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A Comprehensive Bibliometric Analysis Trend of the Top 100 Most Cited Publications in Frailty Research

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Abstract. Frailty among older adults is a critical health issue with complex dimensions. This study presents a bibliometric analysis of frailty literature from 1990 to 2023, focusing on publication trends, leading contributors, and highly cited works.Methods: Using Web of Science and Scopus databases, the top 100 publications were analyzed to identify key countries, institutions, and research themes shaping the field. Results indicate a consistent growth in frailty-related research, with Web of Science emerging as a primary source. Leading countries and institutions demonstrate varying contributions, while highly cited papers highlight pivotal advancements. The findings underscore disparities in global research output and the role of influential journals in shaping geriatric health discourse. This analysis provides valuable insights into research gaps and serves as a guide for future studies and interventions in frailty management.

Keywords: Bibliometric Analysis, Frailty, Elderly individuals, Research

1. Introduction

Frailty refers to a multidimensional condition characterized by increased vulnerability and reduced physiological reserves in older adults (Das & Dhillon, 2023). As a significant health concern among the elderly population, frailty has garnered growing attention due to its profound impact on overall well-being (Wang et al., 2022). Comprehensive efforts to address frailty are essential to mitigate its implications and improve care and support for older individuals (Ofori-Asenso et al., 2019). This report explores various aspects of frailty, including its causes, identification, and management, to provide insights into this crucial area of geriatric healthcare (Duzgun & Sema ustundag., 2021)

Frailty poses a critical challenge globally, particularly in Asia, where the aging population is expanding rapidly. An estimated 12% of individuals aged 65 and older in Asia are frail, with this proportion expected to rise alongside the growing elderly demographic (Ma & Chan, 2020). As a result, there has been a heightened emphasis on frailty research and healthcare interventions in Asia to address the implications of this condition on the well-being of older adults. Efforts to tackle frailty's causes, detection, and management are particularly

significant in addressing the challenges posed by aging populations in Asia (Shaharudin & Rahman, 2022).

The consequences of frailty in older adults reach beyond the physical realm to encompass psychosocial aspects and strain healthcare resources (Puts et al., 2017). Frail individuals are at a heightened risk of falls, functional decline, hospitalization, and mortality (Lu et al., 2022). As healthcare systems contend with the challenges posed by an aging population, research on frailty becomes integral to developing effective interventions and informed healthcare policies (Lewis et al., 2021).

Current studies related to frailty have made significant contributions, shedding light on various facets of this complex condition (Danquah et al., 2024)(Morley et al., 2013). Researchers have explored its epidemiology, diagnostic criteria, clinical manifestations, and potential interventions. However, the sheer volume of literature on frailty necessitates a systematic examination to identify trends, gaps, and key contributors in the research landscape related to frailty (Zhu et al., 2023). This study addresses these gaps through a bibliometric analysis of the top 100 most impactful publications in frailty research from 1990 to 2023. Using Web of Science and Scopus databases, the analysis identifies publication trends, highly cited papers, and influential contributors, including countries, institutions, and researchers (Zhang et al., 2023). Results reveal a steady growth in frailty-related publications, with Web of Science serving as a primary source of impactful research. The analysis highlights leading nations and institutions contributing to this field and identifies key publications that have advanced research into frailty (Basubrain, 2023).

The analysis seeks to offer valuable insights into the study of frailty, focusing on important areas and potential avenues for further exploration. By analyzing significant publications, this research aims to outline the evolving landscape of frailty studies and pinpoint important contributions that have improved our understanding of this complex condition.

This systematic bibliometric analysis will provide useful information for researchers and healthcare professionals, helping them identify both strengths and weaknesses in current frailty research. Potential research gaps and emerging areas of interest that can guide future investigations in the field of frailty, namely with several research questions, RQ1: What are the publication trends over time in frailty research, and is the volume of literature on frailty growing or declining within the top 100 publications?. RQ2: Which countries, institutions, and authors are at the forefront of frailty research in terms of publication output within the selected top 100 publications?. RQ3: How has the contribution of leading countries, institutions, and authors to frailty research changed over time?. RQ4: Which journals have published the most on frailty within the top 100 publications?. RQ5: What are the most cited articles and references in the field of frailty research, and what insights do they offer regarding the intellectual foundations of the discipline?.

By systematically reviewing the current body of literature, this analysis aims to further enhance our understanding of frailty and guide future research efforts. The results will not only improve our grasp of frailty but also establish a basis for creating specific interventions and evidence-supported policies that seek to enhance the well-being and quality of life for elderly individuals grappling with frailty. The findings from this comprehensive bibliometric analysis will contribute to the development of a more holistic approach in addressing frailty, taking into account various aspects such as.

2. Method

2.1. Data Collection

Relevant publications on frailty and fall were retrieved from the Scopus and Web of Science (WoS) databases on January 27, 2024, using a keyword search strategy. The search terms included "Frailty*" and "older*" or "elder*" or "pensioner" or "age" based on recommendations from prior studies.10 No date restrictions were applied. All records containing cited references were exported and pre-processed using ScientoPy (version v2.1.3) software for cleaning and deduplication.

2.2. Data Analysis

Figure 1 presents the study process gained and was refined dataset using the bibliometric tools ScientoPy, and VOSviewer (version 1.6.19).11

ScientoPy provided summary statistics on the loaded papers, omitted papers, duplicated papers, and final dataset composition. VOSviewer was used to visualize collaboration networks, create maps based on co-occurrence, and analyze trends in keywords. Maps were generated for country collaboration, institutional collaboration, co-authorship, keyword co-occurrence, and temporal keyword trends.

Key preprocessing results from ScientoPy indicated 100 original papers loaded, with 97 duplicates removed, leaving a final dataset of 200 papers (50% from WoS, 50% from Scopus). The integration of data mining, information visualization, and contextual interpretation enabled a comprehensive bibliometric analysis to address the stated research questions on publication trends, to encompass various aspects of frailty, epidemiology, clinical manifestations, diagnostic criteria, interventions, and related topics (title, authors, publication year, journal or conference), abstracts, and keyword.

2.3. Inclusion/exclusion criteria

The inclusion criteria for selecting publications encompassed studies related to frailty, its assessment, and interventions targeting frail individuals aged 60 years and above. Exclusion Criteria: Publications outside the predefined timeframe, non-peer-reviewed materials, and literature not directly addressing frailty or its associated aspects were excluded from the analysis. Exclusion (e.g Individuals with severe cognitive impairment or dementia, Individuals with terminal illnesses or severe physical disabilities).

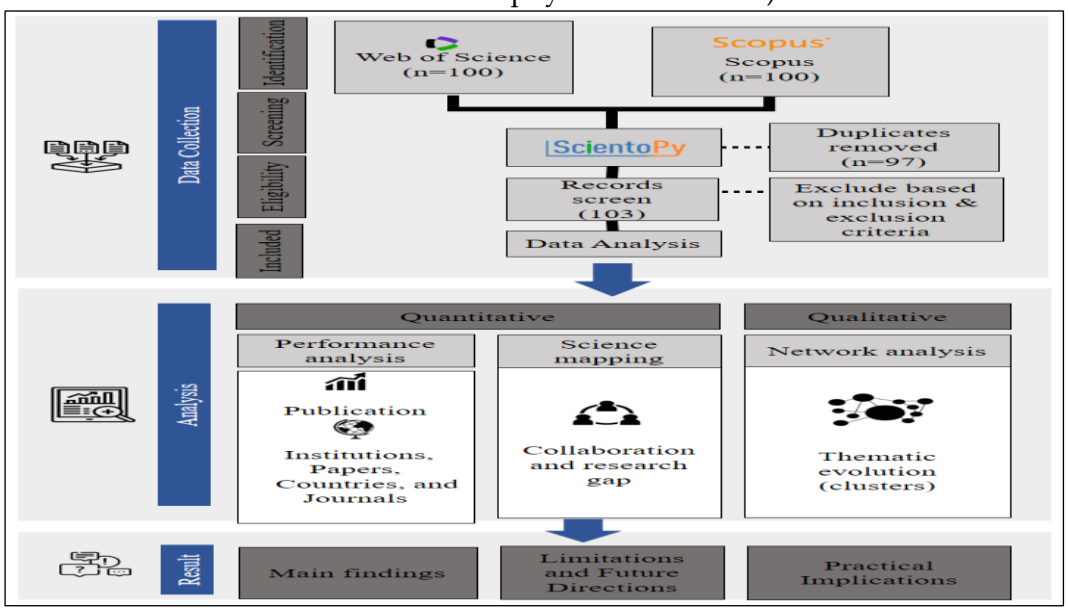

Fig. 1. The Study Process Diagram of the search process adapted from previous study Sumber: (Azizan et al.,2023)

3. Result

3.1. Publication trends over time

Figure 2 provides insights into the publication trends of frailty-related research in two prominent databases, Web of Science (WoS) and Scopus, spanning from 1990 to 2023. The total number of publications is notably higher in WoS, totaling 96 publications, compared to Scopus, which has 7 publications over the same period. This stark difference suggests that WoS is more prolific in capturing research related to frailty, reflecting its comprehensive coverage in this domain.

Examining the publication trends over the years, both databases show a similar pattern of low publication counts in the early years, followed by a noticeable increase from the mid-1990s. However, WoS consistently outpaces Scopus in the number of publications each year. Peaks in publications for both databases are observed in the mid-2000s, indicating a period of heightened research activity. Despite fluctuations, WoS maintains a consistently higher publication count throughout the years, emphasizing its dominance in capturing frailty-related research.

A closer look at the recent trends from 2015 to 2023 reveals interesting dynamics. WoS continues to contribute to frailty research, albeit with a diminishing trend, while Scopus shows a decline in publications after 2016. Furthermore, both databases exhibit minimal to no publications in the most recent years (2020-2023), suggesting a potential recent decrease in research output in the field of frailty.

From the results of linear regression analysis on publication trends: WoS (Web of Science): Trend coefficient (slope): 0.08 (meaning there is an average increase of 0.08 documents per year). P-value: 0.18 (not statistically significant at the 95% confidence level). Scopus:Trend coefficient (slope): 0.002 (almost no change in the number of documents per year).P-value: 0.82 (also not statistically significant). Interpretation: Pre-pandemic period (1994–2019): there is a more consistent growth in the number of publications in WoS compared to Scopus. This indicates increased attention to the topic of frailty, although publications in Scopus remain consistently lower. During the pandemic (2020–2024): A decrease in the number of publications was seen in both databases. This may be due to research limitations due to the COVID-19 pandemic, such as access to research participants and greater allocation of health resources to handling the pandemic compared to long-term research.

Other factors, COVID-19 pandemic, may cause disruptions to research and publications, particularly in older populations who are vulnerable to COVID-19. Technological and funding developments, Increased funding for geriatric research before the pandemic may have encouraged publications, but priorities may have changed during the pandemic. Regional trends, Frailty research may be more focused on specific regions with larger older populations.

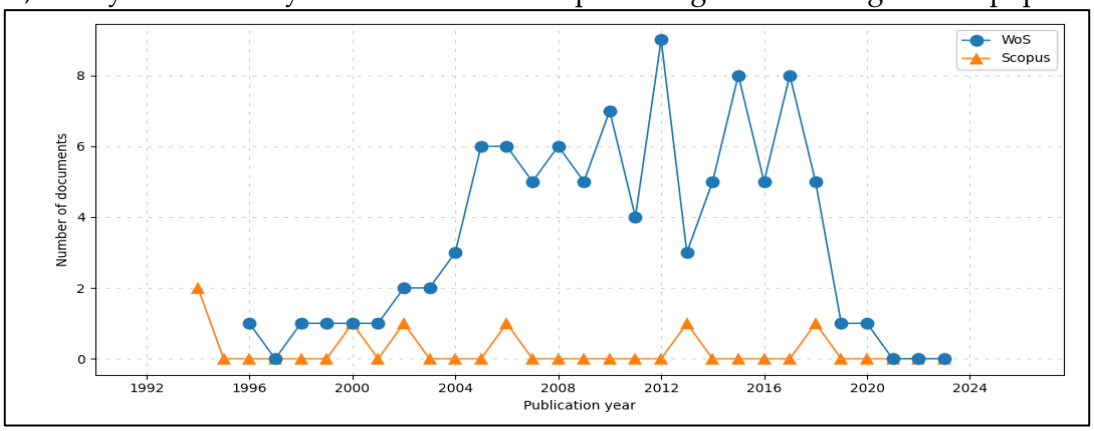

Figure 2. The Publication Trends (1994-2024)

3.2. Top 20 Leading countries, institutions and top cited papers

Figure 3, spanning the years 1990 to 2023, offers a comprehensive overview of frailty and falls-related publications, categorized by country. Notably, the United States emerges with the highest total of 45 publications, showcasing an evident increase in activity from 1994 onwards, peaking in 2013 and gradually declining thereafter. Canada, contributing 22 publications, displays consistent engagement, marked by notable peaks in 1995, 2000, 2009, and 2014, signifying periods of heightened research activity. Similarly, the United Kingdom, also with 22 publications, demonstrates a relatively steady distribution over the years, with a slight increase observed from 2010 onwards and a peak in 2015.

In examining the contributions of France, Italy, and the Netherlands, each with 11 and 10 publications respectively, we observe distinct patterns. France exhibits increased activity from 2009, Italy peaks in 2006, while the Netherlands maintains consistent but modest contributions. Australia, Spain, and Switzerland, with 9, 9, and 6 publications respectively, showcase specific peaks – Australia in 2003 and 2018, Spain in 2012, and Switzerland in 2006 and 2012.

Turning our attention to Germany, Sweden, Poland, Portugal, and Turkey, contributing 5, 4, and 3 publications each, we discern unique trends. Germany shows activity in the early 2000s, Sweden peaks in 2008, and Poland and Portugal demonstrate sporadic contributions. Belgium, Brazil, China, Finland, Ireland, and Japan, each contributing 2 publications, exhibit varying patterns – Belgium and Brazil consistently contribute, while China demonstrates increased activity in 2011 and 2022.

Lastly, several countries contribute one or no publications, indicating differing degrees of engagement in frailty and falls research. The dataset's global distribution highlights the necessity of understanding country-specific trends, providing valuable insights for identifying research intensity and collaborative opportunities on a global scale. Peaks in publication activity for individual countries serve as indicators of heightened research focus, contributing to a nuanced interpretation of the dataset's findings.

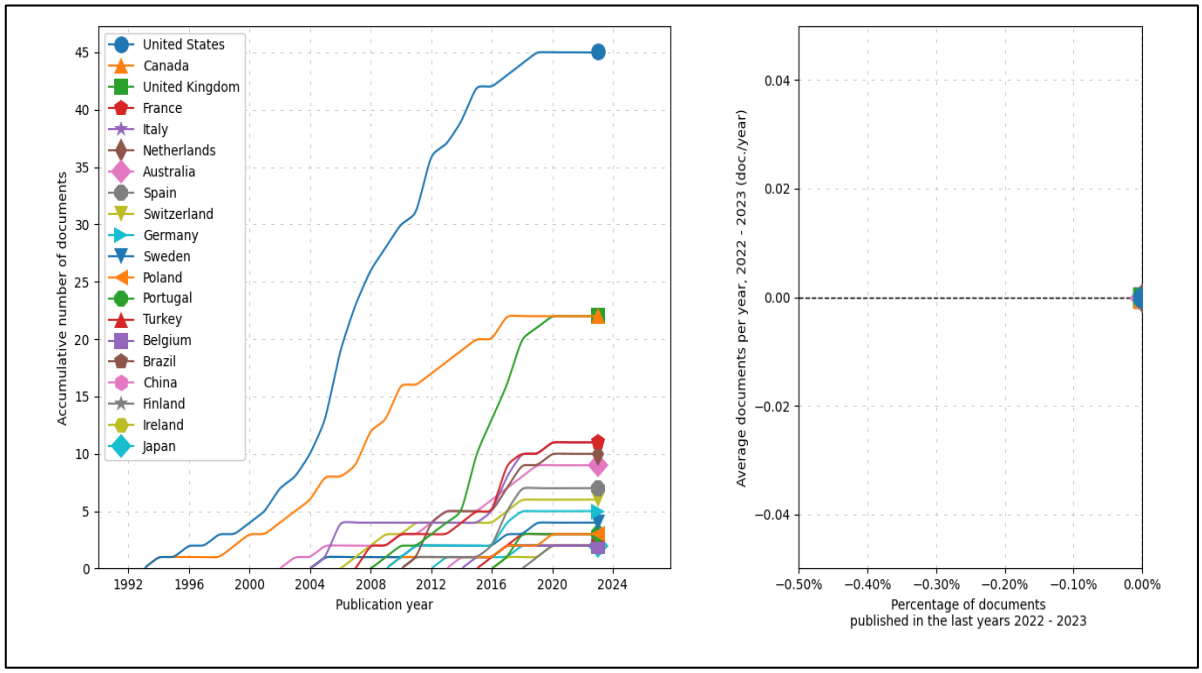

Figure 3. Top 20 countries in Frailty Research

3.3. Top 20 Institutions

The figure 4 shows results section unveils a comprehensive breakdown of frailty and falls-related publications across diverse institutions from 1990 to 2012. Each institution, represented in rows, exhibits distinct publication counts over the years. Noteworthy entities such as "Sch Med," "Dalhousie Univ," "Dept Med," and "McGill Univ" stand out with higher publication counts. This variability underscores dynamic research activity, where certain institutions maintain consistent contributions, while others display peaks, indicative of potential research focus during specific periods.

Temporal trends reveal the evolving engagement of institutions in frailty and falls research. Fluctuations in publication counts suggest shifts in research priorities, highlighting the dynamic nature of scholarly contributions. The dataset's variability in institutional publication counts reflects the diverse landscape within the field, prompting exploration into the factors influencing these patterns.

Additionally, Figure 3 presents the visual representation of these institutional contributions over time, offering a graphical insight into the dynamic trends observed. The figure enhances the understanding of temporal variations, illustrating peaks and troughs in publication counts for different institutions. This visual representation provides a more intuitive grasp of the dataset and serves as a valuable complement to the quantitative analysis.

The figure 4 temporal dynamics also prompt questions about collaboration and network structures. Peaks in publication counts may signify collaborative efforts or increased scholarly activity within certain institutions during specific years. To delve deeper into collaborative patterns and thematic concentrations, additional analyses such as co-authorship networks and keyword assessments could provide valuable insights.

While informative in highlighting institutional contributions, the dataset falls short in providing specific details about publication content or thematic focus. This limitation prompts further exploration into the nuanced aspects of frailty and falls research within individual institutions, fostering a more comprehensive understanding of the scholarly landscape.

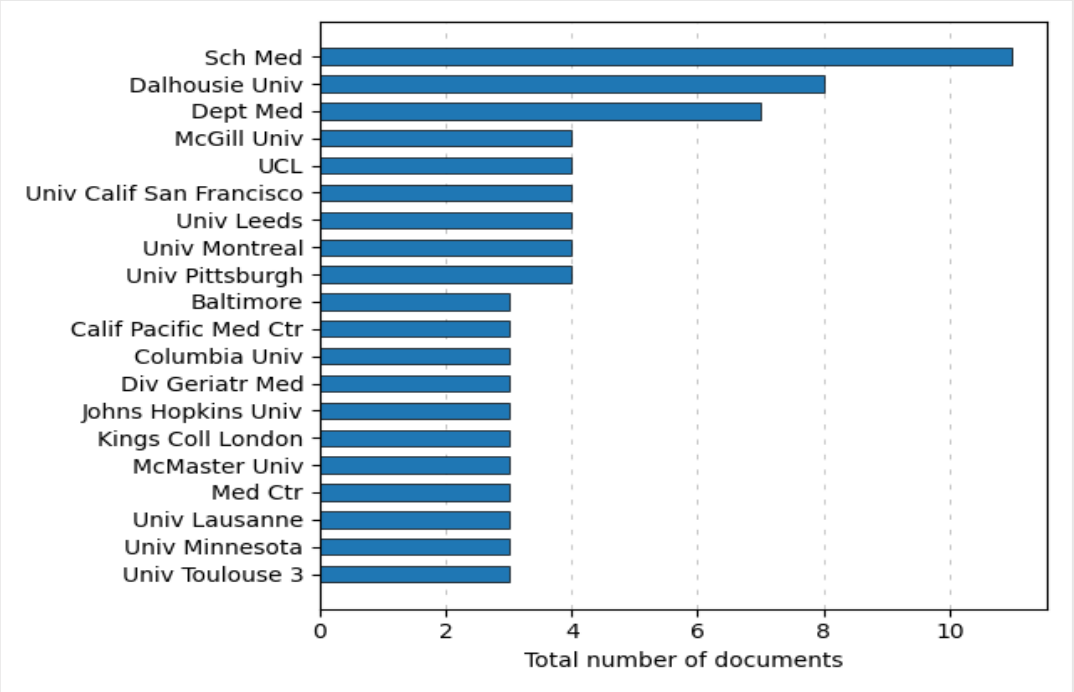

Figure 4. Top 20 Institutions Frailty Research

Table 1 shows the top 20 publications on frailty in older adults present a comprehensive view of the multifaceted aspects of this condition. Each publication contributes unique insights, addressing various dimensions such as defining frailty, assessing its prevalence, understanding its consequences, and proposing interventions.

The most-cited paper, "Frailty in Older Adults: Evidence For A Phenotype," stands out with a remarkable 15,616 citations. This seminal work sets the stage by providing a standardized definition of frailty and demonstrating its predictive validity for adverse outcomes such as falls, hospitalizations, disability, and death. The practical implication of this study underscores the necessity for thorough clinical assessment and targeted interventions to address frailty in older adults.

In a similar vein, "A Global Clinical Measure of Fitness And Frailty In Elderly People" contributes significantly with 5,087 citations. This publication details the development of the 7-point Clinical Frailty Scale, offering a practical and predictive tool for assessing frailty in elderly patients. The scale's ability to determine the risk of death or the need for institutional care makes it a valuable resource in clinical settings. "Frailty In Elderly People" further enriches the discourse on frailty by providing a concept analysis of frailty in the elderly, identifying its key attributes as shrinking, weakness, poor endurance, slowness, and low activity. This paper emphasizes the importance of a clear definition of frailty, particularly in clinical nursing practice, as a means to enhance the understanding of this condition among healthcare professionals.

Moving beyond the conceptualization of frailty, "Exercise Training And Nutritional Supplementation For Physical Frailty In Very Elderly People" delves into the realm of interventions. This publication discusses a randomized trial exploring the effects of exercise training and nutritional supplementation on frail nursing home residents. The findings suggest that these interventions can improve muscle strength and gait velocity in elderly participants, potentially reversing the effects of frailty.

"Prevalence Of Frailty In Community-Dwelling Older Persons: A Systematic Review" takes a systematic approach to understanding the prevalence of frailty in community-dwelling older persons, revealing an overall weighted prevalence of 10.7%. This work emphasizes the importance of improving comparability among studies to gain a more nuanced understanding of frailty prevalence.

The top 20 publications collectively offer a rich tapestry of knowledge, ranging from conceptual frameworks and assessment tools to practical interventions and prevalence studies. This body of work not only enhances our understanding of frailty in older adults but also provides crucial insights for clinicians, researchers, and policymakers aiming to address the complex challenges associated with this condition.

Table 1. The most influential research

Ranks	Title	Citations	Insights	Practical Implication
1	Frailty In Older Adults: Evidence For A Phenotype	15616	The paper provides a standardized definition of frailty in older adults and demonstrates its predictive validity for adverse outcomes such as falls, hospitalizations, disability, and death.	The study provides a potential standardized definition for frailty in older adults. The findings suggest the need for clinical assessment and interventions for frailty

2	A Global Clinical Measure Of Fitness And Frailty In Elderly People	5087	The paper describes the development of the 7-point Clinical Frailty Scale, a tool to assess frailty in elderly patients. It is both predictive and easy to use, and can be used to determine the risk of death or need for institutional care.	The Clinical Frailty Scale is a valid and clinically important tool for assessing frailty in elderly patients. The scale can predict the risk of death or need for institutional care
3	Frailty In Elderly People	4661	The paper provides a concept analysis of frailty in the elderly, identifying its attributes as shrinking, weakness, poor endurance, slowness, and low activity. It also highlights the importance of understanding frailty in clinical nursing practice.	The paper helps clinical nursing staffs understand the concept of frailty in the elderly. A clearly defined definition of frailty can improve elderly health.
4	Exercise Training And Nutritional Supplementation For Physical Frailty In Very Elderly People	2250	The paper discusses a randomized trial that studied the effects of exercise training and nutritional supplementation on frail nursing home residents. The results showed that exercise training improved muscle strength and gait velocity in the elderly participants.	Exercise training and nutritional supplementation can improve muscle strength and gait velocity in frail elderly people. These interventions may help to reverse the effects of frailty in nursing home residents
5	Prevalence Of Frailty In Community-Dwelling Older Persons: A Systematic Review	1964	The paper provides a systematic review of the prevalence of frailty in community-dwelling older persons. The overall weighted prevalence of frailty was found to be 10.7%.	Frailty is common in older adults, but prevalence varies widely between studies. Improving comparability of studies is important for understanding frailty
6	Frailty As A Predictor Of Surgical Outcomes In Older Patients	1520	Frailty in older surgical patients is independently associated with an increased risk of postoperative complications, longer hospital stays, and discharge to assisted or skilled nursing facilities.	Frailty can predict surgical complications, length of stay, and discharge disposition. Assessing frailty using a standardized definition can help inform decision-making
7	Research Agenda For Frailty In Older	1180	The paper discusses the results of the 2004 American Geriatrics	Dentification of physiological vulnerability and risk before poor outcomes.

	Adults: Toward A Better Understanding Of Physiology And Etiology: Summary From The American Geriatrics Society/National Institute On Aging Research Conference On Frailty In Older Adults		Society/National Institute on Aging conference on a Research Agenda on Frailty in Older Adults, focusing on the physical and physiological aspects of frailty. It does not provide a specific research agenda.	Development of interventions to prevent or reduce vulnerability in older patients
8	Age-Associated Increased Interleukin-6 Gene Expression, Late-Life Diseases, And Frailty	992	The paper discusses the relationship between age-associated increase in IL-6 gene expression and late-life diseases and frailty.	Elevated IL-6 levels may contribute to age-related diseases and frailty. IL-6 could be a potential target for intervention in late-life conditions.
9	A Comparison Of Two Approaches To Measuring Frailty In Elderly People	916	The study compared a phenotypic definition of frailty with an index of deficit accumulation and found convergence between the two approaches.	The phenotypic definition of frailty allows for easy clinical operationalization. The frailty index allows for more precise definition of risk.
10	Reducing Frailty And Falls In Older Persons: An Investigation Of Tai Chi And Computerized Balance Training	847	The paper investigates the effects of Tai Chi and computerized balance training on reducing frailty and falls in older persons.	Tai Chi can improve biomedical and psychosocial indicators of frailty in older people. Tai Chi can also reduce the risk of multiple falls
11	Frailty: Emergence And Consequences In Women Aged 65 And Older In The Women's Health Initiative Observational Study	817	The paper discusses the emergence and consequences of frailty in women aged 65 and older in the Women's Health Initiative Observational Study. It identifies risk factors for frailty and investigates its predictive validity for death, hospitalization, hip fracture, and activity of daily living disability.	Frailty in older women predicts poor outcomes such as death, hip fracture, ADL disability, and hospitalizations. Underweight, obesity, smoking, and depressive symptoms are important targets for prevention
12	Transitions Between Frailty States Among Community-	795	The paper discusses a prospective study on transitions between frailty states among community-	Frailty among older persons is a dynamic process with frequent transitions between frailty states.

	Living Older Persons		living older persons. It found that frailty is a dynamic process with frequent transitions between frailty states over time.	There is ample opportunity for prevention and remediation of frailty.
13	Frailty Assessment In The Cardiovascular Care Of Older Adults	777	The paper discusses the role of frailty in patients with cardiovascular disease, but it does not specifically address the assessment of frailty in the cardiovascular care of older adults.	Frailty assessment can help refine estimates of cardiovascular risk in elderly patients. Frailty is associated with an increased risk of mortality in patients with cardiovascular disease
14	The Iana Task Force On Frailty Assessment Of Older People In Clinical Practice	752	The paper is about a comprehensive review of definitions and assessment tools on frailty in clinical practice and research. It aims to obtain a consensual definition and assessment tools of frailty.	Frailty should be considered as a pre-disability state. Disability should be excluded from frailty definitions and assessment tools
15	Prevalence And 10-Year Outcomes Of Frailty In Older Adults In Relation To Deficit Accumulation	739	The paper discusses the prevalence of frailty in older adults and its relationship with 10-year survival outcomes. It found that frailty increases with age and reduces survival.	Frailty increases with age and reduces survival. Frailty Index identifies frail individuals at risk of death.
16	Comparison Of 2 Frailty Indexes For Prediction Of Falls, Disability, Fractures, And Death In Older Women	729	The simple SOF index and the more complex CHS index performed similarly in predicting the risk of falls, disability, fractures, and death in older women.	The simple SOF index can be used to identify frailty in older women in clinical practice. The SOF index predicts risk of falls, disability, fracture, and death as well as the more complex CHS index.
17	Development And Validation Of A Hospital Frailty Risk Score Focusing On Older People In Acute Care Settings Using Electronic Hospital Records: An Observational Study	713	A three-step approach was used to develop and validate a Hospital Frailty Risk Score from International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10) diagnostic codes.	The Hospital Frailty Risk Score provides hospitals and health systems with a low-cost, systematic way to screen for frailty and identify a group of patients who are at greater risk of adverse outcomes and for whom a frailty-attuned approach might be useful.

18	Physical Activity In Older Age: Perspectives For Healthy Ageing And Frailty	688	Regular physical activity is safe for both healthy and frail older people and can decrease the risks of developing various diseases and conditions. However, participation in physical activities remains low among older adults, especially those in less affluent areas. The paper discusses the physiological rationale for physical activity and suggests strategies to encourage older people to increase their activity levels.	Regular physical activity is safe and beneficial for both healthy and frail older people. Encouraging exercise participation requires influence from clinicians, family, and friends
19	A Brief Clinical Instrument To Classify Frailty In Elderly People	679	N/A	N/A
20	Prevalence Of Frailty In Middle-Aged And Older Community-Dwelling Europeans Living In 10 Countries	677	The paper provides information on the prevalence of frailty in community-dwelling middle-aged and older Europeans living in 10 countries.	The study provides estimates of frailty prevalence in middle-aged and older Europeans. The study highlights between-country differences in the distribution of frailty.

Top 20 sources

Table 2 presents bibliometric indicators for key journals in the field of geriatrics, offering insights into their scholarly impact and influence. These metrics, including Citescore 2022, SJR 2022, and SNIP 2022, are crucial for assessing the academic standing and reach of these journals.

The "Journal of the American Geriatrics Society," published by Wiley-Blackwell, leads the list with 16 total publications. With a Citescore of 10.4, SJR of 2.054, and SNIP of 2.072, it demonstrates a robust scholarly impact, making it a prominent source in the field. Oxford University Press follows closely with the "Journals of Gerontology - Series A Biological Sciences and Medical Sciences," showcasing a Citescore of 9.9, SJR of 1.703, and SNIP of 1.522.

The "Journal Of The American Medical Directors Association," published by Elsevier, also stands out with a Citescore of 9.6, SJR of 1.794, and SNIP of 1.970, reinforcing its significance in the academic landscape. "AGE AND AGEING" from Oxford University Press, with a Citescore of 11.8, SJR of 1.738, and SNIP of 2.618, is another notable journal contributing to the scholarly discourse in geriatrics.

Furthermore, the multidisciplinary "Lancet" by Elsevier, renowned for its wide-ranging impact, displays remarkable metrics with a Citescore of 33.2, SJR of 14.607, and SNIP of 25.787. This underscores its interdisciplinary approach and influence beyond the field of geriatrics.

Several journals from Springer Nature, such as "BMC Geriatrics," "Biogerontology," "BMC Medicine," and "Intensive Care Medicine," contribute significantly to the scholarly landscape with varying Citescores, SJRs, and SNIPs. These journals reflect the diverse facets and interdisciplinary nature of geriatrics research.

The table 2 also includes other prestigious journals like the "Journal Of Nutrition Health & Aging," "Journal Of The American College Of Cardiology," and "PLOS One," each providing valuable contributions to geriatrics research with their distinctive metrics.

Table 2. Top 20 Leading Sources

Ranks	Source Title	TP	Publisher	Citescore 2022	SJR 2022	SNIP 2022
1	Journal Of the American Geriatrics Society	16	Wiley-Blackwell	10.4	2.054	2.072
2	Journals Of Gerontology - Series A Biological Sciences and Medical Sciences	13	Oxford University Press	9.9	1.703	1.522
3	Journal Of the American Medical Directors Association	5	Elsevier	9.6	1.794	1.970
4	Age And Ageing	4	Oxford University Press	11.8	1.738	2.618
5	Polish Archives of Internal Medicine	4	Medycyna Praktyczna	4.4	0.512	0.662
6	BMC Geriatrics	4	Springer Nature	5.1	1.127	1.546
7	Ageing Research Reviews	3	Elsevier	17.5	3.007	2.673
8	Lancet	3	Elsevier	33.2	14.607	25.787
9	American Journal of Medicine	2	Elsevier	5.7	0.991	1.050
10	Biogerontology	2	Springer Nature	8.3	0.907	0.969
11	BMC Medicine	2	Springer Nature	14.2	3.447	3.011
12	Clinics In Geriatric Medicine	2	Elsevier	6.3	0.954	1.359
13	Intensive Care Medicine	2	Springer Nature	34.5	6.229	5.381
14	Journal Of Nutrition Health & Aging	2	Springer Nature	8.0	1.269	1.410
15	Journal Of the American College of Cardiology	2	Elsevier	40.8	8.343	6.424
16	PLOS One	2	Public Library of Science	6.0	0.885	1.253
17	Annual Review of Medicine	1	Annual Reviews Inc.	26.2	4.233	3.155
18	Canadian Medical Association Journal	1	Canadian Medical Association	7.3	1.716	1.802
19	Circulation-Cardiovascular Quality and Outcomes	1	Wolters Kluwer Health	8.5	2.538	1.921
20	Journals Of Gerontology Series B-Psychological Sciences and Social Sciences	1	Gerontological Society of America	9.4	2.311	2.163

4. Discussion

This bibliometric analysis offers important insights into the evolving landscape of frailty research over the past three decades (Azizan et al., 2023). Our findings demonstrate a

steady rise in frailty-related publications since the mid-1990s, reflecting the growing recognition of frailty as a pressing health issue (Morley et al., 2013). However, the decline in publications in recent years raises questions about whether frailty research has reached a plateau or if emerging areas of focus could reinvigorate investigations (Marinus et al., 2021).

The prominence of high-income Western nations like the United States, Canada, and several European countries underscores their pioneering role in frailty research. This is likely attributable to their early prioritization and investment in geriatrics and aging research (Gu et al., 2019). However, the relatively modest contribution from Asian countries with rapidly growing elderly populations highlights an urgent need to accelerate frailty studies in these regions (Pradana et al., 2023). Greater attention to frailty in diverse geographical and socioeconomic contexts could provide valuable insights into health inequities and tailored interventions (Ma & Chan, 2020).

While established institutions in North America and Europe have spearheaded frailty research, our analysis reveals opportunities for emerging research centers to make seminal contributions, especially in under-studied regions like South America, Africa, and South Asia (Ghamgosar et al., 2021). Fostering international and interdisciplinary collaborations will be key to amplifying frailty research across borders and disciplines (Hui et al., 2022). International collaboration is a key factor in expanding frailty research. A prime example is the Global Frailty Network, which brings together researchers across countries to share data and develop global guidelines for understanding and managing frailty. In addition, the Asian Working Group for Sarcopenia and Frailty Research has played a key role in developing evidence-based recommendations tailored to the needs of Asian populations. Similar initiatives at the national level, such as the Frailty Prevention Program in Japan, have also inspired adaptations in other countries (Danquah et al., 2024).

The lack of recent publications among the most cited frailty papers suggests the need to review the existing literature and integrate previous findings with new methodologies. Future research should focus on developing strategies that can be applied across populations, including community-based approaches to frailty prevention (Qi & Li, 2022). The use of modern technologies, such as artificial intelligence (AI) for frailty risk prediction, as well as digital health applications for individual monitoring, offers great potential to improve the effectiveness of interventions.

Our findings highlight the interdisciplinary nature of frailty research spanning medicine, nursing, gerontology, pharmacology, and public health (Setiati et al., 2021). This underscores the need for integrated knowledge exchange and translational efforts across specialties to advance the prevention and management of frailty (Durepos et al., 2022). Policymakers and health systems should also prioritize resource allocation for community-based interventions that empower older adults to remain independent and have a good quality of life (Austrom, 2017).

While this analysis focuses on the 100 most influential publications, it underscores the importance of ongoing mapping of emerging knowledge domains and priorities in frailty research (Meredith et al., 2023). The study also elucidates foci and gaps to orient future investigations on this critical topic. Sustained efforts to map knowledge domains and emerging research priorities will further enrich the discourse on frailty and inform impactful interventions (De Labra et al., 2015).

5. Conclusion

This bibliometric analysis of the 100 most cited publications provides valuable insights into the development of frailty research over the past three decades. Key findings show a

steady increase in frailty-related publications since the mid-1990s, reflecting the growing global priority given to this health issue. However, the decline in publications in recent years raises important questions about future research directions and emerging priorities. The analysis also highlights the pioneering contributions of high-income Western countries and emphasizes the need to accelerate frailty research in regions such as Asia that are experiencing rapid population ageing, requiring tailored health interventions and strategies.

Frailty research is multidisciplinary, spanning fields such as medicine, nursing, public health, and gerontology. This suggests the need to build collaborative networks and exchange knowledge across disciplines and geographical boundaries to address ongoing knowledge gaps. The lack of recent publications among the most cited papers underscores the need to synthesize previous research and focus on emerging areas. Certain gaps, such as the limited exploration of frailty in low- and middle-income countries, require urgent attention. Addressing these gaps can guide the development of more equitable and context-specific approaches to frailty prevention and management.

For future research, studies targeting specific regions such as Asia, Africa, and South America are needed to accommodate cultural, social, and economic diversity in frailty-related outcomes. In addition, underexplored areas such as nutrition, polypharmacy, sarcopenia, and technology-based interventions, including artificial intelligence and digital health tools, need to be a major focus. Longitudinal studies evaluating the development of frailty and the long-term effectiveness of interventions should also be prioritized. Collaborative efforts such as those by the Global Frailty Network and the Asian Working Group for Sarcopenia and Frailty Research can be expanded to support cross-regional exchange of data, resources, and expertise.

Implications of this study for practice include the urgent need for health systems to adopt validated frailty assessment tools and develop region-specific strategies for early detection and management of frailty. Policymakers should also ensure adequate resource allocation in line with frailty research priorities to maximize impact at the population level. By highlighting the 100 most influential publications and using robust indicators such as Citescore, SJR, and SNIP, this analysis provides a comprehensive roadmap for researchers, clinicians, and policymakers to navigate the evolving field of frailty research. It provides a strategic basis for advancing patient-centered, evidence-based practice and high-impact collaborative research. Addressing the identified gaps and leveraging interdisciplinary approaches will be crucial in designing effective, inclusive, and sustainable solutions to this pressing global health challenge.

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