

A bibliometric analysis of meta-analyses in multiple sclerosis: Publication trends, thematic structures, and collaboration networks

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Abstract

Background & Objective: Multiple sclerosis (MS) is a complex neurological disorder with a growing body of meta-analytical research. However, the bibliometric structure, thematic trends, and collaborative patterns of this literature have not been systematically assessed. The objective of this study was to conduct a comprehensive bibliometric analysis of meta-analyses related to MS, identifying publication trends, thematic structures, key contributors, and international collaboration networks. **Methods:** A total of 932 meta-analyses published between 1995 and 2026 were included. Analyses were conducted using the Biblioshiny interface of the Bibliometrix R package. Bibliometric indicators and network-based methods, including co-authorship, co-citation, keyword co-occurrence, and thematic mapping, were applied. **Results:** The number of MS-related meta-analyses increased steadily, with an annual growth rate of 2.26%, and a notable rise after 2010. The most prolific authors were Mirmosayyeb O., Shaygannejad V., and Ghajarzadeh M. The United States and the United Kingdom held central roles in international collaboration networks. Keyword co-occurrence analyses showed growing attention to patient-centered outcomes such as fatigue, disability, and quality of life. Nevertheless, thematic mapping indicated that diagnostic and epidemiological topics remain the most developed and central. **Conclusions:** Meta-analytic research in MS has grown substantially, reflecting increasing methodological rigor and global collaboration. While traditional clinical themes dominate, patient-centered and rehabilitation-related topics are emerging yet underrepresented. Targeting these gaps may enhance future MS research.

Keywords: Multiple sclerosis, meta-analysis, bibliometric analysis

INTRODUCTION

Multiple Sclerosis (MS) is a chronic, immune-mediated neurodegenerative disease that affects the central nervous system, leading to demyelination and axonal damage.¹⁻³ It is characterized by a wide range of physical, cognitive, and emotional symptoms, often resulting in significant disability and reduced quality of life.⁴⁻⁶ MS is one of the most common causes of non-traumatic neurological disability among young adults worldwide, with increasing prevalence rates.⁷⁻⁹ Given its complex pathophysiology, heterogeneity in clinical presentation, and the evolving landscape

of therapeutic interventions, MS continues to be a major focus of medical and health science research.¹⁰

In recent years, the use of meta-analysis as a methodological tool has gained prominence in MS research.^{11,12} Meta-analyses synthesize results from multiple primary studies, increasing statistical power and enabling researchers to detect patterns, estimate effect sizes, and resolve uncertainties across diverse findings.¹³

Particularly in a field as multifaceted as MS—with its wide range of clinical trials, rehabilitation studies, epidemiological surveys, and patient-centered outcomes—meta-analyses

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offer valuable insights into treatment efficacy, disease burden, comorbidities, and long-term outcomes.¹⁴⁻¹⁶ However, despite the increasing number of meta-analytical studies in the MS domain, there has been no comprehensive bibliometric assessment of this body of literature. It remains unclear how meta-analyses in MS have evolved over time, which countries, authors, and journals have contributed most significantly, what thematic domains dominate, and how collaborative and intellectual structures are formed.

Bibliometric analysis is a powerful method for quantitatively mapping the structure, development, and dynamics of scientific research. It enables the identification of prolific contributors, high-impact studies, conceptual trends, and collaboration networks across different entities (authors, countries, institutions).^{17,18} When applied to meta-analytical research, bibliometric techniques can also uncover methodological gaps, highlight emerging topics, and inform the future direction of evidence-based synthesis.

Given this background, the present study aims to perform a detailed bibliometric analysis of meta-analyses conducted in the field of MS over the period 1995 to 2026. Using data retrieved from the Web of Science Core Collection, the study addresses the following key questions:

1. How has the volume of MS-related meta-analyses changed over time?
2. Who are the most productive and influential authors, institutions, and countries in this domain?
3. Which journals publish the majority of meta-analytical work on MS?
4. What are the dominant thematic areas within this body of literature?
5. How are authors and countries connected through collaboration networks?
6. Which studies have had the greatest global and local citation impact?
7. What is the intellectual and conceptual structure of the MS meta-analytical literature?

By answering these questions, this study provides a comprehensive overview of the evolution, focus, and collaborative landscape of meta-analytical research in MS. The results are expected to guide researchers, clinicians, and policymakers in understanding the development of the field and in identifying priorities for future research.

METHODS

Study design

This study is a bibliometric analysis conducted in accordance with the BIBLIO Checklist for Reporting Bibliometric Studies of Biomedical Literature.¹⁹ It aims to provide a quantitative and structural overview of published meta-analyses related to Multiple Sclerosis (MS) by evaluating publication trends, influential authors, journals, countries, thematic patterns, and collaboration network.

Data source and search strategy

Bibliographic data were retrieved from the Web of Science (WoS) Core Collection, a comprehensive and widely recognized citation database in the health sciences.^{20,21} The search was conducted on December 8, 2025.

The following search string was applied:

TS = (“multiple sclerosis”) AND (TI = “meta-analysis” OR TI = “metanalysis”)

This query targeted documents where “multiple sclerosis” appeared as a topic and “meta-analysis” or “metanalysis” appeared in the title field, to increase specificity and ensure that the retrieved studies were explicitly designed as meta-analyses.

The search was restricted to the time period 1995 to 2026, including early access publications. Only documents written in English were considered. Document types such as letters, editorials, meeting abstracts, and other non-research formats were excluded to ensure relevance and quality.

The initial search yielded 1,618 records. After removing duplicates, a manual screening of titles and abstracts was conducted independently by two researchers to assess eligibility. Discrepancies were resolved through discussion and consensus. Based on the predefined inclusion and exclusion criteria, a final total of 932 records was included in the analysis.

Data extraction and processing

The selected records were exported from the Web of Science Core Collection in both BibTeX and Plain Text formats. The exported bibliographic information included:

- Title, authors, year of publication, source title, and abstract

- Author keywords and Keywords Plus
- Affiliations, number of citations, and all cited references

Data cleaning and preprocessing—such as duplicate removal and the normalization of author names and institutional affiliations—were carried out using Biblioshiny, the web interface of the Bibliometrix R package (Aria & Cuccurullo, 2017). Manual validation steps were also conducted to ensure consistency and to merge variations in author or institution names when necessary.

Eligibility criteria

The following inclusion criteria were applied to identify eligible studies:

- The article focused on Multiple Sclerosis (MS) and explicitly employed a meta-analysis methodology.
- The publication was written in English.
- The document type was classified as an original article or a review article.

The following exclusion criteria were applied:

- Publications categorized as letters, editorials, meeting abstracts, commentaries, or other non-research formats.
- Articles that did not specifically address MS-related topics or did not include a meta-analysis component (i.e., studies that were systematic reviews without a quantitative synthesis were excluded).

Data synthesis

The bibliometric analysis was carried out using Biblioshiny, the web-based interface of the Bibliometrix R package.²² The study employed both descriptive and relational indicators to comprehensively summarize and interpret the structure of the research field. Descriptive analysis included the calculation of key bibliometric indicators such as annual scientific production, average citations per document, the most productive authors, journals, and countries, as well as the most frequently used keywords (including both author keywords and Keywords Plus). Citation performance was also evaluated based on both global and local citation counts to assess scholarly impact within and beyond the dataset. Relational analyses were conducted

to uncover structural and conceptual linkages among authors, institutions, countries, and research themes. These included co-authorship network analysis (for both authors and countries), keyword co-occurrence analysis, co-citation analysis, and thematic mapping. Thematic maps were generated based on author-defined keywords, using centrality and density values to classify themes into four categories: motor, basic, niche, and emerging or declining. Clustering was performed using association strength as the normalization method. Additionally, network metrics such as betweenness centrality, closeness centrality, and PageRank were computed to identify the most influential nodes within the collaboration and citation networks. All analyses and visualizations were performed within the Biblioshiny platform.

Ethical considerations

This study did not involve human participants, animals, or any intervention requiring ethical approval. All data were obtained from publicly accessible bibliographic databases. Therefore, ethical approval from an institutional review board (IRB) was not required. The study was conducted in accordance with established ethical guidelines for secondary data analysis and bibliometric research.

RESULTS

General characteristics

This bibliometric analysis focuses on meta-analyses conducted in the field of Multiple Sclerosis (MS). The data were retrieved from the Web of Science Core Collection database. An initial search using the keywords “meta-analysis” OR “metanalysis” in combination with “multiple sclerosis” within the abstract field yielded 1,618 records. After a detailed screening of titles and abstracts, and the application of inclusion and exclusion criteria—such as language (English), document type (excluding letters and meeting abstracts), and thematic relevance—a total of 932 eligible publications were identified and included in the final dataset (Figure 1).

The selected documents were published across 301 different sources, including journals and books (Table 1). The number of meta-analyses related to Multiple Sclerosis has steadily increased over time, with an average annual growth rate of 2.26% between 1995 and 2026. This upward trend became particularly

prominent after 2010, peaking in 2021 with 121 publications, reflecting the growing scientific interest in evidence synthesis within the field (Figure 2). The average age of the documents was 4.96 years. The dataset comprises a total of 29,160 references, with an average of 29.76 citations per document, indicating a strong citation impact and sustained scholarly attention to meta-analytical research in MS. Regarding content analysis, the dataset includes 1,962 Keywords Plus (automatically generated terms by Web of Science) and 1,421 author-defined keywords, demonstrating the thematic richness and diversity within MS-related meta-analyses. In terms of authorship, a total of 4,277 unique authors contributed to the 932 publications. Only 13 documents were single-authored, indicating a high prevalence of collaborative research. The average number of co-authors per document was 6.26, and the rate of international co-authorship was 33.91%, reflecting substantial global collaboration in the field. Overall, the general characteristics of the dataset highlight a steadily growing, collaborative, and internationally active research landscape concerning meta-analytical investigations in Multiple Sclerosis.

Most productive authors, journals, and countries

The productivity analysis of authors in meta-analytical research on Multiple Sclerosis (MS) followed a pattern consistent with Lotka’s Law,

where a small number of authors produced a large portion of the publications. The most prolific contributors were Mirmosayyeb, O. with 52 publications, Shaygannejad, V. with 38, and Ghajarzadeh, M. with 34. In terms of citation impact within the dataset (local citations), Motl, R.W. ranked highest with 121 citations, followed by Pilutti, L.A. with 50, and Mirmosayyeb, O. with 44. This suggests that these researchers not only contributed frequently but also influenced subsequent studies in the field.

Regarding publication sources, Multiple Sclerosis and Related Disorders was the most prominent journal with 152 publications, followed by PLOS One and Neurological Sciences. These journals were also identified as core sources based on Bradford’s Law, indicating their centrality in the dissemination of MS-related meta-analytical research (Supplementary Figure 1)

At the country level, China and Iran led in publication output, each with over 160 documents, followed by the USA, UK, and Italy. Notably, the USA showed a balanced contribution between domestic and internationally co-authored studies, reflecting its strong role in global MS research collaboration (Supplementary Figure 1).

Most cited articles

Citation analysis identified key publications that have shaped the field of Multiple Sclerosis (MS)

Table 1: Descriptive Summary of the Bibliometric Dataset

Category	Description	Value
Main Information About Data	Timespan	1995–2026
	Sources	301
	Documents	932
	Annual Growth Rate (%)	2.26
	Average Age of Documents (years)	4.96
	Average Citations per Document	29.76
	References	29,160
Document Contents	Keywords Plus (ID)	1,962
	Author’s Keywords (DE)	1,421
Authors	Total Authors	4,277
	Authors of Single-Authored Documents	12
Author Collaboration	Single-Authored Documents	13
	Co-Authors per Document	6.26
	International Co-Authorships (%)	33.91

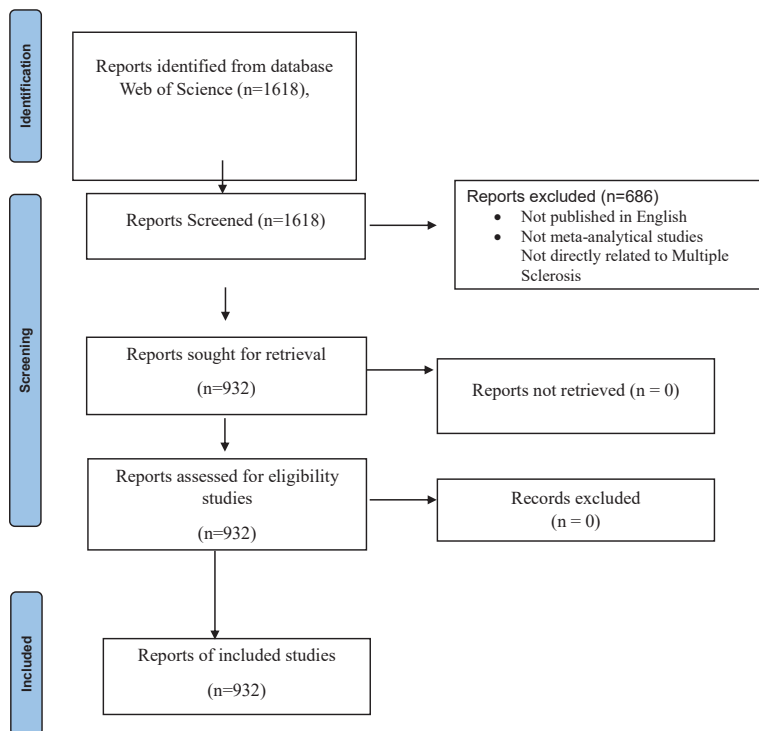


Figure 1. Article selection process

meta-analyses. Based on global citation counts, the most cited study was De Jager *et al.* (2009) in *Nature Genetics* with 650 citations, followed by Belbasis *et al.* (2015) in *The Lancet Neurology* (520) and Boeschoten *et al.* (2017) (498). These

papers had wide interdisciplinary impact beyond the MS field (Figure 3).

In terms of local citations—reflecting influence within the dataset—the top-ranked documents were Pilutti *et al.* (2013) with 24 citations,

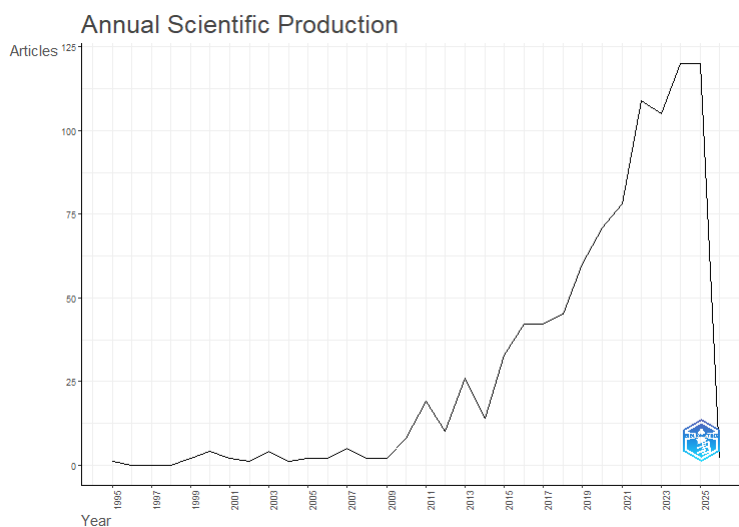


Figure 2. Annual Scientific Production of MS-Related Meta-Analyses (1995–2026)

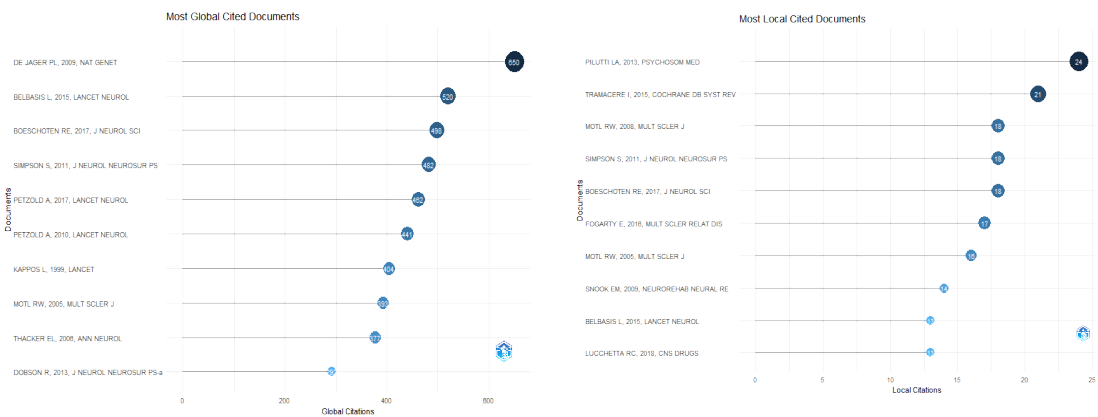


Figure 3. Top 10 Globally Cited Articles in MS-Related Meta-Analyses

Tramacere *et al.* (2015) with 21, and Motl *et al.* (2008) with 18. These studies addressed physical activity, comorbidities, and treatment outcomes in MS. Together, these findings highlight that both highly cited interdisciplinary studies and domain-specific works play pivotal roles in the development of MS research Figure 3).

Keywords and co-occurrence networks

The analysis of author keywords revealed prominent thematic patterns in meta-analytical studies on Multiple Sclerosis (MS). The most frequently occurring terms were multiple sclerosis (n = 693), meta-analysis (n = 334),

and systematic review (n = 151), reflecting the methodological focus of the dataset. Other frequently used terms included fatigue (n = 55), prevalence (n = 44), rehabilitation (n = 43), exercise (n = 38), network meta-analysis (n = 27), quality of life (n = 27), and cognition (n = 25), indicating the breadth of clinical and functional topics addressed (Supplementary Figure 2).

Co-occurrence network analysis based on Keyword Plus terms revealed four distinct thematic clusters in the meta-analytic literature on Multiple Sclerosis. Cluster 1 (red) focused on disease characterization and epidemiology, encompassing terms such as diagnostic criteria, disease, association, and risk factors. Cluster 2

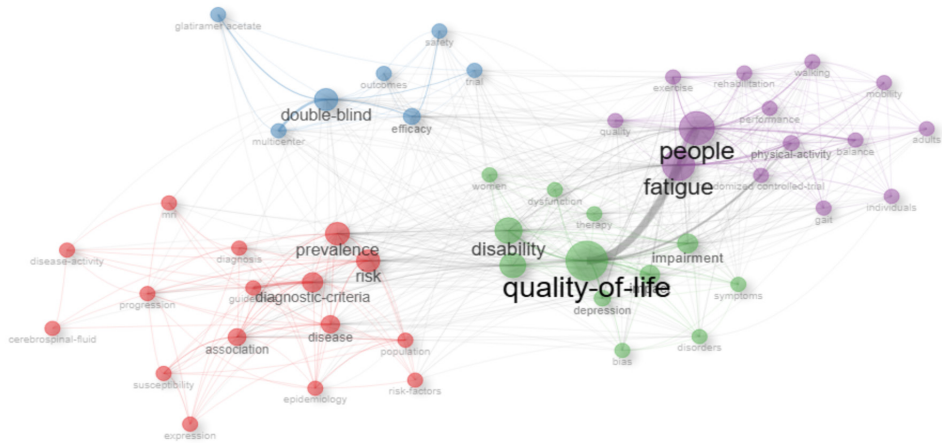


Figure 4. Co-occurrence Network Based on Keyword Plus Terms in MS-Related Meta-Analyses

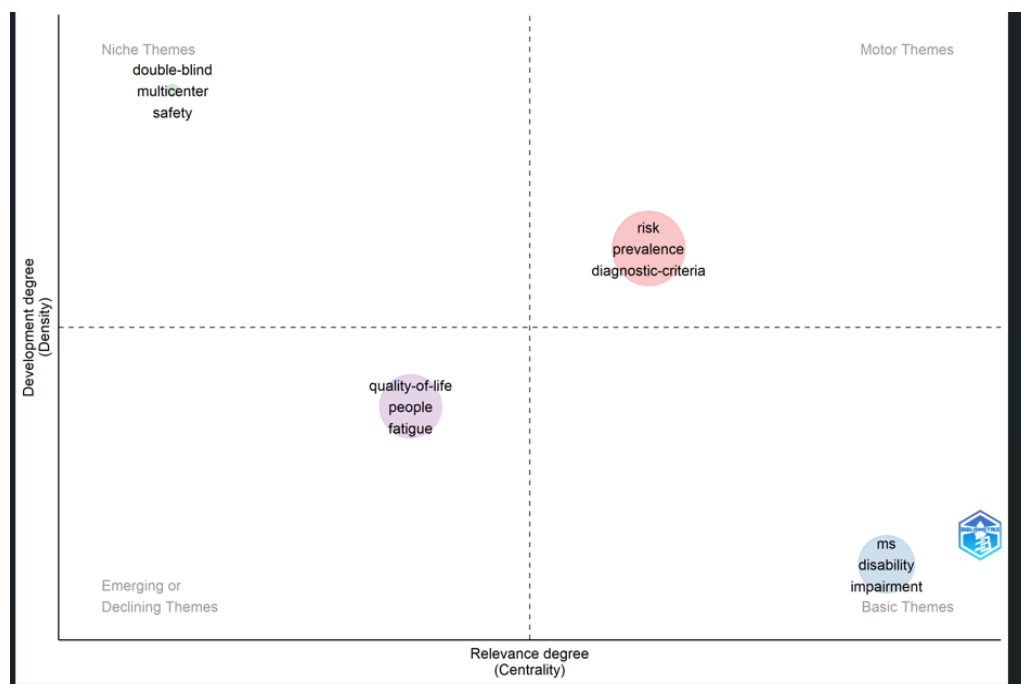


Figure 5. Thematic Map Based on Author Keywords in MS-Related Meta-Analyses

(blue) emphasized clinical trials and treatment evaluation, with prominent terms including double-blind, efficacy, and glatiramer acetate. Cluster 3 (green) centered on quality of life and disability, highlighting concepts such as depression, impairment, and therapy. Cluster 4 (purple) reflected rehabilitation and functional performance, incorporating terms related to fatigue, exercise, physical activity, and mobility. Network metrics, including betweenness and closeness centrality, indicated that keywords such as quality of life, people, fatigue, and disability functioned as major thematic hubs within the network. Overall, these findings demonstrate that meta-analyses in Multiple Sclerosis address a broad spectrum of research priorities, ranging from clinical efficacy to functional and psychosocial outcomes (Figure 4).

Thematic mapping

Thematic mapping using a two-dimensional strategic diagram (centrality vs. density) provides insight into the structural and developmental status of research themes in meta-analytical studies on Multiple Sclerosis (MS). This thematic map illustrates the conceptual structure of the literature based on author-defined keywords, classifying them into four categories: motor themes, niche themes, basic themes, and

emerging or declining themes (Figure 5).

Motor themes are characterized by both high centrality and high density, indicating that they are well-developed and fundamental to the structure of the research field. In this thematic map, the most prominent motor theme comprises the cluster of keywords including “risk,” “prevalence,” and “diagnostic-criteria.” These concepts reflect core research areas in Multiple Sclerosis (MS) meta-analyses, particularly focusing on epidemiological profiling, disease susceptibility, and diagnostic frameworks. Their strong central positioning suggests that they play a pivotal role in connecting various subtopics across the field and serve as a backbone for ongoing and future investigations.

Basic themes, positioned in the lower right quadrant of the thematic map, are defined by high centrality but low density, indicating that they are conceptually important and well-connected to the overall field but remain underdeveloped in terms of internal complexity or thematic depth. In this analysis, the basic theme cluster includes key terms such as “multiple sclerosis,” “disability,” and “impairment,” as well as related concepts like “impact,” “efficacy,” “therapy,” “depression,” “dysfunction,” “trial,” and “women.” These themes form the foundational background of meta-analytical research in MS, frequently appearing across a broad range of

studies. Their structural simplicity, despite central relevance, suggests an opportunity for future research to expand on these topics through more nuanced sub-themes and interdisciplinary integration.

Niche themes are characterized by high density but low centrality, indicating that they are well-developed internally yet have limited connectivity with the broader research field. In this analysis, the niche theme cluster includes not only methodological terms such as “double-blind,” “multicenter,” and “safety,” but also specific pharmacological and clinical concepts such as “glatiramer acetate,” “fingolimod,” “natalizumab,” “placebo-controlled trial,” “interferon beta-1a,” “oral fingolimod,” and “placebo.” These keywords suggest a strong focus on clinical trial design, treatment efficacy, and drug safety in multiple sclerosis meta-analyses. Although these topics are structurally cohesive, their limited interaction with central research themes indicates that they mainly appear in technically focused and specialized studies.

Emerging or Declining Themes, located in the lower-left quadrant of the thematic map, are characterized by both low centrality and low density, suggesting that these topics are either in the early stages of development or losing relevance within the broader field. This cluster includes keywords such as *quality-of-life*, *people*, *fatigue*, *physical activity*, *quality*, *randomized controlled trial*, *exercise*, *walking*,

balance, and *performance*. These terms point to a strong emphasis on patient-centered outcomes and functional capacity in individuals with multiple sclerosis. Although these themes are not yet well-integrated into the core structure of the meta-analytical literature, their presence indicates an emerging research focus on quality-of-life assessments and rehabilitative strategies. Given their thematic nature, these areas hold substantial potential for further exploration and interdisciplinary expansion in future studies.

Co-authorship networks

The co-authorship network reveals a fragmented but thematically organized structure among researchers working on meta-analyses in the field of Multiple Sclerosis (MS) (Figure 6). The analysis identifies several distinct clusters, each represented by a unique color and cluster number.

The largest and most interconnected cluster is Cluster 5 (orange), centered around Mirmosayyeb O, who holds the highest betweenness centrality (17.14) and PageRank (0.0749) (Supplementary Figure 3). This indicates a significant bridging role across the network. Authors such as Mohamadi M, Panahi MY, Mahbizadeh F, and Vaheb S are closely linked within this group, suggesting strong internal collaboration.

Another visible group is Cluster 1 (red), comprising Giovannoni G, Ramagopalan SV, and Dobson R. Their tight interconnection suggests a

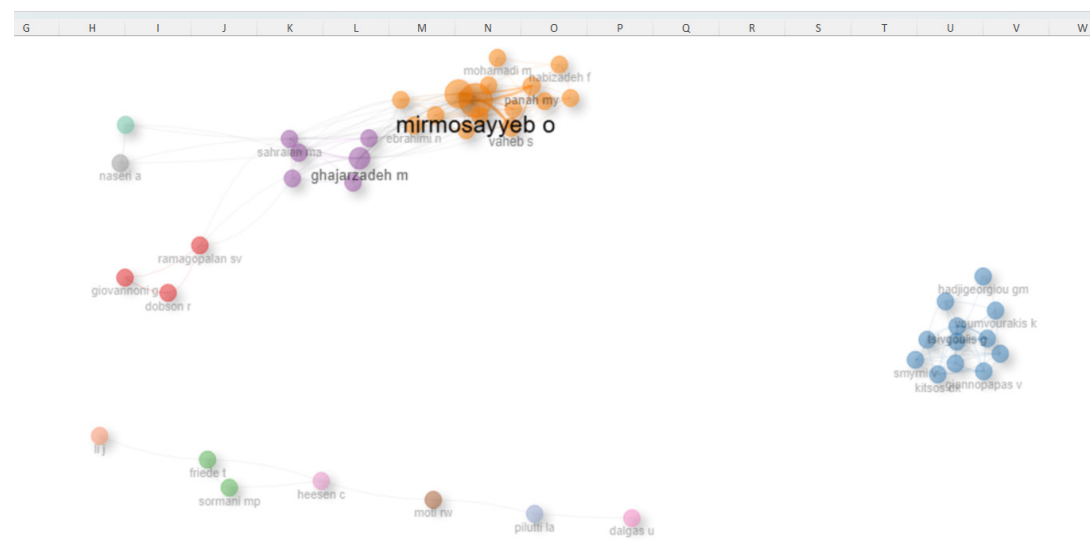


Figure 6. Co-authorship Network of Authors in MS-Related Meta-Analyses

focused collaboration, likely on epidemiological or genetic research themes related to MS. Cluster 2 (blue) is a well-defined and cohesive group featuring Hadjiogeorgiou GM, Tsivgoulis G, Smyrni V, and Kitsos DK, indicating strong intra-group cooperation, possibly regional or institutional in nature. A smaller, more dispersed structure is Cluster 3 (green), which includes Friede T and Sormani MP, located at the network's periphery, suggesting more limited but still identifiable collaborative ties. Cluster 6 (brown) includes Motl RW, connected weakly with Pilutti LA and Dalgas U, forming a linear and sparsely linked mini-network, which reflects more independent or topic-specific studies. Cluster 4 (purple) includes Ghajarzadeh M and Sahraian MA, who, while not part of the densest hubs, appear to serve as intermediaries between clusters, indicating potential for interdisciplinary linkages. Smaller and more isolated nodes such as Cluster 7 (light pink) and Cluster 0 (grey) include authors like Naseri A and IJJ, with minimal connections to the rest of the network. Overall, the structure of the collaboration network suggests that while several clusters exhibit strong internal connectivity, cross-cluster collaboration remains limited. This highlights an opportunity to foster broader international and interdisciplinary research partnerships within MS-related meta-analytical literature.

Country collaboration network

The country collaboration network reveals a structured pattern of international cooperation

in meta-analysis studies on Multiple Sclerosis (MS) (Figure 7). Countries are grouped into clusters based on the intensity and direction of their collaborations, as visualized through distinct colors.

At the center of the network is the USA, which holds the highest betweenness centrality (265.01) and PageRank score (0.1360), indicating its dominant and bridging role in global research collaborations. The USA belongs to Cluster 5 (orange), forming strong ties with countries like Canada, Australia, Switzerland, Ireland, India, Pakistan, and the Philippines, which are also part of this cluster.

The United Kingdom, with a betweenness centrality of 254.84 and PageRank of 0.0944, emerges as another key actor in the network (Supplementary File 4). It is part of Cluster 3 (green), which includes several influential European and Asian countries such as China, Italy, Germany, Spain, Sweden, the Netherlands, Turkey, and Finland. This cluster reflects a dense and geographically diverse collaborative environment, particularly concentrated in Europe and parts of Asia. Countries like Germany, Italy, Iran, and Sweden also show high levels of interaction and centrality, indicating their pivotal roles in connecting different regions within the network. Cluster 3 overall represents a cohesive and well-connected collaboration hub. Cluster 4 (purple) includes countries like Brazil, Portugal, and Iran. Notably, Iran demonstrates a relatively high betweenness centrality (51.68) and PageRank (0.0497), indicating its importance in bridging different research communities. Cluster

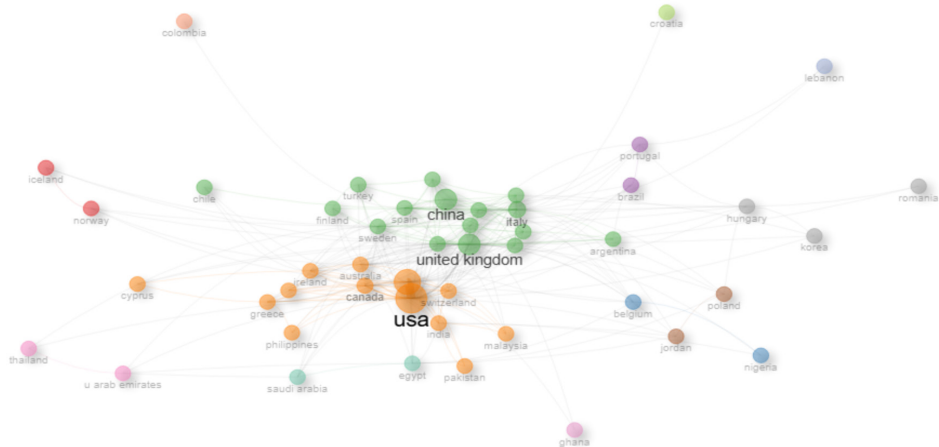


Figure 7. Country Collaboration Network in MS-Related Meta-Analyses

2 (blue) consists of more peripheral countries such as Belgium, Nigeria, and Jordan, which are less central but still maintain some connections to the global network. Cluster 6 (brown) features countries like Poland and Jordan, positioned on the outer edges of the network with limited but existing collaborations. Similarly, Cluster 7 (pink) includes Thailand and the United Arab Emirates, also characterized by low centrality and sparse links. Clusters 8 and 9 (gray and light cyan) include relatively isolated countries like South Korea, Romania, Egypt, and Saudi Arabia, while Cluster 10 (light orange) represents Colombia as a standalone node. Finally, Cluster 11 (light blue) includes Lebanon and Ghana, which remain on the periphery of the network, indicating minimal participation in international collaboration.

Co-citation network

The co-citation network analysis revealed the intellectual structure underlying meta-analysis studies in the field of multiple sclerosis (MS) (Figure 8). Among the most influential references, Egger *et al.* (1997) and Page *et al.* (2021) stood out with the highest centrality and PageRank scores, indicating their pivotal roles in shaping methodological standards (Supplementary Figure 5). These works are frequently cited for their contributions to bias assessment and systematic review guidelines.

Another highly cited study was Kurtzke (1983), known for introducing the Expanded Disability Status Scale (EDSS), which remains a cornerstone in MS clinical research. Similarly, Thompson *et al.* (2018) played a significant role in updating the diagnostic criteria for MS, while McDonald *et al.* (2001) and Polman *et al.* (2005, 2011) contributed to earlier versions of these diagnostic frameworks. These authors formed a tightly connected blue cluster, indicating a shared clinical focus.

The green cluster primarily consisted of methodological references, including Higgins *et al.* (2003, 2011) and Liberati *et al.* (2009), reflecting their impact on evidence synthesis, risk of bias assessment, and reporting standards. Other notable authors in this group include Moher *et al.* (2009) and Duval & Tweedie (2000), both recognized for advancing meta-analytic techniques.

The red and purple clusters featured domain-specific applications, particularly in quality-of-life and exercise-related MS research. For example, Dalgas *et al.* (2010) and Oken *et al.* (2004) contributed to understanding fatigue and physical activity in MS populations, whereas Latimer-Cheung *et al.* (2013) focused on behavioral interventions.

Despite the existence of several thematically coherent clusters, the overall co-citation map shows strong interconnectivity, especially between methodological and clinical references,

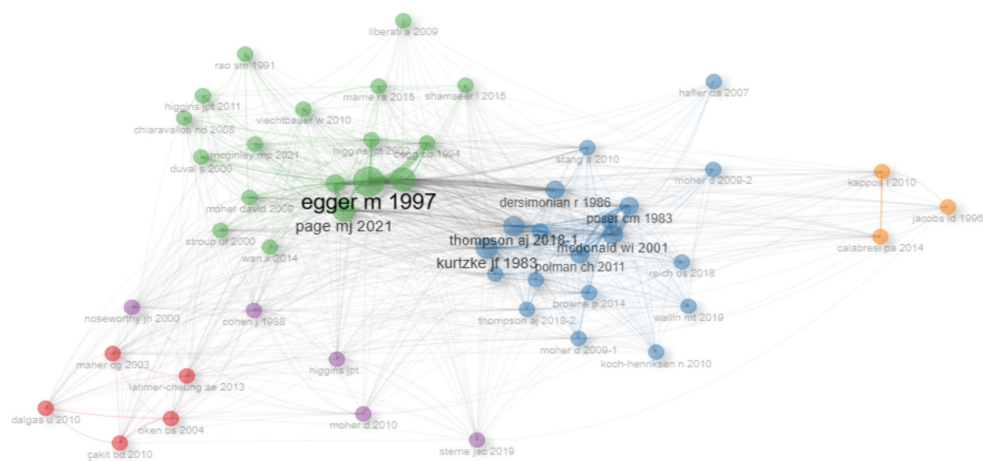


Figure 8. Co-Citation Network of References in MS-Related Meta-Analyses

emphasizing the multidisciplinary foundation of MS meta-analytical literature.

DISCUSSION

This study provides a comprehensive bibliometric analysis of meta-analyses conducted in the field of Multiple Sclerosis (MS), uncovering trends in scientific output, intellectual structure, thematic development, and collaboration networks within the literature. The findings demonstrate that meta-analytical studies in the MS domain have not only increased quantitatively but have also diversified thematically and become more reliant on international collaboration.

The findings of this study demonstrate a steady growth in the production of meta-analyses in the field of Multiple Sclerosis (MS) between 1995 and 2026. The average annual growth rate of 2.26%, with a particularly notable acceleration after 2010, is consistent with trends reported in the literature. For instance, bibliometric analyses by Ismail and Saqr (2022) and Yang *et al.* (2024) have similarly highlighted the increasing pace of scientific publication in MS and the growing academic interest in systematic synthesis in recent years.^{23,24} Additionally, the average of 6.26 authors per publication and an international co-authorship rate of 33.9% in the current study reflect a predominantly multicenter and collaborative model of research production. This aligns with the observations of Özkan (2025) and Shawawrah (2024), who emphasize the effectiveness of global research networks and the rise of interdisciplinary collaboration.^{25,26} Thus, the meta-analytic literature on MS is expanding not only quantitatively but also structurally, with a growing trend toward internationalization and multi-authored research.

The observation that the most prolific authors in this study are affiliated with institutions in Iran and China suggests that these countries are emerging as key contributors to the meta-analytical literature in the field of Multiple Sclerosis (MS). This finding may reflect a broader trend of increasing research output from developing countries and their growing role in global scientific production. Although this topic has been addressed only to a limited extent in the literature, Ismail and Saqr (2022) have noted a shift from a traditionally Western-centric MS research landscape toward a more geographically balanced distribution in recent years. Similarly, Özkan (2025) highlights the expanding role of Asian countries in the production of meta-

analyses. In particular, China's rapid increase in biomedical publication output appears to be mirrored in MS-related meta-analytic research.

On the other hand, the concentration of a significant portion of publications in a limited number of journals—particularly Multiple Sclerosis and Related Disorders—indicates a centralization of knowledge production within core sources. This pattern aligns with the principles of Bradford's Law, which suggests that a small number of high-impact journals account for the majority of the literature in a given field. Studies by Shawawrah (2024) and Yang *et al.* (2024) have similarly demonstrated that MS-related publications are clustered within a few key journals, which serve as primary channels for knowledge dissemination in the field. These findings offer important structural insights regarding publication strategies and researchers' preferences for accessing and sharing scientific information.

In the study, the terms fatigue, quality of life, and disability were found to have high network centrality scores, indicating a strong orientation of meta-analyses in the field of Multiple Sclerosis (MS) toward patient-centered topics. Similarly, the study by Yang (2021) identified fatigue and quality of life as among the most frequently encountered keywords in the nursing-focused MS literature.²⁷ Shafin *et al.* (2022) also reported that these concepts occupy a central thematic position in MS research, noting particularly that fatigue and disability are closely associated with clinical and functional outcomes.²⁸ Likewise, in Uslu's (2024) study, fatigue was identified with high frequency and centrality, while quality of life emerged as a core theme reflecting the growing emphasis on patient-centered approaches. Collectively, these findings indicate an increasing thematic diversity in MS research and underscore the prominent role of patient-focused issues within the meta-analytical literature.²⁹

The thematic map analysis offers an in-depth overview of the structural and conceptual orientations of the meta-analysis literature in the field of Multiple Sclerosis (MS). The prominence of motor themes with high centrality and density values indicates that existing studies are predominantly grounded in epidemiological foundations, such as diagnostic criteria, risk factors, and prevalence, suggesting a high level of methodological maturity in these areas. This finding is consistent with the literature indicating that meta-analyses tend to concentrate

on topics supported by robust primary data and standardized measurement frameworks.^{23,27}

Conversely, basic themes such as “multiple sclerosis,” “disability,” and “therapy” display high centrality but relatively low density, implying that these conceptually fundamental areas have not yet achieved sufficient depth in terms of meta-analytic synthesis. A similar observation was reported by Shafin *et al.* (2021), who noted that frequently studied core concepts often resist deep synthesis due to methodological diversity and heterogeneity across studies.

In addition, niche themes represented by pharmacological terms such as “glatiramer acetate” and “fingolimod” point to the existence of narrowly focused yet technically intensive meta-analyses. This pattern supports the findings of Özkan (2025), who emphasized that pharmacological research within the MS literature tends to maintain limited interconnections with the broader research landscape.

Finally, the low centrality of emerging themes such as “physical activity,” “walking,” and “balance” suggests that patient-centered approaches remain underexplored at the meta-analytic level, a concern also highlighted by Uslu (2024) and Yang (2021). Nevertheless, the increasing visibility of these themes may be interpreted as an important indicator of a growing research interest, suggesting that rehabilitation-oriented syntheses are likely to gain greater prominence in future MS meta-analytic literature.

This study makes a substantial contribution to the field by being among the first comprehensive bibliometric analyses to systematically examine meta-analyses conducted in the domain of Multiple Sclerosis (MS). Beyond relying solely on quantitative indicators, the study provides an in-depth evaluation of the intellectual structure, thematic orientations, and collaboration networks within the literature. The application of advanced bibliometric techniques—including co-citation, co-occurrence, and thematic map analyses—further enhances the methodological rigor and analytical depth of the study.

Nevertheless, several limitations should be acknowledged. First, the data were exclusively retrieved from the Web of Science Core Collection (WoS). As a result, relevant meta-analyses indexed in other major databases such as Scopus, PubMed, and Embase were not included, which may have led to the omission of influential studies. Second, due to language restrictions, only studies published

in English were considered. This may have excluded valuable research, particularly studies based on local or regional data published in other languages. Finally, by its very nature, bibliometric analysis prioritizes quantitative and structural indicators over content-based quality assessment. Consequently, the methodological quality and clinical robustness of the included meta-analyses were not directly evaluated within the scope of this study.

In conclusion, this bibliometric analysis demonstrates that meta-analytic research in the field of Multiple Sclerosis (MS) has increased markedly, particularly after 2010, indicating a progressively maturing literature. Despite growing thematic diversity, meta-analyses continue to focus predominantly on traditional topics such as diagnostic criteria, therapeutic approaches, and epidemiological indicators.

Thematic mapping and keyword analyses show that patient-centered themes, including quality of life, fatigue, and disability, are gaining visibility but remain positioned at relatively low centrality within the research network. This suggests that meta-analytic output in these areas is still limited and highlights the ongoing need for high-quality primary studies to support robust synthesis.

Collaboration analyses indicate that MS meta-analyses are largely produced through international and multi-authored efforts, although these collaborations are concentrated in specific geographic regions. In addition, the concentration of publications in a limited number of journals points to a centralized structure of knowledge production. Overall, while the meta-analytic literature on MS continues to evolve, strengthening patient-centered research, enhancing methodological rigor, and expanding global research collaborations remain critical for the field’s future development.

DISCLOSURE

Date availability: The bibliographic data analyzed in this study were retrieved from the Web of Science Core Collection. The dataset supporting the conclusions of this article is available from the corresponding author upon reasonable request.

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