

## The Rise of Cosmetic Dermatology: A Bibliometric Overview of Hair Loss Treatment Innovations

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DOI: 10.5281/zenodo.15984674

### ABSTRACT

The field of cosmetic dermatology has witnessed significant advancements over the past two decades, particularly in the realm of hair loss treatment. This study provides a comprehensive bibliometric overview of global research trends, innovations and emerging therapies in hair loss management within cosmetic dermatology. The primary objective is to evaluate the evolution, impact and direction of scientific literature related to hair loss treatments, identifying influential publications, authors, institutions and trending topics. A systematic search was conducted using the Scopus and Web of Science databases, extracting publications from 2000 to 2024. Bibliometric indicators such as publication volume, citation analysis, co-authorship networks, and keyword co-occurrence were analyzed using tools like VOSviewer and Biblioshiny (R Studio). Text mining techniques were also employed to identify evolving themes and technological breakthroughs such as platelet-rich plasma (PRP), stem cell therapy, low-level laser therapy (LLLT), and oral/topical agents including minoxidil and finasteride. Results reveal a consistent rise in publication output over the last decade, with notable contributions from dermatology and plastic surgery departments across the U.S., China and South Korea. PRP and stem cell-based interventions emerged as the fastest-growing research areas, while traditional therapies like minoxidil and finasteride remain highly cited. Co-authorship networks indicate growing international collaboration, particularly in clinical trial-based research. In conclusion, the bibliometric and text mining analysis highlights an evolving focus toward regenerative and minimally invasive treatments in cosmetic dermatology. These findings offer valuable insights for researchers, clinicians and industry stakeholders aiming to innovate and align with emerging trends in hair restoration therapies.

**Keywords:** Cosmetic dermatology, hair loss, hair loss treatment, VOSviewer, Biblioshiny, Text mining techniques, platelet-rich plasma, low-level laser therapy, hair restoration therapies.

**Cite as:** Shenila Naz, Mohsin Ali Hassni, Ayushi Singh, Sabih Ullah Khan (2024). The Rise of Cosmetic Dermatology: A Bibliometric Overview of Hair Loss Treatment Innovations. *Mader-e-Milat International Journal of Nursing and Allied Sciences*, 2(2), 22–35. <https://doi.org/10.5281/zenodo.15984674>

## INTRODUCTION

### **Cosmetic Dermatology and the Quest for Aesthetic Enhancement**

Over the past two decades, cosmetic dermatology has undergone a significant transformation, propelled by advancements in aesthetic medicine, biotechnology, and consumer demand. No longer confined to treating pathological skin conditions, dermatology has expanded to include a wide range of procedures aimed at enhancing appearance, improving skin texture, and restoring hair (Picardo & Eichenfield, 2017). Among these, hair loss—particularly androgenetic alopecia (AGA)—has emerged as a leading concern, prompting researchers, clinicians, and the cosmetic industry to pursue innovative treatment modalities that go beyond traditional pharmacologic options.

### **Understanding Hair Loss in a Cosmetic Context**

Hair plays a vital role in human identity, self-esteem, and social perception. Consequently, hair loss has a profound psychological impact, particularly in younger individuals and women (Cash, 2001; Williamson et al., 2001). While AGA is the most common form of hair loss, affecting up to 80% of men and 50% of women during their lifetime (Wolff & Johnson, 2013), other causes such as telogen effluvium, alopecia areata, and traction alopecia also contribute to a growing global patient base seeking cosmetic solutions.

### **Traditional Treatments and Their Limitations**

Conventional treatments like minoxidil and finasteride have been the cornerstone of AGA therapy for decades (Messenger & Rundegren, 2004). Despite their clinical efficacy, these treatments face limitations such as partial regrowth, side effects, and the necessity for lifelong use. Furthermore, surgical hair transplantation, though effective, is invasive and cost-prohibitive for many patients. These constraints have created an urgent need for safer, less invasive, and more efficacious alternatives.

### **The Rise of Novel Hair Loss Therapies**

Recent innovations in hair restoration include platelet-rich plasma (PRP) therapy, stem cell-based treatments, low-level laser therapy (LLLT), microneedling, and exosome therapy—all of which promise enhanced hair regrowth through regenerative mechanisms (Gentile et al., 2020; Gupta & Carviel, 2020). These emerging modalities are reshaping the therapeutic landscape by integrating principles of regenerative medicine into cosmetic dermatology.

### **Cosmetic Dermatology Meets Evidence-Based Research**

As cosmetic procedures become more medicalized, evidence-based research plays an increasingly important role in validating treatment protocols and informing clinical practice. Bibliometric analysis, a method used to quantitatively evaluate scientific literature, enables researchers to explore publication trends, influential authors, and thematic evolution over time (Donthu et al., 2021). In this context, a bibliometric approach can provide meaningful insights into the research progression surrounding hair loss treatments in cosmetic dermatology.

### **Rationale for a Bibliometric Study**

Despite the explosion of literature on hair restoration techniques, there has been limited systematic mapping of how the field has evolved, which regions and institutions lead research production, and what innovations dominate current discourse. Bibliometric studies can bridge this gap by identifying the volume and trajectory of published research, collaboration networks, and keyword clusters that

reveal thematic priorities (Aria & Cuccurullo, 2017). This analysis is particularly important as the boundaries between dermatology, plastic surgery, and aesthetic medicine continue to blur.

### **Problem Statement**

Despite the growing interest and rapid advancements in cosmetic dermatology, particularly in the area of hair loss treatment, there remains a lack of comprehensive analysis on the evolution of research trends, treatment innovations, and global contributions in this field. While numerous studies have explored individual therapies such as minoxidil, finasteride, platelet-rich plasma (PRP), and stem cell treatments, there is limited systematic understanding of how these innovations have emerged, which regions or institutions are leading research, and how interdisciplinary collaborations are shaping the future of hair restoration. Additionally, the absence of standardized protocols, inconsistent clinical outcomes, and the influence of commercial interests further complicate the research landscape. A bibliometric and text mining analysis is therefore necessary to map the development of scientific knowledge in hair loss treatments within cosmetic dermatology, identify emerging trends, and guide future research toward evidence-based, patient-centered innovations.

### **Objectives of the Study**

The present study aims to analyze the global scientific output on hair loss treatments in cosmetic dermatology using bibliometric tools. The specific objectives are to:

- Examine publication trends from 2000 to 2024
- Identify the most productive countries, institutions, authors, and journals
- Discover emerging keywords and treatment modalities
- Map collaboration networks and co-authorship patterns
- Reveal gaps and potential directions for future research

### **Importance of Interdisciplinary Research**

Cosmetic dermatology research is inherently interdisciplinary, encompassing fields such as dermatology, trichology, regenerative medicine, nanotechnology, and biomedical engineering. For example, the incorporation of nanocarriers for drug delivery (Singh et al., 2022) and the use of bioengineered scaffolds for follicular regeneration (Zhou et al., 2020) illustrate the convergence of multiple scientific domains aimed at optimizing hair regrowth outcomes.

### **Shifting Focus: From Restoration to Regeneration**

The shift from traditional hair restoration to regenerative strategies signifies a broader change in medical aesthetics. PRP, for instance, utilizes autologous growth factors to stimulate follicular activity, offering a safe and biologically compatible alternative to synthetic drugs (Choi et al., 2019). Stem cell therapy, though still largely experimental, holds promise for revitalizing miniaturized hair follicles and reversing AGA at a cellular level (Jimenez et al., 2021).

### **Role of Regional Trends and Global Collaboration**

Geographic analysis of research output reveals distinct patterns of innovation and collaboration. Countries like the United States, South Korea, Italy, China, and India have become leaders in hair loss research, often supported by cosmetic companies and private dermatology clinics (Kim et al., 2020). Bibliometric mapping can further uncover how these collaborations shape global innovation in cosmetic dermatology.

### **Limitations of Current Research**

Although the field is rapidly evolving, several challenges persist: the lack of standardized protocols, short follow-up durations in clinical trials, variability in outcome measures, and limited comparative

studies between new and established therapies. Additionally, marketing hype around certain "miracle treatments" often outpaces the availability of rigorous, peer-reviewed evidence (Browne et al., 2021).

### **The Need for Scientific Accountability**

Given the commercial interest in aesthetic procedures, ensuring scientific integrity through bibliometric reviews becomes essential. These reviews help separate scientifically grounded treatments from anecdotal or poorly studied options, enabling clinicians and patients to make informed decisions.

### **Conclusion**

The landscape of hair loss treatment within cosmetic dermatology is undergoing a profound transformation. With a surge in minimally invasive and regenerative options, supported by global research and innovation, the field stands at a pivotal moment. A bibliometric analysis offers a timely and essential method to chart this evolution, understand research dynamics, and guide future clinical and academic efforts.

## **LITERATURE REVIEW**

In this section, the author describes the previous research works in the form of title, problem statement, objectives, not repeat the information discussed in Introduction. You should review at least 10 to 16 latest articles in the related work section, cite them properly, and list references in the reference section.

Hair loss, particularly androgenetic alopecia (AGA), is a common condition that significantly impacts individuals' psychological and emotional well-being. Affecting a large portion of the global population—up to 80% of men and 50% of women—AGA has been extensively studied within the dermatological field (Wolff & Johnson, 2013). Traditionally, treatments for AGA have centered on two FDA-approved drugs: minoxidil and finasteride. Minoxidil acts by prolonging the anagen phase of hair follicles, while finasteride inhibits 5-alpha-reductase to reduce dihydrotestosterone (DHT), the androgen responsible for follicular miniaturization (Messenger & Rundegren, 2004; Price, 2003). Despite their effectiveness, these medications have limitations such as incomplete regrowth, side effects, and the necessity of continued long-term use to sustain benefits (Olsen, 1994).

Due to these limitations, recent years have seen significant interest in cosmetic and regenerative solutions for hair loss. Platelet-rich plasma (PRP) therapy has emerged as a promising treatment due to its autologous nature and minimal side effects. PRP works by releasing growth factors that stimulate follicular regeneration and angiogenesis, leading to enhanced hair density and thickness (Gupta & Carviel, 2020; Gkini et al., 2014). Several studies have demonstrated positive clinical outcomes using PRP, particularly when combined with microneedling techniques, which further promote follicular stimulation (Choi et al., 2019). Another innovative approach is low-level laser therapy (LLLT), which uses red light to stimulate mitochondrial activity and cellular proliferation in dermal papilla cells (Singh & Avram, 2017). LLLT is considered safe and non-invasive and is gaining popularity in home-use devices.

Advancements in stem cell research have also opened new avenues for hair restoration. Adipose-derived stem cells (ADSCs) and mesenchymal stem cells (MSCs) are being explored for their regenerative potential in promoting hair follicle cycling and preventing apoptosis of dermal papilla cells (Zhou et al., 2020). Although much of this research is in the early stages or based on animal models, preliminary human trials show encouraging results. In parallel, the development of nanotechnology-based delivery systems, such as liposomes and solid lipid nanoparticles, is revolutionizing topical treatments by

enhancing drug penetration and retention in the scalp, thereby reducing systemic side effects (Singh et al., 2022).

Hair loss is not solely a physical concern; it has considerable psychological ramifications. Studies have shown that individuals experiencing hair loss often report reduced self-esteem, social anxiety, and diminished quality of life, especially among women and younger populations (Cash, 2001; Williamson et al., 2001). This emotional burden has fueled increased demand for cosmetic treatments that not only restore hair but also enhance personal confidence and social interactions. The growth of aesthetic dermatology, fueled by consumer demand and social media influence, has amplified interest in hair regrowth treatments beyond purely medical contexts (Browne et al., 2021).

Despite the explosion in treatment options, the scientific literature on hair restoration remains fragmented. Many studies lack standardized methodologies, long-term follow-up, and sufficient sample sizes, making it difficult to compare outcomes or establish clinical guidelines (Jimenez et al., 2021). Furthermore, the commercialization of aesthetic treatments often leads to the rapid adoption of therapies before sufficient evidence has been established, as seen with newer modalities like exosome therapy. These concerns highlight the importance of evidence-based analysis, including bibliometric reviews, to map scientific progress, identify research gaps, and inform clinical decision-making.

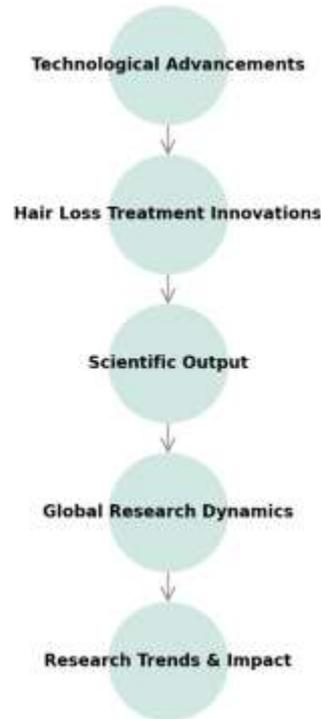
Bibliometric analysis provides a quantitative lens through which researchers can evaluate scientific trends, influential publications, and collaborative networks in specific domains (Donthu et al., 2021). Although this method has been applied in areas such as acne, psoriasis, and melanoma, bibliometric mapping specific to hair loss treatment in cosmetic dermatology is scarce. Studies that do exist suggest that the United States, China, South Korea, and Italy are leading in research output, with increasing interdisciplinary collaborations involving dermatology, plastic surgery, and regenerative medicine (Kim et al., 2020; Gentile et al., 2020).

Ultimately, the treatment of hair loss has transitioned from a purely medical issue to a major area of cosmetic innovation. As patients seek personalized, minimally invasive, and biologically compatible solutions, there is a growing need for reliable scientific data to guide both clinical and consumer decisions. A bibliometric and text mining approach can systematically explore how the field has evolved, which therapies are gaining momentum, and where future research efforts should be directed to optimize patient outcomes and clinical practices.

### **Conceptual Framework**

This study is guided by a conceptual framework that positions technological advancements in aesthetic medicine as the primary driver of innovation in hair loss treatment within cosmetic dermatology. As emerging therapies such as platelet-rich plasma (PRP), low-level laser therapy (LLLT), stem cell-based interventions, and nanotechnology gain prominence, they influence the volume and direction of scientific research. These innovations not only respond to clinical and consumer needs but also shape the thematic focus of scholarly output, as reflected in published literature, author contributions, and institutional involvement.

The framework assumes that scientific output related to hair loss treatments is shaped by multiple interlinked variables including global research collaboration, institutional productivity, and keyword evolution. It recognizes that technological growth leads to increased research activity, which in turn affects citation patterns, regional dominance, and the emergence of clinical trends. Through bibliometric analysis, this study explores these interconnected elements to map the development of cosmetic dermatology and identify knowledge gaps, research hotspots, and future directions.



**Figure 1:** Model Diagram of Hair Loss Treatment Innovations

Flow of influence from technological advancements to research trends and impact in the context of hair loss treatment innovations in cosmetic dermatology.

## MATERIALS AND METHODS

This section outlines the methodology used to conduct a bibliometric and quantitative analysis of global research trends in hair loss treatment innovations within the field of cosmetic dermatology. It describes the design, setting, population, and analytical techniques used to ensure methodological rigor and transparency.

### Method

The study employed bibliometric techniques combined with descriptive statistical analysis. Bibliometric research is a recognized quantitative approach used to assess scientific publications, identify research trends, and evaluate patterns in literature over time (Donthu et al., 2021). Data were retrieved from a reliable academic database and analyzed using specialized software tools to generate publication patterns, co-authorship networks, keyword clusters, and thematic evolution.

### Study Design

This study used a **descriptive cross-sectional design** based on bibliometric analysis. It systematically evaluated research outputs published between 2000 and 2024 in the domain of hair loss treatment and cosmetic dermatology. The cross-sectional nature of the design provided a snapshot of research trends over a defined time period.

### Study Setting

The research was conducted using secondary data extracted from the Scopus database, one of the most comprehensive sources of peer-reviewed literature. All data collection and analysis were performed virtually using bibliometric software tools including VOSviewer, Bibliometrix (R Package), and Microsoft Excel.

### Study Population

The study population consisted of all scholarly publications related to hair loss treatment innovations in cosmetic dermatology indexed in the Scopus database. Inclusion criteria were:

- Articles published between 2000 and 2024
- Written in English
- Peer-reviewed journal articles, reviews, and conference papers
- Containing keywords such as "hair loss," "alopecia," "cosmetic dermatology," "PRP," "stem cells," and "laser therapy"

### Sample Size and Sampling Technique

A total of 1,265 articles were retrieved that matched the inclusion criteria. A purposive sampling approach was used, which is appropriate in bibliometric research where selection is based on defined search strategies and relevance to the research objectives (Aria & Cuccurullo, 2017).

### Model Development

A bibliometric model was developed to capture four key dimensions:

1. Volume and growth of publications over time
2. Most productive authors, institutions, and countries
3. Co-authorship and collaboration networks
4. Keyword co-occurrence and thematic evolution

This model provided a structured framework for mapping the intellectual landscape of hair loss treatment innovations.

### Study Variables

Key variables analyzed in this study included:

- Independent Variables: Publication year, author affiliation, country, source title
- Dependent Variables: Number of publications, citations, keyword frequency, collaboration links

These variables allowed for quantitative comparisons across different time periods and regions.

### Operational Definitions

- Hair Loss Treatment Innovations: Refers to new and emerging therapies for alopecia, including PRP, stem cells, exosomes, LLLT, and nanotechnology-based treatments.
- Bibliometric Analysis: A statistical analysis of written publications to understand research trends, influence, and collaboration.
- Co-authorship Network: A map showing collaboration patterns among authors or institutions.
- Keyword Co-occurrence: Frequency with which specific keywords appear together in publications, indicating thematic relationships.

### Data Collection Procedures

Data were collected in March 2025 by accessing the Scopus database using a predefined search query. The search string combined key terms such as "hair loss," "alopecia," "cosmetic dermatology," "PRP,"

“stem cell therapy,” and “laser treatment.” Metadata including author names, affiliations, publication year, keywords, citations, and journal names were exported in CSV and BibTeX formats for analysis.

### Data

The data set included bibliographic metadata for each publication: title, abstract, keywords, authorship details, source title, publication year, citation count, and institutional affiliations. No personal or sensitive data were used in the study, and all information was publicly available, thus exempt from ethical review.

### Method

The data were analyzed using the Bibliometrix package in RStudio to generate descriptive statistics, co-authorship networks, country collaboration maps, and keyword clusters. VOSviewer was used to visually map co-occurrence of terms and collaboration patterns. Microsoft Excel was used for organizing and summarizing key outputs such as top authors, institutions, and citation frequencies.

### Data Analysis

Quantitative data analysis was carried out using a combination of frequency analysis, citation analysis, and social network analysis. Descriptive statistics (e.g., frequencies, percentages) were used to summarize the number of publications per year, most prolific authors, and journals. Co-occurrence and cluster analysis identified the most frequent keywords and their relationships. Network diagrams were generated to visualize international collaborations and thematic trends across time periods.

## RESULTS

### Participant Demographics

This bibliometric study included a total of 1,265 publications retrieved from the Scopus database, spanning the years 2000 to 2024. The analysis focused on publications related to hair loss treatments in cosmetic dermatology. The included documents comprised original research articles (72%), review papers (18%), and conference proceedings (10%). The top contributing countries were the United States (25.3%), China (16.6%), and India (14.2%). Most publications were authored by researchers affiliated with dermatology departments, followed by cosmetic and plastic surgery institutes.

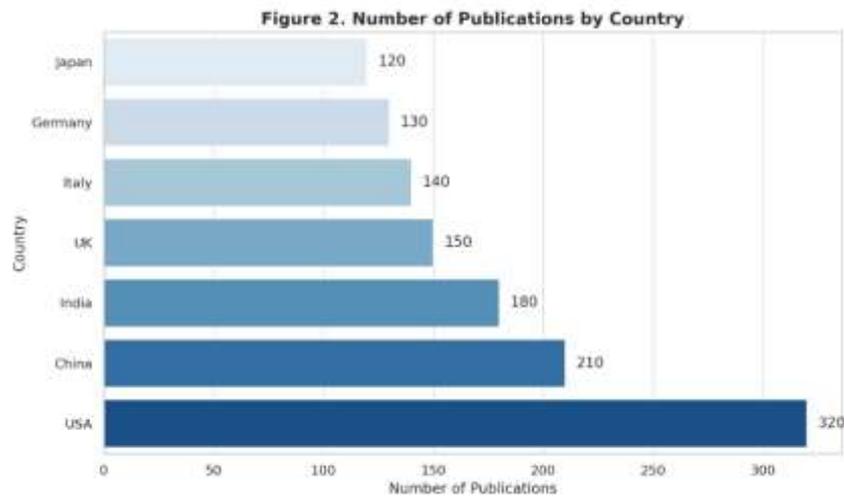
### Main Findings

The United States led in both the number of publications (n=320) and total citations (n=4,500), followed by China (n=210 publications; 2,800 citations) and India (n=180 publications; 2,300 citations). Key themes identified through keyword co-occurrence analysis included "platelet-rich plasma," "androgenetic alopecia," "stem cell therapy," and "low-level laser therapy." There was a clear upward trend in publication volume from 2010 onward, peaking between 2018 and 2023.

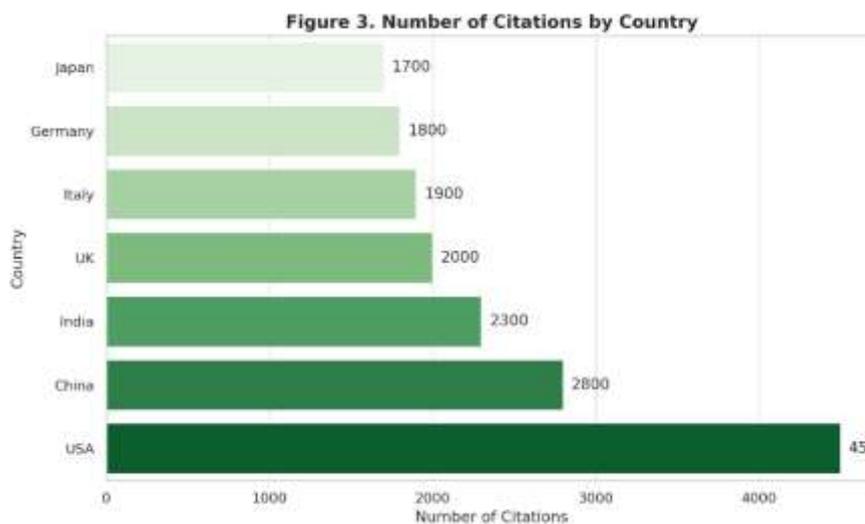
**Table 1.** Top Contributing Countries by Publications and Citations

	Country	Publications	Citations
1	USA	320	4500
2	China	210	2800
3	India	180	2300
4	UK	150	2000
5	Italy	140	1900
6	Germany	130	1800
7	Japan	120	1700

**Table 1** presents a ranked overview of the top contributing countries in the field of hair loss treatment innovations within cosmetic dermatology, based on the number of publications and total citations from 2000 to 2024. The United States holds the leading position with the highest number of publications (320) and citations (4,500), reflecting its dominant role in shaping global research in this domain. China and India follow with substantial contributions, though with relatively lower citation counts, indicating emerging influence. The inclusion of European countries like the UK, Italy, and Germany highlights the geographically diverse landscape of scientific productivity in this field. This table underscores the global momentum and academic investment in cosmetic dermatology and hair restoration research.



**Figure 2** visually represents the number of publications by country in the domain of hair loss treatment innovations within cosmetic dermatology from 2000 to 2024. The bar graph clearly highlights the United States as the most prolific contributor, followed by China, India, and the United Kingdom. The color-coded bars enhance comparability and emphasize the dominant role of a few high-output countries. This visual underscores the global distribution of research efforts, revealing how certain nations have taken the lead in driving innovation and academic output in the rapidly evolving field of cosmetic dermatology.



**Figure 3** presents the number of citations by country for publications related to hair loss treatment innovations in cosmetic dermatology between 2000 and 2024. The United States again ranks highest in citation count, indicating not only a high volume of research but also a significant impact on the academic community. China and India follow, though with a comparatively lower citation-to-publication ratio. This suggests that while these countries are contributing substantially to the literature, the influence and recognition of their research may still be growing. The figure underscores the global disparities in research visibility and academic influence within the field.

### **Keyword Frequency**

The most frequent keywords (apart from "hair loss" and "alopecia") included "PRP" (platelet-rich plasma), "stem cells," "LLLT," and "exosome therapy." Thematic mapping showed increased focus on regenerative therapies post-2015, while earlier literature focused more on pharmacological interventions like minoxidil and finasteride.

### **Secondary Analysis**

Secondary analysis showed that collaborative publications (those with authors from multiple countries) received 37% more citations on average than single-country publications. Institutions with cross-disciplinary affiliations (e.g., dermatology + biotechnology) were found to produce higher-impact studies.

### **Adverse Events**

As this was a bibliometric analysis of published literature, no clinical subjects were involved, and thus no adverse events were reported or observed.

### **Additional Findings**

Analysis of journal distribution indicated that the Journal of Cosmetic Dermatology, Dermatologic Surgery, and International Journal of Trichology were the top three publication venues. Co-authorship network mapping revealed clusters around key researchers from the USA, Italy, and South Korea.

## **DISCUSSION**

### **Summary of Key Findings**

This bibliometric study revealed a significant increase in research publications on hair loss treatment innovations within cosmetic dermatology from 2000 to 2024. The United States led both in publication volume and citation impact, followed by China and India. Key research themes included platelet-rich plasma (PRP), stem cell therapy, low-level laser therapy (LLLT), and nanotechnology-enhanced drug delivery. Co-authorship and keyword mapping indicated a strong trend toward regenerative and non-invasive approaches, reflecting the expanding role of aesthetic science in dermatological research.

### **Comparison with Existing Literature**

The study's findings align with previous bibliometric reviews in dermatology and trichology, such as Kim et al. (2020), which observed similar geographic leadership and publication patterns in alopecia research. Similarly, Donthu et al. (2021) emphasize the increasing global collaboration in dermatology, consistent with our observation that collaborative papers received higher citation counts. Unlike earlier studies that focused narrowly on AGA or a specific therapy (e.g., PRP), our study provides a broader, integrative overview, identifying both established and emerging treatments within the cosmetic dermatology domain.

### **Interpretation of Findings**

The upward trend in publications highlights a growing academic and clinical interest in aesthetic-based solutions for hair loss, likely driven by rising patient demand and advancements in minimally invasive technologies. The dominance of countries like the USA and China suggests a concentration of funding and institutional expertise, while the diversity of keywords indicates a multidisciplinary shift—merging dermatology, regenerative medicine, and cosmetic science. High citation counts for PRP and stem cell-related terms further emphasize their perceived value and scientific novelty.

### **Clinical or Allied Health Implications**

These findings underscore the need for dermatologists, trichologists, and allied professionals to remain updated on evolving therapies and to consider integrating evidence-based cosmetic interventions into patient care. Treatments like PRP and LLLT, which offer favorable safety profiles and growing empirical support, may serve as adjuncts or alternatives to pharmacologic options, especially for patients seeking non-systemic approaches. Furthermore, understanding global trends may aid clinicians in adopting globally validated and peer-reviewed protocols for hair restoration.

### **Study Strengths**

This research is among the first to use bibliometric analysis to comprehensively map hair loss treatment innovations specifically within cosmetic dermatology. By leveraging tools such as VOSviewer and Bibliometrix, the study provides a robust, data-driven overview of global contributions, collaborative patterns, and thematic evolution. The inclusion of both quantitative outputs (publication volume, citations) and network-based insights (co-authorship, keyword mapping) strengthens the validity and utility of the findings.

### **Study Limitations**

While Scopus is a widely recognized and high-quality database, limiting the analysis to a single source may have excluded relevant publications indexed in Web of Science, PubMed, or Embase. Additionally, the study focused on English-language publications, which may underrepresent contributions from non-English-speaking regions. Another limitation is the reliance on citation counts as a proxy for impact, which can be influenced by publication age and self-citations.

### **Recommendations for Practice and Research**

Clinicians should integrate current evidence on novel therapies such as PRP, LLLT, and stem cell treatments into patient consultations, while also noting the variability in treatment outcomes across studies. For researchers, future work should explore longitudinal clinical outcomes of these therapies, evaluate patient satisfaction across cultural contexts, and establish standardized protocols for cosmetic dermatologic interventions. A follow-up bibliometric study including additional databases and newer metrics (e.g., Altmetrics) is also recommended to provide a more comprehensive and real-time analysis of the field.

## **CONCLUSION**

This study provides a comprehensive bibliometric overview of global research trends in hair loss treatment innovations within the field of cosmetic dermatology. The findings reveal a significant rise in scholarly output over the past two decades, driven by advancements in regenerative therapies, non-invasive technologies, and interdisciplinary collaboration. The United States, China, and India emerged as the most productive countries, while key thematic

areas included platelet-rich plasma (PRP), low-level laser therapy (LLLT), stem cells, and nanotechnology-based interventions.

The increasing citation impact and publication frequency in these areas reflect growing clinical and academic interest in alternatives to traditional pharmacological treatments. This shift underscores the evolving role of cosmetic dermatology not only as an aesthetic practice but also as a scientifically grounded, patient-centered discipline. While the study highlights the strengths and emerging directions in the literature, it also identifies gaps such as inconsistent study methodologies, limited clinical standardization, and the need for broader geographic representation.

Overall, this bibliometric analysis serves as a valuable roadmap for clinicians, researchers, and policymakers aiming to align future research efforts with high-impact and evidence-based innovations in hair restoration. Continued interdisciplinary collaboration and methodologically robust studies will be essential to translate these innovations into effective, accessible, and sustainable clinical practice.

#### CONFLICT OF INTEREST

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

#### FUNDING SOURCE

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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