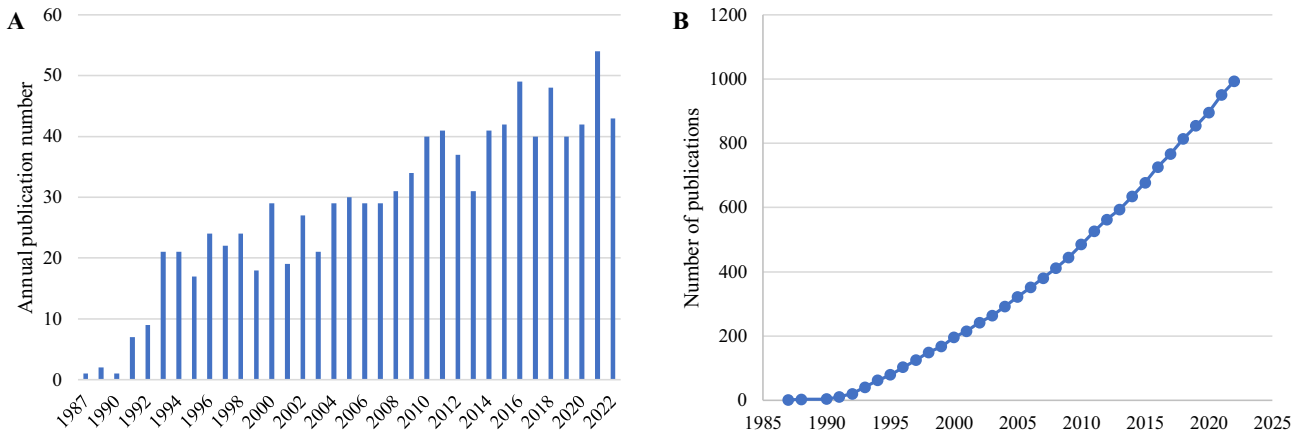

Figure 1 Distribution of publications by year. (a) The annual number of publications and (b) the cumulative number of publications on endothelial cells research in psoriasis.

gradually slowed down, it continued to grow overall. The growth rate peaked in 1988, 1991, and 1993, indicating a rapid increase in publications during those years and suggesting increased attention from researchers in the related field.

Regarding geographical distribution, a total of 993 papers were produced from 54 distinct countries and regions. We categorized the documents by country and depicted the spatial distribution in a heatmap (Figure 2). Table 1 shows the top 10 most productive countries. The United States had the highest number of publications (186 publications, 16.0%), significantly outpacing China (138 publications, 10.2%) and Germany (108 publications, 7.2%). In terms of citations, the United States also led by a wide margin. However, the citation count for papers published by China was relatively lower, placing it fifth. As per the country collaboration map (Figure 3), the United States was the most frequent collaborator with other countries in publishing papers (31 countries, 130 papers), followed by Germany (28 countries, 78 papers) and Italy (27 countries, 52 papers). The countries most frequently collaborating with the United States included Germany (21 papers) and the United Kingdom (13 papers).

Examination of Prominent Institutions and Public Sources

The visualization (Figure 4) displays all 84 prolific institutions that have published more than two articles. The most productive institutions were Harvard University and Rockefeller University, each with 17 publications, followed by

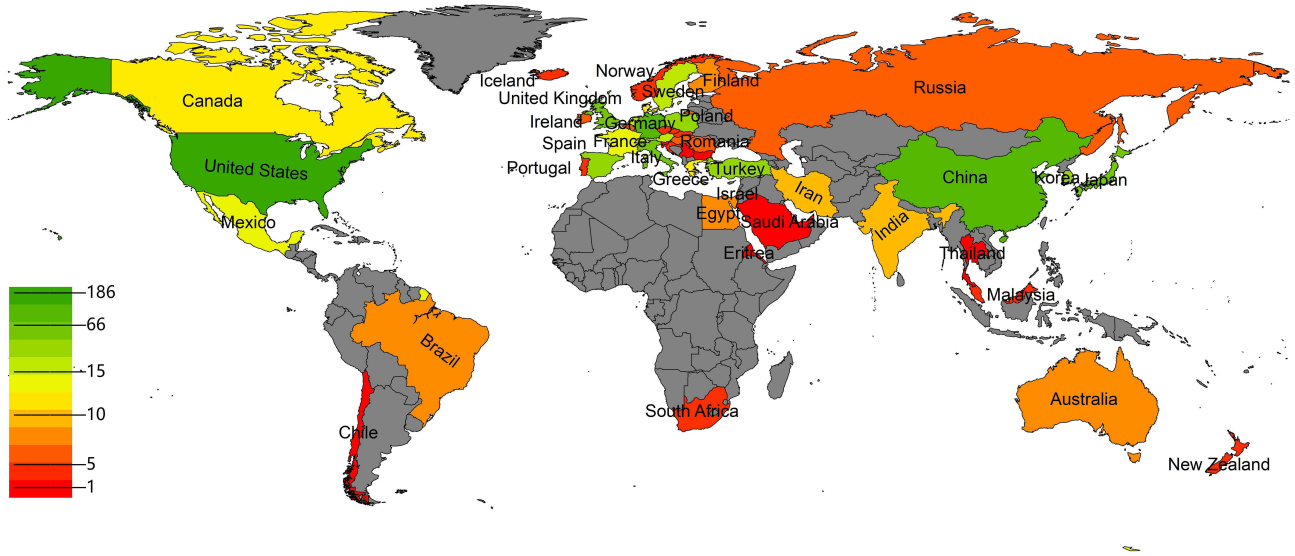

Figure 2 Geographical distribution of global publications. The green-to-red gradient represents a decreasing number of publications. Gray represents countries with no publications.

Table 1 Top 10 Most Productive Countries and Regions

Rank	Country/Region	Publications	Citations	Citations per Publication
1	USA	186	19,582	105.30
2	China	138	2449	17.70
3	Germany	108	7544	69.90
4	Italy	66	2861	43.30
5	United Kingdom	66	9336	141.50
6	Japan	186	2255	40.30
7	Poland	56	397	14.70
8	Spain	27	1469	70.00
9	Korea	21	726	36.30
10	Turkey	20	566	28.30

Shanxi Medical University with 13 publications, and the University of Michigan with 10 publications. Half of the top 10 most productive institutions (Harvard University, Rockefeller University, University of Michigan, Emory University, Tufts University) are based in the United States. This suggests that the United States leads in research on the role of endothelial cells in psoriasis.

A total of 349 journals have contributed to this field of study. The ten most prolific of these have been extracted and their impact factor and h-index are tabulated in Table 2. The *Journal of Investigative Dermatology*, with an impact factor of 6.5, holds the most records (n=64) and is the most cited journal, with a total of 4535 citations. The *British Journal of Dermatology* and *Experimental Dermatology* follow as the second and third most prolific journals, with 53 and 34 publications respectively, and impact factors of 10.3 and 3.2. These findings suggested that the *Journal of Investigative Dermatology* may be the most influential journal in the field of endothelial cell research in psoriasis. All ten journals originate from developed countries in Europe and America. Of the top ten most cited journals, 70% are categorized as Q1, while the remaining three fall into the Q2 category.

Our study analyzed publications from a total of 4707 authors. We identified the top 10 most prolific authors based on the number of published documents, total citations, and H index, and we have visualized the authors' production over time (Table 3 and Figure 5). Prof. Michael Detmar from Switzerland stands out as the most productive author in this field, with 20 articles cited 2326 times. Following him is Li J from Shanxi Medical University, with 18 publications and 211 total citations,

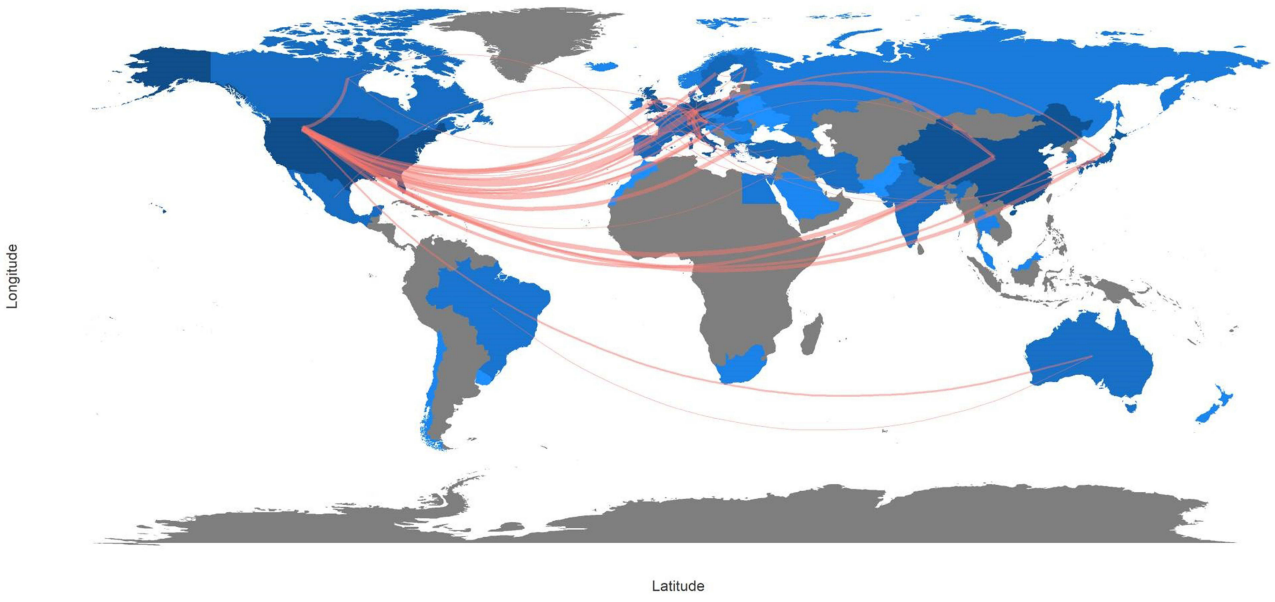

Figure 3 Country collaboration map.

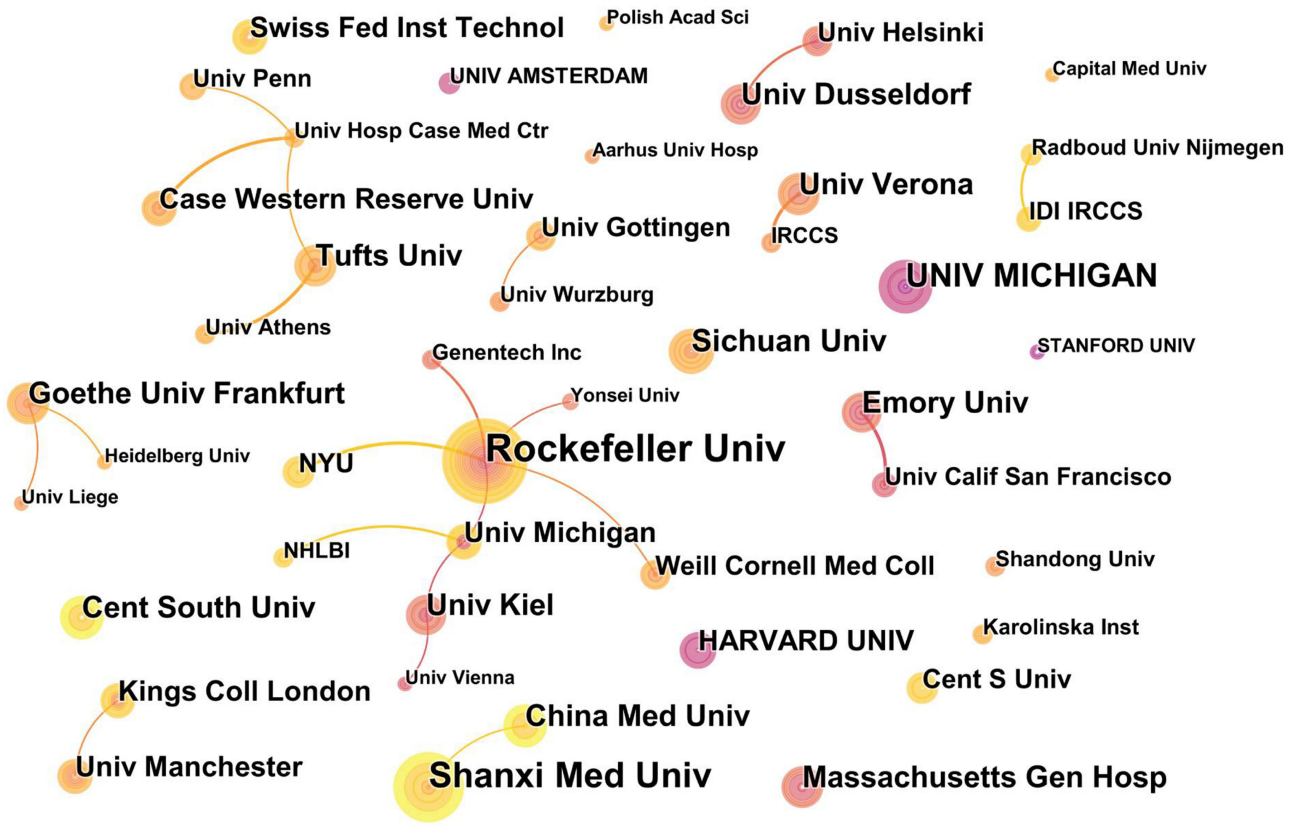

Figure 4 Co-authorship analysis of organizations.

and Schon MP from the University of Gottingen with 17 publications and 1355 total citations. When considering the H-index, a measure proposed to better gauge scholarly influence, Detmar M (20), Krueger JG (15), Barker Jnwn (13), and Schon MP (13) emerge as leading authors. Notably, two scholars from China have a substantial volume of publications, but their H-index is relatively low, suggesting a need to enhance the quality of research within the relevant field.

Keyword and Burst Term Analysis

A co-occurrence map was created to illustrate the relationships between keywords based on their frequency of appearance in the dataset. This keyword analysis was conducted using Citespace software, identifying terms that were used more than twice

Table 2 Top 10 Most Prolife Journals

Rank	Journal	Publications	h-Index	Impact Factor (2023)	JCR[a]
1	*Journal of Investigative Dermatology*	64	39	6.5	Q1
2	*British Journal of Dermatology*	53	32	10.3	Q1
3	*Experimental Dermatology*	34	18	3.6	Q1
4	*Archives of Dermatology Research*	26	18	3.0	Q2
5	*Journal of Dermatological Science*	22	15	4.6	Q1
6	*International Journal of Molecular Sciences*	21	10	5.6	Q1
7	*Journal of Immunology*	20	19	4.4	Q2
8	*PLoS One*	18	13	3.7	Q2
9	*Frontiers in Immunology*	18	10	7.3	Q1
10	*Acta Dermato-Venereologica*	17	10	3.6	Q1

Abbreviation: [a]JCR, Journal Citation Reports.

Table 3 Top 10 Core Authors by Number of Publications

Rank	Authors	Organizations	Publications	Local Citations	h-Index
1	Detmar M	Swiss Federal Institutes of Technology Domain ()()(Germany)	20	2326	20
2	LI J	Shanxi Medical University (China)	7	211	18
3	Schon MP	University of Gottingen (Germany)	17	1355	13
4	Krueger JG	Rockefeller University (USA)	15	2567	15
5	Barker JNWN	King's College London (UK)	13	2554	13
6	Boehncke WH	University of Geneva (SWITZERLAND)	13	882	10
7	Nickoloff BJ	Michigan State University (USA)	13	2730	12
8	Griffiths, C. E. M	University of Manchester (UK)	12	2213	10
9	Albanesi C	IRCCS Istituto Dermopatico dell'Immacolata (Italy)	10	884	8
10	Zhang KM	Shanxi Medical University (China)	10	58	4

during the analysis. A total of 99 keywords were extracted (Figure 6). The most frequently occurring keywords were "psoriasis" (n = 435), "expression" (n = 254), "endothelial cell" (n = 210), "inflammation" (n = 205), "endothelial growth factor" (n = 177), and "angiogenesis" (n = 177).

Monitoring changes in keywords over time can offer valuable insights into the evolution of research topics and the emergence of new areas of interest. Figure 7 presents a timeline map of keywords with a frequency greater than 2, spanning from 1987 to 2022. Each keyword in the figure is arranged within each time bar according to when it first appeared, demonstrating the evolution of keywords and their interrelationships.

The keywords that appeared from 1987 to 1991 include: "expression", "interleukin 1", "Langerhans cell"; from 1992 to 1996: "keratinocyte", "T cell", "dendritic cell", "endothelial cell", "vascular permeability factor", "angiogenesis"; from 1997 to 2001: "in vitro", "in vivo", "vascular endothelial growth factor (VEGF)"; from 2002 to 2006: "mast cell", "P selectin", "intercellular adhesion molecule 1"; from 2007–2011: "transgenic mice", "myocardial infarction", "skin inflammation", "tumor necrosis factor-α", "nuclear factor kappa-B"; from 2012–2016: "metabolic syndrome", "cardiovascular disease", "atherosclerosis"; from 2017–2021: "oxidative stress", "endothelial dysfunction"; and from 2021–2022: "interleukin-17", "integrin", "regulatory T cell", "adhesion", "macrophage", "neutrophil".

Table 4 displays the top 10 keywords with the most significant frequency bursts. The red bars represent the duration of these bursts, with the combined blue and red lines forming a timeline. The red segment signifies the time period of the keyword burst. Keywords related to mechanisms such as "tumor necrosis factor", "interferon gamma", "adhesion molecule", and "vascular permeability factor" exhibited substantial strength, suggesting potential mechanisms. For example, endothelial cells regulate the expression of cell adhesion molecules, participating in the adhesion and migration

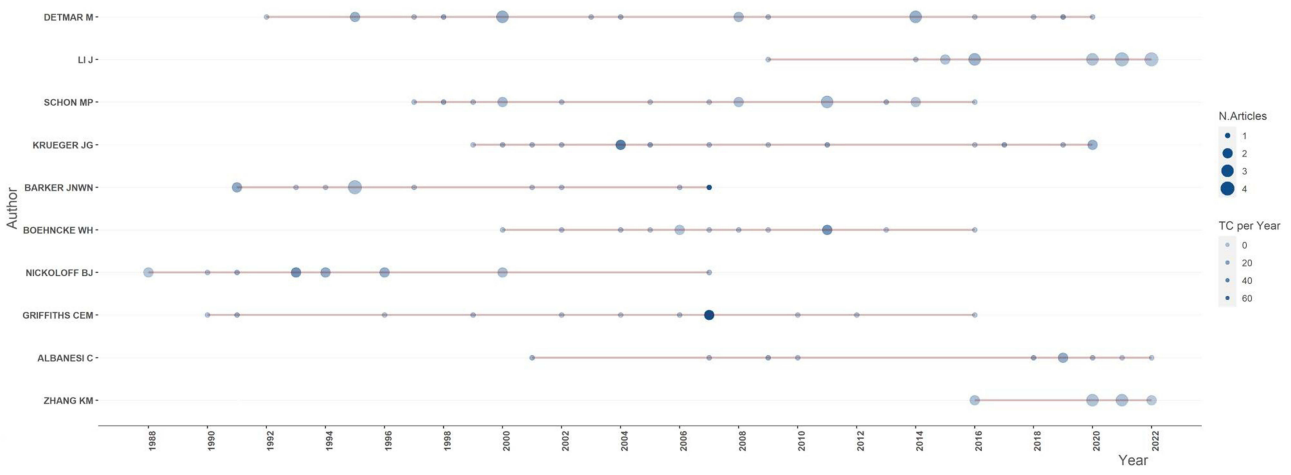

Figure 5 Overlay visualization of the top ten authors' productions over time.

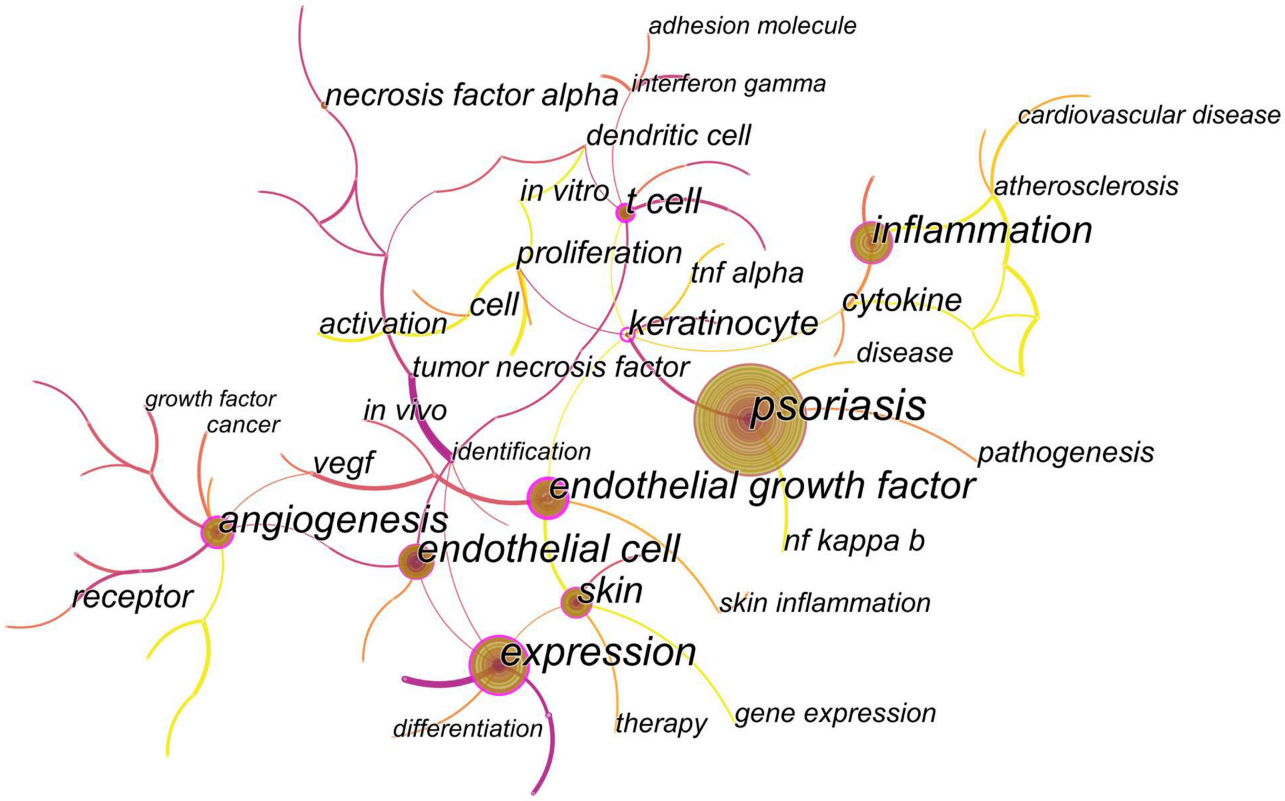

Figure 6 Co-occurrence analysis of keywords.

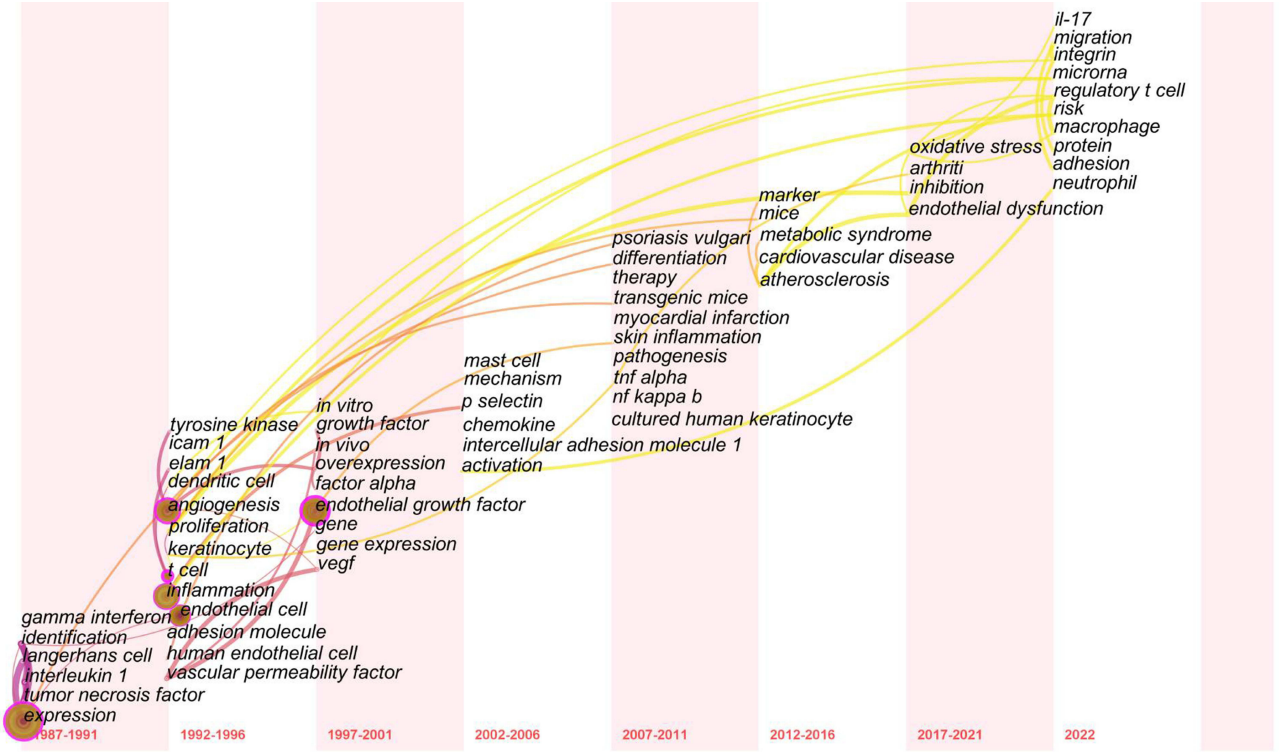

Figure 7 Keyword time zone map (1987–2022).

Table 4 The Top 10 Key Words with the Strongest Citation Bursts

Keywords	Strength	Begin	End	1987–2022
Tumor necrosis factor	13.33	1991	2002	
Endothelial cell	7.89	1992	2004	
Interferon gamma	10.07	1992	2004	
Adhesion molecule	9.63	1993	2006	
Vascular permeability factor	6.9259	1993	2001	
Lymphocyte	6.5582	1993	1996	
Cardiovascular disease	8.9562	2012	2022	
Atherosclerosis	9.2784	2014	2022	
Oxidative stress	6.493	2017	2022	
Endothelial dysfunction	6.928	2017	2022	

processes of inflammatory cells. By releasing inflammatory mediators and regulating vascular permeability, they play a crucial role in inflammatory modulation, thus contributing to the onset and progression of psoriasis. These keywords have been a consistent research focus in recent years.

However, in the most recent years, the burst keywords shifted to include terms like "cardiovascular disease", "atherosclerosis", "endothelial dysfunction", and "oxidative stress". This shift suggests that researchers' interests have transitioned towards exploring the mechanisms linking psoriasis, endothelial dysfunction, and cardiovascular comorbidities. "Keratinocyte" (1.13), "endothelial growth factor" (0.77), and "T cell" (0.66) achieved the highest centrality, indicating their crucial role as intermediaries in transformative discoveries and as bridges. These key words may be the core concepts in this field. This centrality represents the interaction between vascular endothelial cells and other inflammatory cells, with a focus on modulating their activation states through mutual interaction with immune cells in current research.

Keyword Cluster Analysis

Keyword clustering analysis involves grouping similar keywords together based on their semantic similarity, which helps researchers gain insights into the main themes and trends within a specific research field. In this network, keywords were primarily divided into nine distinct clusters. The silhouette value for each cluster surpasses 0.8, suggesting a robust relationship among the keywords within each cluster. As depicted in Figure 8, #0 predominantly includes keywords related to cell migration, such as "integrin", "endothelin-1 antagonist", "notch4 gene polymorphisms", and "notch2 gene polymorphisms". #1 and #6 primarily encompass keywords associated with cardiovascular complications in psoriasis, like "atherosclerosis" and "cardiovascular diseases". #2, #4, and #8 incorporate other cell-endothelial cell interactions, including "macrophage" and "T lymphocyte". #3, #5, and #7 represent molecular biology mechanisms, featuring "glucocorticoid receptor", "cytokines", "tumor necrosis factor", "adhesion molecule", and "VEGF".

Publication Citation Analysis

Table 5 lists the top 10 locally cited documents with the highest citation rates. Generally, the global citation count varies from 614 to 2070. The article[11] published in the *New England Journal of Medicine* in 2009 holds the top position. The top 10 articles are either reviews or basic experimental immunology research. Regarding locally cited documents, most articles were published in the *New England Journal of Medicine* and *Nature*, indicating their dominant role in medical research publication, particularly high-quality research.

Of note, out of the ten highly cited studies, three have a betweenness centrality of 0.1 or higher (Figure 9). Among them, two reviews[12,14] about psoriasis pathogenesis and angiogenesis scored 0.4 and 0.37, respectively. As shown in the figure, they are centrally positioned with dense connections, highlighting their significance as network hubs.

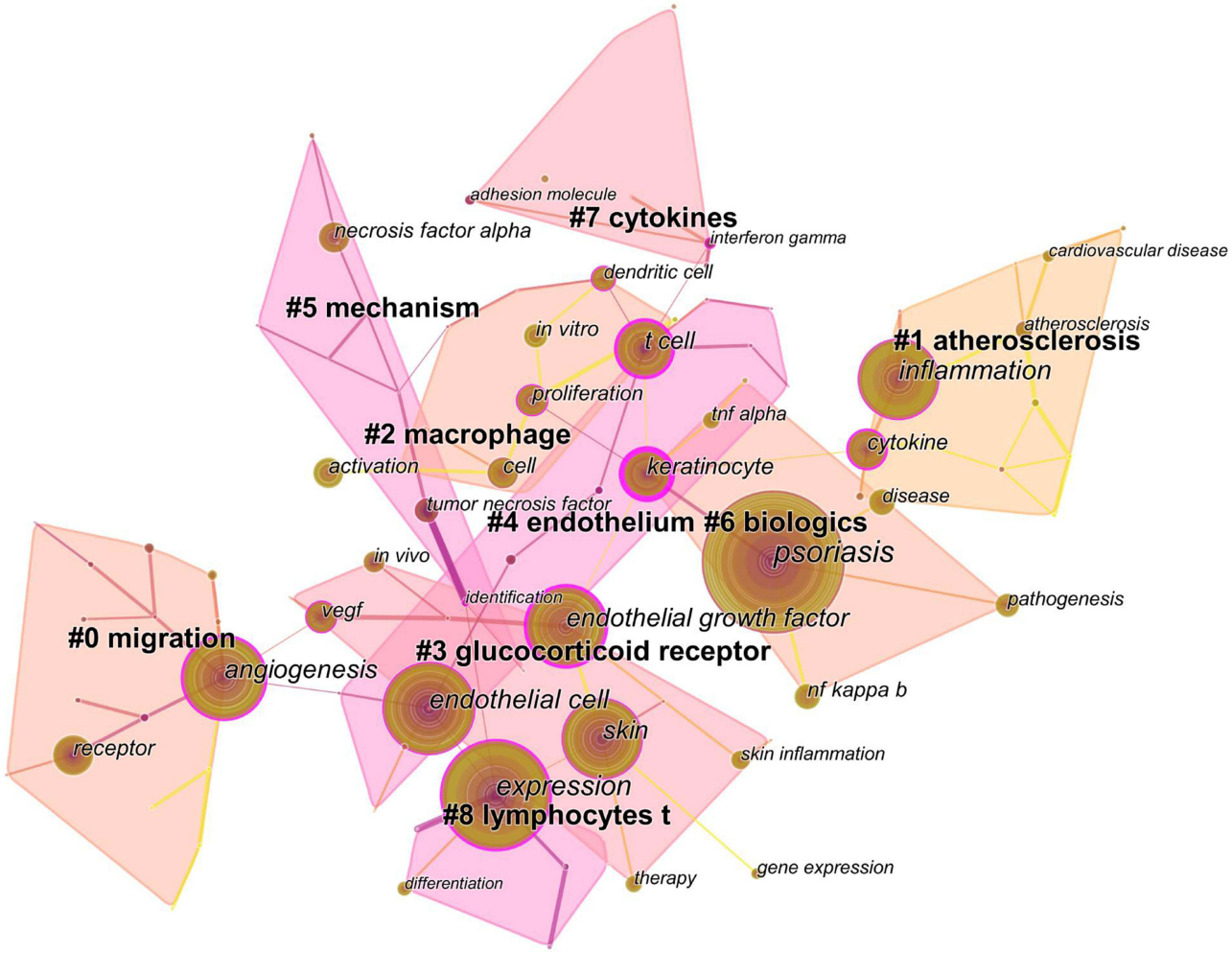

Figure 8 Cluster analysis of key words.

Burst References

References burst signify a sudden increase in citations for a specific paper indicating heightened interest. The top 10 high-burst references are gathered in Table 6. The reference

> Characterization of intercellular adhesion molecule-1 and HLA-DR expression in normal and inflamed skin: modulation by recombinant gamma interferon and tumor necrosis factor[21]

Table 5 The Top 10 Most Highly Cited Publication

Rank	Title	Source	Publication Year	Local Citation
1	Pathogenesis and therapy of psoriasis[12]	*Nature*	2007	53
2	Transgenic delivery of VEGF to mouse skin leads to an inflammatory condition resembling human psoriasis[13]	*BLOOD*	2003	45
3	Angiogenesis drives psoriasis pathogenesis[14]	*Int J Exp Pathol*	2009	39
4	Psoriasis[11]	*NEW ENGL J MED*	2009	38
5	Overexpression of vascular permeability factor/vascular endothelial growth factor and its receptors in psoriasis[15]	*J Exp Med*	1994	31

(*Continued*)

Table 5 (Continued).

Rank	Title	Source	Publication Year	Local Citation
6	Psoriasis[16]	*LANCET*	2015	26
7	Single-nucleotide polymorphisms of vascular endothelial growth factor in psoriasis of early onset[17]	*J Invest Dermatol*	2004	24
8	Psoriasis[18]	*NEW ENGL J MED*	2005	23
9	Risk of myocardial infarction in patients with psoriasis[19]	*JAMA*	2006	23
10	Interleukin-22, a T(H) 17 cytokine, mediates IL-23-induced dermal inflammation and acanthosis[20]	*Nature*	2007	22

had the earliest burst beginning year of 1989. The reference published in t*he New England Journal of Medicine* 2009 owned the highest burst strength of 18.7. The most recent references were about the immunological underpinnings of psoriasis and its correlation with cardiovascular comorbidities.[13,15,17,19,20]

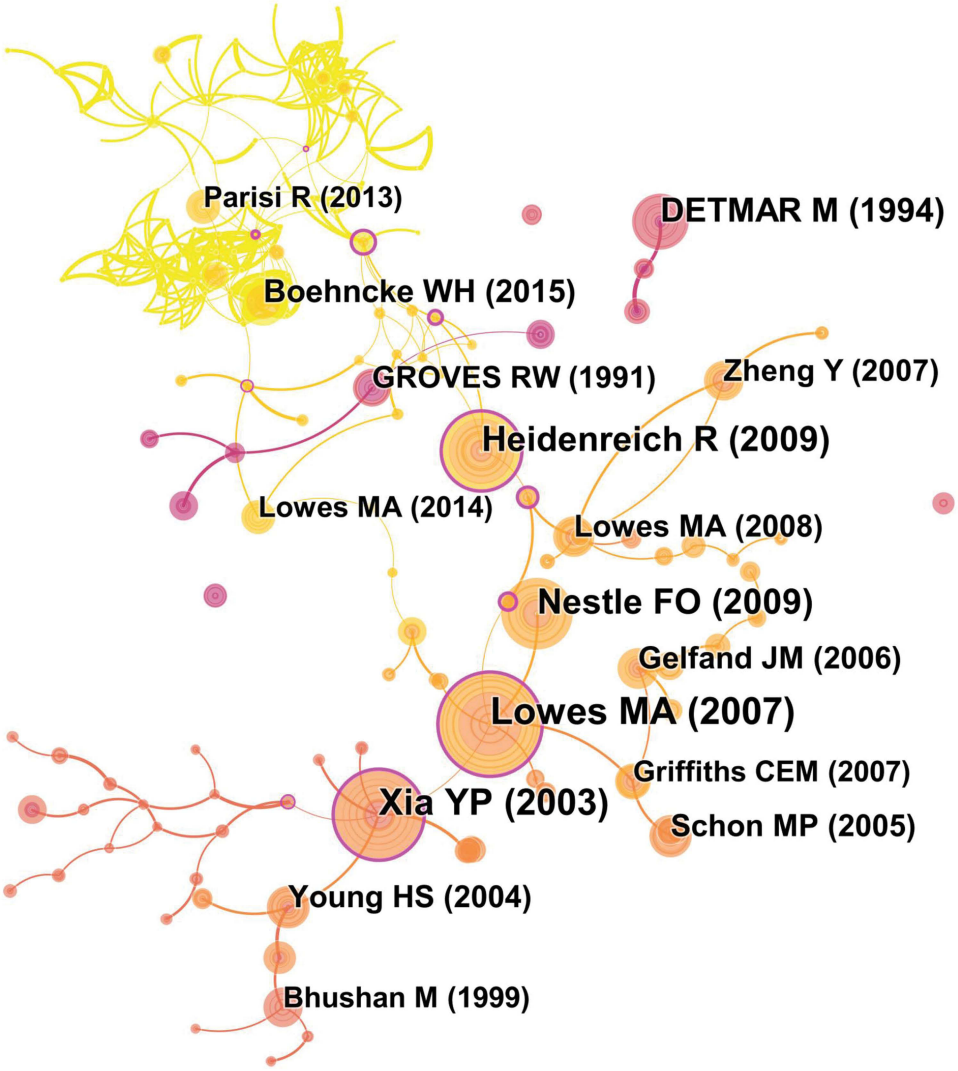

Figure 9 References co-citation network of co-cited literature on endothelial cells research in psoriasis.

Table 6 The Top 10 References with the Strongest Citation Bursts

References	Strength	Begin	End	1987–2022
Griffiths CEM, 1989[21]	9.43	1989	1996	
Detmar M, 1994[15]	16.21	1994	2006	
Picker LJ, 1991[22]	9.14	1992	1996	
Xia YP, 2003[13]	17.49	2003	2011	
Bhushan M, 1999[23]	10.97	2002	2006	
Young HS, 2004[17]	9.24	2004	2011	
Nestle FO, 2009[11]	18.7	2009	2021	
Heidenreich R, 2009[14]	16.93	2009	2021	
Lowes MA, 2014[24]	12.56	2014	2022	
Mehta NN, 2010[25]	8.87	2012	2021	

Discussion

Over the past decade, emerging evidence has suggested that endothelial cells play a pivotal role in the initiation and perpetuation of psoriatic inflammation. In psoriasis, endothelial cells undergo phenotypic changes and exhibit a pro-inflammatory state, leading to the recruitment and activation of immune cells within the skin. This endothelial dysfunction is thought to be a key driver of the aberrant immune response observed in psoriatic lesions.

Our research utilized CiteSpace and R to analyze 993 articles sourced from the WoS. The results revealed that, despite minor fluctuations over the years, the number of publications in this field has generally increased, signifying that this field has attracted more attention from researchers.

The United States and Europe are the primary contributors to this field of research, with the United States leading in terms of publication count and citation frequency. Half of the most prolific institutions are based in the America, and collaborations between the America and other countries are notably common, further emphasizing the central role of the America in academic research. In contrast, China has a comparatively lower citation count for its published articles and a lesser H-index for its authors, suggesting that Chinese scholars and institutions could benefit from additional experience in the field or increased collaborations with international counterparts to enhance their research efforts.

Among the top ten most productive authors, Detmar M from the Swiss Federal Institutes of Technology stands out. Prof. Michael Detmar is recognized for pioneering the inflammatory theory of angiogenesis and lymphangiogenesis in relation to tumor metastasis, as well as for his work on the molecular control of chronic inflammation and responses to specific therapies. Recent publication trends, as depicted in Figure 5, suggest that Li J and Zhang KM could become leading researchers in the future due to their active publishing in the last two years.

Identifying leading journals in a specific discipline helps scholars define their research focus, understand the latest findings and theoretical advancements. This guides their academic pursuits and manuscript submission strategies. Among the most productive journals, the *Journal of Investigative Dermatology* is considered the most influential journal in this field, with a high publication count and impact factor. In 2022, the *Journal of Investigative Dermatology* published one research article[26] which studied the changes in gene expression in different types of blood and lymphatic cells taken directly from psoriatic and healthy human skin with 5' single-cell RNA sequencing, each type of these cells underwent specific changes related to cell adhesion and the organization of the extracellular matrix.

To explore the evolving trends in psoriasis research, we conducted an analysis of keywords and burst terms. The chronological evolution of research in this field covers several important aspects. Firstly, studies have shown that inflammation and immune response play a crucial role in the initiation and maintenance of psoriasis. Specifically, endothelial cells have been found to produce various inflammatory mediators that contribute to the development of psoriasis;[27] Secondly, angiogenesis, which is the formation of new blood vessels, has been identified as another important aspect of psoriasis. Endothelial cells directly participate in angiogenesis, and their abnormal behavior is believed to contribute to the development of the disease;[8,10,28,29] Thirdly, endothelial dysfunction, which refers to the loss of normal physiological properties in the inner lining of blood vessels, has gained interest as a key factor in psoriasis. Several

studies have highlighted the role of endothelial dysfunction in the pathogenesis of psoriasis;[30–32] Moreover, researchers have identified potential therapeutic targets for psoriasis. Small molecule inhibitors and monoclonal antibodies targeting endothelial cell activation inhibitors have shown efficacy in suppressing inflammation in psoriasis therapy studies, with additional anti-angiogenic effects.[33] Furthermore, changes in endothelial cell function and phenotype have been proposed as potential biomarkers for the diagnosis and monitoring of psoriasis;[34–37] Additionally, there has been growing interest in studying the crosstalk between endothelial cells and immune cells, such as T cells and dendritic cells, in the context of psoriasis;[38,39] Lastly, researchers have also investigated the mechanisms underlying endothelial dysfunction in psoriasis and its association with cardiovascular comorbidities.[27,29,30]

Overall, the research trends in psoriasis have shifted from fundamental studies of inflammation and immune responses to more intricate explorations of endothelial dysfunction, the interplay between endothelial cells and other immune cells, and the involvement of endothelial cells in psoriasis and cardiovascular comorbidities. These evolving trends reflect the increasing understanding of the complex mechanisms underlying psoriasis and the potential for novel therapeutic approaches.

Strengths and Limitations

Bibliometric research facilitates quantitative analysis of academic literature by statistically analyzing data, thereby enabling the measurement of a specific research piece's impact and relevance. It aids in recognizing trends over time and analyzing collaborations between various authors, institutions, and countries.

While our study offers a comprehensive analysis into the field, it's crucial to acknowledge its limitations. Firstly, the research only takes into account published and indexed documents in the WoS Core Collection database, thereby excluding relevant unpublished or non-indexed documents. Additionally, it's prone to citation bias as highly cited papers do not necessarily imply high quality. English language or positive results publications are more likely to be cited. Furthermore, bibliometric analysis lacks the ability to assess the quality of individual studies, as citation metrics are time-dependent and recent articles may not have accumulated enough citations yet. Moreover, bibliometrics research focuses on quantitative analysis and may lack the contextual information provided by qualitative research methods. Factors such as the author's perspective and specific study details cannot be captured in bibliometric analysis. This limitation restricts the ability to fully understand the underlying mechanisms and nuances of the relationship between psoriasis and endothelial cells.

Conclusion

The bibliometric analysis indicates that there has been an increasing interest in studying endothelial cells in psoriasis in recent years. The United States has made the largest contribution to this field, and the *Journal of Investigative Dermatology* being the most influential journal. Strengthening international collaboration, investigating the interaction between endothelial cells and other immune cells, along with the study of mechanisms underlying endothelial dysfunction in psoriasis and cardiovascular comorbidities are all essential for advancing psoriasis targeted treatment through endothelial cells and improving patient outcomes.

Abbreviations

WoS, web of science; VEGF, vascular endothelial growth factor.

Data Sharing Statement

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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Disclosure

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

1. Sorokin AV, Kotani K, Elnabawi YA, et al. Association between oxidation-modified lipoproteins and coronary plaque in psoriasis. *Circ Res*. 2018;123(11):1244–1254. doi:10.1161/CIRCRESAHA.118.313608
2. Brezinski EA, Dhillon JS, Armstrong AW. Economic burden of psoriasis in the United States: a systematic review. *JAMA Dermatol*. 2015;151(6):651–658. doi:10.1001/jamadermatol.2014.3593
3. Kimball AB, Guérin A, Tsaneva M, et al. Economic burden of comorbidities in patients with psoriasis is substantial. *J Eur Acad Dermatol Venereol*. 2011;25(2):157–163. doi:10.1111/j.1468-3083.2010.03730.x
4. Pober JS, Sessa WC. Evolving functions of endothelial cells in inflammation. *Nat Rev Immunol*. 2007;7(10):803–815. doi:10.1038/nri2171
5. Chiang CC, Cheng WJ, Korinek M, Lin CY, Hwang TL. Neutrophils in psoriasis. *Front Immunol*. 2019;10(2376). doi:10.3389/fimmu.2019.02376
6. Matsushita Y, Shimada Y, Kawara S, Takehara K, Sato S. Autoantibodies directed against the protease inhibitor calpastatin in psoriasis. *Clin Exp Immunol*. 2005;139(2):355–362. doi:10.1111/j.1365-2249.2005.02701.x
7. Rajendran P, Rengarajan T, Thangavel J, et al. The vascular endothelium and human diseases. *Int J Biol Sci*. 2013;9(10):1057–1069. doi:10.7150/ijbs.7502
8. Williams JW, Huang LH, Randolph GJ. Cytokine circuits in cardiovascular disease. *Immunity*. 2019;50(4):941–954.
9. Wang W, Wang H. Astilbin reduces ROS accumulation and VEGF expression through Nrf2 in psoriasis-like skin disease. *Biol Res*. 2019;52(1):49.
10. Xian D, Song J, Yang L, Xiong X, Lai R, Zhong J. Emerging roles of redox-mediated angiogenesis and oxidative stress in dermatoses. *Oxid Med Cell Longev*. 2019;2019(2304018):1–14. doi:10.1155/2019/2304018
11. Nestle FO, Kaplan DH, Barker J. Psoriasis. *N Engl J Med*. 2009;361(5):496–509. doi:10.1056/NEJMra0804595
12. Lowes MA, Bowcock AM, Krueger JG. Pathogenesis and therapy of psoriasis. *Nature*. 2007;445(7130):866–873. doi:10.1038/nature05663
13. Xia YP, Li B, Hylton D, Detmar M, Yancopoulos GD, Rudge JS. Transgenic delivery of VEGF to mouse skin leads to an inflammatory condition resembling human psoriasis. *Blood*. 2003;102(1):161–168. doi:10.1182/blood-2002-12-3793
14. Heidenreich R, Röcken M, Ghoreschi K. Angiogenesis drives psoriasis pathogenesis. *Int J Exp Pathol*. 2009;90(3):232–248. doi:10.1111/j.1365-2613.2009.00669.x
15. Detmar M, Brown LF, Claffey KP, et al. Overexpression of vascular permeability factor/vascular endothelial growth factor and its receptors in psoriasis. *J Exp Med*. 1994;180(3):1141–1146. doi:10.1084/jem.180.3.1141
16. Boehncke WH, Schön MP. Psoriasis. *Lancet*. 2015;386(9997):983–994. doi:10.1016/S0140-6736(14)61909-7
17. Young HS, Summers AM, Bhushan M, Brenchley PE, Griffiths CE. Single-nucleotide polymorphisms of vascular endothelial growth factor in psoriasis of early onset. *J Invest Dermatol*. 2004;122(1):209–215. doi:10.1046/j.0022-202X.2003.22107.x
18. Schön MP, Boehncke WH. Psoriasis. *N Engl J Med*. 2005;352(18):1899–1912. doi:10.1056/NEJMra041320
19. Gelfand JM, Neimann AL, Shin DB, Wang X, Margolis DJ, Troxel AB. Risk of myocardial infarction in patients with psoriasis. *JAMA*. 2006;296(14):1735–1741. doi:10.1001/jama.296.14.1735
20. Zheng Y, Danilenko DM, Valdez P, et al. Interleukin-22, a T(H)17 cytokine, mediates IL-23-induced dermal inflammation and acanthosis. *Nature*. 2007;445(7128):648–651. doi:10.1038/nature05505
21. Griffiths CE, Voorhees JJ, Nickoloff BJ. Characterization of intercellular adhesion molecule-1 and HLA-DR expression in normal and inflamed skin: modulation by recombinant gamma interferon and tumor necrosis factor. *J Am Acad Dermatol*. 1989;20(4):617–629. doi:10.1016/S0190-9622(89)70073-6
22. Picker LJ, Kishimoto TK, Smith CW, Warnock RA, Butcher EC. ELAM-1 is an adhesion molecule for skin-homing T cells. *Nature*. 1991;349(6312):796–799. doi:10.1038/349796a0
23. Bhushan M, McLaughlin B, Weiss JB, Griffiths CE. Levels of endothelial cell stimulating angiogenesis factor and vascular endothelial growth factor are elevated in psoriasis. *Br J Dermatol*. 1999;141(6):1054–1060. doi:10.1046/j.1365-2133.1999.03205.x
24. Lowes MA, Suárez-Fariñas M, Krueger JG. Immunology of psoriasis. *Annu Rev Immunol*. 2014;32:227–255.
25. Mehta NN, Azfar RS, Shin DB, Neimann AL, Troxel AB, Gelfand JM. Patients with severe psoriasis are at increased risk of cardiovascular mortality: cohort study using the General Practice Research Database. *Eur Heart J*. 2010;31(8):1000–1006. doi:10.1093/eurheartj/ehp567
26. He Y, Kim J, Tacconi C, et al. Mediators of capillary-to-venule conversion in the chronic inflammatory skin disease psoriasis. *J Invest Dermatol*. 2022;142(12):3313–3326. doi:10.1016/j.jid.2022.05.1089
27. Young KZ, Plazyo O, Gudjonsson JE. Targeting immune cell trafficking and vascular endothelial cells in psoriasis. *J Clin Invest*. 2023;133(9). doi:10.1172/JCI169450
28. Lee HJ, Hong YJ, Kim M. Angiogenesis in chronic inflammatory skin disorders. *Int J Mol Sci*. 2021;22(21):12035.
29. Benhadou F, Glitzner E, Brisebarre A, et al. Epidermal autonomous VEGFA/Flt1/Nrp1 functions mediate psoriasis-like disease. *Sci Adv*. 2020;6(2):x5849. doi:10.1126/sciadv.aax5849
30. von Stebut E, Reich K, Thaçi D, et al. Impact of secukinumab on endothelial dysfunction and other cardiovascular disease parameters in psoriasis patients over 52 weeks. *J Invest Dermatol*. 2019;139(5):1054–1062. doi:10.1016/j.jid.2018.10.042
31. Weber B, Merola JF, Husni ME, Di Carli M, Berger JS, Garshick MS. Psoriasis and cardiovascular disease: novel mechanisms and evolving therapeutics. *Curr Atheroscler Rep*. 2021;23(11):67. doi:10.1007/s11883-021-00963-y
32. Lynch M, Ahern T, Sweeney CM, et al. Adipokines, psoriasis, systemic inflammation, and endothelial dysfunction. *Int J Dermatol*. 2017;56(11):1103–1118. doi:10.1111/ijd.13699
33. Otto M, Dorn B, Grasmik T, et al. Apremilast effectively inhibits TNFα-induced vascular inflammation in human endothelial cells. *J Eur Acad Dermatol Venereol*. 2022;36(2):237–246. doi:10.1111/jdv.17769
34. Shao S, Fang H, Li Q, Wang G. Extracellular vesicles in inflammatory skin disorders: from pathophysiology to treatment. *Theranostics*. 2020;10(22):9937–9955. doi:10.7150/thno.45488

35. Elnabawi YA, Garshick MS, Tawil M, et al. CCL20 in psoriasis: a potential biomarker of disease severity, inflammation, and impaired vascular health. *J Am Acad Dermatol*. 2021;84(4):913–920. doi:10.1016/j.jaad.2020.10.094
36. Liu JH, Chen Y, Zhen Z, et al. Relation between endothelial progenitor cells and arterial stiffness in patients with psoriasis. *J Dermatol*. 2016;43 (8):888–893. doi:10.1111/1346-8138.13235
37. Batycka-Baran A, Paprocka M, Krawczenko A, Kantor A, Duś D, Szepietowski JC. Reduced number of circulating endothelial progenitor cells (CD133+/KDR+) in patients with plaque psoriasis. *Dermatology*. 2012;225(1):88–92. doi:10.1159/000341534
38. Reynolds G, Vegh P, Fletcher J, et al. Developmental cell programs are co-opted in inflammatory skin disease. *Science*. 2021;371(6527). doi:10.1126/science.aba6500
39. Li Z, Wang M, Tan J, et al. Single-cell RNA sequencing depicts the local cell landscape in thyroid-associated ophthalmopathy. *Cell Rep Med*. 2022;3(8):100699. doi:10.1016/j.xcrm.2022.100699