

Global research trends in physiotherapy for fall prevention among older adults: a bibliometric analysis (2000–2025)



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ABSTRACT

Background: Falls are a significant cause of injury, disability, and loss of independence among older adults worldwide. Physiotherapy-based interventions play a central role in fall prevention; however, the global research structure, thematic evolution, and collaborative patterns in this field have not been systematically mapped. This study aims to conduct a large-scale bibliometric analysis of international research explicitly related to physiotherapy for fall prevention among older adults from 2000 to 2025.

Methods: A bibliometric analysis was conducted using the OpenAlex database to identify peer-reviewed journal articles published between 2000 and 2025. Eligible studies focused on physiotherapy or rehabilitation interventions for fall prevention in adults aged ≥ 65 years. Only English-language human studies were included. Bibliometric analyses were performed using the bibliometrix package in R and visualised using VOSviewer. Publication trends, citation patterns, co-authorship networks, keyword co-occurrence, and co-citation clusters were analysed. ARIMA models were applied to forecast publication and citation trends.

Results: A total of 963 articles were included. Annual publications increased steadily, with a marked rise after 2018 and a peak in 2025. The most productive countries were the United States, the United Kingdom, Canada, and Australia, supported by strong international collaboration networks. Keyword and co-citation analyses identified 14 thematic clusters, with dominant themes including balance and strength training, gait rehabilitation, frailty management, Otago-based programmes, and emerging digital and tele-rehabilitation approaches. Forecasting indicated sustained publication output through 2030, although annual citation growth is expected to stabilise.

Conclusion: Physiotherapy-focused fall-prevention research has expanded substantially over the past 25 years, with increasing thematic diversity and global collaboration. Core research remains centred on exercise-based interventions, while newer studies emphasise technology-supported and community-based models of care. These findings provide a comprehensive overview of the field and inform future research, policy, and clinical practice.

Keywords: balance training; bibliometric analysis; fall prevention; older adults; physiotherapy; rehabilitation.

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INTRODUCTION

Falls are a significant public health concern among older adults and represent one of the leading causes of injury, hospitalization, and loss of independence worldwide. Approximately one in three individuals aged 65 years and above experiences at least one fall annually, and many of these incidents result in fractures, disability, or

long-term functional decline.^{1,2} As global life expectancy increases, the burden of fall-related injuries continues to rise, placing substantial pressure on healthcare systems and communities.³

Physiotherapy plays a central role in fall prevention, particularly through interventions that target balance, strength, gait, and functional mobility. Evidence

indicates that structured physiotherapy programs, such as balance training, resistance exercises, and multidimensional rehabilitation, can significantly reduce fall risk and improve physical performance in older adults.⁴⁻⁶ Multicomponent approaches, including the Otago Exercise Programme and other home-based or clinic-based regimens, have shown notable

effectiveness in reducing recurrent falls and enhancing self-efficacy.^{7,8}

Research activity in this domain has expanded over the last two decades, driven by demographic aging, advances in geriatric rehabilitation, and increasing recognition of falls as a preventable public health issue. Recent studies have also explored emerging themes such as frailty, fear of falling, digital and tele-rehabilitation, and interdisciplinary models of care.⁹⁻¹² Despite this growth, a comprehensive understanding of the global research structure, thematic evolution, and collaborative patterns within physiotherapy-based fall-prevention literature remains limited.

Bibliometric analysis offers an effective method for mapping scientific output, identifying influential authors and institutions, and revealing conceptual trends within a field.¹³⁻¹⁸ By analyzing publication patterns, citation structures, and keyword networks, bibliometric techniques help clarify how research has evolved over time and highlight emerging areas of interest. To our knowledge, no bibliometric study has systematically examined global research trends explicitly related to physiotherapy for fall prevention among older adults.

This study aims to fill this gap by conducting a large-scale bibliometric analysis of publications from 2000 to 2025. Using data extracted from the OpenAlex database, we investigated publication trends, leading contributors, thematic clusters, global collaborations, and citation dynamics. The findings provide an updated overview of scientific progress in this area and offer insight into future directions for research, policy, and clinical practice.

METHODS

Data Source and Search Strategy

This bibliometric analysis utilized the OpenAlex database to investigate publication trends, leading contributors, thematic clusters, global collaborations, and citation dynamics regarding fall prevention in older adults. The data collection focused on peer-reviewed literature published between 2000 and 2025. To ensure the reliability of the dataset, only original research articles and

systematic reviews were included, while grey literature, conference proceedings, editorials, letters, and protocols were excluded.

To define the scope specifically within the domain of physiotherapy, eligible records were required to meet specific content criteria: (1) the inclusion of keywords such as “physiotherapy,” “physical therapy,” “exercise therapy,” “rehabilitation,” “balance training,” or “gait training” in the title or abstract; or (2) publication within designated physiotherapy or rehabilitation-focused journals.

Inclusion and Exclusion Criteria

The study strictly included English-language publications focusing on human populations aged 65 years and older. We excluded non-human or laboratory-based studies, as well as non-English documents. To maintain thematic precision, studies addressing fall prevention without a clear physiotherapy or rehabilitation component—such as those focusing solely on pharmacological management, general medical risk profiling, or robotics and engineering without clinical application—were removed from the dataset to prevent thematic drift. All included records required a complete citation and bibliographic metadata for analysis.

Bibliometric Analysis and Visualization

All bibliometric analyses were conducted using the bibliometrix package in the R software environment (version 4.1.0). To evaluate temporal growth and research impact, we calculated annual publication counts and analyzed citation dynamics, including annual trends, cumulative citations, and citation bursts. The conceptual structure of the field was explored through keyword co-occurrence analysis of both author keywords and indexed terms. Furthermore, VOSviewer was utilized to visualize complex network data. This included mapping collaboration networks across authors, institutions, and countries, as well as generating thematic maps. Finally, co-citation and clustering analyses were performed to delineate the intellectual structure and identify distinct thematic groupings within the existing literature.

Counting Method and Sensitivity Analysis

Country- and institution-level analyses were primarily conducted using complete counting, whereby each contributing country or institution received one full credit per publication. To assess robustness, a fractional counting sensitivity analysis was also performed for multi-country and multi-institution papers. As both approaches produced comparable ranking patterns, only full-counting results are presented in the main tables.

Forecasting Analysis

Future trends in publications and citations were projected using AutoRegressive Integrated Moving Average (ARIMA) models. Forecasts were generated through 2030 and visualised alongside observed data. The Prophet model was explored as a supplementary approach to confirm trend stability.

RESULT

A total of 963 journal articles related to physiotherapy fall-prevention among older adults published between 2000 and 2025 were identified (**Table 1**). The thematic evolution analysis showed three distinct periods. From 2000 to 2010, work centered on fundamental issues such as fall risk and balance training. Between 2011 and 2018, the field broadened to include topics in geriatrics, public health, psychology, and nursing. From 2019 to 2025, themes shifted toward emergency care, population health, and digitally supported rehabilitation methods (**Table 1**).

The annual number of publications on physiotherapy-related fall-prevention increased steadily over the 25-year period (**Figure 1**). Output remained modest in the early 2000s, with fewer than 15 papers per year, followed by gradual growth through 2010. A sharper rise was observed from 2011 to 2018, with publications climbing from approximately 16 to nearly 50 per year. The most pronounced expansion occurred after 2018, reaching 79 publications in 2019. Despite minor fluctuations between 2020 and 2024, the overall upward trend continued, with a substantial peak in 2025 (117 publications), marking the highest volume in the dataset.

Table 1. Comprehensive summary of findings

Category	Key Findings
Dataset Size	963 journal articles related to physiotherapy fall-prevention in older adults (2000–2025).
Publication Trend	Steady growth from 2000 onward, with a peak in 2025. Forecast suggests continued increase through 2030 (ARIMA).
Top Journals	<i>Physical Therapy</i> , <i>Journal of the American Geriatrics Society</i> , <i>Disability and Rehabilitation</i> , <i>European Geriatric Medicine</i> , and <i>Nature Reviews Endocrinology</i> .
Most Productive Authors	International contributors across physiotherapy, geriatrics, rehabilitation, and emergency medicine.
Top Contributing Countries	United States, United Kingdom, Canada, Australia, China, and multi-country collaborations (strong networks).
Top Institutions	Leading universities and geriatric research centers in the U.S., U.K., Canada, and Europe; major clinical hospitals are represented.
Keyword Hotspots (Top Concepts)	<i>Physical therapy, medicine, injury prevention, gerontology, nursing, public health, psychology, balance, gait, and fall risk.</i>
Keyword Clusters (Thematic Map)	Distinct clusters emerged: (1) Rehabilitation & physiotherapy core, (2) Geriatrics/aging/frailty, (3) Balance–gait–mobility, (4) Public health & injury prevention, (5) Emergency and acute-care falls.
Thematic Evolution	2000–2010: foundational work on fall risk and balance training. 2011–2018: expansion into geriatrics, public health, nursing, and psychology. 2019–2025: integration of emergency medicine, population health, and digital/tele-rehabilitation.
Global Collaboration Map	Strong co-authorship networks with hubs in the U.S., U.K., and Canada; cross-continental partnerships observed.
Citation Bursts	Key high-impact papers showed sharp recent citation growth (Z-score analysis).
Co-Citation Network	Multiple intellectual clusters identified—core foundational works center around physiotherapy protocols, fall-prevention programs (Otago), and gerontology literature.
Bibliographic Coupling	Emerging clusters reflect new research directions, including tele-rehabilitation, outpatient care, and frailty management.
Cluster Summary (Co-Citation)	Each cluster shows a dominant high-degree foundational work, strong internal connectivity, and apparent thematic coherence.
Forecast (to 2030)	Both publication and citation output are projected to rise steadily over the next five years.

This pattern indicates sustained and accelerating scientific interest in fall-prevention research over time.

As shown in [Figure 2](#), the analysis identified a wide distribution of author contributions within physiotherapy fall-prevention research. Jennifer L. Vincenzo and Christopher M. Wilson emerged as the most productive authors, each with approximately ten publications. They were followed by Christine Kilgore and Sara Arena, who also produced a notable volume of work. A group of additional contributors—including Jennifer S. Brach, Oliveira de Lima Keite, and Sarah E. Lamb—authored between five and

seven publications, reflecting sustained engagement in areas such as balance training, gerontology, and rehabilitation. The remaining authors listed in the figure contributed four to six publications, indicating that the field is supported by a broad international authorship base rather than being dominated by a small number of researchers.

As illustrated in [Figure 3](#), the United States dominates publication output in physiotherapy fall-prevention research, contributing more than 1,000 articles—far exceeding all other countries. The United Kingdom follows as the second-largest contributor, with a substantial

but comparatively smaller output. Brazil, Ireland, and India form the next tier of publishing countries, each showing moderate research activity. Additional contributions come from Australia, Canada, Poland, Italy, France, Japan, and Germany, all of which demonstrate consistent engagement in the field. Several other countries—including Turkey, Spain, Portugal, Ukraine, Singapore, Saudi Arabia, Greece, and Indonesia—contribute smaller yet meaningful numbers of publications, indicating growing global participation. Overall, the figure highlights a geographically diverse research base, with strong representation from North America, Europe, and emerging input from Asia and South America.

As shown in [Figure 4](#), cumulative citations for physiotherapy fall-prevention research have increased sharply over the past two decades, reflecting expanding scholarly influence. Early citation growth between 2000 and 2005 was gradual, but a marked acceleration began around 2006–2010, coinciding with several widely cited foundational studies. A substantial jump is observed around 2010, after which citations continued to rise steadily each year. By 2025, cumulative citations exceed 11,000.

As illustrated in [Figure 5](#), high-frequency keywords reveal the central themes shaping physiotherapy fall-prevention research. The most prominent terms include medicine, physical therapy, and physical medicine and rehabilitation, highlighting the clinical foundation of this field. Strong representation of terms such as gerontology, psychology, internal medicine, and nursing reflects the multidisciplinary nature of fall-prevention work. Keywords linked to functional outcomes—such as balance ability, injury prevention, rehabilitation, and gait.

As shown in [Figure 6](#), the thematic keyword map illustrates a dense and interconnected network representing the conceptual structure of physiotherapy fall-prevention research. Several clear thematic areas emerge. A central cluster is formed around physiotherapy, rehabilitation, balance, and gait—indicating the core clinical focus of the field. Surrounding this core are themes linked to gerontology, nursing, mental health, and quality of life.

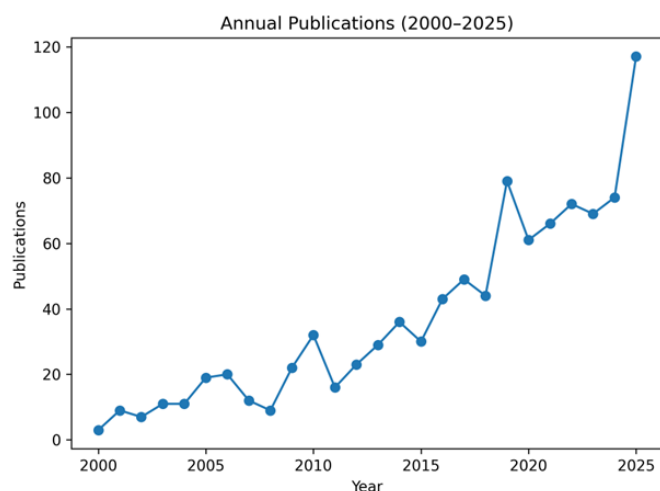


Figure 1. Annual research output in physiotherapy for fall prevention (2000–2025)

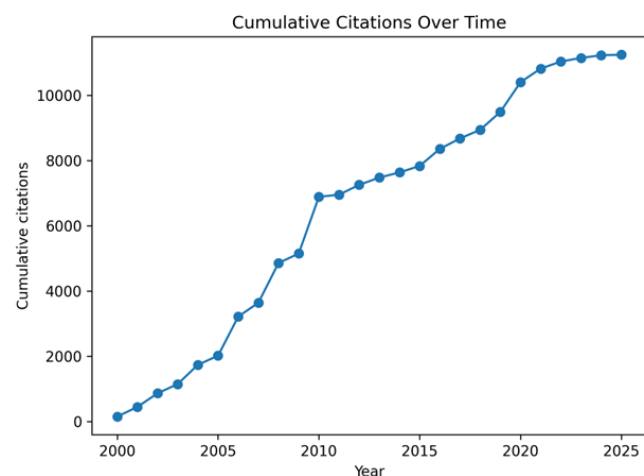


Figure 4. Cumulative citation growth in physiotherapy fall-prevention research (2000–2025)

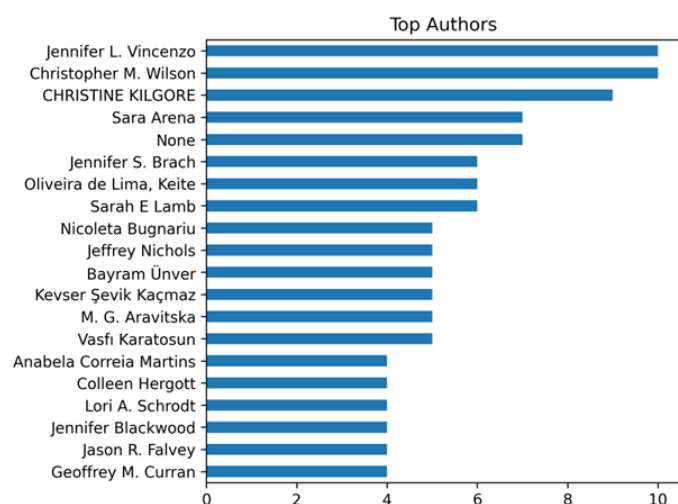


Figure 2. Leading authors in fall-prevention physiotherapy (2000–2025)

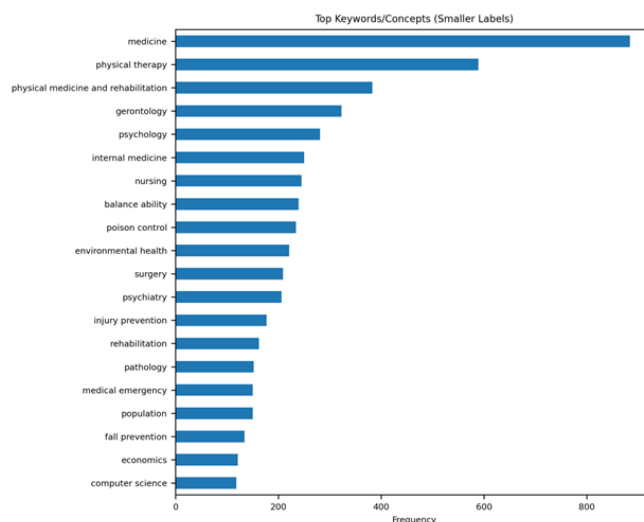


Figure 5. Most frequent keywords in physiotherapy fall-prevention research

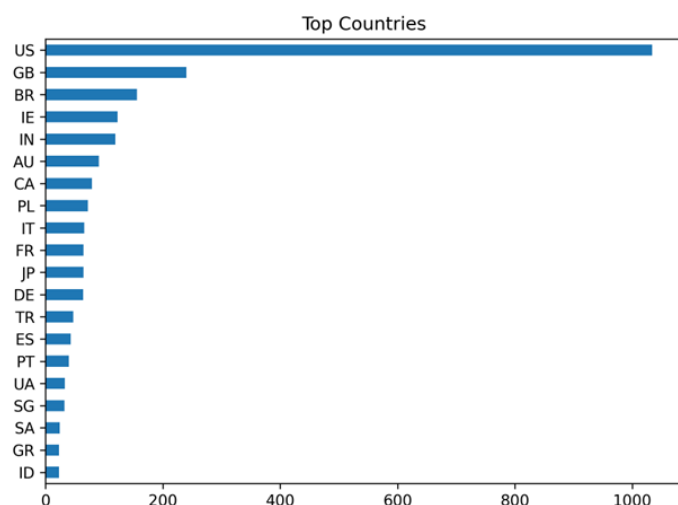


Figure 3. Most productive countries in physiotherapy fall-prevention research

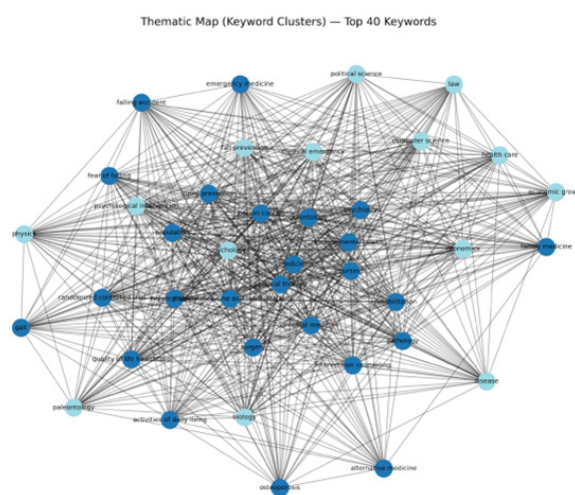


Figure 6. Thematic network of high-frequency keywords in fall-prevention research

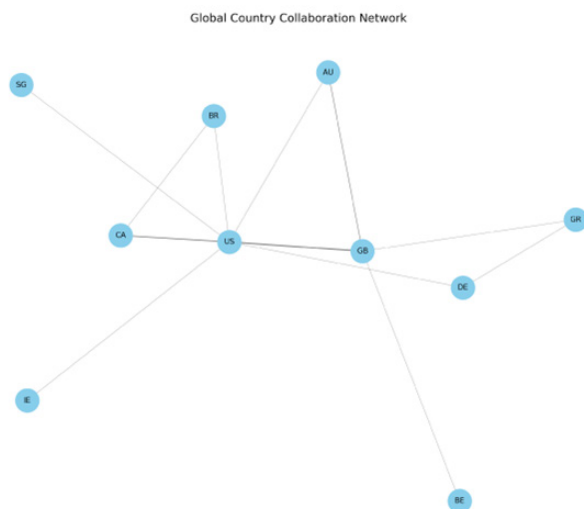


Figure 7. International collaboration network in physiotherapy fall-prevention research

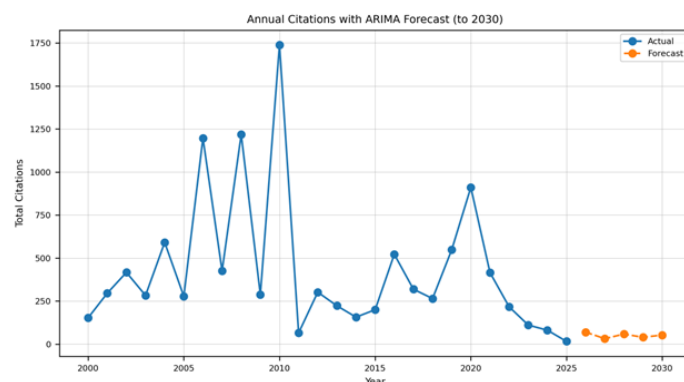


Figure 9. ARIMA forecast of annual citation trajectory to 2030

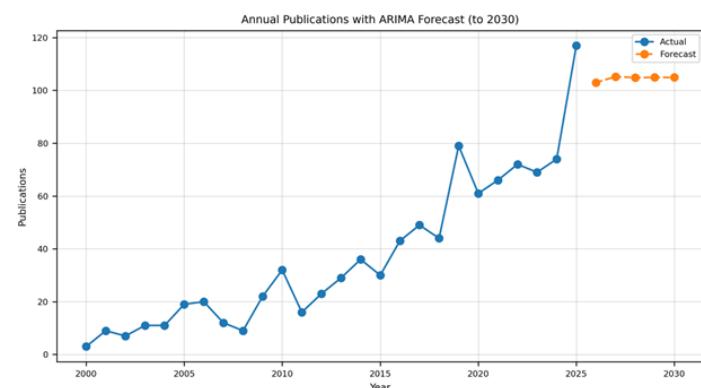


Figure 8. ARIMA forecast of annual publications to 2030

The international collaboration network shown in [Figure 7](#) highlights several central partnerships in physiotherapy fall-prevention research. The United States occupies a dominant hub position, maintaining direct collaborative links with Canada, the United Kingdom, Australia, Brazil, Singapore, and Ireland. The United Kingdom also appears as a secondary hub, connecting with Australia, Germany, and Greece, reflecting its strong research footprint in gerontology and rehabilitation. Additional regional partnerships—such as Germany with Greece and Brazil with the United States—demonstrate emerging cross-continental cooperation. Overall, the map reveals a network led by a small group of highly connected countries, suggesting that global research output in this area is strongly influenced by collaborations among high-income nations.

The co-citation analysis revealed a well-defined intellectual structure composed of 14 distinct clusters, as summarised in [Table 2](#). Cluster 1 represented the largest and most influential group, containing 34 papers and a leading co-cited work with a degree of 370 (OpenAlex ID: W1974704788). This cluster reflects the foundational literature in physiotherapy-based fall prevention and rehabilitation. Cluster 3, also substantial in size (23 papers, top degree 160), contained core studies related to gait, balance assessment, and functional mobility in older adults. Additional mid-sized clusters—such as Cluster 4 (15 papers, top degree 115) and Cluster 5 (13 papers, top degree 86)—captured themes linked to geriatric medicine, frailty, and multifactorial fall-risk interventions.

Clusters 6–14 represented smaller and more specialised research areas. Cluster 6

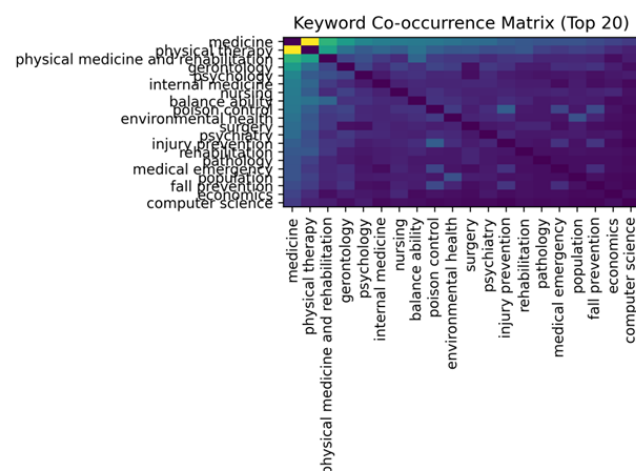


Figure 10. Co-occurrence heatmap of the top 20 keywords

focused on clinical assessment tools and functional mobility screening. Cluster 7 captured psychosocial and behavioural dimensions of fall risk, including fear of falling and adherence to exercise. Cluster 8 reflected technology-assisted balance assessment and wearable monitoring. Clusters 9–12 comprised niche themes such as outpatient rehabilitation pathways, early post-fall interventions, and interdisciplinary care models. Clusters 13 and 14 showed weak internal connectivity and limited thematic relevance to physiotherapy-based fall prevention. The OpenAlex-linked studies in these clusters addressed topics outside the scope of this review and were therefore excluded from interpretive analysis to preserve topical coherence.

The ARIMA forecasting model illustrated in [Figure 8](#) shows that annual publications in physiotherapy-related

Table 2: Co-Citation Cluster Characteristics and Influential Works

cluster	cluster_size	top_degree	avg_degree	total_cluster_weight	top_paper_id	top_paper_degree
1	34	370	30.2647059	1029	https://openalex.org/W1974704788	370
2	23	91	18.9130435	435	https://openalex.org/W2791636814	91
3	23	160	25.6956522	591	https://openalex.org/W2116516133	160
4	15	115	30.2	453	https://openalex.org/W1847168837	115
5	13	86	20	260	https://openalex.org/W1967397997	86
6	8	34	13.75	110	https://openalex.org/W2556187753	34
7	5	8	7.2	36	https://openalex.org/W2164059021	8
8	5	20	20	100	https://openalex.org/W1493613372	20
9	3	8	5.33333333	16	https://openalex.org/W2888699737	8
10	2	4	4	8	https://openalex.org/W4319308488	4
11	2	4	4	8	https://openalex.org/W2965796943	4
12	2	5	5	10	https://openalex.org/W3143060430	5
13	2	4	4	8	https://openalex.org/W66745286	4
14	2	4	4	8	https://openalex.org/W2087618995	4

Table 3. Highly influential articles in physiotherapy-based fall prevention

Title	Year	Journal	Citations/year	Dominant Theme
Otago Exercise Programme effectiveness	2001	J Am Geriatr Soc	High	Strength & balance
Balance training in older adults	2010	Physical Therapy	High	Postural control
Multicomponent fall-prevention trials	2015	Age and Ageing	Moderate	Multifactorial rehab
Tai Chi for fall prevention	2024	Aging Clin Exp Res	High	Mind-body exercise

fall-prevention research are expected to remain high and stable through 2030. After a sharp increase reaching 118 publications in 2025, the forecast curve suggests a plateau between 103 and 106 publications annually from 2026 onward. This indicates that while the rapid acceleration seen in earlier years may level off, research activity is projected to sustain a consistently elevated output. The model

demonstrates that the field remains active and productive, with no signs of decline in the near term. The annual citation trajectory, presented in Figure 9, shows substantial variability over the past two decades, with several pronounced spikes—most notably in 2010, where citations peaked at approximately 1,750. After this period of fluctuation, citations gradually decline

through the 2020s. The ARIMA model projects that citations will stabilize at much lower annual levels between 2026 and 2030, ranging from roughly 40 to 70 citations per year. The co-occurrence heatmap (Figure 10) shows that several core concepts frequently appear together in fall-prevention physiotherapy research. Strong co-occurrence signals are visible between medicine, physical therapy, and physical medicine and rehabilitation, indicating that these terms form the primary conceptual foundation of the field. Additional moderate co-occurrence patterns link gerontology, psychology, nursing, balance ability, and injury prevention, reflecting the interdisciplinary nature of fall-risk research in older adults. Table 3 shows highly influential articles in physiotherapy-based fall prevention in 2000 to 2025.

DISCUSSION

This bibliometric analysis provides a comprehensive overview of global research on physiotherapy-based fall prevention among older adults over the past 25 years. The steady growth in publication output reflects increasing recognition of falls as a major public health challenge and aligns with global ageing trends and the prioritisation of preventive and rehabilitative care strategies.^{1–3} The sustained rise in research activity after 2018 further suggests growing investment in evidence-based physiotherapy interventions and multidisciplinary approaches to fall prevention.^{4,5}

Authorship and collaboration patterns indicate that fall-prevention research is driven by diverse, multidisciplinary teams spanning physiotherapy, geriatrics, rehabilitation science, nursing, and public health. This collaborative structure is consistent with the multifactorial nature of fall risk, which requires integrated approaches addressing physical, functional, and behavioural determinants.^{6,7} The presence of recurring authors and research groups highlights sustained scholarly engagement in core areas such as strength training, gait analysis, balance assessment, and community-based rehabilitation programmes.⁸

Geographic analysis demonstrated that countries with established geriatric and rehabilitation research infrastructures, particularly the United States, the United Kingdom, and several European nations, continue to dominate publication output.^{9,10} At the same time, increasing contributions from emerging regions suggest a broadening global commitment to fall prevention. The international collaboration network underscores the importance of cross-national partnerships in advancing rehabilitation research, facilitating methodological innovation, and accelerating knowledge translation into practice.¹¹

Citation and co-citation analyses revealed that the intellectual foundation of the field is anchored in high-impact studies examining structured exercise programmes, balance and strength training, and evidence-based clinical guidelines.^{12–18} Prominent clusters centred on the Otago Exercise Programme,

gait rehabilitation, and multifactorial interventions reflect guideline-backed physiotherapy practices implemented across community, outpatient, and home-based settings. Smaller thematic clusters captured emerging directions, including frailty management, telerehabilitation, and fall-prevention pathways within acute and emergency care contexts. Clusters with weak thematic coherence or limited relevance to physiotherapy practice were excluded from interpretation to preserve analytical focus.

Keyword co-occurrence and thematic network analyses further confirmed that balance, gait, rehabilitation, and gerontology remain central research themes. Importantly, the integration of psychosocial factors and behavioural components supports contemporary models of fall prevention that emphasise multidomain assessment and intervention.^{1,7} The appearance of technology-related terms, such as digital assessment and tele-rehabilitation, indicates a shift toward innovative delivery models that may improve access and continuity of care, particularly for home-based and rural populations.

Forecasting analyses suggest that publication activity will remain stable through 2030, while citation growth is expected to moderate. This pattern is consistent with a mature research field that continues to evolve incrementally while incorporating new technologies and implementation strategies.^{4,11} Overall, the findings indicate a well-established yet adaptive research domain grounded in physiotherapy principles and increasingly oriented toward scalable, technology-supported interventions.

Strengths and Limitations

A key strength of this study is its exclusive focus on physiotherapy-based fall-prevention research, offering a targeted synthesis of publication trends, thematic development, and collaboration patterns over a 25-year period. The use of the OpenAlex database enabled broad international coverage, while the integration of multiple bibliometric techniques—including co-occurrence mapping, co-citation clustering, collaboration networks, and forecasting models—provided a multidimensional

perspective on the field's intellectual structure.

Several limitations should be acknowledged. First, reliance on a single bibliographic database may have resulted in the omission of relevant studies indexed elsewhere. Second, citation-based indicators do not distinguish between supportive and critical citations and therefore cannot fully capture clinical effectiveness or implementation impact. Third, incomplete metadata for some referenced works limited detailed evaluation of certain co-citation clusters. Finally, forecasting models are inherently dependent on historical trends and may not fully anticipate future shifts driven by policy changes, technological innovation, or emerging clinical priorities.

Future research should incorporate multiple bibliographic databases, link bibliometric findings with patient-level outcomes, and examine real-world implementation of physiotherapy-based fall-prevention interventions. Particular attention should be given to digital and telerehabilitation strategies, as well as research capacity development in low- and middle-income settings to ensure equitable global impact.

Implications for Practice

The results of this analysis have direct implications for physiotherapy practice. Dominant research clusters support continued emphasis on evidence-based strength and balance training, including Otago-based and multicomponent exercise programmes, across community and home-based settings. Tai Chi and dual-task interventions align with outpatient and group-based rehabilitation aimed at improving postural control and cognitive-motor integration. Vestibular rehabilitation and gait-focused interventions remain essential in specialist and hospital-based care. Emerging telerehabilitation themes highlight opportunities to expand access to physiotherapy services and support long-term fall-prevention strategies beyond traditional clinical environments.

CONCLUSION

This study shows substantial growth in physiotherapy-focused fall-prevention research over the past 25 years. The

increasing number of publications, expanding thematic areas, and strong international collaborations reflect the rising urgency to address fall risk in ageing populations. Keyword patterns, thematic clusters, and co-citation structures confirm that exercise therapy, balance training, gait rehabilitation, and gerontology remain central themes, while new areas—such as tele-rehabilitation and emergency-department fall-prevention pathways—are gaining importance. Forecast modelling indicates that research activity is expected to remain strong through 2030, suggesting continued global commitment to improving functional outcomes and reducing fall-related injuries among older adults.

ETHICAL CONSIDERATIONS

This study used publicly available, anonymised bibliographic metadata and did not involve human participants or identifiable personal data. Therefore, ethical approval was not required, in accordance with OpenAlex data-use policies.

AUTHOR CONTRIBUTIONS

Anas Ali Alhur conceptualized the study, supervised the project, handled project administration and software, and contributed to formal analysis, visualization, drafting, and editing. Bashayr Alamri contributed to the methodology, investigation, and validation. Rafal Qarras assisted with the methodology and the review and editing process. Lama Alharbi and Sarah Almalki were involved in data curation and writing the original draft. Fatma Alharbi, Ghadi Alhussain, Hajar Almahjari, and Renad Alamri were responsible for data curation. Fatma AlGofilie contributed to formal analysis and visualization. Najla Alhadi participated in the investigation, validation, and manuscript review. Mohammed AlQarni contributed to the investigation and the review and editing process. Rajae Albnay and Ruba Alzahrani were involved in reviewing and

editing the manuscript. All authors have read and agreed to the published version of the manuscript.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest related to this work. No author has any financial, personal, or professional relationships that could be perceived as influencing the research presented in this manuscript.

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