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Publication trends in vitiligo research from 1991 to 2024: a comprehensive bibliometric analysis

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Abstract

Over the last three decades, vitiligo research has expanded across clinical, genetic, and therapeutic domains. Accurate literature retrieval and bibliometric analysis are essential for identifying major themes and emerging topics within this field. A bibliometric analysis was conducted to identify vitiligo-related studies published between 1991 and 2024, using the Science Citation Index Expanded (SCIE) database. Using a “front page” strategy, articles containing “vitiligo” in the title, abstract, or author keywords were included. Extracted data encompassed titles, abstracts, and keywords to identify dominant research themes. Citation indicators, including total and annual citations, were used to assess impact and trends. Analyses were performed using Microsoft Excel 365. A total of 4,925 vitiligo articles were retrieved and divided into three periods: 1991-2010 (1,654); 2011-2018 (1,541); and 2019-2024 (1,730). The most frequent title word was “patients” (17%), while abstracts frequently included “patients” (63%), “skin” (46%), and “treatment” (41%). Prominent author keywords were “melanocytes”, “autoimmunity”, and a growing focus on “epidemiology”. Increasing trends appeared for “immunotherapy” and “oxidative stress”, while “efficacy”, “prevalence”, and “polymorphism” declined. Research is shifting toward molecular mechanisms and innovative therapies, offering guidance for future studies and improved disease understanding and management.

Introduction

In bibliometric research, accurate literature retrieval is crucial for valid results. Early searches in the Web of Science Core Collection (WoSCC) relied mainly on topic (TS) and title (TI) fields, often capturing irrelevant records. To improve precision, Wang and Ho (2011) introduced the “front page” method, filtering articles with keywords only in the title, abstract, or author keywords, excluding less relevant mentions in the field of Keywords Plus.¹ Initially done manually in Excel, the method has since been validated by several studies, revealing significant differences, up to 55%, between TS and “front page”-filtered results across various medical topics.² With advances in WoSCC search tools, researchers now incorporate the “front page” criteria directly using *title*, *abstract*, and *author keywords* fields.³ A research paper’s title serves as a brief yet informative representation of its main content, often acting as the initial, and sometimes only, point of engagement for readers.^{4,5} Complementing the title, the abstract summarizes the study’s purpose, methodology, key results, and conclusions, enabling readers to grasp its essential contributions without delving into the full text.⁵ Author keywords, selected by the researchers, highlight the primary themes of the work and reflect the authors’ specific focus, free from the constraints of standardized vocabularies.⁶ Conversely, Keywords Plus are algorithmically derived by Web of Science based on citation analysis, often

bringing in broader or indirectly related terms.⁷ Although these keywords can help uncover related literature, they may not represent the study's focus as precisely as author-assigned keywords.⁸

Keyword analysis has been an essential bibliometric method employed by Ho's research group since 2008 to identify research trends and thematic evolution across scientific literature.⁹ This methodology typically involves evaluating the frequency and distribution of keywords in titles, abstracts, author keywords, and Keywords Plus entries.^{10,11} In some studies, keyword extraction from abstracts has also been used to track the progression of scientific themes.^{8,12} This study focuses on evaluating research articles related to vitiligo studies indexed in the Science Citation Index Expanded (SCIE) database from 1991 to 2024. To uncover key themes and emerging topics within this field, a word analysis was conducted using a carefully constructed word bank, based on term frequency and distribution patterns across the included bibliographic fields.

Materials and Methods

The data utilized in this study were extracted from the SCIE database, available through Clarivate Analytics' WoSCC. Journal impact factors (IF₂₀₂₄) were obtained from the 2024 edition of the Journal Citation Reports (JCR), released on June 23, 2025. In accordance with the methodological recommendations by Chiu and Ho (2021), only publications from 2024 were included after the release of the 2024 impact factors to ensure temporal consistency in citation analysis.

Data retrieval was conducted on September 3, 2025, using an advanced search in WoSCC. The search term "vitiligo" was used within the *title*, *abstract*, and *author keywords* fields, following the "front page" approach outlined by Usman and Ho (2021).

The records were downloaded and processed using Microsoft Excel 365 for further bibliometric analysis.^{13,14} This strategy yielded a total of 8,484 documents, of which 8,429 (99%) were published between 1991 and 2024. Generally, the document type of articles comprises whole research sections, such as introduction, methodology, results, discussion, and conclusion.¹⁵ Only 4,925 articles in the 8,484 documents were selected to evaluate for publication trend research.

The evaluation of articles was performed using multiple citation-based indicators to assess research impact and influence. These included:

- i) C₂₀₂₄: the number of citations from WoSCC an article has received in the year 2024 alone. This annual citation indicator was introduced by Ho (2012) and is useful for measuring current relevance and short-term impact.
- ii) TC₂₀₂₄: the total number of citations from WoSCC that an article has accumulated from its publication year through the end of 2024. This cumulative metric, proposed by Wang *et al.* (2011), reflects the long-term influence and overall citation performance of a publication.¹

Results

Keyword analysis

To improve thematic relevance, grammatical function words such as prepositions, conjunctions, and articles were excluded from all analyses.¹⁶ In this study, a total of 4,925 articles on vitiligo indexed in the SCIE database from 1991 to 2024 were analyzed. These publications were divided into three approximately equal timeframes: 1991-2010 (1,654 articles); 2011-2018 (1,541 articles); and 2019-2024 (1,730 articles). The 20 most frequently occurring keywords, excluding original search terms, were identified within four bibliographic elements. Temporal distributions were analyzed to track the evolution of research focus in the vitiligo field.

Title word analysis

A frequency analysis of individual words in article titles was conducted, focusing on unigrams for consistency across the dataset.⁹ As titles are concise representations of article content, they offer immediate insights into research themes, though they are limited in scope.⁷ Common grammatical words were excluded to retain semantic clarity. The word “patients” emerged as the most frequent title word, appearing in 839 titles, 17% of total articles (Table 1). Its usage increased modestly across periods: 224 titles (15%) in 1991-2010, 278 (18%) in 2011-2018, and 317 (18%) in 2019-2024. The most cited article containing “patients” was by Banchereau *et al.* (2001), reporting on melanoma patients who developed progressive vitiligo following dendritic cell-based immunotherapy (TC₂₀₂₄=692; C₂₀₂₄=5).¹⁷ This study indicated a possible link between melanoma-specific immunity and melanocyte destruction. Another highly cited article by Hua *et al.* (2016) (TC₂₀₂₄=496; C₂₀₂₄=32) demonstrated that vitiligo development in melanoma patients treated with pembrolizumab was associated with favorable treatment outcomes, suggesting vitiligo may serve as an indicator of effective immunotherapy.¹⁸

Other trends in title word usage revealed shifts in research priorities. Terms such as “efficacy”, “pathogenesis”, “risk”, and “prevalence” showed declining frequencies, while mechanistically oriented terms like “epidermis” increased in usage, indicating a move toward more molecular and mechanistic investigations (Table 1).

Abstract word analysis

A total of 4,785 articles (97% of the dataset) included abstracts, enabling a robust word-frequency analysis. Abstracts provide broader thematic coverage than titles but often rely on general language. As with titles, non-substantive words were excluded.⁹ The most frequent abstract words were

“patients” (3,038 articles; 63%), “skin” (2,206; 46%), and “treatment” (1,953; 41%) (Table 2). General terms remained dominant; however, there was a notable rise in the use of words such as “role” and “significantly”, indicating increasing interest in functional interpretation and statistically validated results. Conversely, declining trends were observed for terms like “therapy”, “patient”, and “lesions”, suggesting subtle changes in research framing and focus (Table 2).

Author keyword analysis

Out of 4,925 articles, 3,322 (67%) contained author-provided keywords. These keywords offer a precise reflection of an article’s core content and methodology. Table 3 summarizes the 20 most frequently used author keywords (excluding search terms). The most common terms were “melanocytes” (165 mentions), “melanocyte” (156), and “autoimmunity” (150). The authors showed a preference for the plural form. The most cited article using either term was by Alkhateeb *et al.* (2003) (TC₂₀₂₄=491; C₂₀₂₄=19), which described vitiligo as an autoimmune disease resulting in melanocyte loss and depigmentation.¹⁹ The article highlighted a strong genetic component and comorbid autoimmune disorders. The second most cited article was Alikhan *et al.* (2011) (TC₂₀₂₄=446; C₂₀₂₄=49), providing a comprehensive clinical overview of vitiligo and emphasizing its variable onset, autoimmune associations, and psychological impact.²⁰ The emergence of the keyword “epidemiology” reflected growing interest in population-level analyses, increasing from 0.42% (4 mentions) in 1991-2013 to 1.7% (24 mentions) in 2021-2024. The most cited article using this keyword was by Tsai *et al.* (2011) (TC₂₀₂₄=253), which found a significant association between psoriasis and vitiligo, suggesting shared autoimmune mechanisms.²¹ Recent years have also seen increased use of terms such as “atopic dermatitis”, “autoimmune diseases”, “immunotherapy”, “melanogenesis”, and “oxidative stress”, while interest in older themes such as “hypopigmentation”, “polymorphism”, and “depigmentation” declined, indicating evolving thematic directions within the field.

Keywords Plus analysis

A total of 4,406 articles (89%) included Keywords Plus, terms algorithmically generated from the titles of cited references. While this approach may introduce broader or less thematically relevant terms,^{7,22} it remains valuable for mapping conceptual associations. The most frequent Keywords Plus terms were “skin” (491 articles; 11%), “vitiligo” (446; 10%), and “expression” (413; 9.4%). (Table 4). Terms like “pathogenesis”, “risk”, and “prevalence” have shown increased usage in recent years, reflecting a shift toward systemic and epidemiological perspectives. In contrast, terms such as “epidermis”, “generalized vitiligo”, and “repigmentation” have declined, suggesting decreasing emphasis on descriptive and morphological classifications (Table 4).

Word cluster analysis

To address the shortcomings of analyzing metadata elements independently, a word cluster analysis was performed by combining terms from multiple sources, including article titles, abstracts, author keywords, and Keywords Plus.⁸ Relying on a single element, such as the title or abstract, can result in the use of isolated terms that lack sufficient contextual depth. Abstracts, in particular, often contain generalized language that may not accurately capture specific research topics. Additionally, variations in metadata completeness across articles indexed in the SCIE database, such as the absence of abstracts, author keywords, or Keywords Plus, can compromise the consistency and reliability of analyses based on a single source alone.

To effectively address the limitations of single-source analyses and gain a more comprehensive understanding of research trends, a structured, multi-step word cluster analysis was employed.^{8,11} This methodology integrated multiple metadata sources to improve the accuracy and depth of thematic classification in vitiligo research:

i) Identification of main research or interesting topics in the vitiligo field: applying the word bank supported by four kinds of word analysis results to find the main research topics using professional knowledge of vitiligo research.

ii) Thematic classification *via* “front page” metadata: find the supporting words for each topic from the word bank. Articles containing any supporting words in the title, abstract, or author keywords, collectively referred to as the “front page”, are defined as topic-related articles.

iii) Temporal trend analysis: the annual distribution of articles across defined topics was analyzed to reveal research trajectories, highlight the main research topics and emerging topics of interest, and track the evolution of thematic focus over time.

This integrative, multi-source approach enhances the robustness of thematic analysis by capturing both high-level trends and detailed conceptual linkages. The resulting word clusters offer a rich, data-driven perspective on the dynamic and evolving landscape of vitiligo research.

Discussion

This bibliometric analysis reveals the evolving landscape of vitiligo research over the past three decades, reflecting both the profound impact of the disease on patients’ quality of life and the innovation in diagnosis and treatment. Our results cluster into three major research groups: i) clinical characteristics; ii) epidemiology and genetics; iii) pathogenesis and treatment innovations reflected in frequently used keywords.

Across all decades, there was a persistent use of the word “patients” emphasizing the considerable clinical and psychosocial burden of the disease. Although often perceived as a cosmetic issue, vitiligo can impact physical, economic, educational, and psychological aspects, contributing to stigma, social avoidance, and reduced life quality.^{23,24} Early research was characterized by descriptive outcome-related terms such as “efficacy” and “prevalence”, but over time, translational research focusing on molecular mechanisms gained momentum, enriching clinical understanding and paving the way for new treatments.²⁵

The increasing occurrence of “epidemiology” reflects growing interest in vitiligo’s association with comorbid autoimmune diseases. Genome-wide association studies (GWAS) have identified multiple genetic loci shared among vitiligo and other autoimmune conditions, supporting shared genetic and immunological pathways.²⁶ Spritz *et al.* identified strong co-occurrence between vitiligo, thyroid disease and other autoimmune conditions, highlighting overlapping immune-related genes that link these diseases together.²⁷ In earlier phases of vitiligo research, the main keyword was “polymorphisms”, reflecting candidate-gene approaches to uncover genetic variations. As GWAS evolved, research emphasis has shifted toward immune regulation and targeted therapies, explaining the decrease in “polymorphisms” usage. This observed transition from broad genetic terminology to specific molecular targets such as interferon (IFN)- γ and the Janus kinase/signal transducers and activators of transcription (JAK-STAT) pathway reflect progress in our understanding and management of the disease.

Vitiligo research has progressively evolved from a primary focus on clinical descriptions as “efficacy” and disease “prevalence” to a more nuanced understanding driven by mechanistic insights with prominent keywords such as “autoimmunity”, “melanocytes”, “oxidative stress”, and “immunotherapy” signaling this transition. Early work primarily described melanocyte destruction and depigmentation, whereas recent studies reveal deeper mechanistic exploration into immune dysregulation, oxidative injury, and cellular signaling. Oxidative stress plays a crucial role as an initiating trigger of the signaling cascade of immune responses, leading to cell damage and death of melanocytes.²⁸ Concurrently, treatment approaches have evolved from focusing on broad clinical outcomes to targeting underlying molecular mechanisms. Throughout the last three decades, “treatment” has remained one of the most frequent keywords, appearing consistently in titles, abstracts, and author keywords. The emerging prominence of the keyword “immunotherapy” ties vitiligo research to advances in cancer immunology treatment, for example, melanoma, where immune-mediated melanocyte destruction correlates with a favorable prognosis. The relationship between vitiligo and melanoma could result from immune-mediated destruction and is associated with favorable prognostic factors.²⁹

Nevertheless, this bibliometric analysis presents several limitations. First, the potential impact of self-citation was not excluded from the citation metrics, indicating that citation rank may reflect popularity rather than quality. Future work can address this issue by applying citation filtering tools, which allow the exclusion of self-cited articles when calculating impact. Second, older articles are naturally more likely to accumulate higher citation counts, while newly published studies, even those with significant innovation, may be underrepresented in the analysis. Third, limiting the database to WoSCC exclusively, may omit relevant publications that are indexed and create selection bias.

Conclusions

In conclusion, we provide an analysis of research trends on vitiligo in the past three decades. Issues including treatment options, pathogenesis, comorbidity, and clinical aspects were the critical focus. These shifts correspond with key scientific and therapeutic evolutions in the field of dermatology and immunology and could possibly become a resource for future research and patient care information.

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Table 1. Top 20 most frequently used words in vitiligo article titles from 1991 to 2024.

Words in title	TP	1991-2024 R (%) n=4,925	1991-2010 R (%) n=1,654	2011-2018 R (%) n=1,541	2019-2024 R (%) n=1,730
Patients	839	1 (17)	1 (15)	1 (18)	1 (18)
Treatment	580	2 (12)	2 (12)	2 (11)	2 (12)
Skin	391	3 (7.9)	4 (6.8)	3 (7.2)	3 (10)
Autoimmune	315	4 (6.4)	3 (7.1)	4 (6.0)	5 (6.0)
Melanocytes	267	5 (5.4)	5 (5.5)	7 (5.2)	7 (5.5)
Disease	252	6 (5.1)	7 (4.6)	8 (5.0)	6 (5.7)
Clinical	246	7 (5.0)	17 (3.1)	6 (5.3)	4 (6.5)
Cells	226	8 (4.6)	13 (3.9)	9 (4.9)	8 (5.0)
Association	221	9 (4.5)	17 (3.1)	5 (5.6)	9 (4.8)
Melanoma	220	10 (4.5)	6 (5.3)	9 (4.9)	23 (3.4)
Human	199	11 (4.0)	8 (4.5)	11 (3.8)	16 (3.8)
Cell	189	12 (3.8)	11 (3.9)	11 (3.8)	16 (3.8)
Therapy	186	13 (3.8)	14 (3.7)	11 (3.8)	14 (3.9)
Topical	181	14 (3.7)	9 (4.5)	26 (2.8)	19 (3.7)
Diseases	178	15 (3.6)	19 (3.0)	19 (3.1)	10 (4.6)
Melanocyte	172	16 (3.5)	15 (3.5)	17 (3.2)	18 (3.8)
Epidermal	161	17 (3.3)	11 (3.9)	17 (3.2)	34 (2.7)
Syndrome	155	18 (3.1)	9 (4.5)	21 (3.0)	52 (2.0)
Expression	147	19 (3.0)	22 (2.5)	15 (3.6)	28 (2.9)
Phototherapy	147	19 (3.0)	41 (1.8)	14 (3.7)	21 (3.5)

TP, total number of articles containing the keywords in the article title; R, rank.

Table 2. Top 20 most frequently used words in vitiligo article abstracts from 1991 to 2024.

Words in abstract	TP	1991-2024 R (%) n=4,785	1991-2010 R (%) n=1,561	2011-2018 R (%) n=1,516	2019-2024 R (%) n=1,708
Patients	3,038	1 (63)	1 (63)	1 (64)	1 (63)
Skin	2,206	2 (46)	2 (42)	2 (45)	2 (50)
Treatment	1,953	3 (41)	4 (33)	3 (41)	3 (48)
Disease	1,864	4 (39)	3 (35)	4 (38)	4 (43)
Methods	1,690	5 (35)	5 (29)	5 (37)	5 (39)
Background	1,372	6 (29)	9 (23)	6 (31)	6 (32)
Clinical	1,218	7 (25)	11 (22)	7 (27)	9 (27)
Melanocytes	1,195	8 (25)	6 (25)	11 (26)	11 (24)
Significant	1,187	9 (25)	13 (20)	8 (27)	8 (28)
Autoimmune	1,176	10 (25)	10 (22)	10 (26)	10 (25)
Significantly	1,149	11 (24)	18 (17)	9 (26)	7 (29)
Cells	1,049	12 (22)	8 (23)	14 (21)	13 (21)
Patient	1,024	13 (21)	7 (25)	13 (21)	17 (19)
Diseases	1,013	14 (21)	16 (18)	12 (22)	12 (23)
Lesions	908	15 (19)	12 (20)	15 (19)	20 (18)
Cell	905	16 (19)	14 (19)	19 (18)	15 (20)
Role	814	17 (17)	28 (14)	17 (18)	16 (19)
Therapy	796	18 (17)	15 (18)	26 (16)	28 (16)
Conclusions	795	19 (17)	22 (15)	16 (19)	26 (16)
Disorder	793	20 (17)	19 (15)	21 (17)	22 (17)

TP, total number of articles containing the keywords in the article abstract; R, rank.

Table 3. Top 20 most frequently used author keywords in vitiligo articles from 1991 to 2024.

Author keywords	TP	1991-2024 <i>R</i> (%) n=3,322	1991-2010 <i>R</i> (%) n=948	2011-2018 <i>R</i> (%) n=1,002	2019-2024 <i>R</i> (%) n=1,372
Melanocytes	165	1 (5.0)	2 (5.8)	1 (5.0)	2 (4.4)
Melanocyte	156	2 (4.7)	4 (5.2)	2 (4.7)	2 (4.4)
Autoimmunity	150	3 (4.5)	1 (5.9)	5 (4.0)	4 (3.9)
Melanoma	129	4 (3.9)	3 (5.4)	5 (4.0)	8 (2.8)
Oxidative stress	126	5 (3.8)	6 (3.0)	7 (3.6)	1 (4.5)
Psoriasis	116	6 (3.5)	5 (3.4)	4 (4.2)	7 (3.1)
Phototherapy	115	7 (3.5)	7 (2.8)	3 (4.3)	6 (3.3)
Melanogenesis	101	8 (3.0)	11 (2.0)	8 (3.1)	5 (3.7)
Quality of life	84	9 (2.5)	10 (2.3)	9 (2.9)	9 (2.4)
Repigmentation	73	10 (2.2)	9 (2.4)	15 (1.8)	10 (2.3)
Tyrosinase	68	11 (2.0)	13 (1.9)	10 (2.8)	17 (1.6)
Immunotherapy	66	12 (2.0)	17 (1.6)	14 (1.9)	10 (2.3)
Alopecia areata	58	13 (1.7)	20 (1.5)	11 (2.3)	19 (1.5)
Treatment	56	14 (1.7)	11 (2.0)	18 (1.6)	19 (1.5)
Autoimmune diseases	54	15 (1.6)	25 (1.2)	15 (1.8)	14 (1.8)
Depigmentation	54	15 (1.6)	14 (1.8)	12 (2.2)	31 (1.1)
Polymorphism	50	17 (1.5)	14 (1.8)	12 (2.2)	43 (0.80)
Atopic dermatitis	45	18 (1.4)	53 (0.74)	25 (1.4)	15 (1.7)
Hypopigmentation	45	18 (1.4)	8 (2.5)	32 (1.1)	47 (0.73)
Epidemiology	45	18 (1.4)	100 (0.42)	17 (1.7)	15 (1.7)

TP, total number of articles containing the keywords in the author keywords; *R*, rank.

Table 4. Top 20 most frequently used Keywords Plus in vitiligo articles from 1991 to 2024.

Keywords Plus	TP	1991-2024 <i>R</i> (%) n=4,406	1991-2010 <i>R</i> (%) n=1,444	2011-2018 <i>R</i> (%) n=1,449	2019-2024 <i>R</i> (%) n=1,513
Skin	491	1 (11)	1 (11)	1 (13)	2 (10)
Expression	413	2 (9.4)	4 (7.9)	3 (8.9)	1 (11)
Melanocytes	391	3 (8.9)	2 (11)	4 (8.8)	4 (7.4)
Association	283	4 (6.4)	14 (4.0)	6 (6.8)	3 (8.4)
Repigmentation	270	5 (6.1)	3 (8.1)	7 (6.3)	16 (4.1)
Cells	247	6 (5.6)	7 (5.9)	14 (5.0)	7 (5.9)
Generalized vitiligo	241	7 (5.5)	11 (4.2)	2 (10)	35 (2.0)
Oxidative stress	240	8 (5.4)	24 (2.9)	5 (7.0)	6 (6.4)
Psoriasis	234	9 (5.3)	8 (5.4)	9 (5.9)	11 (4.6)
Therapy	232	10 (5.3)	6 (6.3)	12 (5.4)	14 (4.2)
Disease	223	11 (5.1)	10 (4.6)	8 (6.2)	12 (4.4)
Pathogenesis	198	12 (4.5)	66 (1.4)	14 (5.0)	5 (7.0)
Prevalence	177	13 (4.0)	45 (1.8)	14 (5.0)	8 (5.2)
T-cells	173	14 (3.9)	28 (2.7)	11 (5.5)	18 (3.6)
Epidemiology	166	15 (3.8)	24 (2.9)	13 (5.3)	19 (3.1)
Children	152	16 (3.4)	17 (3.5)	17 (4.3)	22 (2.5)
Autoimmune-diseases	144	17 (3.3)	41 (2.1)	10 (5.7)	33 (2.1)
Risk	141	18 (3.2)	54 (1.5)	24 (3.0)	9 (5.0)
Epidermis	140	19 (3.2)	9 (5.0)	22 (3.1)	52 (1.5)
Efficacy	138	20 (3.1)	113 (0.83)	18 (4.2)	13 (4.3)

TP, total number of articles containing the keywords in Keywords Plus; *R*, rank.