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ORIGINAL ARTICLE

The future of skin aging studies: An analysis of global trends

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Abstract

This study presents a bibliometric analysis of global trends in skin aging research, identifying key contributors, dominant themes, and research gaps. A bibliometric analysis was conducted on skin aging research published between 1990 and 2024. Using the Web of Science database, 579 studies were identified with keywords such as "skin aging," "aging mechanisms," and "skin physiology." After screening, 567 articles were analyzed. Text mining and data visualization techniques were applied using VOSviewer to enhance accuracy and interpretability. The analysis included 567 articles with 25,312 citations, averaging 45 citations per article, and an H-index of 83. The number of publications and citations has steadily increased since 2001, with 70% of studies originating from the United States, Canada, and the United Kingdom. Physiology was the leading research category (55%), followed by dermatology, cell biology, and sports science. Additionally, 94% of articles were indexed in SCI-Expanded, indicating strong representation in health sciences. Keyword analysis identified interconnected research clusters, with skin physiology, aging, and skin blood flow as dominant themes. Skin aging research is multidisciplinary, incorporating advanced methodologies such as machine learning and high-throughput omics. Despite significant progress, research gaps persist, particularly in understanding the role of systemic inflammation and disparities in global research output. This study underscores the growing interest in skin aging research, highlighting key trends, challenges, and the need for interdisciplinary collaboration and technological advancements to further explore its systemic implications.

Keywords: Skin aging, aging mechanisms, skin physiology

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Introduction

Aging is a complex process driven by interconnected molecular and cellular mechanisms [1,2]. It involves a gradual decline in cellular function and systemic tissue integrity, increasing vulnerability to age-related diseases [3,4]. Aging reduces both functionality and quality of life, widening the gap between lifespan and healthspan, and presenting significant healthcare and socioeconomic challenges [2]. Understanding these molecular mechanisms is crucial for developing strategies to slow aging and extend healthspan [3]. Skin aging, as a critical aspect of the overall aging process, serves as both a visible marker of aging and a reflection of systemic health. The skin's barrier function comprises physical, chemical, immune, and microecological components [5], which protect against environmental stressors and play a pivotal role in systemic aging. A notable age-related change is the decline in skin barrier functionality, contributing to chronic, low-grade systemic inflammation [6]. This inflammation is closely linked to the onset of systemic age-related disorders [7].

Furthermore, skin health is strongly tied to overall health, mortality risk, and lifespan, with its condition often reflecting an individual's general well-being [8-10]. Research into skin aging extends beyond cosmetic concerns, offering insights into managing age-related conditions in internal organs due to the protective role of healthy, youthful skin [11]. Despite advances in medical and cosmetic sciences, key questions about the mechanisms, clinical implications, and systemic effects of skin aging remain unresolved. Understanding these mechanisms is essential for developing therapies that not only improve skin health but also potentially delay the onset of aging-related disorders in other organs [12-14]. Such therapies are guided by studies on molecular pathways regulating the skin's protective role, supported by innate and adaptive immune responses [15]. These pathways are intricately regulated through molecular and immunological signaling networks [16]. This study conducts a bibliometric analysis of global trends and impacts in skin aging research. By reviewing publications from various disciplines, it highlights key works and their significance in understanding the future directions and implications of skin aging studies. The primary aim is to assess the importance of these publications and analyze relevant trends and clusters within the field.

Materials and Methods

As this bibliometric research did not involve any human or animal subjects, and did not use any patient data, ethical approval was not required. To ensure the reliability of our study and the accuracy of the results, we employed a systematic data collection method, a well-defined search strategy, and network analysis software. These methodologies enabled the collection and analysis of the most up-to-date and comprehensive data available in the literature. The evaluation of this data highlights emerging trends and advancements in skin aging research, with a focus on mechanisms such as molecular pathways, barrier function decline, and systemic effects. It also identifies future directions and underscores the broader impact of these studies on fields like dermatology and regenerative medicine. By examining various factors, including the most influential researchers, countries, and frequently used keywords—global publication trends on skin aging were effectively identified.

However, it should be noted that variables such as the number of universities in each country, the number of researchers working in the field, and country population were not included in the current analysis. These criteria, although relevant for a deeper understanding of the context behind country-level contributions, were beyond the scope of our bibliometric methodology and data availability.

Data collection method and search strategy

This bibliometric study examines the global trends, future directions, and impacts of research on skin aging conducted between 1990 and 2024 (last access date: October 1, 2024) using the "Web of Science Core Collection" database (WOS, Clarivate Analytics, Philadelphia, PA, USA). A search using the keywords "skin aging," "aging mechanisms," and "skin physiology" yielded 579 studies. After excluding irrelevant

studies, those published before 1990, and non-article formats, 567 articles were included in the analysis. Extracted data from the database were evaluated based on details such as title, authors, publication year, journal, and citation count. The materials were accessed through the online library and digital resources of Van Yüzüncü Yıl University. The search language was English. This study analyzed global trends in skin aging research using bibliometric methods, utilizing data from the WOS database, a well-known resource that includes academic articles across various disciplines and topics. It serves as a valuable tool for conducting interdisciplinary research. Publications from the WOS database were collected using precise search terms and subjected to bibliometric analysis. The data was extracted via the WOS online interface and analyzed based on diverse parameters. The analysis highlighted publication growth, the most active countries and institutions, and keyword mapping. All articles were meticulously reviewed.

Network analysis

This study utilized VOSviewer (version 1.6.20, Leiden University, Netherlands) to analyze collaboration networks, key highlights, and future directions in skin aging research, aiming to identify global trends and significant topics in the field. Systematic data collection was conducted using the WOS database, and the full-text data of selected publications were analyzed through VOSviewer software. The analysis employed text mining and data visualization techniques, including bubble maps and other graphical tools, to ensure accuracy and reliability.

Bubble maps

Bubble maps are visual tools that group published articles within a research field based on frequency. Each keyword or group is represented as a "bubble," with the bubble size corresponding to the frequency of that keyword or group. The bubbles are color-coded, with the colors highlighting relationships between keywords or groups, ensuring that related items are positioned closely together.

Results

A total of 575 articles published in the WoS database were analyzed. These articles received a total of 26,009 citations (25,348 citations excluding self-citations), with an average of 45 citations per article. The H-index was calculated as 84. Notably, both the number of citations and the number of articles showed an upward trend starting from 2001. The distribution of publications and citations is presented in Figure 1.

When analyzed based on the selected keywords, it was observed that the most extensive and interconnected subject areas included keywords such as "aging," "skin," "skin aging," "skin physiology," and "skin blood flow" (Figure 2).

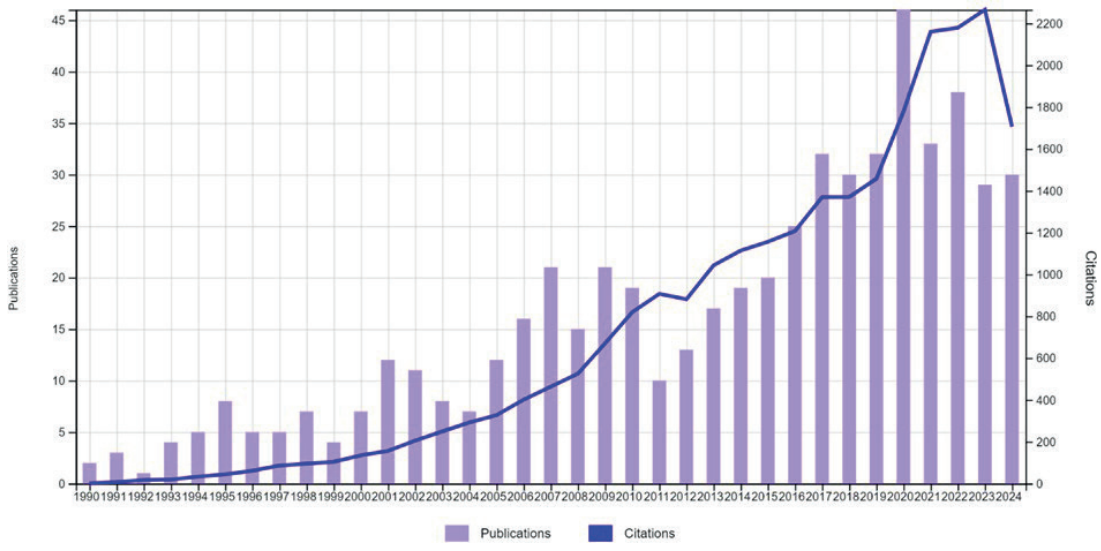

Figure 1. Frequency of publications and citations by year (last access 01.10.2024).

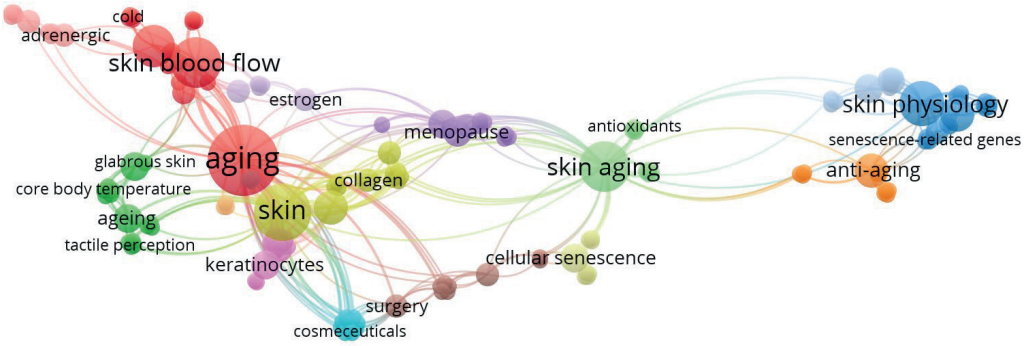

Figure 2. Keyword analysis reveals the association of the topic with specific keywords and the frequency of their usage.

The majority of the articles were categorized under Physiology (54.5%), followed by sport science (15.9%), dermatology (12.7%) and cell biology (9.5%). The distribution of publications by research area is presented in Table 1.

The United States ranked first in the number of published articles (n=288; 50.8%), followed by Canada (n=54; 9.5%), the United Kingdom (n=48; 8.5%), and Japan (n=48; 8.5%). In total, articles were published by researchers from 69 countries worldwide, including these top 4 countries, with Türkiye ranking 28th. The top 15 countries with 10 or more publications are listed in Table 2.

The bibliographic coupling analysis by country reveals that the USA, Germany, England, South Korea, and Japan are among the leading contributors in this field (Figure 3).

Table 1. Categories of publications.

Research Areas	Record Count	% of 567
Physiology	309	54.497
Sport Sciences	90	15.873
Dermatology	72	12.698
Cell Biology	54	9.524
Neurosciences Neurology	45	7.937
Pharmacology Pharmacy	34	5.996
Cardiovascular System Cardiology	31	5.467
Biochemistry Molecular Biology	30	5.291
Chemistry	24	4.233
Psychology	18	3.175
Endocrinology Metabolism	17	2.998
Science Technology Other Topics	17	2.998
Geriatrics Gerontology	15	2.646
Engineering	13	2.293
Behavioral Sciences	11	1.940
Showing 15 out of 63 entries		

Table 2. Countries with at least 20 publications.

Countries/Regions	Record Count	% of 2.695
USA	288	50.794
CANADA	54	9.524
ENGLAND	48	8.466
JAPAN	48	8.466
GERMANY	47	8.289
AUSTRALIA	29	5.115
FRANCE	28	4.938
CHINA	23	4.056
ITALY	21	3.704
SOUTH KOREA	19	3.351
SWEDEN	16	2.822
SWITZERLAND	16	2.822
AUSTRIA	12	2.116
NETHERLANDS	11	1.940
BRAZIL	10	1.764
Showing 15 out of 69 entries		

Figure 4 illustrates the countries with the highest levels of international collaboration, with the USA leading the network. Other significant collaborators include Germany, England, the Netherlands, France, Brazil, and Poland, all showing strong and impactful connections within the global research network.

Pennsylvania Higher Education PCSHE (10.6%), Pennsylvania State University (9.3%), and Pennsylvania State University Park (8.5%) were the top organizations contributing the highest number of publications. Consequently, most of the leading affiliations were concentrated in the United States. Of the 987 records analyzed, 15 are highlighted in Table 3.

An analysis of the WOS indexes revealed that most articles were categorized under the "Science Citation Index Expanded (SCI-Expanded)" (94.4%), followed by the "Social Sciences Citation Index (SSCI)" (6.2%) and the "Emerging Sources Citation Index (ESCI)" (3.7%) (Table 4).

Figure 3. Bibliographic coupling analysis was performed for countries (the correlation between items was established by evaluating the number of references they share).

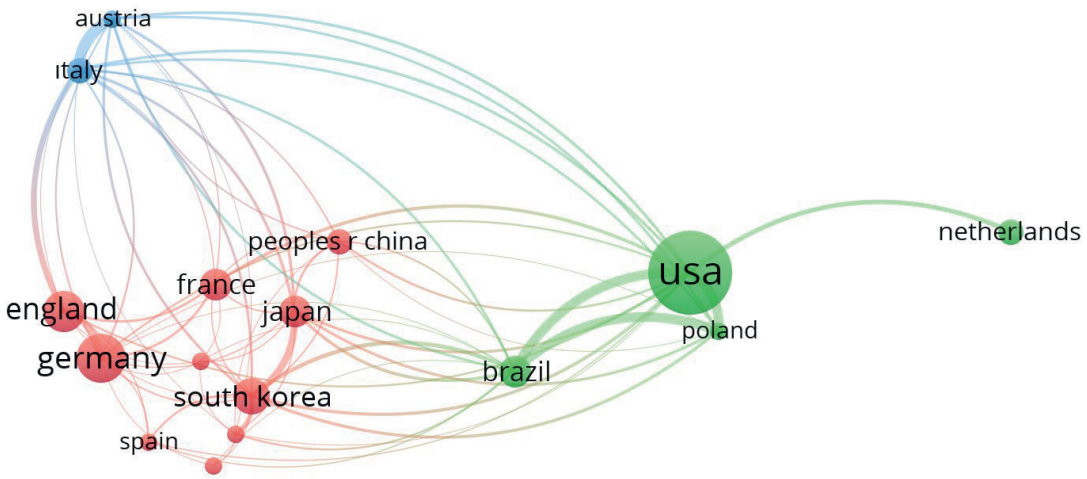

Figure 4. International collaboration network map illustrates collaboration between countries through lines, where the thickness denotes the strength of collaboration, and the size of circles/text reflects the level of international collaboration.

Table 3. Top affiliations ranking.

Affiliations	Record Count	% of 2.695
Pennsylvania Higher Edu PCSHE	60	10.582
Pennsylvania State University	53	9.347
Pennsylvania State University Park	48	8.466
University of Ottawa	27	4.762
University of Texas System	26	4.586
University of California System	19	3.351
University of Tsukuba	17	2.998
University of Oregon	13	2.293
Us department of Veterans Affairs	12	2.116
Veterans Health Administration VHA	12	2.116
Harvard University	11	1.940
University of Sherbrooke	11	1.940
Free University of Berlin	10	1.764
Mayo Clinic	10	1.764
University of London	10	1.764
Showing 15 out of 987 entries		

Table 4. Web of Science Categories Index.

Web of Science Index	Record Count	% of 2.695
Science Citation Index Expanded (SCI-Expanded)	535	94.356
Social Sciences Citation Index (SSCI)	35	6.173
Emerging Sources Citation Index (ESCI)	21	3.704
Conference Proceedings Citation Index - (CPCI-S)	11	1.940
Book Citation Index - Science (BKCI-S)	9	1.587

Discussion

This bibliometric analysis provides a comprehensive overview of global trends in skin aging research, identifying key contributors, dominant themes, and research gaps. The analysis of 567 studies revealed significant growth in skin aging research since 2001, with the United States leading in publication output, followed by Canada and the United Kingdom.

Despite this growth, notable gaps remain. For instance, limited research explores the interplay between systemic inflammation and skin aging beyond cosmetic implications. Additionally, disparities in research output among countries highlight unequal resource allocation and access to funding, particularly in developing regions. Addressing these gaps requires collaborative, interdisciplinary approaches that integrate dermatology, cell biology, and gerontology. Another emerging theme is the role of advanced methodologies, such as machine learning and high-throughput omics technologies, in uncovering novel biomarkers and mechanisms underlying skin aging. These tools offer immense potential for identifying therapeutic targets and developing personalized interventions. This study highlights the increasing global focus on skin aging, with research efforts spanning multiple disciplines. Advances in medical technology have extended lifespan, while declining birth rates have accelerated population aging. This demographic shift has intensified interest in healthy aging, prompting significant research efforts to elucidate the mechanisms of aging [17]. The increasing number of studies on skin aging reflects its recognition as a key indicator of overall health, given that its functional decline closely mirrors age-related systemic diseases [18,19]. The bibliometric analysis further reveals that the most prominent publication categories include physiology, sports science, dermatology, and cell biology (Table 1). The strong representation of physiology aligns with the biological mechanisms underlying skin aging, including cellular senescence, collagen degradation, oxidative stress, and impaired barrier function. Sports science explores the relationship between physical activity and skin aging, while dermatology focuses on clinical approaches to managing aging-related conditions. Cell biology contributes insights into molecular mechanisms such as stem cell dynamics and autophagy. This distribution reflects the inherently interdisciplinary nature of skin aging research. .Keyword analysis reveals closely linked research clusters, particularly connecting *skin aging* with *skin physiology* and *skin blood flow*. The association between skin aging and vascular dynamics is significant, as recent studies highlight the crucial role of microcirculation in maintaining skin integrity [20]. Enhanced skin blood flow, often achieved through regular exercise, supports nutrient delivery, hydration, and overall skin function, helping to counteract the effects of aging [21]. These associations suggest that these topics are often studied together to provide a comprehensive understanding of skin aging.

In terms of geographical contributions, the United States stands out as the leading country in skin aging research, followed by Canada, the United Kingdom, and Japan. Researchers from 69 countries have published in this field, demonstrating its global significance. Notably, Türkiye ranked 28th, indicating an emerging research presence. While China has surpassed the United States in overall publication output across various fields, the United States remains a leader in aging-related research, largely due to substantial funding from institutions such as the National Institutes of Health (NIH). Similar funding bodies, including the Canadian Institutes of Health Research (CIHR) and UK Research and Innovation (UKRI), also support skin aging studies. A bibliographic analysis of indexed articles reveals that most publications are found in the Science Citation Index Expanded (SCI-Expanded) within the Web of Science, with fewer appearing in the Social Sciences Citation Index (SSCI) and Emerging Sources Citation Index (ESCI). Despite the availability of diverse bibliographic databases, Web of Science remains the most detailed and widely referenced platform in the field.

Conclusion

This bibliometric analysis provides a comprehensive overview of global trends in skin aging research, identifying key contributors, dominant themes, and existing gaps. By recognizing skin aging as both a cosmetic and systemic concern, this study underscores the need for interdisciplinary collaboration to address its multifaceted challenges. Future research should prioritize: Investigating the molecular pathways linking skin aging to systemic health. Exploring the role of environmental and lifestyle factors in modulating aging mechanisms. Addressing geographic and economic disparities in research funding and output. Moreover, bibliometric insights can help pinpoint critical gaps in the field, offering opportunities to bridge the divide between lifespan and healthspan and ultimately guiding more effective interventions for healthy aging. The integration of advanced technologies and multi-disciplinary approaches will be essential in shaping the future of skin aging research and developing innovative therapeutic and public health strategies.

Ethics committee approval

As this study is a bibliometric analysis and does not involve human or animal experiments, ethics committee approval is not required.

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Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

References

1. Karimi N. Approaches in line with human physiology to prevent skin aging. Front Physiol. 2023;14:1279371. doi: 10.3389/fphys.2023.1279371.
2. Karimi N, Ahmadi V. Aquaporin channels in skin physiology and aging pathophysiology: Investigating their role in skin function and the hallmarks of aging. Biology (Basel). 2024;13(11):862. doi: 10.3390/biology13110862.
3. Li Y, Tian X, Luo J, Bao T, Wang S, Wu X. Molecular mechanisms of aging and anti-aging strategies. Cell Commun Signal. 2024;22(1):285. doi: 10.1186/s12964-024-01315-7.
4. Singh PP, Demmitt BA, Nath RD, Brunet A. The genetics of aging: A vertebrate perspective. Cell. 2019;177(1):200-20. doi: 10.1016/j.cell.2019.02.038.
5. Eyerich S, Eyerich K, Traidl-Hoffmann C, Biedermann T. Cutaneous barriers and skin immunity: differentiating a connected network. Trends Immunol. 2018;39(4):315-27. doi: 10.1016/j.it.2018.01.005.
6. Agrawal R, Hu A, Bollag WB. The skin and inflamm-aging. Biology (Basel). 2023;12(11):1590. doi: 10.3390/biology12111590.
7. Wang Z, Man MQ, Li T, Elias PM, Mauro TM. Aging-associated alterations in epidermal function and their clinical significance. Aging (Albany NY). 2020;12(6):5551–65. doi: 10.18632/aging.102942.
8. Gunn DA, de Craen AJ, Dick JL, Tomlin CC, van Heemst D, Catt SD, et al. Facial appearance reflects human familial longevity and cardiovascular disease risk in healthy individuals. J Gerontol A Biol Sci Med Sci. 2013;68(2):145-52. doi: 10.1093/gerona/gls154.
9. Gunn DA, Larsen LA, Lall JS, Rexbye H, Christensen K. Mortality is written on the face. J Gerontol A Biol Sci Med Sci. 2016;71(1):72-7. doi: 10.1093/gerona/glu236.
10. Huang S, Haiminen N, Carrieri AP, Hu R, Jiang L, Parida L, et al. Human skin, oral, and gut microbiomes predict chronological age. mSystems. 2020;5(1):e00630-19. doi: 10.1128/mSystems.00630-19.
11. Blagosklonny MV. Disease or not, aging is easily treatable. Aging (Albany NY). 2018;10(11):3067–78. doi: 10.18632/aging.101633.
12. Ansary TM, Hossain MR, Kamiya K, Komine M, Ohtsuki M. Inflammatory molecules associated with ultraviolet radiation-mediated skin aging.

Int J Mol Sci. 2021;22(8):3974. doi: 10.3390/ijms22083974.

13. Zhang S, Duan E. Fighting against skin aging: The way from bench to bedside. Cell Transplant. 2018;27(5):729-38. doi: 10.1177/0963689718769879.
14. Gu Y, Han J, Jiang C, Zhang Y. Biomarkers, oxidative stress and autophagy in skin aging. Ageing Res Rev. 2020;59:101036. doi: 10.1016/j.arr.2019.101036.
15. Zhang C, Merana GR, Harris-Tryon T, Scharschmidt TC. Skin immunity: Dissecting the complex biology of our body's outer barrier. Mucosal Immunol. 2022;15(4):551-61. doi: 10.1038/s41385-022-00538-4.
16. Velarde MC. Epidermal barrier protects against age-associated systemic inflammation. J Invest Dermatol. 2017;137(6):1206-8. doi: 10.1016/j.jid.2017.03.022.
17. Cai Y, Song W, Li J, Jing Y, Liang C, Zhang L, et al. The landscape of aging. Sci China Life Sci. 2022;65(12):2354-54. doi: 10.1007/s11427-022-2161-3.
18. Zouboulis CC, Makrantonaki E. Clinical and laboratory skin biomarkers of organ-specific diseases. Mech Ageing Dev. 2019;177:144-9. doi: 10.1016/j.mad.2018.01.005.
19. Nikolakis G, Makrantonaki E, Zouboulis CC. Skin mirrors human aging. Horm Mol Biol Clin Investig. 2013;16(1):13-28. doi: 10.1515/hmbci-2013-0003.
20. Cracowski JL, Roustit M. Human skin microcirculation. Compr Physiol. 2020;10(3):1105-54. doi: 10.1002/cphy.c190038.
21. Oizumi R, Sugimoto Y, Aibara H. The potential of exercise on lifestyle and skin function: Narrative review. JMIR Dermatol. 2024;7:e51962. doi: 10.2196/51962.