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Exploring Fall Risk Factors and Prevention Strategies for Older Adults: A Comprehensive Bibliometric Analysis of Home Environment Assessments

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Abstract

With the growth of the older population, there is a global consensus to actively address the issue of ageing and to promote coordinated economic and social development. Life safety is crucial for the elderly, and falls are a major health problem worldwide. The development of intelligent systems or products to prevent falls in the elderly can reduce the risk of falls and avoid the physical and mental injuries and huge economic costs that falls bring to the elderly. Therefore, experts and scholars from all walks of life have paid more attention to the research on the topic of preventing falls in the elderly. In this paper, a bibliometric analysis of all published scopus database and science direct database on fall risk and prevention in home environment from 1991 to 2024 was conducted. The current status of research in fall risk and prevention in home environment is further discussed. The bibliometric analysis during the study period revealed annual scientific publications, average citations, locally cited literature, most relevant sources, country of corresponding author, national scientific production and national collaborations world map. The ten most cited articles are described in detail in the qualitative analysis section of the paper.

Keyword: Fall, Fall risk factors, Prevention strategies, home environment Bibliometric Methods

Introduction

Falls are a common and serious health problem faced by the global population [1,2], with falls contributing to an estimated 646,000 deaths per year globally [3], with older adults being the most predominant population. Falls pose a significant threat to the physical and mental health of older adults, and because many older adults who fall fear falling again, they may voluntarily reduce their outdoor activities, which has a negative impact on health-related quality of life [4]. However, accurate detection and timely intervention in cases of unintentional falls can mitigate the risk of death and injury [5]. Therefore, many previous studies have focused on finding the risk factors that influence falls in older adults, and then preventing and ameliorating the risk factors so as to reduce the probability of older adults experiencing falls in their daily lives.

The location of falls in older adults is also of interest. Studies have shown that the probability of experiencing a fall is higher in the home compared to the community [3], which may be due to the fact that people are more aware of the fall risk factors that exist in the community and

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already have a sense of anticipation and precaution, which allows them to focus on avoiding these factors and proactively avoiding falls. At home, however, people's "risk awareness" of fall risk factors is limited due to their familiarity with the home environment. Therefore, by reviewing and analyzing the literature related to fall risk and prevention in the home environment over the past 30 years, this study hopes to gain a clearer understanding of the sub-themes and future trends related to research.

Bibliometric can be used as an analytical method to measure the progress of the discipline and it facilitates a detailed analysis of the relevant literature [6,7]. In order to evaluate research, some other indicators are needed. In numerous cases, citation analysis and peer review have ensured better judgment [8,9]. Nowadays, a number of tools clearly make it easier to produce bibliometric reports [10]. This range includes databases from Scopus, Web of Science, ScienceDirect, and Google Scholar, which have added merged citation handling features the data used in bibliometric analysis are very diverse

[11-14]. In this paper, literature from the Scopus and Sciencedirect databases was chosen as the data source for the econometric analysis. The Scopus database was chosen because it brings together the features of Wos and PubMed and provides a broader and more accurate analysis of the data than PubMed or Google scholar [15,16]. Science Direct, a website that contains high-quality research databases from around the globe [17], also publishes a number of articles related to fall risk and prevention in home environment related published articles.

Methodology

This article conducts a topic search on "home environment" and "fall prevention or risk". The main two databases used for collecting academic publication data were Scopus and Science Direct. To ensure completeness in the number of documents and the feasibility of literature analysis, the decision was made to merge documents from the two databases, resulting in a total of 203 documents. Figure 1 illustrates that the number of publications on "home environment" and "fall prevention or risk" from 1991 to 2024 generally exhibits an upward trend. Despite fluctuations, the number of citations for relevant documents increases sharply each year. Indicating a gradual increase in attention and importance in this research field.



Documents by year

Figure 1: (Left) Published Trends in the Field of Fall Risk and Prevention in the Home Environment Research 1991 – 2024.



Figure 2: (Right) the Prisma Flow Diagram for the Bibliometric Analysis on Fall Risk and Prevention in the Home Environment.

The data collection procedure is illustrated in Figure 2, depicting the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow chart. Subsequently, data analysis was performed on these 178 documents. Data analysis was carried out using the BiBliometrix package (http://www.bibliometrix.org/), an R tool for comprehensive science mapping analysis.

Table 1 summarizes key information derived from the collected bibliometric data. The dataset comprises 130 articles, 19 conference papers, and 28 reviews. To comprehend the latest subtopics in the field offall risk and prevention in home environment, we selected the 10 most frequently cited documents from the pool of 130 articles for qualitative analysis. Subsequent sections present both quantitative and qualitative scenarios.

| Description | Results |
|--------------------------------|-----------|
| MAIN INFORMATION ABOUT DATA | |
| Timespan | 1991:2024 |
| Sources (Journals, Books, etc) | 134 |
| Documents | 178 |
| Annual Growth Rate % | 2.12 |
| Document Average Age | 10.2 |
| Average citations per doc | 34.35 |
| DOCUMENT TYPES | |
| article | 130 |
| article article | 1 |
| conference paper | 19 |
| review | 28 |

Table 1: Summary of the Main Information of Collected Bibliometric Data.

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Quantitative Analysis

Analysis of Year of Publication

Figure 3 illustrates the annual scientific output of articles on fall risk and prevention in the home environment, spanning from 1991 to January 28, 2024. Over this period, a total of 178 scientific papers were published, reflecting a continuous annual increase in the number of publications. The number of publications increased from one article in 1991 to 13 articles in 2023. Two distinct phases have characterized the past 30 years. The period from 1991 to 2011 witnessed a rapid increase in publications focusing on fall risk and prevention in the home environment, indicating a growing scholarly interest in this field. From 2012 to 2023, the annual number of publications generally remained above 10, with notable peaks in 2011 and 2019 when the number reached 15. Despite fluctuations, such as the drop in publications from 13 in 2014 to 5 in 2015, the overall trend indicates a yearly increase since 2020.

Figure 4 depicts the average annual number of citations for articles from 1991 to 2024. In 1997, the average number of citations for a publication was 4.86, and with only one paper published, it signifies the paper's significant representation in the field of fall risk and prevention in the home environment. In 2011, the average citation rate was 11.27, marking the highest year and coinciding with the year of the largest number of publications.

Figure 5 clearly displays the top 10 articles with the highest global citations during the period from 1991 to 2024. The figure illustrates that the top three globally cited articles are from 2011, 2013, and 2006, with 1,368, 221, and 207 citations, respectively.



Figure 3: Annual Scientific Output Forfall Risk and Prevention in the Home Environment Research, 1991-2024.



Figure 4: Average Number of Citations Per Year of Articles Used in the Field of Fall Risk and Prevention in the Home Environment Research, 1991-2024.



Figure 5: Top 10 Most Local Cited Documents Published on Fall Risk and Prevention in the Home Environment Research Field.

Analysis of the Authors

Figure 6 presents the output of the top 10 most relevant authors in the field of fall risk and prevention in the home environment from 1991 to 2024. The red line depicts each author's timeline. For instance, SHERRINGTON C authored 4 articles in the field of fall risk and prevention in the home environment from 1997 to 2022, establishing the longest timeline among the authors. The size of each bubble corresponds to the number of documents published in a given year. For instance, MACKENZIE L published 2 papers in 2002 and 2009. Additionally, the intensity of the bubble color corresponds to the total number of citations per year. For instance, the citation rate of papers authored by SKUBIC M is higher than that of other authors. The figure reveals an increase in both the number of publications and citation rates of articles on fall risk and prevention in the home environment, particularly after 2011. This significant rise indicates a growing interest among researchers in this field, prompting more research endeavors.



Figure 6: Top 10 Most Relevant Author's Production on Fall Risk and Prevention in the Home Environment Research Field From 1997 to 2023 (Red Line: The Author's Timeline, Bubble Size: The Number of Publications, Bobble Color Intensity: Total Citations Per Yea.

Source Analysis

Figure 7 discloses the top 10 publisher sources most relevant to fall risk and prevention in the home environment. Each source has 2 or more papers related to the field of fall risk and

prevention in the home environment. Foremost, INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH and JOURNAL OF THE AMERICAN GERIATRICS SOCIETY stand out as the primary journals in this field, each publishing 6 papers between 1991 and 2024. Additionally, the journal DISABILITY AND REHABILITATION holds the second position with 5 related articles. Furthermore, the journal CLINICS IN GERIATRIC MEDICINE has included 4 articles. Therefore, when preparing to submit a paper, the top four journals in the chart are crucial for researchers studying fall risk and prevention in the home environment.

Figure 8 illustrates the trend in the number of publications among the top 8 publications from 1991 to 2024. CLINICS IN GERIATRIC MEDICINE is the earliest journal to publish articles in this field, and it has exhibited a continuous increase over the past 30 years. Despite the INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH appearing only in 2018, its annual publication count has grown rapidly, and it is projected to surpass both the CLINICS IN GERIATRIC MEDICINE and the DISABILITY AND REHABILITATION journals in 2023, establishing itself as the leading source journal in this field.







Figure 8: Annual Incidence of the Top 8 most Relevant Sources in Fall Risk and Prevention in the Home Environment from 1994 to 2023.

Analysis of the State

A total of 178 papers were published in the field of fall risk and prevention in the home environment, distributed across 37 countries. In Figure 9, the top 20 countries are ranked based on their scientific output. The red line indicates the publication rate in the corresponding author's

country, incorporating one or more foreign partners. The blue line in the figure represents the number of articles published within the same country. These publications are referred to as Multinational Publications (MCP) and Single Country Publications (SCP). The figure distinctly illustrates that the USA (29), AUSTRALIA (16), and the UK (11) are the top three most relevant countries in the field of fall risk and prevention in the home environment. AUSTRALIA and the UK are engaged in the largest number of international collaborations to date.

Figure 10 provides a comprehensive view of the number of documents affiliated with the publishing country. Figure 11 depicts the number of joint documents published by the leading countries in the field of fall risk and prevention in home environment research. In both plots, the shade of blue corresponds to the number of publications per country. Each shade of blue represents the number of documents, ranging from dark blue with 130 articles published by the USA to only 1 article by MEXICO, which represents the lightest color. Observing the color depth, it is evident that the USA is the central research country in the field of fall risk and prevention in the home environment, followed by CANADA as the second most productive country.

In Figure 11, the thickness of the red line corresponds to the number of joint publications between each country. The thicker the red line, the greater the collaboration between the countries at both ends of the line. From the thick red line representing 3 times of cooperation between AUSTRALIA and AUSTRIA to the thin red line indicating one cooperation between AUSTRALIA and MEXICO. In general, the UK has established close scientific research cooperation relationships with numerous other countries.



N. of Documents





Figure 10: Country's Scientific Production World Map of Fall Risk and Prevention in the Home Environment Research Field (Blue Color Intensity: the Number of Authors Affiliated with Each Country, Gray Color: Non-related Country).



Figure 11: Country Collaboration World Map of Fall Risk and Prevention in the Home Environment Research Field (Blue Color Intensity: The Number of Documents with Each Country, Gray Color: Non-related Country, Red Line Thickness: The Number of Joint Publications).

Subject Analysis

To analyze the primary topics of publications related to fall risk and prevention in the home environment, a keyword network was employed. Keyword networks depict co-occurrences in bibliographic datasets. Clustering keyword networks enables the highlighting of diverse themes. Each keyword is assigned to a unique topic. A topic map is a specific diagram representing each identified topic. Figure 12 displays the topics in the topic map, concentrating on the field of fall risk and prevention in the home environment. Each bubble represents a keyword network cluster. The cluster name is the word with the highest frequency of occurrence. Hence, human, fall risk, exercise, algorithm, vitamin D, information technology, health risks, newborn, intelligent building, and fall detection are the most relevant thematic indicators.

The size of the bubble is proportional to the number of occurrences of the cluster word, and its position is determined by the centrality and density of the cluster. Centrality and density indicate the importance and completeness of topics in the field of interior design research, respectively. Consequently, highly developed and isolated themes are in the upper left corner, maneuverable themes are in the upper right corner, emerging or declining themes are in the lower left corner, and dominant and transversal themes are in the lower right corner of the theme map. For instance, the keywords intelligent building, newborn, and fall detection serve as representatives of the four clusters. These terms appear infrequently and are situated in emerging or declining topic areas, indicating that these topics have not garnered much attention. Conversely, vitamin D, algorithm, and exercise keywords serve as three cluster representatives, positioned in the maneuvering quadrant. This implies that these topics have matured in the field of fall risk and prevention in the home environment and are integral to the structure of the research field [18]. The Information technology keyword topic holds the utmost importance and has the highest centrality, while human and fall risk are the most frequently occurring keyword topics.



Figure 12: Thematic Map of Keywords Network Clusters in Fall Risk and Prevention in the Home Environment Research Field (Bubble Size: The Clusters Word Occurrence).

Keyword Analysis

Figures 13 and 14 present graphs of three fields that concentrate on the most important keywords. Figure 13 displays the selection of three primary metadata fields. The middle field represents keywords, the left field represents the source, and the right field represents the author. It illustrates the relationship between the most frequent keywords, the most renowned authors, and the most relevant sources. As depicted in Figure 13, Mackenzie L and Lord Sr employed the majority of the keywords in their publications. The keywords Accidental falls, older adults, falls, fall prevention, and elderly are the most frequently used terms in articles, by authors, and in journals. The sources include CLINICS IN GERIATRIC MEDICINE and INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH, both of which are prominent journals publishing on fall risk and prevention in the home environment.

Figure 14 was generated by selecting the remaining three metadata fields. The middle field represents keywords, the left field represents journals, and the right field represents authors. The figure illustrates the relationship between top keywords plus, top authors, and top journals. A keyword plus is a term or phrase that frequently appears in a title citation and is automatically generated by a computer. Analyzing keywords and prevalent research topics that represent the research field of fall risk and prevention in the home environment will assist readers in discovering the latest research. Figure 14 illustrates that the keyword plus reveals the research objects that researchers most commonly select, such as aged, human, female, male, etc. Additionally, there are research themes such as risk assessment, accidental falls, risk factor, and accident prevention. The keywords plus "risk factor" and "home environment" exhibit higher acceptance in the figure because most of the top authors have employed them in their articles, and nearly 70% of publishers utilize them. Journals such as "International Journal of Environmental Research and Public Health," "Australian Occupational Therapy Journal," "Clinics in Geriatric Medicine," and "American Family Physician" have all published articles on the keywords "risk factor," "accident prevention," and "home environment." These journals can be ideal choices as top journals in the field of fall risk and prevention in home environment research.

Figure 15 unveils the relationship between keywords appearing in all publications through the design concept structure diagram. The two points in the figure represent the average position of the documents associated with each keyword, and the center point in the figure represents the core of fall risk and prevention in the home environment. In a conceptual structure, the terms from each document are interconnected in a network. This co-word network structure aids readers in comprehending the topics within the research field and exploring the frontiers of research. Data reduction techniques (factor analysis) enable the identification of subdomains, distinct from network analysis. Correspondence analysis (CA) serves as a dimensionality reduction technique in the generation process of concept formation diagrams.

As illustrated in Figure 15, each color represents a cluster of known words. Thus, these keywords are categorized into two groups. The blue cluster comprises only one keyword: review. On the other hand, the red cluster unmistakably indicates that it includes significantly more keywords than the blue cluster, totaling 49 keywords. Risk assessment and exercise, risk factor and body equilibrium, risk reduction, and aging are all closely positioned.

Figure 16 presents an alternative conceptual diagram of the keyword titled "Topic Treemap This figure encompasses the same information as Figure 15 but provides a different perspective. Typically, this conceptual framework tree displays two sets of keywords. The height is determined by the distance between words or phrases. Each dendrogram illustrates a partition and positions it correctly. The farther apart the words are, the less likely they are to co-occur in the same article.



Figure 13: Three-field Plot for the Relationship Among Top Keywords (the Middle Field), Top Authors (the Right Field), Top Sources (the Left Field) in Fall Risk and Prevention in the Home Environment Publications.



Figure 14: Three-field Plot for the Relationship Among Top Keywords Plus (the Middle Field), Top Authors (the Right Field), Top Sources (the Left Field) in Fall Risk and Prevention in the Home Environment Publications.

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Figure 15: Conceptual Structure Map of Keywords in Fall Risk and Prevention in the Home Environment Publications (Dim.1 and Dim.2: the Average Position of the Articles Included in Each Keywords.



Figure 16: Conceptual Structure Topic Dendrogram of Keywords in Fall Risk and Prevention in the Home Environment (Height: The Distance Among Clusters of Words).

Readers must quickly grasp the most representative vocabulary in the research field. In Figures 17, 18, 19, and 20, keyword plus, author keywords, title keywords, and abstract words are presented at the top of these sections. Keywords and words contribute depth to the article's content. Author keywords represent a list derived from the author's subjective perspective and are based on the article's content. While in bibliometric analysis, keyword plus author keywords are equally effective in exploring content related to learning or culture, keyword plus provides a more comprehensive overview.

Figure 17 illustrates the evolution of keywords related to fall risk and prevention in the home environment from 1991 to January 28, 2024. The font size and various colors of the keywords in the image signify their respective importance levels. Keywords presented in Figure 17 occur between 218 and 7 times. Terms such as aged, human, falling, risk assessment, home environment, and accidental falls are represent key keywords in this research field. Figure 18 presents author keywords, appearing from 27 to 2 times, predominantly encompassing falls, fall prevention, accidental falls, and older adults. Figure 19 highlights the most relevant

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keywords in the title, such as falls, home, risk, prevention, etc. Figure 20 displays the words prevalent in the abstract, with frequent occurrences of terms such as falls, home, risk, study, prevention, assessment, and participants. These frequently occurring abstract words are commonly found in publications related to fall risk and prevention in the home environment. In summary, it is surprising that the keywords in authors' names, titles, or abstracts exhibit remarkably similar patterns. Therefore, when writing, one should focus on incorporating more relevant words in the title, abstract, or within the publication.

Figure 21 illustrates the frequency of top keywords related to fall risk and prevention in the home environment from 1991 to January 28, 2024. The research topic of aged has been rapidly growing since 1991, reaching 218 occurrences in 2023. The frequency of research on keywords such as risk assessment, home environment, and accidental falls has steadily increased since 2011. It is anticipated that additional research on these topics will be conducted in the field of fall risk and prevention in the home environment.



Figure 17: Top Keywords Plus in Fall Risk and Prevention in the Home Environment Publications (Font Size: Word Occurrences).



Figure 18: Word of Top Author's Keywords in Fall Risk and Prevention in the Home Environment Publications (Font Size: Word Occurrences).



Figure 19: Top Title Words Infall Risk and Prevention in the Home Environment Publications (Font Size: Word Occurrences).



Figure 20: Top Abstract Words in Fall Risk and Prevention in the Home Environment Publications (Font Size: Word Occurrences).



Figure 21: Annual Occurrences of Top Keywords in Fall Risk and Prevention in the Home Environment Research Field Within 1991 to 2024 Period.

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Qualitative Analysis

Between 1991 and January 2024, 178 papers were published in the literature related to fall risk and prevention in the home environment. Of these ARTICLES, 130 were published, and in this section, the ten most highly cited articles are qualitatively analyzed.

These ten most highly indexed papers cover multiple aspects of falls in older adults, including prevention, detection, monitoring, and intervention, and provide insight into a comprehensive understanding of the problem. These studies share a focus on multifactorial approaches, objective assessment, the importance of family interventions, and the perception of fall history as a predictor. However, challenges facing the field include methodological limitations, the complexity of factor interactions, and the need for contextualized interventions. Among these, studies by Helen et al. (2014) and Stone and Skubic (2011) emphasized the potential of technology in preventing and monitoring falls. Nancy et al. (2007) and Lisa et al. (2011), drawing from an analysis of falls and outcomes among older women in the community and among older adults discharged from the hospital after a stroke, emphasized the importance of understanding the specific context and events of falls for developing targeted interventions. Dan et al. (1998), on the other hand, proposed a falls risk model through a study of nursing home residents and emphasized the importance of a history of falls. And in a study of falls in home residents, Hausdorff et al. (2013) used triaxial accelerometers for objective gait assessment to gain insight into fall risk.Sherrington & Lord's (1997) paper focuses on the effectiveness of a home weightbearing exercise program for individuals following a hip fracture, demonstrating the role of home interventions in building lower extremity strength and reducing fall risk potential in terms of lower extremity strength and reducing the risk of falls. In addition, environmental factors and home modifications have emerged as important research components in fall prevention, with several scholars' papers exploring home environmental risk factors that contribute to falls and the efficacy of home modifications (Lord et al., 2006; Helen et al., 2014; Stone & Skubic, 2011). These studies emphasize the interplay between environmental stressors and physical abilities and recommend targeted interventions for individuals with a history of falls and activity limitations. Ultimately, these studies collectively recommend recommendations centered around increasing awareness of falls, tailoring interventions to specific situations, and utilizing technology for ongoing assessment. The motivation for these recommendations centers around maintaining independence, understanding fall risk, and developing effective prevention strategies for specific populations. Overall, these papers provide an in-depth, multifaceted perspective on falls in older adults, offering important insights into technological advances, environmental considerations, and the development of individualized interventions. Together, the variety of approaches and findings emphasize the complexity of the challenges associated with falls and the critical importance of adopting a customized, evidence-based approach to improving the well-being and safety of older adults.

Conclusion

This paper presents an econometric analysis of the research literature on FALL RISK AND PREVENTION IN HOME ENVIRONMENT from 1991 to 2024 using the Scopus database and the science direct database. The results show that fall risk and prevention in the home environment is making progress in recent years. Due to the turning point in 2011, annual publications on fall risk and prevention in the home environment continue to increase. Researchers from USA, AUSTRALIA, and UK contributed the most to publications.

INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH and JOURNAL OF THE AMERICAN GERIATRICS SOCIETY were identified as the most relevant journals for FALL RISK AND PREVENTION IN THE HOME ENVIRONMENT.

The motorized and basic themes in our bibliography are representative of keywords such as vitamin d, algorithm, exercise, and information technology. in recent years, keywords such as aged, risk assessment, home environment, and accidental falls have become more visible. falls are keywords with increasing visibility. Additionally, qualitative analyses indicated that prevention of falls in older adults, fall detection, monitoring, and intervention were listed as the most frequently cited research themes in the field of FALL RISK AND PREVENTION IN HOME ENVIRONMENT RESEARCH. It is hoped that the results of this work will provide a better vision of future research directions.

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