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EVOLUTION OF RESEARCH HOTSPOTS AND EMERGING FRONTIERS IN OLDER ADULT FALLS: A BIBLIOMETRIC AND VISUALIZATION ANALYSIS

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Abstract: CiteSpace and VOSviewer software were used to visually analyze the literature related to falls in the elderly from 2015 to 2025, so as to clarify the research hotspots and evolution trends, and provide support for subsequent research. The core databases of CNKI, Wanfang and WOS were searched, 887 valid Chinese literatures and 141 English literatures were screened, and the analysis was carried out from multiple dimensions by software. A total of 887 Chinese and 141 English articles were included. It was found that the distribution of journals reflected the characteristics of integration of sports and medicine, but the density of cross-agency cooperation was insufficient. This field mainly focuses on the two major themes of physiological factors of falls and exercise intervention in the elderly. And the research in this field has shown a phased development trend. The integration of sports and medicine is the core trend. There are deficiencies in current research. In the future, it is necessary to strengthen collaborative research, build an active fall prevention system, and promote the transformation of fall prevention and control to source governance.
Keywords: Elderly people falling down; CiteSpace; VOSviewer; Visualized analysis

1 INTRODUCTION

China's population is ageing at an increasingly rapid rate; the Seventh National Population Census of 2020 revealed that the proportion of the population aged 60 and over had reached 18.7 per cent [1]. The ongoing progression of population ageing has led to a gradual decline in physical function and immune function amongst the elderly, as well as a high incidence of health issues such as chronic underlying conditions [2], These physiological changes directly result in a continuous weakening of the elderly's motor coordination, balance and muscle strength, which have become the core physiological factors contributing to falls. In China, the annual fall rate among people aged 60 and over is approximately 20 per cent; in 2021, the number of people affected by falls reached 53.4 million, and the fall rate shows a significant upward trend with increasing age [3]. Furthermore, falls among older adults have multiple consequences. They can result in physical injuries such as sprains and fractures, and in severe cases, even death [4-6]. They can also lead to a fear of falling and increase the financial burden on family carers and the social healthcare system [7-8].

Given the multiple harms that falls cause to older adults, their families and society, exercise intervention—as a key means of preventing and managing falls in older adults—has become a major area of research in the field of health promotion for older adults. Studies have indicated that core strength training can effectively improve dynamic and static balance in older adults, thereby preventing falls [9]; whole-body vibration training can serve as an effective intervention for preventing falls by improving balance and the strength of relevant muscle groups in older adults [10]; Cognitive Behavioural Therapy (CBT) can enhance balance in older adults, with interventions lasting three months or longer showing significant effects in reducing their fear of falling [11]. In addition to the above-mentioned single intervention methods, dual-task intervention, as an emerging research direction in the field of fall prevention and control for the elderly, its application value in improving the functions of the elderly and reducing the risk of falls has also attracted wide attention from the academic community. Scholars at home and abroad will carry out the dual-task paradigm of posture control and cognitive tasks at the same time, which will be applied to the fields of elderly fall prevention and treatment training and fall injury rehabilitation, and have achieved good application results [12]. For example, double-task training can improve the muscle strength of the lower limbs, so as to prevent the elderly from falling [13]. In addition, the dual-task paradigm can also be used as a means of evaluation. The assessment found that the elderly women who have been trained in Tai Chi have stronger lower limb strength and less risk of falling [14]. In summary, single interventions such as core strength training, whole-body vibration training and cognitive behavioural therapy have all demonstrated good efficacy in the prevention and management of falls in older adults; however, the dual-task paradigm, which combines training intervention with risk assessment, offers a new approach to the scientific prevention and management of falls in older adults that is better suited to daily activities.

As an emerging literature metrology method in recent years, scientific knowledge atlas can not only reveal the origin and historical development laws of knowledge, but also present the knowledge structure relationship and evolution vein of related fields in a graphical way [15]. Citespace has the dual attributes of graph and spectrum. It is a visual knowledge graphic and a serialized knowledge genealogy [16]. VOSviewer is supported by the principle of co-citation and co-citation of literature as the core, and can complete the construction and visualization of the literature measurement atlas [17]. Among them, Citespace's institutional cooperation analysis can help researchers understand the

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development status and cooperation pattern of research institutions in this field, accurately grasp the development direction of institutional cooperation, and thus provide strong support for in-depth research in this field [18]. Its keyword emergent analysis can identify research frontiers and academic hotspots, grasp the policy orientation of the field, and provide a key basis for research direction planning. It can also explore the driving role of policies on academic research and guide the implementation of focused research [19]. The keyword co-appearing network of VOSviewer can highly refine and summarize the core ideas and themes of the literature, reflecting the relevant research hotspots and development trends in this field [20]. The combination of the two can realize the complementarity of "quantitative statistics + visualization" and improve the comprehensiveness of the research results.

This study, through the retrieval and screening of literature on ‘falls in older adults’, systematically reviews the current status, hot topics and evolving trends in the field of research on falls in older adults from multiple dimensions, including the journals in which the papers were published, institutional contributions and keyword analysis. It identifies the main risk factors for falls in older adults and effective exercise intervention strategies, analyses the strengths and weaknesses of current research, and explores exercise intervention models more suited to older adults, thereby providing direction, methodology and theoretical support for in-depth research in this field.

2 MATERIALS AND METHODS

2.1 Literature Search Strategy and Selection Criteria

This study utilised two bibliometric tools: CitSpace and VOSviewer. For Chinese literature, the keyword ‘falls among older adults’ was used, with the search period set from January 2015 to December 2025 and no disciplinary restrictions applied. To ensure the reliability of the visualisation analysis results, core journals such as the Northern Core, CSCD and CSSCI were selected. Data sources for the literature included China National Knowledge Infrastructure (CNKI) and the Wanfang Database. The screening of Chinese literature adhered to the following criteria: (1) Exclusion of duplicate publications: publications were deemed duplicates if the ‘author + title + core research content’ matched exactly; priority was given to those published in core journals and more recently; (2) Exclusion of non-academic literature: This includes articles with missing or incomplete author information, conference proceedings unrelated to the topic of ‘falls among the elderly’, newspaper articles, policy guidelines and popular science articles; (3) Exclusion of low-quality literature: Articles lacking an abstract or keywords, those with unclear research methods, or those without substantive research data were excluded. Following rigorous screening, a total of 887 valid Chinese articles were ultimately identified.

English-language literature was retrieved via the WOS Core database, with the following inclusion criteria: subject terms set as ‘elderly people falls’, ‘older adults falls’ and ‘geriatric falls’; subject areas covering sports science, geriatrics, nursing, rehabilitation medicine and public health; language restricted to English; and document type restricted to research articles. A total of 141 valid English-language articles were ultimately included.

2.2 Data Processing Procedure

2.2.1 Literature processing

Chinese literature was managed uniformly using RefWorks software; literature data was exported in RefWorks format from the CNKI and Wanfang databases respectively. Following duplication checking, screening and data standardisation, the final dataset was exported in RefWorks-CiteSpace format. English literature was exported directly from the WOS database in ‘full-text’ format for subsequent analysis.

2.2.2 Data format standardisation

The data format standardisation process is as follows: (1) Standardisation of keywords: Chinese keywords were standardised in accordance with the Thesaurus of Chinese Subject Terms, whilst English keywords were standardised using the MeSH thesaurus; (2) Standardisation of institutional names: Different names for the same institution were merged; (3) Standardisation of file formats: All exported files were uniformly named in the format ‘download_.txt’ in accordance with CiteSpace software requirements, retaining core field information such as title, author, institution, keywords, abstract and year of publication, whilst removing duplicate fields and invalid characters [21].

2.3 Data Analysis Methods

Basic statistical analysis of the literature data was conducted using Excel spreadsheets, including institutional contribution, journal source distribution and keyword frequency; in-depth analysis was subsequently performed using visualisation tools. VOSviewer 1.6.20 software was used to construct a keyword co-occurrence network. The keyword extraction rules were as follows: core terms from the title, abstract and keyword fields of the literature were retained, whilst generic and meaningless vocabulary was excluded; the threshold for co-occurrence analysis was set at ‘frequency of occurrence ≥ 5 times’. CiteSpace 6.4.R1 software was utilised for analysis, with the following parameter settings: Time span: 2015–2025; slice length: 1 year [22]; the threshold for institutional collaboration network analysis was set to “Top N=50”; keyword clustering employed the LLR (Log-Likelihood Ratio) algorithm; and the threshold for emerging terms analysis was set to “Minimum Duration=2 years”.

3 RESULTS

3.1 Analysis of Publishing Journals

Based on statistics compiled using Excel, the top 10 journals by number of published articles in both Chinese and English are presented in Table 1. Statistics show that the 887 Chinese articles were published in 218 journals, among which the Chinese Journal of Gerontology, which ranks first in terms of publication, published 66 articles, accounting for 7.0%. Among the Top10 journals, the Chinese Journal of Gerontology, Nursing Research, Practical Geriatrics and other core journals account for a prominent proportion, indicating that the high-quality results of the fall research of the elderly are mostly concentrated in such authoritative academic platforms. The research of these journals mainly focuses on the causes of falls in the elderly, the current situation of falls in the elderly, and how to prevent falls in the elderly.
141 english articles are distributed in 33 journals, and the top 3 articals are GAIT & POSTURE (44 articles), JOURNAL OF AGING and PHYSICAL ACTIVITY (18 articles) and CLINICAL BIOMECHANICS (11 articles). The research topics of international journals focus on cutting-edge fields, including the mechanism of action between chronic diseases and falls in the elderly, the relationship between balance ability and falls in the elderly, and how to prevent falls in the elderly.

Table 1 Top 10 Chinese and English-Language Journals by Number of Publications

Journals publishing Chinese-language articles	Number of articles published	Percentage (%)	Journals in which English-language articles were published	Number of articles published	Proportion (%)
Chinese Journal of Gerontology	66	7	GAIT & POSTURE	44	31
Nursing Research	57	6	JOURNAL OF AGING AND PHYSICAL ACTIVITY	18	13
Practical Geriatrics	40	5	CLINICAL BIOMECHANICS	11	7
Journal of Nursing	40	5	ARCHIVES OF PHYSICAL MEDICINE AND REHABILITATION	10	7
Chinese Journal of Rehabilitation Medicine	35	4	HUMAN MOVEMENT SCIENCE	7	5
Chinese Genology Medicine	28	3	PM&R	6	4
Modern Preventive Medicine	24	3	RESEARCH IN SPORTS MEDICINE	5	4
Chinese Nursing Magazine	23	3	AMERICAN JOURNAL OF PHYSICAL MEDICINE & REHABILITATION	5	4
Chinese Journal of Rehabilitation Theory and Practice	21	2	MEDICINA DELLO SPORT	4	3
Chinese Journal of Clinical Health	20	2	MOTOR CONTROL	3	2

Note: The total number of articles published in the Top10 journals of Chinese literature is 354, accounting for 40% of the total Chinese literature (887 articles); the total number of articles published in the Top10 journals of English literature is 113, accounting for 80% of the total articles in English (141 articles), indicating that the core journals of English literature are more concentrated, and international research results are more likely to be published in authoritative journals in the professional field.

3.2 Institutional Cooperative Network Analysis

Institutional cooperation network analysis can present the scientific research level and achievement distribution of various institutions in this field, and help clarify the research strength and influence of various institutions in this field [23]. The results show that 887 Chinese literatures involve 267 research institutions. Institutional cooperation network analysis can present the scientific research level and achievement distribution of various institutions in this field, and help clarify the research strength and influence of various institutions in this field. In the visual spectrum 1, the size of the node is positively correlated with the amount of institutional output, and the thickness of the connection between nodes indicates the closeness of cooperation. The top three institutions are the General Hospital of the People's Liberation Army of China (12 articles), the College of Nursing and Rehabilitation of North China University of Technology (12 articles) and the East China Hospital affiliated to Fudan University (11 articles).
247 English documents involve 203 institutions, and the top two institutions include Harvard University and Harvard Medical School. Both the Chinese and English collaboration networks reveal collaborative links between institutions; in particular, the English-language collaboration network forms clusters of cross-institutional collaboration. The top 10 institutions by publication output are shown in Table 2 (Figure 1).

Table 2 Top 10 Institutions by Number of Publications

Rank	Institutions Publishing Chinese Literature	Number of Publications/Article	Rank	Institutions Publishing in English	Number of Publications/Article
1	General Hospital of the Chinese People's Liberation Army	12	1	Harvard University	4
2	School of Nursing and Rehabilitation, North China University of Science and Technology	12	2	Harvard Medical School	4
3	East China Hospital, Fudan University	11	3	University of Texas System	4
4	Shanghai University of Traditional Chinese Medicine	10	4	Harvard University Medical Affiliates	4
5	Shanghai University of Sport	9	5	Vrije Universiteit Amsterdam	4
6	West China Hospital, Sichuan University	7	6	Pennsylvania Commonwealth System of Higher Education (PCSHE)	4
7	Peking Union Medical College Hospital, Chinese Academy of Medical Sciences	7	7	Monash University	3
8	Beijing Hospital	7	8	Geriatric Research Education & Clinical Center	3
9	The Third Affiliated Hospital of Anhui Medical University	7	9	University System of Georgia	3
10	Central South University	7	10	Guangzhou Sport University	2

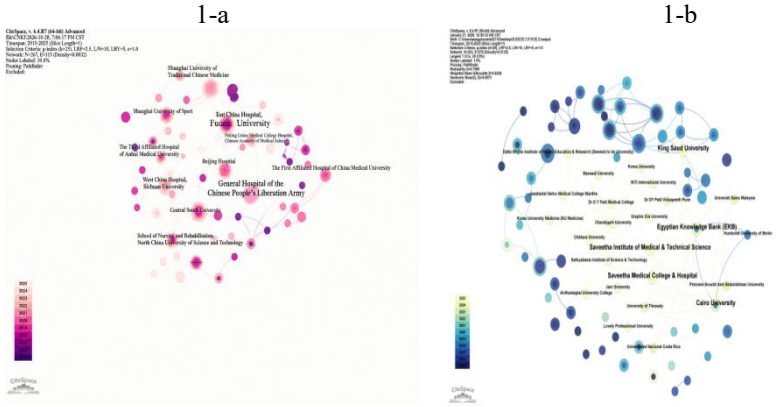


Figure 1 Knowledge Graph of Institutional Collaboration in the Literature

3.3 Keyword Analysis

3.3.1 Keyword co-occurrence analysis

The key word is the author's high level of condensation of the article, which can reflect the core idea of the article [24]. This study uses VOSviewer and citespace software to analyze the keyword knowledge atlas of 1028 documents (887 in Chinese and 141 in English), and finally selects a clearer VOSviewer atlas. It can be seen from the Chinese and English keyword co-appearing chart 2 that the node size is positively correlated with the frequency of keywords. The thickness of the connection between nodes represents the co-appearing intensity of the keyword, that is, the thicker the connection, the higher the frequency of the keyword at the same time (Figure 2).

The top 10 keywords by frequency are shown in Table 3. The most frequent Chinese keyword was 'elderly people' (495 occurrences), followed by 'falls' (324 occurrences), 'influencing factors' (62 occurrences) and 'risk of falls' (62 occurrences), indicating that domestic research primarily focuses on the causes of falls among the elderly. Analysis of keyword co-occurrence in English-language literature reveals that the key nodes are 'elderly-people', 'older-adults', 'elderly' (subject term: elderly, 84 occurrences), 'falls' (65 occurrences) and 'balance' (42 occurrences), indicating that international research emphasises the relationship between falls in older adults and balance ability, gait and executive function.

Table 3 Co-Occurrence of Keywords in Chinese and English Literature

No.	Keywords in Chinese Literature	Frequency/occurrences	No.	Keywords from English literature	Frequency/occurrences
1	Elderly people	495	1	falls	65
2	fall	324	2	people	49
3	Influencing factors	62	3	balance	42

No.	Keywords in Chinese Literature	Frequency/occurrences	No.	Keywords from English literature	Frequency/occurrences
4	Risk of falling	62	4	gait	35
5	Community	51	5	performance	33
6	Weak	46	6	elderly-people	31
7	Risk factors	44	7	older-adults	28
8	Review	43	8	risk	27
9	Balance	42	9	elderly	25
10	sarcopenia	42	10	walking	23

2-a 2-b

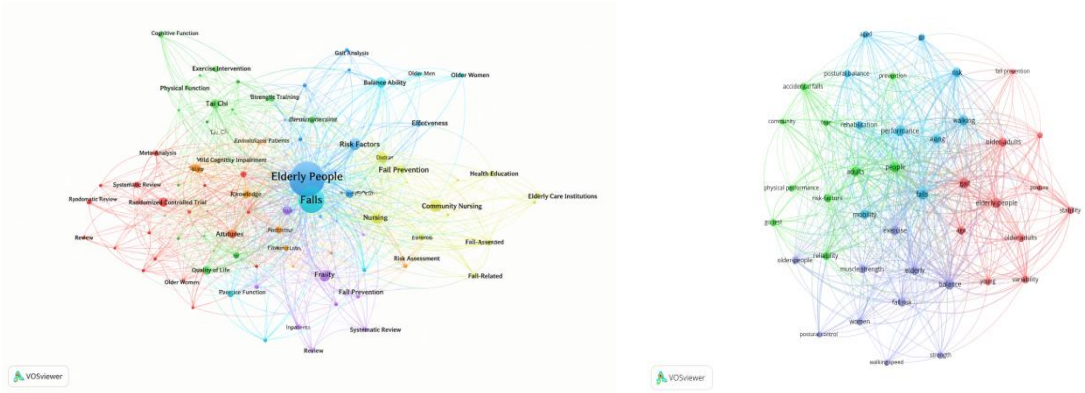


Figure 2 Co-Occurrence Graph of Keywords in the Literature

3.3.2 Keyword clustering and clustering timeline analysis

The cluster analysis of keywords is conducive to a comprehensive analysis of research hotspots, which can explain the hot issues in a certain research field and their future development trends [25]. This study conducts keyword cluster analysis and draws a keyword cluster map of the literature obtained from the screening. The cluster ranking starts from #0. The higher the ranking, the more nodes it contains and the larger the scale of the cluster, indicating that the higher the popularity of the cluster research. The results are shown in Figure 3.

3-a 3-b

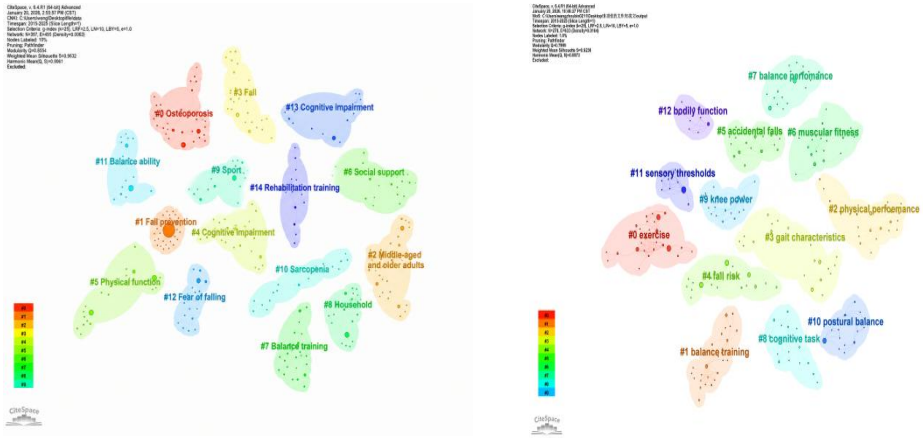


Figure 3 Literature Keyword Cluster Diagram

There are a total of 15 clusters of Chinese literature keywords, of which the Q value is 0.8554, the Silhouette value is 0.9632, and Q>0.7, indicating that the cluster structure is clear, and the credibility and stability are high [26]. According to Table 4, it can be summarized into three core dimensions. (1) Dimensions of falling risk factors: covering 5 clusters such as osteoporosis (32 nodes) and cognitive impairment (25 nodes), which correspond to physiological, cognitive-physiological coordination and psychological risks respectively, reflecting the multi-factor interaction characteristics of fall risk. (2) Dimensions of intervention measures: including 4 clusters such as balance ability (23 nodes) and movement (22 nodes), reflecting the core intervention means of improving balance ability through movement and reducing the risk of falling. (3) Social support dimension: including social support, family care and other related clusters, which is an important guarantee for the effective implementation of sports intervention measures. The popularity of cluster research such as cognitive disorders tends to decline, which is closely related to the shift of research to integrated intervention in recent years.

A total of 13 clusters of English literature keywords are drawn, among which Q = 0.7999, Silhouette = 0.9236, which has good significance. As shown in Table 4, it can be divided into three categories: #3gait characteristics, #4 fall risk

and other 7 clusters focus on fall risk-related factors, among which #4 (21 nodes) and #5 (20 nodes) are the core of the risk dimension, and each cluster is connected Intensive, reflecting the risk of falling is the result of multi-dimensional physiological function decline; #0exercise, #1balance training and other 4 clusters focus intervention measures, #0 (29 nodes) as the core, reflecting the effective intervention of exercise and balance training on the fall of the elderly; #2 Performance, #8cognitive task focuses on cognition-motor coordination, which is related to the intervention dimension, highlighting the research value of double-task training. In addition, #11sensory thresholds and #12 bodily function clustering are relatively hot, which is related to the study's shift to integrated intervention mode.

Table 4 Clustering of Chinese and English Keywords

Chinese Literature				English Literature			
Cluster Name	Number of Nodes	E-value	Cluster ID	Cluster Name	Number of Nodes	E-value	Cluster ID
Osteoporosis	32	0.974	0	exercise	29	0.918	0
Fall	31	1	1	balance training	27	0.963	1
Social support	29	1	2	physical perfoemance	22	0.89	2
Cognitive impairment	25	0.956	3	gait characteristics	21	0.897	3
Balance ability	23	0.947	4	fall risk	21	0.912	4
Sport	22	0.96	5	accidental falls	20	0.923	5
Cognitive impairment	21	0.97	6	muscular fitness	19	0.876	6
Rehabilitation training	21	0.952	7	balance perfomance	18	0.993	7
Household	20	0.939	8	cognitive task	17	0.927	8
Middle-aged and older adults	20	0.935	9	knee power	17	0.906	9
Sarcopenia	19	0.917	10	postural balance	15	0.882	10
Fall prevention	16	0.948	11	sensory thresholds	10	0.937	11
Physical function	16	0.981	12	bodily function	8	1	12
Fear of falling	15	0.979	13				
Balance training	13	0.951	14				

The keyword cluster timeline chart can reveal the evolution process of a specific field or topic over time, and help researchers identify research trends and turning points [27], as shown in Figure 4-a, the core continuous clustering of Chinese literature (2015-2025) is #1 fall, #4 balance ability, #5 movement, #7 rehabilitation training Practice and #14 balance training; heat decay clusters are #3 cognitive disorder, #6 cognitive weakness, #13 fall fear, reflecting the deepening of the academic community's understanding of the causes of falls, and the research gradually shifts to specific intervention measures and health. The timeline analysis of English literature keywords shows that the time span of each topic cluster is more than 10 years, which proves that sports intervention, balance function training and muscle strength improvement for the elderly have always been the key areas of attention of the international sports science community (Figure 4-b). The current hot spots focus on dual tasks, optimization of lower limb explosive force and gait dynamics mechanism, etc.

4-a 4-b

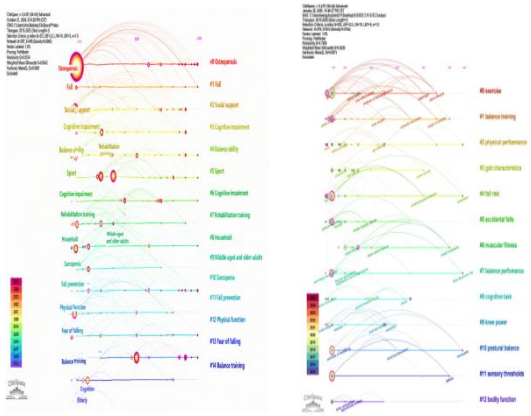


Figure 4 Timeline of Literature Clustering

3.3.3 Keyword emergence analysis

A keyword emergence view clearly illustrates the temporal evolution of keywords. Based on keyword frequency, it identifies trending terms according to their growth rate and defines research frontiers by analysing the temporal correlations among these terms [28]. The keyword emergence map for Chinese literature (Figure 5-a) indicates that research in this field can be broadly divided into three phases: (1) 2015–2018: the stage of basic motor function assessment. Emergent terms centred on ‘unexpected falls’, ‘core strength’, ‘muscle strength’, ‘gait’ and ‘balance ability’, reflecting that the risk of falls among older adults is essentially the result of the combined effects of insufficient core

strength, declining muscle strength, abnormal gait and impaired balance function; (2) 2019–2021 constituted the psychological–behavioural intervention phase. The emergence of terms such as ‘fall efficacy’, ‘fear of falling’ and ‘dual-task’ underscored the importance of enhancing cognitive function training; (3) From 2022 to now is the stage of precise intervention. "Strensity=4.66" (strength=4.66) is the strongest emerging word, and the emergence of keywords such as "resistance exercise" and "incidence" has continued to this day. This trend is closely related to the release of the "Consensus of Chinese Experts on the Outpatient Management Standards for Myasthenia in the Elderly (2024 Edition)". The consensus clearly states that sarcopenia is the core physiological risk factor for the elderly to fall, which promotes the application research of resistance movement in myasthenia intervention. At the same time, "incidence" has become an emerging word, reflecting the research. The transformation from "risk identification" to "quantitative assessment of intervention effect" echoes the policy requirements of the domestic public health field for the assessment of the prevention and control effect of the elderly.

5-a



5-b

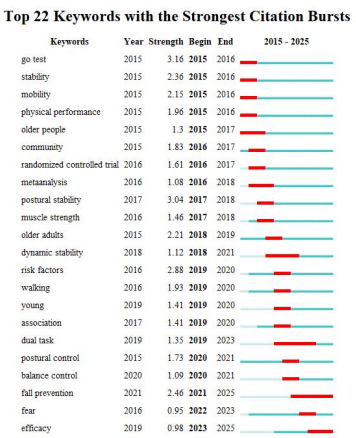


Figure 5 Keyword Emergence Diagram of the Literature

The emergence atlas of English literature keywords (Figure 5-b) shows: (1) 2015-2018 is the stage of standardized evaluation and evidence-based system construction, "go test", "stability", "mobility" and other physical evaluation indicators and "randomized controlled trial methodology keywords such as ontrolled trial and "meta analysis" emerge and establish a scientific research system; (2) 2019-2021 is the dynamic posture control stage, "dynamic stability" and "dualWords such as "task" and "balance control" have emerged, paying attention to dynamic stability and dual-task training; (3) From 2021 to now, "fall prevention" and "efficacy" have continued to emerge to the present stage of fall prevention effectiveness. Focus on the verification of the implementation effect of sports intervention. Assessment and prevention of falls in older people--concise guidance clearly puts forward clinical research on the assessment of falls in the elderly and sports intervention-related measures [29].

4 DISCUSSION

4.1 Research Overview

The increasing aging of the global population has made the fall of the elderly a major public health problem, and sports intervention as the core means of preventing falls has attracted more and more attention from the sports science community. This study is based on the measurement and analysis of 887 Chinese and 141 English literatures from CNKI, Wanfang and WOS databases from 2015 to 2025.

This study found that Chinese and English literature is mostly published in medical journals, showing obvious intersection of disciplines and reflecting the characteristics of the integration of body medicine. The reason for this phenomenon may be that the study of elderly falls involves multiple dimensions such as physiological mechanisms, intervention measures, care support, etc., which requires the coordinated development of geriatrics, sports science, nursing and other disciplines. As an important platform for interdisciplinary research, core journals are more likely to gather such high-quality research results. This feature also proves that the integration of physical medicine has become the core trend of fall research for the elderly. In the future, it is necessary to further strengthen the publication and exchange of interdisciplinary journal results and promote multidisciplinary research collaboration.

Domestic research takes the General Hospital of the People's Liberation Army of China, the College of Nursing and Rehabilitation of North China University of Technology, Shanghai Sports College, etc. as the core nodes, and the density of cooperation between institutions is low; foreign research is dominated by Harvard University and other comprehensive university medical schools, and the international cooperation network is relatively mature. Chinese and English literature has highlighted the trend of integration of physical medicine, which has initially formed a collaborative research pattern of body medicine, but there are still shortcomings in the lack of cross-institutional cooperation and the focus of research on the nursing side, which is highly in line with the urgent need for elderly health in China's aging process; foreign research takes the comprehensive university medical school as the core, according to

With the mature international cooperation network, the research focuses on prevention, highlighting its forward-looking layout for the active health of the elderly.

4.2 Research Hotspots and Evolutionary Trends

Keyword analysis shows that research at home and abroad revolves around the main line of the causes of falls for the elderly, sports intervention and validity verification, but the focus is different. Chinese literature focuses on keywords such as "fall", "influencing factors" and "balance ability", which can be divided into three parts. First, the physiological factors of the elderly fall, including osteoporosis, muscle reduction, cognitive impairment, etc.; Second, exercise intervention for the elderly, including Tai Chi, resistance exercise, core strength, balance training, etc.; Third, the social support caused by the fall of the elderly, including families, communities, nursing homes, etc.; English Literature focuses on functional indicators such as "balance", "gait", "physical performance", etc., forming "exercise", "balance training", "muscular fitness", etc. The sports prescription-oriented cluster cluster highlights the international frontier of biomechanical accurate evaluation and evidence-based training.

Judging from the evolutionary vein, domestic research can be divided into three stages. From 2015 to 2018, it was marked by unexpected words such as "accidental fall", "core strength" and "gait", focusing on the identification of fall risks, reflecting the use of basic physical fitness indicators to assess the risk of falls for the elderly; in 2019-2021, words such as "fall effectiveness", "fear of falling" and "double task" appeared, and the study from Single body training has been extended to psychological behavioral factors and cognitive-exercise dual-task training; from 2022 to now, "strength = 4.66) has become the strongest emerging word, which is consistent with the results of previous research on balance training, which confirms that precision intervention has become a hot spot in domestic research. At the same time, the "anti-resistance exercise" has continued to this day, marking the upgrade of the intervention method from general balance training to a precise strength prescription for myosthenia. This is closely related to the orientation of domestic policies. For example, the "Healthy China 2030" Planning Outline was issued in 2016, which clearly emphasized the construction of relevant regulations on health protection for the elderly, which in turn promoted the research and development in the field of fall risk assessment. On this basis, the "Standards for the Management of Outpatient Myascularism for the Elderly" were successively issued. The 2021 and 2024 editions of the National Expert Consensus further guide the research to focus on myasthenia, a core risk factor for elderly health, and promote the in-depth promotion of relevant precise intervention research.

Foreign research also shows stage characteristics: in 2015-2018, it mainly established a standardized evaluation system, and quantitatively evaluated the risk of falling through methods such as getting up and walking test; in 2019-2021, it turned to dynamic stability and dual-task training, focusing on the physical control ability of completing other tasks while walking. ; Since 2021, more has verified the actual preventive effect of exercise intervention, that is, English research has experienced the development of "standardized evaluation → dynamic control → effectiveness verification". The reason is that international research has established an evidence-based medical system earlier. After 2015, "randomized controlled The popularization of methods such as trial and "meta analysis" has promoted the construction of a standardized evaluation system. Subsequently, with the development of dynamic balance detection technology, it turned to dynamic stability and dual-task training research, and finally focused on the validity verification of the intervention effect, reflecting the international research "methodological norms" The mature path of "→ technological innovation → effect verification". And this is proposed by Xu Y to improve the balance of the elderly through core training [30]. Celletti C et al.'s finding that enhancing lower limb muscle strength is beneficial for preventing falls in older adults [31]; and Lee G C's proposal to use foot-operated equipment for balance training in older adults to reduce their fall rates and anxiety regarding falls compared to these analyses of single interventions, the present study, by incorporating multiple databases, has further clarified the rising international interest in "dual-task training" [32].

Furthermore, this study has the following limitations: (1) Limitations regarding data sources. Chinese-language literature did not include relevant journals from Hong Kong, Macao and Taiwan, whilst foreign-language literature remained predominantly in English, failing to cover non-English literature such as German and Japanese, which may have resulted in the omission of research findings from certain regions; (2) Limitations regarding the search strategy. Although the disciplinary scope of English-language literature was expanded, there may still be issues with the omission of derived subject terms; (3) Limitations regarding sample size. The imbalance in the number of Chinese and English-language publications has not yet been fully rectified, which may result in insufficient representativeness of international research trends, with an imbalance in the sample sizes of Chinese and English-language literature. In future, multilingual literature searches could be incorporated, and methods such as spatio-temporal network analysis adopted, to further enhance the comprehensiveness and accuracy of the research.

5 CONCLUSIONS

Based on the findings from the two visualisation tools, CiteSpace and VOSviewer, existing research has largely focused on the physiological mechanisms of falls in older adults and exercise interventions targeting balance alone, with insufficient attention paid to the synergistic effects of cognitive–somatic function. Furthermore, the research remains predominantly centred on a passive response model of 'fall, assessment, intervention'. Therefore, future research should focus on the synergistic mechanisms of cognitive and physical functions, shifting the focus from post-fall assessment to the core mechanism of fall prevention. This will break away from the passive 'fall, assessment, intervention' model and

establish a pre-emptive prevention system characterised by 'proactive prediction, precise prevention and control, and a closed-loop process throughout', thereby achieving a fundamental shift in fall prevention and control from 'remedial measures after the event' to 'source-based governance'

COMPETING INTERESTS

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