REVIEW ARTICLE

Patterns and risk factors of falls among older adults: a systematic review

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Abstract

Background and Study Aim: Falls represent a significant health concern for older adults, leading to a decline in quality of life and other adverse consequences. The aim of this systematic review is to identify the key patterns and risk factors of falls among older adults and propose recommendations for their prevention.

Material and Methods: The Web of Science Core Collection database was selected as the data source. The search included publications from the last 10 years (2014–2024). Bibliographic data of the articles were extracted, revealing a total of 852,909 documents. A refined search reduced the dataset to 32,631 documents, from which a subset of 31,009 documents was formed for analysis. Two algorithms were used for the automatic extraction of the most significant documents from a dataset of 31,009 records. The first algorithm is based on extracting documents with the highest citation metrics. The second algorithm employs an approach that combines keyword analysis, their weighting coefficients, and document abstracts. The Latent Dirichlet Allocation (LDA) thematic model was applied for text data processing using the Python programming language. The model quality was assessed using the Perplexity Score (model prediction accuracy) and Coherence Score (topic coherence). For visualization and in-depth analysis of thematic distributions, the pyLDAvis library and Gephi software were utilized.

Results: The application of two document extraction algorithms enabled the identification of two groups (n = 2 × 25) of the most relevant and high-quality articles, which was confirmed using statistical methods. This approach minimizes subjectivity and randomness in selection, enhancing the accuracy and validity of the analysis. The review identified key themes focused on assessing and preventing fall risks among older adults. Risk factors include cognitive and sensorimotor impairments, changes in gait parameters such as reduced speed, shortened step length, and increased variability. Additionally, fear of falling, physiological changes, and external conditions contributing to fall likelihood were noted. A multifactorial approach incorporating modern technologies and regular monitoring demonstrated effectiveness in reducing fall risk. The analysis results showed that the LDA method effectively identifies significant themes related to fall issues, risk factors, mobility, and prevention strategies. Ten key topics were identified, reflecting two main research algorithms.

Conclusions: The analysis identified key risk factors for falls among older adults, including cognitive impairments, reduced sensorimotor function, changes in gait parameters, as well as physiological and external factors. The findings highlight the diversity of approaches to risk assessment and prevention. A comprehensive strategy that integrates regular monitoring, individualized preventive measures, and modern technologies proves to be the most effective in reducing fall risk and maintaining the quality of life for older adults. The use of advanced algorithmic and statistical approaches enhances the objectivity and quality of systematic reviews, ensuring more accurate and reproducible results.

Keywords: cognitive impairments, sensorimotor function, gait analysis, fall prevention strategies, systematic review methodology

Glossary

Term. Description/Synonyms

Elderly. A general term for referring to older people.

Older Adults. Often used in medical and social research to describe senior individuals.

Seniors. A commonly used term for older people, especially retirees.

Senior Citizens. A formal term referring to retired or elderly individuals.

Geriatric. Related to gerontology; pertains to medical care for older people.

Aged. A term often used in academic and medical contexts to describe elderly individuals.

Older Individuals. A less formal term for referring to senior people.

Mature Adults. Highlights the maturity and experience of older people.

Aging Population. Describes demographic shifts related to an increasing proportion of older individuals in society.

Aged Population. Similar to "aging population," referring to the elderly demographic.

Older People. A general term for referring to elderly individuals.

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Older Populations. Used in research to describe groups of older individuals.
Older Persons. A formal term for referring to senior individuals.
Retirees. People who have retired, commonly used to refer to pensioners.

Introduction

Falls among older adults represent one of the most pressing issues, significantly impacting their quality of life, level of independence, and overall health. Given the increasing proportion of the elderly population worldwide, research on fall risk factors and patterns has become particularly relevant. Falls are not only a leading cause of injuries and mortality but also result in substantial economic costs associated with treatment and rehabilitation. The importance of studying this issue lies in the need to develop effective preventive measures based on a deep understanding of risk factors and to formulate recommendations for reducing fall incidence. In this context, numerous studies have focused on identifying fall patterns and risk factors, which play a key role in developing prevention strategies.

Physiological Factors. Physiological factors include balance impairments, reduced muscle strength, deterioration of vision and hearing, as well as comorbid conditions such as osteoporosis, diabetes, and neurological disorders. Numerous studies [1, 2, 3, 4, 5] have established that physiological parameters, including muscle strength and endurance, balance, reaction time, and cognitive functions, play a crucial role in predicting and preventing falls among older adults. It has been shown that deteriorating postural stability, decreased muscle strength, and prolonged reaction time significantly increase the risk of falls, especially when combined with age-related changes in vision and hearing. Researchers emphasize that regular physical exercises aimed at strengthening the lower limb muscles and improving balance can significantly reduce fall risk. Additionally, assessing physiological parameters is recommended for identifying at-risk groups and developing individualized prevention programs.

Social Factors. This category includes factors such as social isolation, access to healthcare, the level of family and community support, and the impact of economic conditions on participation in preventive programs. Studies by Bloom et al. [6], Rhee et al. [7], and Lohman et al. [8] have highlighted the significant role of social connections and support in reducing fall risk among older adults. Additionally, the quality of family and community support has been shown to influence mental health and the ability to recover after falls. Furthermore, a strong correlation has been identified between social interactions and reduced levels of depression and anxiety. Researchers emphasize that strengthening social networks, actively engaging older adults in community life, and fostering a supportive social environment can contribute to a lower likelihood of falls and overall health improvement. It is also noted that social factors have a mediating effect on adherence to physical activity recommendations and participation in preventive programs.

Behavioral Factors. Behavioral factors include habits such as inappropriate footwear choices, insufficient physical activity, and neglecting the use of assistive devices (e.g., canes or walkers). Numerous studies [9, 10, 11, 12, 13, 14, 15] on behavioral factors have identified the predominant role of activity habits and self-efficacy in fall prevention. The influence of fear of falling and depressive symptoms on reduced physical activity has been demonstrated. Additionally, a connection has been established between lifestyle factors (including sleep patterns and smoking) and the risk of developing sarcopenia and other conditions that increase fall likelihood. Researchers emphasize that modifying behavioral factors – such as increasing physical activity levels, reducing fear of falling, and maintaining a healthy sleep regimen – can significantly reduce fall risk and its adverse consequences. The importance of motivational approaches is also highlighted, including counseling and support programs aimed at fostering healthy habits and increasing engagement in preventive measures.

Preventive Programs. This category includes comprehensive approaches that incorporate individually tailored physical exercises, consultations with physicians and psychologists, and educational activities. Researchers and developers of fall prevention programs for older adults explore various strategies [16, 17, 18, 19]. Key approaches include enhancing confidence in risk management, multifactorial programs, cognitive stimulation combined with physical exercises, and interventions aimed at reducing fear of falling. Experts emphasize that a comprehensive approach should address physical, cognitive, and psychological aspects, significantly improving the effectiveness of preventive measures.

Environmental Modifications. This category includes eliminating hazardous factors in the home environment (e.g., low-traction rugs, poor lighting) and installing handrails and non-slip surfaces. Studies by Lim et al. [20], Welti et al. [21], and Siefkas et al. [22] examine the impact of environmental modifications on the daily activities of older adults. Researchers highlight the role of home modifications in maintaining functional health. Particular attention is given to the relationship between social isolation, fear of falling, and the use of bathroom modifications. Experts emphasize that adapting the environment and improving home safety can significantly reduce fall risk and enhance the quality of life for older adults.

Educational Initiatives. This category includes training older adults and their families in effective fall prevention strategies. It also encompasses recommendations on physical activity, nutrition, and safe household behaviors [23, 24, 25, 26, 27]. Researchers examine educational interventions aimed at reducing the use of inappropriate medications associated with fall risks in older adults. They also discuss the need for training healthcare professionals to improve elderly care. Specific recommendations are provided on teaching older adults safe cycling and enhancing their competence in various activities. Particular emphasis is placed on educational strategies to improve the effectiveness of preventive programs. Studies highlight the necessity of initiatives focused on enhancing the safety of older adults. Experts note that such programs contribute to improving the quality of life and reducing fall risks among the elderly.

Cognitive Factors. A key aspect of this category is the role of cognitive impairments (such as dementia, memory decline, and reduced concentration) in increasing fall risk. A significant number of studies have focused on cognitive factors and their role in fall prevention [28, 29, 30, 31, 32, 33, 34, 35, 36]. In the development of fear of falling, researchers highlight several areas of study: the impact of cognitive training on balance and gait in older adults, the influence of cognitive status and executive functions on fall risk, and the role of cognitive processes (such as attention and sensory information processing). Additionally, the effect of cognitive processing speed on gait variability is examined, along with the interaction between cognitive and physiological factors in mobility. Special attention is given to specific aspects such as diabetes-related stress and self-efficacy, which influence fear of falling and physical activity. Researchers emphasize the importance of considering cognitive factors in the development of fall prevention programs and mobility improvement strategies for older adults.

Psychological Factors. This category includes fear of falling, reduced self-confidence, and stress levels, which can limit activity and contribute to physical decline. Researchers highlight several psychological aspects, including anxiety, depression, mental well-being, balance confidence, and fear of falling, as well as their relationship with fall risk and behavior among older adults [37, 38, 39, 40, 41, 42, 43, 44, 45]. Studies examine the impact of depression and subjective health perception on fall risk. Additionally, the relationship between neuroticism, fear of falling, and depressive symptoms with avoidance behaviors is explored. Researchers emphasize that intervention programs aimed at reducing fear of falling and improving balance confidence can significantly enhance the psychological well-being of older adults. Moreover, such programs promote more active participation in daily life and help reduce fall risk.

Gender Differences. This category includes an analysis of differences between men and women in fall risk, which are influenced by physiological, social, and behavioral factors. Gender differences are examined in terms of injury rates, walking speed, gait variability, fear of falling, and levels of physical activity [46, 47, 48, 49, 50, 51, 52, 53]. Key gender-related factors include self-efficacy, social support, and overall health status. Special attention is given to older adults living alone. Researchers emphasize that considering gender-specific characteristics in prevention and rehabilitation programs can help more accurately identify vulnerable groups and develop more effective strategies to improve physical condition and quality of life for both older men and women.

Social Networks. This category explores the role of support from friends, family, and social groups in reducing fall risk and increasing physical activity among older adults. Studies by Bloom et al. [6], Tsunoda et al. [54], and Lee et al. [55] actively promote ideas analyzing the role of social networks in the lives of older individuals and their impact on physical activity, mental health, and nutritional quality. The relationships between social support, religiosity, and depressive symptoms are examined, along with the effectiveness of digital tools in improving the health of elderly patients. Researchers emphasize that expanding social networks and utilizing digital technologies are crucial directions for maintaining the health and well-being of older adults.

Socioeconomic Factors. Key factors in this category include the impact of income level, access to healthcare and support, housing quality, and transportation infrastructure on fall risk. Numerous studies examine the socioeconomic aspects affecting health and fall risks among older adults [56, 57, 58, 59, 60]. Particular attention is given to the influence of factors such as age, gender, education level, employment status, and income on mobility limitations, loss of independence, and fracture risk. The role of social support and financial stability in maintaining elderly health and reducing fall risk is also explored. Researchers emphasize that considering socioeconomic factors and their interactions is crucial for developing effective fall prevention programs and improving the quality of life for older adults.

Climatic and Seasonal Factors. This category examines the risk of falls associated with weather conditions, including ice, slippery surfaces in winter, heat exposure, and dehydration during hot seasons. Studies by Giladi et al. [61] and Tenías et al. [62] explore the impact of climatic factors on fall risk and related injuries among older adults. The relationships between low temperatures, snowy and icy conditions, and fracture risk are analyzed, as well as the influence of seasonal changes and wind on fracture incidence. Researchers emphasize

the importance of considering weather conditions when developing preventive strategies to reduce fall risks and injuries among the elderly. Notably, identifying fall patterns and risk factors involves the application of big data analysis methods. In this context, machine learning and artificial intelligence (AI) techniques are used to predict fall probabilities, analyze behavior models, and monitor health status. Studies [63, 64, 65, 66, 67] employ various data analysis methods to enhance the safety of older adults. Researchers explore the use of wearable sensor data processing technologies to assess fall risk and analyze biometric data in real time. AI and data analytics focus on evaluating and improving the physical and cognitive abilities of older adults, enabling risk prediction and improving health monitoring. Additionally, AI-based technologies for posture recognition and fall prevention are investigated, contributing to the early detection of hazardous situations and reducing injury risks.

The listed research areas cover key aspects of fall-related issues among older adults. Their analysis provides a comprehensive examination of risk factors and prevention strategies, ultimately enhancing opportunities to improve the quality of life for the elderly. At the same time, there is a growing number of studies on falls among older individuals, indicating the emergence of new solutions to address these challenges. Despite the existence of systematic reviews on elderly falls [59, 23, 31], the potential of such analyses requires automation in data search and extraction processes. In this context, the need for more effective approaches to data summarization and analysis is evident. Based on this, the aim of the present systematic review is to identify key patterns and risk factors of falls among older adults and propose recommendations for their prevention.

Methodology

The study was conducted following the PRISMA protocol (Figure 1) [68].

The authoritative Web of Science Core Collection database was selected as the information source. The search included data from the last 10 years (from January 1, 2014, to October 30, 2024). Bibliographic data from the documents (articles) were extracted.

Automation of Relevant Document Selection from Large Data Sets

One of the key challenges in conducting a systematic review is selecting the most high-quality and relevant documents from the vast number of records found in scientific databases such as Web of Science (WoS). Traditional approaches rely on citation metrics or manual review of abstracts and full-text articles. However, citation count, while a popular criterion, does not always reflect a document's relevance to a specific study. Moreover, manually analyzing abstracts or full texts is time-consuming and may result in the omission of important documents, reducing analytical efficiency and potentially distorting conclusions.

To address this issue, an algorithm was developed to fully automate the document selection process from large data sets (in this case, 31,009 documents). The algorithm integrates:

1. Keyword and phrase analysis to ensure maximum thematic relevance.
2. Statistical validation of selection quality, allowing for an assessment of the relevance of the retrieved document set.
3. A dual-selection approach, providing

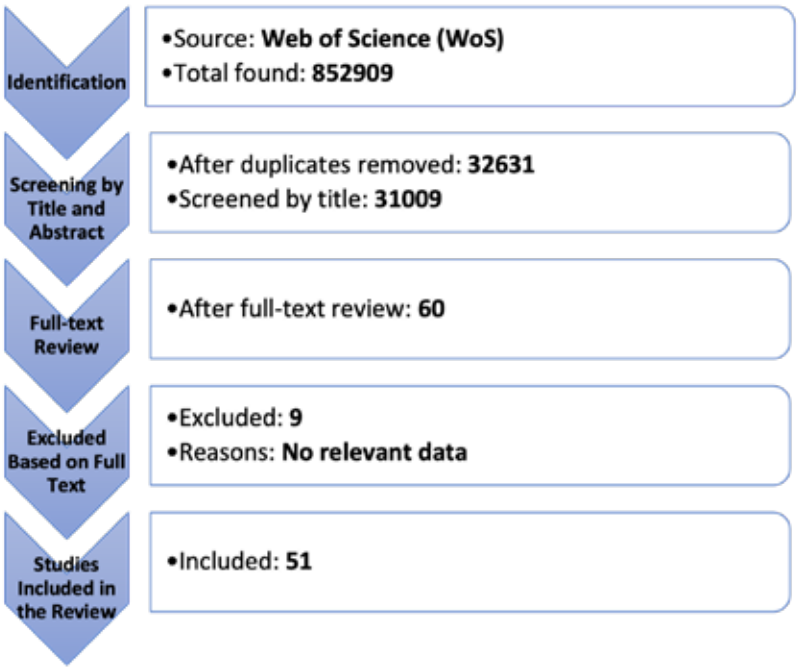

Figure 1. PRISMA Flow Diagram

independent verification of document significance and quality.

The application of this algorithm enabled the extraction of 50 highly relevant and high-quality articles, as confirmed by statistical methods. This approach not only minimizes subjectivity and randomness in selection but also enhances the accuracy and reliability of the analysis.

Data Extraction Process

A search query related to "older adults" was used in various combinations: (*"elderly" OR "older adults" OR "seniors" OR "senior citizens" OR "geriatric" OR "aged" OR "older individuals" OR "mature adults" OR "aging population" OR "aged population" OR "older people" OR "older populations" OR "older persons" OR "retirees".*)

This search yielded 852,909 results from the Web of Science Core Collection. A refined search using the keyword *fall*** identified 32,631 English-language documents.

The document information was saved through the Export/Plain text file/Record Content menu. The selection criteria ensured the inclusion of essential fields for further analysis:

- Author(s).
- Title.
- Source.
- Times Cited Count.
- Accession Number.
- Abstract.
- Keywords.
- Highly Cited.

Each field contains 21 keys in the form of two uppercase letters or a letter and a number. Twelve keys were selected for analysis:

1. PT - Publication Type.
2. AU - Authors of the article.
3. AF - Author Full Names.
4. TI - Title of the article.
5. SO - Source (Journal name).
6. DE - Keywords provided by the authors or publisher.
7. ID - Additional keywords or terms used for indexing.
8. AB - Abstract (Summary of the article).
9. TC - Total number of citations for the article.
10. Z9 - Total citations across all databases.
11. PD - Publication Date (month of publication).
12. PY - Publication Year.
13. VL - Volume of the journal.
14. IS - Issue number of the journal.
15. BP - Beginning Page of the article.
16. EP - Ending Page of the article.
17. DI - DOI (Digital Object Identifier), a unique identifier for the article.
18. EA - Early Access Date (when the article was made available online before print).
19. UT - Unique Identifier in the Web of Science database.
20. DA - Date Added to the Web of Science database.
21. ER - End of Record (marks the end of a document).

Processing of Extracted Documents

For processing 32631 documents from WoS, recommendations were applied to analyze text similarity and cluster selected documents [69, 70, 71, 72]. Additionally, guidelines for information visualization of documents were utilized [73, 74]. The Latent Dirichlet Allocation (LDA) model was employed to identify key topics and analyze significant terms [75, 76]. Recommendations by Wu et al. [77] on the use of keyword pairs were also incorporated. For processing relevant documents, clustering, and result visualization, recommendations by Hidayat et al. [78], Xie et al. [73], and Mittal et al. [79] were followed, applying thematic modeling (LDA) using the Python programming language.

The process of automatic extraction of relevant documents was divided into two procedures, followed by the merging of results.

Procedure 1: Automatic Extraction of Relevant Documents

To process the dataset (32631 documents), several specialized Python scripts were developed and implemented using relevant libraries. Each stage of data processing (filtering, text cleaning, field merging, and statistics generation) was executed with a separate script to enhance workflow structure and reproducibility. All data processing was conducted in the PyCharm Community Edition integrated development environment, ensuring ease of code writing, debugging, and testing. For visualizing extracted document records and identifying structural relationships, Gephi [80] was utilized, providing graphical representation capabilities.

Steps of the Procedure:

Step 1. Extracted data in text format were merged into a single file.

Step 2. Missing keys (DE, ID - keywords) were added based on the condition: DE = ID. If both keys were absent in a document record, the text "nokey" was added to the DE, ID field. Additionally, if a record lacked an AB (abstract) key, it was completely removed (from PT to EF keys).

Step 3. The text file was converted into a CSV table, retaining the following key fields: UT, TC, Z9, TI, AB, DE. The final CSV file contained 31,009 rows (document records).

Step 4. A new CSV table was created by merging the fields TI, AB, DE (title, abstract, and keywords) under the column name "CombinedText".

Step 5. Preliminary data processing was performed using the Latent Dirichlet Allocation (LDA) model. LDA is a probabilistic model that assumes each document consists of a set of topics, with each topic defined by a combination of keywords

with varying probabilities. LDA helps structure large text datasets, identifying key thematic directions to facilitate analysis and interpretation.

This approach enabled the extraction of the most relevant topics and documents from 31009 records. The LDA model's results were stored in a CSV table, representing the distribution of keyword weights across different topics (Table 1).These weights indicate how significant or characteristic a given word is for a particular topic.

Table 1. Distribution of Keyword Weights Across Top Topics

Topic	Word	Weight
1	older	0.99580866
1	fall	0.0041559665
1	falling	6.7021147e-06
1	elderly	5.7571765e-06
1	balance	5.75464e-06
1	walking	5.7506927e-06
1	gait	5.7442717e-06
1	postural	5.741899e-06
2	gait	0.63395333
2	walking	0.36469632
2	fall	0.0013053055
2	falling	9.018048e-06
2	older	9.014671e-06
2	elderly	9.005692e-06
2	balance	9.000762e-06
2	postural	8.973012e-06
3	elderly	0.6865127
3	falling	0.31161395
3	fall	0.0018433775
3	older	6.0187717e-06
3	walking	6.008367e-06
3	balance	6.000416e-06
3	postural	5.988088e-06
3	gait	5.988021e-06
4	fall	0.9999709
4	falling	1.44649675e-05
4	older	2.7497747e-06
4	elderly	2.3839439e-06
4	balance	2.3603882e-06
4	walking	2.3590424e-06
4	gait	2.3568257e-06
4	postural	2.3542493e-06
5	balance	0.7588264
5	postural	0.21586762
5	fall	0.025264248
5	falling	8.464655e-06
5	older	8.363051e-06
5	elderly	8.338245e-06
5	gait	8.323125e-06
5	walking	8.315811e-06

Note. Topic – topic numbers, Word – keywords, Weight – keyword weights.

Step 5.1.

Document extraction can be performed based on citation metrics or relevance. However, selecting documents based on citation counts has a drawback: articles published in the last five years may have lower citation metrics compared to older publications (five years or more) [81].

Therefore, relevance-based extraction was chosen. To obtain the most relevant documents for each topic, the "keyword weights" of each topic were used. These keyword weights were then matched with the content of each document. As a result, top documents were identified for each topic based on the total weight of keywords within each document.

Data Processing Procedure. A systematic selection of relevant documents was carried out using an approach that combines keyword analysis, their weighting coefficients, and document abstracts. The code consists of multiple stages. First, the data is loaded: a list of topics with keywords and their weights, along with the document text dataset. All texts are converted to lowercase for uniform processing.

Next, for each topic, document relevance is calculated based on the sum of keyword weights found in the text. Documents are then sorted in descending order of relevance, and unique top-N documents are selected for each topic. If a document has already been included in another topic's selection, it is marked as a duplicate. This ensures that each document is assigned to a single topic, maintaining the independence of topics.

As a result, two tables are generated (with column titles similar to Table 1 – Step 5**):**

- Primary table containing unique documents distributed by topics (Step 5.1).
- Supplementary table containing duplicate documents (Step 5.1).

These tables allow for a systematic analysis of the data, highlighting key publications for each topic while minimizing data redundancy.

Step 5.2.

Topic Modeling Using the Latent Dirichlet Allocation (LDA) Algorithm

A topic modeling process based on the LDA algorithm was implemented for text data analysis.

In the first stage, data preprocessing was performed, including the removal of stop words, numbers, symbols, and short words, improving the model's quality (Step 5). A text corpus was then created using a dictionary formed from the preprocessed data, with filtering of rare and overly frequent words.

In the second stage (Step 5.2), the LDA model was trained with parameter tuning, including the number of topics, iterations, and passes. To assess model quality, Coherence Score and Perplexity Score metrics were calculated, ensuring the stability

and meaningfulness of the extracted topics.

The final results included:

• A list of keywords for each topic, saved in CSV format (Table 2).

• Coherence and Perplexity metric scores, providing an objective interpretation of the model.

This approach enabled the systematic identification of latent topics and their key characteristics.

Step 6.

Automating Bibliographic Data Generation for Large Document Sets

In the WoS database, queries were executed in the following order: the "Accession Number" field was used to copy document identifiers from the final results of Step 5. The retrieved results were saved as a text file via the Export/EndNote desktop menu.

A Python script was then used to process the text file containing bibliographic records and convert them into a table format within a Word document. This approach efficiently structures large datasets and simplifies the creation of bibliographies for scientific publications that include 100 or more cited documents.

Procedure 2: Automatic Extraction of Relevant Documents

Procedure 2.1. Preliminary Data Preparation

The data preparation process utilized results from Procedure 1, including:

• Keyword weight distribution across different topics (Step 5.2).

• Data merging key fields (TI, AB, DE)—title, abstract, and keywords. A total of 31,009 document records (Step 4).

Based on Procedure 1 (Step 5) data, 140 keyword pairs were generated in various combinations. A Python script was used to create a table with 140 keyword pair combinations and two CSV tables for visualization in Gephi (CSV table for edges and CSV table for nodes).

For example (CSV table for edges): The keyword pair "older-fall" has Weight = 0.49998 and belongs to Topic 1.

The keyword pair metrics (CSV table for edges) "older-fall" correspond to individual keywords (CSV table for nodes):

• "older" (Weight = 0.9958, Topic 1).

• "fall" (Weight = 0.0041, Topic 1).

Table 2. List of Keywords for Each Topic

Topic	Word	Weight	Topic	Word	Weight	Topic	Word	Weight	Topic	Word	Weight	Topic	Word	Weight
1	gait	0.0254	2	care	0.0236	3	risk	0.0359	4	exercise	0.0151	5	fall	0.0389
1	balance	0.0166	2	health	0.0229	3	falls	0.0314	4	intervention	0.0137	5	elderly	0.0175
1	walking	0.0122	2	sleep	0.0092	3	fall	0.0170	4	physical	0.0111	5	detection	0.0159
1	postural	0.0119	2	social	0.0086	3	factors	0.0131	4	training	0.0109	5	based	0.0099
1	control	0.0079	2	home	0.0084	3	fracture	0.0095	4	group	0.0096	5	falls	0.0092
1	adults	0.0071	2	prevention	0.0073	3	regression	0.0072	4	falls	0.0091	5	human	0.0077
1	cognitive	0.0061	2	adults	0.0066				4	interventions	0.0079	5	proposed	0.0068
1	stability	0.0060	2	falls	0.0066				4	program	0.0069	5	monitoring	0.0062
1	motor	0.0055	2	nursing	0.0063							5	model	0.0061
1	healthy	0.0055	2	people	0.0060									

Topic	Word	Weight	Topic	Word	Weight	Topic	Word	Weight	Topic	Word	Weight	Topic	Word	Weight
6	frailty	0.0158	7	aged	0.0092	8	physical	0.0216	9	bone	0.0187	10	patients	0.0580
6	patients	0.0142	7	age	0.0073	8	balance	0.0153	9	vitamin	0.0182	10	injury	0.0107
6	risk	0.0137	7	rates	0.0048	8	test	0.0141	9	muscle	0.0172	10	hospital	0.0102
6	geriatric	0.0122	7	population	0.0047	8	functional	0.0134	9	mass	0.0122	10	trauma	0.0099
6	clinical	0.0119	7	years	0.0047	8	sarcopenia	0.0115	9	blood	0.0113	10	patient	0.0090
6	cognitive	0.0077	7	results	0.0039	8	strength	0.0105	9	body	0.0113	10	fractures	0.0083
6	disease	0.0073	7	increase	0.0036	8	muscle	0.0104	9	levels	0.0101	10	hip	0.0081
6	medication	0.0073				8	performance	0.0101	9	women	0.0074	10	fracture	0.0078
						8	fear	0.0089	9	diabetes	0.0070	10	elderly	0.0070
						8	scale	0.0085				10	treatment	0.0069

Note. Topic – Theme numbers, Word – Keywords, Weight – Keyword weights.

This approach enables a visual assessment of keyword relationships in the documents.

Procedure 2.2.

A Python script was developed to analyze document texts by identifying records with varying levels of relevance based on the number of unique keyword pairs. The goal was to categorize the large dataset into high, medium, and low relevance groups, facilitating further thematic analysis.

As a result:

- Documents were cleaned of irrelevant words.
- Classified based on the number of significant keyword pairs.
- Saved as separate files.

The final distribution is stored in a CSV table (31,009 rows), where the data is sorted by the "PairCount" column (Table 3).

As a result, the documents were categorized into three groups:

- High relevance documents: 3,852 (12%).
- Medium relevance documents: 5,211 (16%).
- Low relevance documents: 21,946.

Procedure 2.3.

Topic Modeling with LDA (Latent Dirichlet Allocation)

LDA modeling was previously applied (Step 5) to identify the most significant topics in the context of this study.

The LDA process involved:

- Loading text data.
- Preprocessing by removing noise (stop words, numbers, symbols).
- Converting text into a numerical representation (Bag-of-Words or TF-IDF).
- Training the model on transformed data using a predefined number of topics.
- The results included:
- Probabilities of each document belonging to specific topics.
- Lists of keywords characterizing each topic.

To verify the findings, topic visualization and keyword coherence evaluation were conducted, confirming the meaningfulness of the identified thematic directions.

LDA topic modeling was implemented using Python code. As a result, a CSV table was created, containing keyword sets that define each of the five topics (Table 4).

These results differ from Step 5.2 (which used individual keywords) because a different document extraction approach was applied, utilizing keyword pairs instead of single keywords.

To verify the results, topic visualization was performed using the interactive interface provided by the pyLDAvislibrary. This approach has proven effective in other studies by Xie et al. [73], Onah et al. [82], and Majhi and Mukherjee [83].

The visualization is presented as a web page (Figure 2), allowing for a clear assessment of identified topics, their relationships, and key keywords. By embedding the file in a styled web page, the analysis results become easily accessible for detailed examination.

The Intertopic Distance Map was created using multidimensional scaling (MDS). Additionally, the visualization presents:

- Graphs of overall term frequency

Table 3. Distribution of the Dataset into High, Medium, and Low Relevance Categories (Excerpt from the First Row of 31,009 Rows in the CSV Table)

UT	TC	Z9	CombinedText	CleanedText	PairCount
WOS:000596058500001	10	10	Gait Disorder among Elderly People, Psychomotor Disadaptation Syndrome. Abstract. Keywords	gait disorder among elderly people psychomotor disadaptation syndrome falls among older people health years age postfall syndrome walking occurring following fall absence acute orthopedic rheumatic directly medical history lifestyle falls functional mobility risk factors age walking postural balance psychomotor	56

Note. UT – document identifier; TC – citation count; Z9 – total citation count; CombinedText – text containing the document title, abstract, and keywords; CleanedText – processed text containing only significant keywords; PairCount – number of keyword pairs.

Table 4. Set of Keywords Characterizing Each of the Five Topics

Topic	Keywords
1	adults, assessment, using, test, balance, elderly, older, falls, risk, fall
2	step, sway, task, walking, control, stability, postural, older, adults, balance
3	associated, study, factors, adults, patients, falling, fall, older, risk, falls
4	program, falls, adults, physical, intervention, older, group, exercise, training, balance
5	length, step, cognitive, older, time, parameters, variability, speed, walking, gait

- Term frequency within the selected topic

Term Relevance is Calculated Using the Following Formulas [84, 85]:

Saliency:

$$\text{saliency}(w) = \text{frequency}(w) \cdot \left[\sum_t p(t|w) \cdot \log \left(\frac{p(t|w)}{p(t)} \right) \right]$$

Where:

- P(w)– Probability of the term ww appearing in the corpus.
- P(t|w) – Probability of topic tt given the term ww.
- P(t) – Overall probability of topic tt in the corpus.

Relevance:

$$\text{relevance}(w|t) = \lambda \cdot p(w|t) + (1 - \lambda) \cdot \frac{p(w|t)}{p(w)}$$

Where:

- P(w|t)– Probability of term ww appearing in topic tt.
- P(w) – Overall probability of term ww in the corpus.
- λ – Adjustable relevance parameter (0⩽λ⩽1), controlling the balance between exclusivity to the topic and general corpus frequency.

The visualization in Figure 2 confirms the identified thematic structure from high-relevance documents. The interactive intertopic distance map clearly illustrates relationships and overlaps between the five identified topics.

- Each topic is represented as a circle, where the size reflects the proportion of documents associated with that topic.
- The list of most relevant terms for each topic enhances interpretability by displaying the most frequent and contextually significant words.
- The adjustable relevance metric (λ) allows for fine-tuning the balance between term frequency within a topicand term exclusivity.

All these elements confirm that the model successfully identifies meaningful and significant topics.

Procedure 2.4.

Document Distribution by Topics

For each of the five identified topics, the 10 most relevant documents were automatically selected. The process consisted of the following steps:

1. Using the keyword table for each topic (Procedure 2.3), a dictionary was created, assigning a set of keywords to each topic.
2. High-relevance document texts (Procedure 2.2) were analyzed for keyword matches.
3. For each document, the number of keyword matches was counted, and the document was assigned to the topic with the highest match

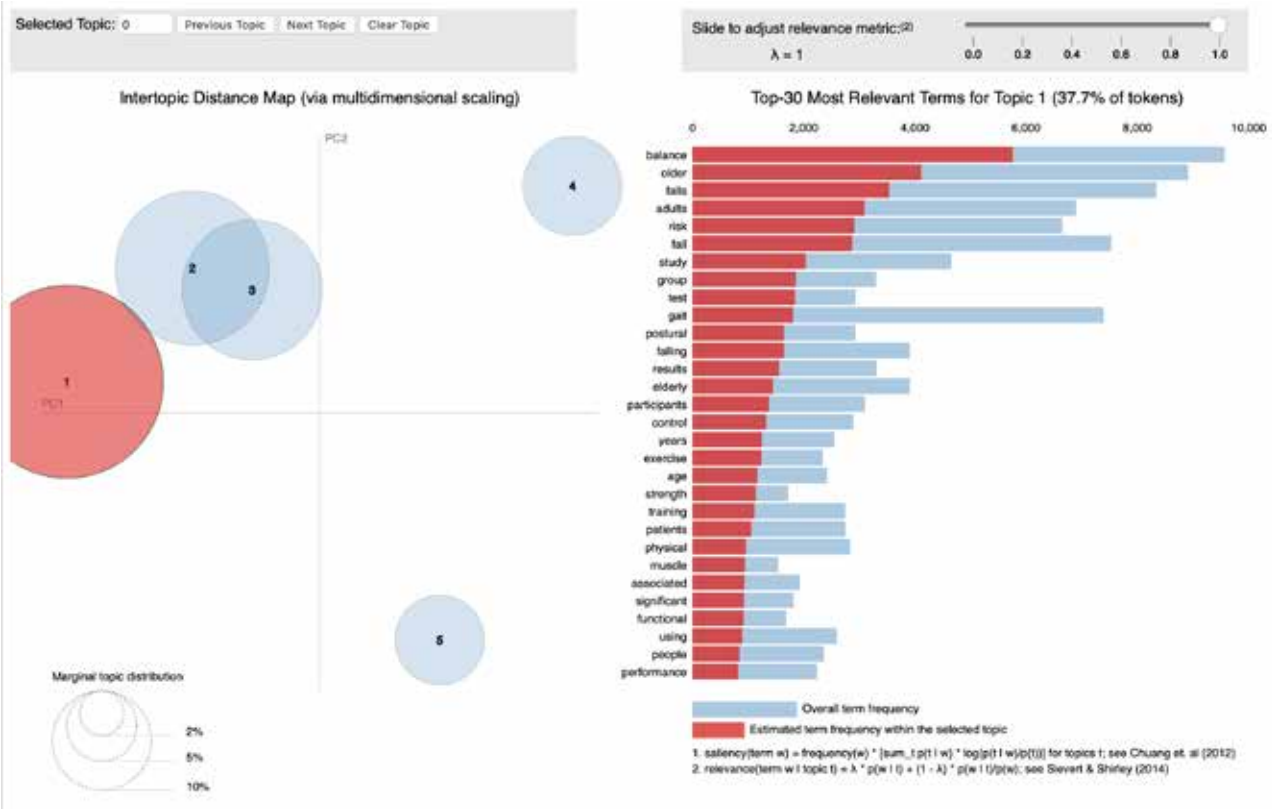

Figure 2. Screenshot of the Web Page

Note: The visualization includes an adjustable relevance metric slider (Slide to adjust relevance metric; λ = 1). The 30 most relevant terms for the selected topic are displayed (e.g., Top-30 Most Relevant Terms for Topic 1, which accounts for 37.7% of all tokens).

count.

4. After topic assignment, documents within each topic were sorted in descending order based on the number of keyword matches.
5. The sorted data was saved as a CSV table, enabling the selection of the most relevant documents for each topic.
6. From this CSV table, the top 10 documents per topic were selected, based on the highest keyword match count. These documents were deemed most representative of their respective topics, allowing for an in-depth exploration of their content.
7. The final selection was saved to a file, ensuring an objective, consistent, and structured distribution of documents across topics.

The visualization in Figure 2 confirms the identified thematic structure from high-relevance documents. The interactive intertopic distance map clearly illustrates the relationships and overlaps between the five identified topics.

- Each topic is represented as a circle, with its size reflecting the proportion of documents associated with that topic.
- The list of most relevant terms for each topic enhances interpretability by displaying the most frequent and contextually significant words.
- The adjustable relevance metric (λ) allows for fine-tuning the balance between term frequency within a topicand term exclusivity.

All these elements confirm that the model successfully identifies meaningful and significant topics.

Procedure 2.5.

Two approaches were used to select relevant documents:

1. Single-keyword method (Procedure 1).
2. Keyword-pair method (Procedure 2).

The data from Procedure 1 (Step 5.1) and Procedure 2 (Step 2.4) were compared.

Single-Keyword Method (Procedure 1)

- This method analyzes text for the presence of individual keywords characteristic of a topic.
- If a document contains one or more keywords from the list, it is included in the selection.
- This approach captures a larger number of documents but reduces precision, as single words can appear in various contexts without strong relevance to the topic.

Keyword-Pair Method (Procedure 2)

- This method requires the co-occurrence of keyword pairs within a document.
- The presence of both terms together strengthens the thematic connection between the document and the assigned topic.
- This approach produces a narrower but more precise selection of relevant documents.

A comparative analysis of the two methods for automatic extraction of relevant documents – using single keywords (Procedure 1) and keyword pairs (Procedure 2) – revealed significant differences. These differences explain the discrepancies in results obtained through the two approaches.

- The single-keyword method provides a broad overview of the topic, capturing a larger set of documents.
- The keyword-pair method focuses on in-depth analysis, extracting only the most relevant texts.

After applying LDA (Procedure 1) to identify topics and distribute words within each topic, a stability check of the modeling results was performed using various parameters (e.g., number of topics and passes). Additionally, the internal consistency of the model was evaluated using Coherence Score and Perplexity Score.

Evaluation of Topic Modeling Stability

To assess the quality of the LDA model (Procedure 2), two key metrics were calculated: Perplexity Score and Coherence Score.

- The Perplexity Score was -8.35, indicating an adequate fit of the model to the data.
- The Coherence Score was 0.478, which falls within the acceptable range for topic interpretability.

These metrics confirm the stability of the modeling results under the given parameters. The findings demonstrate that the identified topics accurately represent the content of the analyzed text corpus.

Comparative Analysis of Keyword Selection Methods

To verify the stability of LDA topic modeling results, two approaches were applied for keyword selection:

1. Single-keyword selection (Procedure 1)
2. Keyword-pair selection (Procedure 2)

The model quality was assessed using Perplexity Score and Coherence Score.

Results

- Single-keyword method (Procedure 1):
  - Perplexity Score: -8.6913
  - Coherence Score: 0.5155
- Keyword-pair method (Procedure 2):
  - Perplexity Score: -8.35
  - Coherence Score: 0.478

The single-keyword approach (Procedure 1) demonstrates better model quality, as indicated by higher coherence and lower perplexity values. However, the keyword-pair approach (Procedure 2) remains a more precise method, ensuring greater relevance of the identified topics.

Proposed Integration of Both Approaches

To achieve a balance between broad thematic coverage and detailed specificity, the results of both

methods were combined. This integration allows for:

- Capturing general thematic trends through single keywords.
- Identifying focused relationships between keywords through keyword pairs.

As a result, 51 documents were selected, reflecting a hybrid approach that integrates both single-keyword and keyword-pair methodologies. Notably, Study [29] was identified in both approaches.

Procedure 2.6

In this study, a text clustering approach was applied to select the most significant topics, based on content similarity. This method accounted for both thematic diversity and the uniqueness of each selected text.

The approach consisted of the following steps:

1. Text Vectorization Using TF-IDF:
   - Texts from the CleanedText column were converted into numerical representations using TF-IDF (Term Frequency-Inverse Document Frequency).
   - This method highlights word importance within a document and the entire dataset.
   - TF-IDF filters out frequent but uninformative words (e.g., conjunctions, prepositions), improving model accuracy.
2. Clustering Using the K-Means Algorithm:
   - Documents were grouped based on their vector representations.
   - The K-Means algorithm segmented the dataset into 50 clusters, minimizing intra-cluster differences while maximizing inter-cluster variation.
   - This process helped identify thematically related documents.
3. Selection of Key Documents:
   - One representative document per cluster was selected as the core document for its respective cluster.
   - A simple selection approach was used: the first document from each group was chosen.

Benefits of This Method

- Optimized text analysis while maintaining data representativeness.
- Reduced redundancy, ensuring a focus on key aspects of the research topic.
- The final set of 51 documents enables a comprehensive yet non-repetitive investigation of the subject matter.

Statistical Analysis

A Latent Dirichlet Allocation (LDA) model was applied for text data analysis, implemented using Python. Topic modeling was conducted on a dataset of 31,009 records to identify key themes and analyze significant words. For model evaluation, Perplexity Score and Coherence Score were used. To analyze data cluster structures, the K-Means clustering algorithm was applied. The pyLDAvis package was used for interactive topic visualization. Preprocessing techniques excluded numbers, symbols, and frequently occurring generic words to improve segmentation accuracy.

Results

The extracted bibliographic data from the Web of Science (WoS) database and their processing indicate a significant number of documents closely related by keywords. The relationships, distribution, and frequency of keywords are presented in Figure 3.

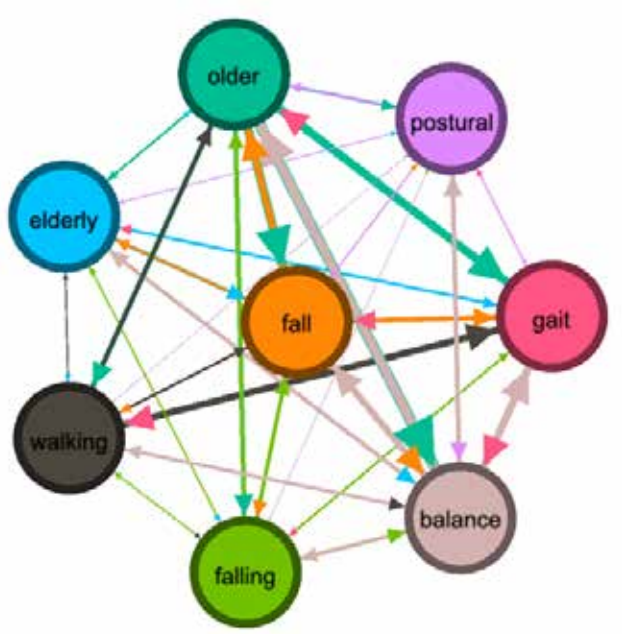

Figure 3. Visualization of Keyword Relationships and Frequency in Scientific Publications Based on WoS Data (Created Using Gephi [80]).

Figure 3 presents a data visualization created using Gephi [80]. The nodes in the graph represent keywords, while the edges (lines) between them depict their connections.

The interpretation of Figure 3 is as follows:

- Node Size: The larger the node, the more frequently the corresponding keyword appears in the dataset. In this case, node sizes are approximately the same.
- Edge Thickness: Thicker lines indicate a stronger relationship between keywords, while thinner lines represent a weaker connection.
- Arrow Direction: Indicates the direction of interaction between keywords.

Topic Modeling Based on LDA (Procedure 1)

LDA-based topic modeling (Procedure 1) demonstrates sufficient quality in data extraction using single keywords. Each topic is characterized

by the following data:

1. Topic 1 is defined by the words "older" (0.9958), "fall" (0.0042), and "balance" (5.75e-06), highlighting issues related to aging, falls, and balance maintenance. The high weight of "older" underscores the importance of old age as a key factor in the study.
2. Topic 2 focuses on movement, as indicated by the words "gait" (0.6340) and "walking" (0.3647), which have significant weights. This topic is crucial for understanding physical mobility and fall-related risks.
3. Topic 3 is centered around "elderly" (0.6865) and "falling" (0.3116), emphasizing fall risks among older adults and the impact of aging on falls. It is closely linked to fall prevention and safety measures in daily life.
4. Topic 4 is represented by the word "fall" (0.9999), making falls the central focus of the analysis. This topic explores various scenarios, consequences, and prevention strategies related to falls.
5. Topic 5 includes "balance" (0.7588) and "postural" (0.2159), stressing the importance of balance and posture. This topic is associated with physical exercises aimed at improving balance and reducing fall risks, likely related to training and muscle-strengthening approaches.

The analysis results confirm that LDA effectively identifies key topics, each reflecting critical aspects of elderly health and safety (Table 5). The topics cover fall risks, mobility, prevention methods, and safety strategies.

Based on the analysis of Table 5, several trends can be identified:

- Topic 4 has the largest number of documents, indicating its broad coverage.
- Average citation values (TC and Z9) gradually decrease from Topic 1 to Topic 5, which may suggest declining research attention to these topics.
- Average relevance values remain high across all topics, confirming the importance of the selected keywords.
- The lowest standard deviation in Topic 4 indicates stable relevance across its documents.

These findings are further supported by the data in Table 6.

Extracted Key Topics Based on Keywords (Procedure 2):

1. Topic 1: Fall Risk Assessment in Older Adults. This topic covers studies focused on identifying risk factors for falls in older adults. The primary focus is on using tests and methods to analyze balance and predict fall likelihood.
2. Topic 2: Biomechanical Aspects of Gait and Stability. This includes research on postural stability, movement control, and gait characteristics. Keywords indicate a focus on balance-related tasks and movement regulation.
3. Topic 3: Factors Associated with Falls. This topic examines various factors influencing fall frequency in adults and older individuals, including medical and behavioral aspects. It also addresses fall risk assessment and characteristics.
4. Topic 4: Physical Activity Programs and Their Impact. This covers intervention programs, including physical exercises and training aimed at fall prevention and improving physical fitness in adults and older individuals. The emphasis is on group sessions and their effectiveness.
5. Topic 5: Cognitive and Temporal Gait Parameters. This topic highlights gait characteristics such as step length, speed, and variability, as well as their relation to cognitive processes and timing parameters. The studies focus on movement analysis.

Following these topics (Procedure 2), the most relevant documents were extracted (Table 7).

Overall, the data in Tables 6 and 7 represent the 10 most typical topics that characterize various research directions. The results of LDA-based topic modeling demonstrated that both approaches – using a single keyword ("Procedure 1") and keyword pairs ("Procedure 2") – effectively identify significant topics related to the studied field. Topics identified in "Procedure 1" are characterized by a broad interpretation of key aspects, allowing for an effective analysis of general research directions. At the same time, "Procedure 2" demonstrated a more precise focus, ensuring the selection of documents with a higher degree of relevance.

A comparative analysis of the extracted documents (Tables 6 and 7) suggests that both approaches have their advantages. The single-

Table 5. Statistical Indicators of Citation and Document Relevance for the Top 5 Topics (Procedure 1)

Topic	Document_Count	TC	Z9	Relevance_Score_Mean	Relevance_Score_StdDev
1	5	29.4 ± 22.15	34.0 ± 25.15	0.9999977805	0.0000031450
2	10	22.9 ± 20.47	27.7 ± 22.7	0.9999936866	0.0000043344
3	8	13.12 ± 7.4	14.88 ± 8.43	0.9999962887	0.0000030991
4	15	20.33 ± 19.27	24.13 ± 21.73	0.9999980458	0.0000009748
5	8	9.12 ± 7.53	10.62 ± 8.93	0.9999948755	0.0000043038

Table 6. Top 25 Publications Extracted Based on Procedure 1

Topic	Document_ ID	Research Objective	Participants	Age (Mean ± SD)	Methods (Tests and Equipment)	Results	Conclusions
1	[86]	To compare COM-COP indicators during walking in older adults with and without a history of falls to identify fall mechanisms.	40	Not specified	Vicon system for kinematic analysis; two force platforms for measuring ground reaction forces.	COM-COP at heel contact was higher in fallers (stumbled: 14.3 ± 2.7 cm, slipped: 15.3 ± 1.1 cm) than in non-fallers (12.0 ± 2.7 cm); at full support, COP was behind in slip-fallers (-14.9 ± 3.6 cm) vs. non-fallers (-10.3 ± 3.9 cm); at mid-step, COM in stumbled-fallers was ahead of COP (0.9 ± 1.6 cm) vs. behind in slip-fallers (-1.2 ± 2.2 cm).	Differences in balance control between groups indicate distinct fall mechanisms depending on the type of fall.
1	[87]	To study the effects of age and uneven surfaces on motor control for stabilizing the mediolateral trajectory of the swing limb.	13 young, 11 older adults	Young: 23 years; Older: 73 years	Uncontrolled Manifold Analysis (UCM); lower limb segment angles as degrees of freedom for trajectory analysis.	Both young and older adults used motor flexibility to stabilize foot trajectory, but older adults increased «good» variability to compensate for age-related instability on uneven surfaces.	Increased variability is a compensatory strategy for age-related declines in strength and balance. Fall prevention may include exercises to strengthen synergies.
1	[88]	To identify risk factors for postural disadaptation syndrome (PDS) in older adults after a fall and conduct a one-year follow-up.	70 patients over 70 years old	Not specified	Case-control study; clinical data, imaging data from the past 3 years, annual follow-up.	PDS was identified in 29 of 70 patients (41.4%). Risk factors: age, gait impairment before the fall, walker use, lack of outdoor walking, vision impairment, dorsiflexion restriction, grip strength, and fear of falling. After one year, 52.9% with PDS could transfer, and 64.7% could walk (compared to 80.7% and 85.2% in those without PDS).	Functional impairments and activity restrictions before the fall suggest a pre-existing psychomotor disadaptation syndrome. Improving vision, strength, and reducing fear of falling could be key prevention strategies. PDS diagnosis may serve as a marker of mobility loss.
1	[89]	To assess the effects of task management and resistance training on gait parameters in older adults under dual-task (DT) conditions.	78 older participants	72.0 ± 4.9 years	Randomized controlled trial; task management training (balance and coordination) and resistance training; gait assessment and Stroop task on a treadmill.	Training improved step length ($p < 0.001$) and step line (ST: $p < 0.01$; DT: $p < 0.05$) in both training groups. The BDT group showed the greatest improvements in step length ($p < 0.001$) and step line ($p < 0.01$) under DT conditions; fear of falling decreased in both groups ($p < 0.05$).	Integrating task management strategies into balance and strength training demonstrated a promising approach to fall prevention in older adults.

Table 6. Continued

Topic	Document_ ID	Research Objective	Participants	Age (Mean ± SD)	Methods (Tests and Equipment)	Results	Conclusions
1	[90]	To evaluate the effects of a dual- and multitask balance training program on self-efficacy, fear of falling, gait, and balance in older adults with osteoporosis and high fall risk.	90–96 older participants	66–87 years	Randomized controlled trial; progressive balance training 3 times per week and physical activity (30 min, 3 times per week); assessment of self-efficacy, fear of falling, gait speed under tasks, and balance/function tests (GAITRite®).	Both intervention groups improved self-efficacy in falls ($p = 0.034$) and balance compared to the control; significant differences in dual-task gait speed ($p = 0.003$), fast walking ($p = 0.008$), and improved lower limb function ($p = 0.034$).	A dual- and multitask balance training program enhances self-efficacy, gait speed, balance, and physical function in older adults with osteoporosis.
2	[91]	To assess the prevalence of fall risk factors among older adults living in long-term care facilities.	163 older participants	60–95 years	Fall risk assessment for long-term care facilities, Mini-Mental State Examination (MMSE), Berg Balance Scale, Fall Risk Assessment Form, Dynamic Gait Index; analysis using odds ratio, chi-square test, and t-test.	Falls were associated with poor vision (OR = 1.851), chronic diseases (OR = 1.633), dizziness (OR = 2.237), balance impairment (OR = 3.105), fear of falling (OR = 3.227), and previous falls (OR = 5.661) (all $p < 0.001$). High- and low-risk groups significantly differed in functional and cognitive indicators.	Fall history, poor vision, polypharmacy, chronic diseases, assistive device use, dizziness, and balance issues are linked to an increased fall risk in older adults in care facilities. Women had a higher fall risk than men.
2	[92]	To evaluate the long-term effects of balance training on fall-related anxiety, gait, balance, and physical function in older adults with osteoporosis and high fall risk.	96 older participants	66–87 years	Randomized controlled trial; balance training with dual-task and multitask exercises, FES-I, gait assessment with cognitive tasks, balance and physical function tests (LLFDI).	The balance training group showed long-term positive effects on fall-related anxiety ($p < 0.001$) and gait ($p \leqslant 0.05$, improvement of 0.9–1.4 m/s) by 15 months. In the training + physical activity group, scores returned to baseline at 9 months and declined by 15 months.	Balance training reduced fall-related anxiety and improved gait in older adults with osteoporosis and high fall risk over the long term, which is important for fall prevention.
2	[93]	To examine differences in balance function between older adults with and without diabetes (DM) and identify factors associated with balance function in older adults with DM.	208 older participants	Not specified	Balance assessment (POMA), activity measures (ADL, IADL), cognitive status (MMSE); HbA1c, FPG, TC, TG, and LDL measurements in the DM group.	Fall incidence was higher in the DM group ($p < 0.01$). POMA, ADL, and IADL scores were lower in diabetics ($p < 0.05$). In the DM group, POMA score was positively correlated with ADL, IADL, and MMSE scores and negatively correlated with age and diabetes complications. Decreased POMA scores were associated with diabetes complications, reduced IADL, and lower MMSE scores.	Multiple diabetes complications, lower MMSE, ADL, and IADL scores were linked to impaired balance function in older adults with DM. This may serve as a warning for early medical intervention.

Table 6. Continued

Topic	Document_ ID	Research Objective	Participants	Age (Mean ± SD)	Methods (Tests and Equipment)	Results	Conclusions
2	[94]	To assess the diagnostic accuracy of self-reported measures from the STEADI program for identifying fall risk in older adults.	95 older participants	65+ years	Self-reported STEADI questions, Timed Up-and-Go (TUG) test as a fall risk criterion; ROC analysis.	Two self-reported questions («I feel unsteady when walking» and «I need to push with my hands to stand up from a chair») showed high discriminatory ability (AUC 0.906; 95% CI 0.870–0.942) for identifying fall risk. Additional questions did not improve accuracy.	Two self-reported questions effectively identify individuals at risk of falling, potentially reducing the need for performance-based tests in routine screening.
2	[95]	To determine the relationship between competence, usability, environment, and fall risk in older adults.	123 older participants	70+ years	Tinetti Scale, CESD-7, Montreal Cognitive Assessment, home usability questionnaire, home environment assessment; regression models.	42.0% of participants experienced falls, more frequently among women and those aged 70–75. Fall risk factors included the home environment, walking, and usability. A negative association was found between usability and depressive symptoms, cognitive health, balance, walking, and the social and physical environment ($p < 0.05$). A positive correlation was observed between walking and balance ($p < 0.05$).	The study helps understand the connections between usability, fall risk, and other variables, which is important for fall prevention strategies.
3	[96]	To investigate changes in balance function in older adults after an 8-week perturbation-based balance training program.	17 older participants	Not specified	Dynamic perturbation-based balance training program; specialized treadmill inducing perturbations; 3D motion analysis system; paired t-test.	After training, COM control significantly improved during quiet standing with perturbations, while COP control without perturbations remained unchanged. The training positively affected dynamic balance function.	A new balance training program may be beneficial for high-fall-risk patients and represents an important direction in balance research for older adults.
3	[97]	To compare the effects of upper and lower body exercises on postural balance in older women and determine recovery time after exercise.	9 older women	Not specified	Arm ergometry (ACE), cycle ergometry (CE), treadmill walking (TM); force platform for postural balance assessment; balance recovery measurements at 1, 3, 5, 10, 15, and 30 minutes.	ACE did not cause balance impairments, while CE and TM induced significant balance disturbances lasting about 10 minutes post-exercise.	Older adults should exercise caution after lower limb workouts to reduce fall risk.

Table 6. Continued

Topic	Document_ ID	Research Objective	Participants	Age (Mean ± SD)	Methods (Tests and Equipment)	Results	Conclusions
3	[98]	To determine the prevalence of balance impairments and the impact of sociodemographic, medical, and social factors on postural balance in older adults.	607 older participants	73.99 ± 6.6 years	Home-based survey, sociodemographic and medical data collection; Berg Balance Scale (BBS).	Balance impairments were found in 34.3% of older adults. Factors associated with balance impairments included age, disability, presence of four or more chronic diseases, incontinence, fall history, lack of regular walking, absence of active leisure, and obesity.	Balance impairments are widespread among older adults and may be influenced by biological and social factors. National measures are needed to address causes and enhance prevention as the elderly population grows.
3	[99]	To assess differences in P300 event-related potential between young and older adults during a balance maintenance task.	Young and older adults	Young: < 35 years; Older: > 64 years	Visual oddball paradigm, P300 event-related potential recording during a postural task.	P300 latency significantly increased ($p < 0.001$) in older adults during complex postural tasks, whereas balance did not affect latency in young adults. Older adults required more time for stimulus processing.	Increased attentional demands in older adults require additional brain resources for balance tasks, suggesting age-related changes in cognitive function.
3	[100]	To study the effects of low-intensity vibration on ankle muscles and postural stability in young adults, healthy older adults, and older adults at high fall risk.	Young (HY), healthy older adults (HE), older adults at high fall risk (FR)	Not specified	Anterior-posterior and mediolateral angular deviations, linear COM displacements; vibration at 30 and 40 Hz; quiet standing with eyes open and closed.	During quiet standing with eyes open, the FR group showed greater deviations and COM displacements. Vibration at 40 Hz increased deviations in HY and HE groups but had no effect on FR. At 30 Hz, angular deviations and COM displacements decreased in the FR group.	Mild ankle muscle vibration improves balance in high-fall-risk older adults, potentially reducing fall risk and enhancing postural stability.
4	[101]	To determine whether demographic variables, cognitive function, and self-perceived balance predict gait speed variability in older adults during single-task and dual-task conditions.	62 older participants	Not specified	Demographic data, cognitive function (MoCA), functional mobility, ABC scale for self-perceived balance, PASE scale for physical activity; linear regression models.	MoCA score ($p = 0.003$), gender ($p = 0.040$), and years of education ($p = 0.010$) significantly predicted DTGSCV ($R^2 = 0.297$). MoCA score ($p = 0.008$) and years of education ($p < 0.001$) predicted DTEGSCV. The regression model for STGSCV was significant, but without significant individual predictors.	Older adults with lower MoCA scores and higher education levels exhibit greater gait speed variability in dual-task conditions, which may indicate mobility issues and fall risk.

Table 6. Continued

Topic	Document_ ID	Research Objective	Participants	Age (Mean ± SD)	Methods (Tests and Equipment)	Results	Conclusions
4	[102]	To compare the effects of dual-task (DT) training on gait parameters in older adults with and without concern about falling (CoF) versus a control group.	90–95 older participants	71.5 ± 5.2 years	Single-center parallel RCT; 12-week training (60 min sessions); visual-verbal Stroop task; gait measurement on a treadmill; repeated-measures ANOVA 2x2x2.	Participants in the intervention group showed increased step length under ST and DT conditions compared to the control group. Improved foot roll motion and cognitive performance were observed only in participants without CoF.	DT training improves gait parameters in older adults with and without CoF. Additional interventions, such as cognitive-behavioral therapy, may help eliminate cautious gait patterns in participants with CoF.
4	[103]	To examine the relationship between physical activity (PA), physical performance, and psychocognitive functions in older adults in long-term care facilities to develop fall prevention strategies.	44 older participants	85 ± 8 years	PA assessment using activPAL3™; balance tests, gait speed, dual-task performance, reaction time, coordination, grip strength, and leg strength tests; assessment of quality of life, balance confidence, fear of falling, and cognitive function; linear and ordinal regression models.	Average walking time was 0.5 ± 0.4 hours/day. Higher PA levels were significantly associated with improved balance (B = 1.6 for moderate level, B = 1.3 for high level) and dual-task performance (OR = 7.9 per 0.5 hours/day). No associations were found with other measures.	More physically active residents showed better balance and dual-task performance, which may contribute to fall prevention. PA programs aimed at improving these skills are beneficial in long-term care facilities.
4	[104]	To investigate the effects of a multicomponent training program on ankle muscle strength and health in older adults.	26 older participants (EG: 12, CG: 14)	EG: 69.7 ± 4.8 years; CG: 70.86 ± 6.48 years	Multicomponent training focusing on ankle extensors, 3 times per week for 12 weeks; assessment of strength (plantar flexion and dorsiflexion), reactive ability (Step test), and functional mobility (gait speed and TUG test).	In the EG group, peak torque increased by 50% (d = 1.59), reactive ability improved (Swing phase time decreased by 19%, total Step test time by 14%), gait speed increased by 15% (d = 1.37), and TUG time decreased by 17% (d = 1.73).	Multicomponent training effectively reduces age-related muscle strength loss and improves functional ability, which may help lower fall risk in older adults.

Table 6. Continued

Topic	Document_ ID	Research Objective	Participants	Age (Mean ± SD)	Methods (Tests and Equipment)	Results	Conclusions
4	[105]	To examine the effects of gait speed on the functional roles of individual lower limb muscles in healthy older adults.	10 young and 10 older participants	Not specified	3D gait recording at slow, normal, and fast speeds (0.7 m/s, 1.4 m/s, 1.7 m/s); full musculoskeletal model to calculate muscle forces and contributions to ground reaction forces.	Lower limb muscle function was similar at equivalent speeds in both groups. In older adults, the gluteus maximus generated greater support and braking force in early stance, while the gastrocnemius contributed less to forward propulsion in late stance.	The findings enhance understanding of lower limb muscle roles in older adults and may help develop exercises aimed at improving support and balance in individuals at risk of falling.
5	[106]	To examine the effects of Pilates on fall risk, fear of falling, postural balance, mobility, and physical activity in older adults.	61 older adults	70.08 ± 5.51 years	RCT; Pilates twice a week for 12 weeks; cognitive function assessment (MoCA), postural balance (force platform), gait speed (electronic treadmill); GEE analysis.	Pilates positively affected TUG, balance in AP and ML directions, step frequency, stance time, step length, and double support. Step time and double support showed significant differences between groups ($p < 0.05$). Age and health status were significant factors for TUG, FRT, and balance.	Pilates improves functional mobility, balance, and gait parameters in older adults. Further research is needed to assess its long-term effectiveness in fall prevention.
5	[107]	To separate the physical and psychological aspects of threat and assess the effects of verbal warning about an upcoming perturbation on gait parameters in young and older participants.	10 young, 10 older participants	Young: 29.4 ± 3.9 years; Older: 72.9 ± 3.5 years	Measurement of spatiotemporal and balance parameters using a motion analysis system and treadmill; repeated-measures ANOVA.	Verbal warning in young participants led to reduced step length ($p = 0.008$), increased step width ($p = 0.049$), forward COM shift ($p = 0.016$), increased stabilizing forces, and reduced destabilizing forces. Most older participants did not show this effect.	Psychological threat affects gait and balance parameters in young participants similarly to physical threat but is observed in only a minority of older participants.
5	[108]	To assess the short-term effects of dual-task balance training on spatiotemporal gait parameters in older women with osteoporosis.	90–95 older women with osteoporosis	Not specified	12-week balance training (3 times per week) or standard care; electronic walkway system for gait assessment in single-task and dual-task conditions.	The training group increased gait speed in both conditions ($P \leqslant .044$), improved step frequency ($P \leqslant .012$), and reduced step time and swing phase duration ($P \leqslant .045$). Significant differences in gait variability were observed in dual-task conditions ($P \leqslant .041$). Speed improvement was greater in the dual-task condition (0.10 m/s) than in the single-task condition (0.05 m/s).	Dual-task training improves various gait parameters and supports safer walking in older women with osteoporosis, highlighting the importance of cognitively demanding exercises.

Table 6. Continued

Topic	Document_ ID	Research Objective	Participants	Age (Mean ± SD)	Methods (Tests and Equipment)	Results	Conclusions
5	[109]	To compare the Timed Up and Go (TUG) test and the Performance-Oriented Mobility Assessment (POMA) test for predicting fall risk in older patients.	340 older participants	70.79 ± 5.38 years	Balance and gait assessment using TUG and POMA tests; collection of demographic data, comorbidities, and risk factors.	TUG sensitivity was 76.2%, POMA was 69.5%; TUG specificity was 91.1%, POMA was 89.8%. Kappa values for TUG and POMA were 0.680 and 0.606, respectively. TUG positively correlated with falls (r = 0.642), while POMA correlated negatively (r = -0.372).	The TUG test is a useful tool for assessing fall risk in older adults.
5	[110]	To assess changes in posturographic parameters associated with balance improvement in older adults and identify biomechanical markers of fall risk.	Older adults aged 65+ living in care facilities	Not specified	Computerized posturography, automated gait analysis, monthly measurements of static and dynamic balance; variance analysis to assess MDC.	Results not yet published; it is hypothesized that balance improvement through the APA program will lead to a reduction in falls and improved postural parameters, allowing the identification of biomechanical markers sensitive to physical condition changes.	The study may identify new posturographic and kinematic markers predicting fall risk, which could enhance fall risk assessment and prevention strategies in care facilities.

Table 7. Top Publications Extracted Based on Procedure 2.

Topic	Document_ID	Research Objective	Participants	Age (Mean ± SD)	Methods (Tests and Equipment)	Results	Conclusions
1	[111]	To assess which tools best predict fall risk in older adults.	Not available	Not available	Electronic searches (Medline, EMBASE, Cochrane Library, etc.); QUADAS-2 tool; meta-analysis using MetaDisc 1.4.	Out of 2,321 articles, 33 studies were selected. The Berg Balance Scale and fall chart showed high specificity, whereas other tools (Downton, Hendrich II, etc.) demonstrated low predictive validity.	Using two tools simultaneously allows for considering the multifactorial nature of falls and maximizing effectiveness in predicting fall risk.
1	[112]	To examine the effects of the Otago Exercise Program (OEP) on the functionality of older adults using technology.	Minimum 30 participants	65 years and older	Quasi-experimental study using the FallSensing Home app, Kallisto device, and tests for balance, strength, and mobility.	Participant recruitment was suspended due to COVID-19. The study was approved on October 9, 2020, with resumption expected in Q3 2021.	The study results will contribute to the development and implementation of large-scale research aimed at testing technologies in clinical settings.

Table 7. Continued

Topic	Document_ID	Research Objective	Participants	Age (Mean ± SD)	Methods (Tests and Equipment)	Results	Conclusions
1	[113]	To evaluate the use of the G-STRIDE prototype for fall risk analysis in older adults, determine threshold values, and develop a predictive model to distinguish between fallers and non-fallers.	163 participants: 86 fallers, 77 non-fallers	82.63 ± 6.01 years	SPPB, frailty criteria, FES-I, TUG, GDS, inertial measurement unit (IMU). Logistic regression for fall prediction using 70% of data for training and 30% for testing.	G-STRIDE achieved an AUC of 77.6% (sensitivity 0.773, specificity 0.780). A total of 46 threshold values were identified for parameters. Predictions for the test group were comparable to traditional methods.	The G-STRIDE IMU predicts fall risk with high accuracy (77.6%), offering an accessible and cost-effective tool for early intervention and fall prevention in older adults.
1	[114]	To assess the reliability and validity of postural control measurements using a force platform (FP) in healthy older adults.	46 healthy older adults	67.67 ± 5.1 years	NeuroCom Equitest FP (LOS, MCT, SOT tests), Mini-BESTest, Functional Gait Assessment, 10-meter and 6-minute walk tests; ICC, SEM, MDC95, Pearson correlation.	LOS, MCT, and SOT tests demonstrated good reliability (ICC up to 0.90). However, SEM and MDC95 values were high. Correlations between FP and clinical balance and gait tests were moderate or absent.	FP provides reliable balance data, but high SEM and MDC95 values limit its application in healthy older adults. The relationship between FP and clinical tests was not confirmed. Further research is needed.
1	[115]	To evaluate the effectiveness of a modified version of the Otago Exercise Program (OEP) for fall prevention in adults with intellectual and/or cognitive disabilities (IDD).	15 participants	Not specified	CDC STEADI tools, 30-second chair stand test, 4-stage balance test, 2-minute walk test. Weekly 1-hour sessions and home exercises for 7 weeks.	Improvements in chair stand, balance, and walking tests. Three participants improved independent walking. No falls were recorded.	Further research is needed on the modified OEP program for adults with IDD, including multicenter studies with larger samples, extended participation, and long-term follow-up.
1	[116]	To examine the application of the Short Physical Performance Battery (SPPB) for fall risk assessment in older adults and its integration into the STEADI model.	417 older adults	76 years (IQR: 70–82)	SPPB assessment (gait time, chair rise, balance), classification into three performance groups. Quarterly fall monitoring for 4 years, multivariate regression.	Low SPPB scores and slow gait time were associated with increased fall risk at 1 year (RR 1.53; CI 1.09–2.17) and 4 years (RR 1.61; CI 1.07–2.41). Risk was higher in participants with positive STEADI screening and low SPPB.	SPPB shows potential for fall risk assessment and may complement the STEADI model. Further research is needed to confirm its effectiveness in larger populations.

Table 7. Continued

Topic	Document_ID	Research Objective	Participants	Age (Mean ± SD)	Methods (Tests and Equipment)	Results	Conclusions
2	[117]	To examine the effects of increased visuomotor errors on head and torso movements and test the hypothesis of visual error minimization.	Not specified	Not specified	Immersive virtual environment, task with increasing visuomotor errors, analysis of head and torso movements, mediolateral range, step length/width, and mediolateral postural sway.	Participants increased mediolateral torso movements in response to optic flow with positive feedback. After exposure, mediolateral postural sway decreased, and steps became longer and narrower.	Sustained reduction in postural sway may be used for balance control training during walking, which is promising for older adults.
2	[118]	To investigate neuroplasticity induced by slip-response training and identify neural substrates involved in balance adaptation.	10 young participants	Not specified	Treadmill training with acceleration of 6 m/s² over 3 days. MRI study of brain activity during imagined slipping and walking.	Reduction in compensatory steps and improved stability after training. Increased activity in the DLPFC, parietal, and occipital cortices post-training.	Slip-response training leads to cortical changes, including in the DLPFC. The CNS actively engages motor, parietal, and occipital areas to control movement, enhancing balance adaptation efficiency.
2	[119]	To examine how cognitive and sensorimotor functions influence older adults' ability to adapt gait when encountering obstacles and performing target stepping tasks.	50 healthy older adults	74 ± 7 years	Stroop test, Trail-Making test, reaction time tests, obstacle avoidance and target stepping tasks on a projection treadmill, postural sway analysis, and quadriceps strength assessment.	Stroop and reaction time tests identified participants with step errors. Poor Trail-Making test results were associated with shorter penultimate steps. Weak reaction time and postural sway correlated with lower step speed and accuracy, while quadriceps weakness also reduced accuracy.	Executive function, processing speed, muscle strength, and balance contribute to successful gait adaptation. These findings are valuable for fall risk assessment and prevention strategies. Processing speed is critical for precise steps and step length adjustments.
2	[120]	To evaluate the effectiveness of long-term balance training with and without vibrotactile sensory augmentation in community-dwelling older adults.	12 older adults	75.6 ± 4.9 years	8-week home-based training (45 min, 3 times per week) using a smartphone balance trainer. Balance assessment with Sensory Organization Test, Mini Balance Evaluation Systems Test, and Five Times Sit-to-Stand Test.	The experimental group showed significant improvements in the Sensory Organization Test, Mini Balance Evaluation Systems Test, and Five Times Sit-to-Stand Test compared to the control group. No differences were found in other clinical tests between groups.	Vibrotactile sensory augmentation is effective for balance rehabilitation in older adults. Telerehabilitation with minimal specialist involvement is feasible and effective.

Table 7. Continued

Topic	Document_ID	Research Objective	Participants	Age (Mean ± SD)	Methods (Tests and Equipment)	Results	Conclusions
3	[121]	To investigate whether fear of falling is a cause, consequence, or combination of both in community-dwelling older adults (⩾ 75 years).	640 participants	Not specified	Longitudinal study; collection of sociodemographic data, health status, fall history, and fear of falling (2009–2011).	Falls were observed in 25% of participants at baseline and in 35.2% after 24 months. Fear of falling was associated with female gender, disability, and depressive symptoms.	Fall history is a predictor of fear of falling. However, fear of falling predicts falls only in unstandardized models. Gender should be considered as a modifier of this relationship.
3	[122]	To compare fall history in older adults with and without stroke and identify factors associated with falls and fear of falling.	75 stroke patients, 50 control participants	66 ± 7 years	Fall Efficacy Scale-International, Berg Balance Scale, Functional Ambulation Category, Fatigue Severity Scale, Montreal Cognitive Assessment, Patient Health Questionnaire-9, Fugl-Meyer Motor Assessment.	Stroke patients had more recurrent falls ($P < 0.01$) and greater fear of falling ($P < 0.01$). Ambulation level explained 22% of the variance in fear of falling among stroke patients.	Stroke patients experience more recurrent falls and greater fear of falling. Fear of falling is associated with ambulation level. The results highlight the importance of identifying risk factors for fall prevention.
3	[123]	To assess the frequency of fall risk evaluation and treatment in older adults with upper limb fractures.	309,947 older adults	66–99 years	Analysis of Medicare claims, outpatient hospitalization data (2007–2009), logistic regression, narrow (gait training) and broad (gait training/ physical therapy) service definitions.	Only 10.7% of patients received assessment or treatment under the narrow definition and 18.5% under the broad definition. Factors increasing service likelihood: prior assessment, more comorbidities, nursing home residence, older age, shoulder fracture, female sex, and white race.	A small proportion of older adults with upper limb fractures receive fall risk assessment or treatment. Efforts are needed to improve fall risk management in this group.
3	[124]	To evaluate the impact of cataract surgery, vision impairment, and associated risk factors on fall frequency in older adults.	380 patients	>50 years	Cross-sectional study, medical records and personal interviews, logistic regression analysis.	Fall frequency: cataract group – 18.9%, surgery group – 11.6%. Major risk factors: taking >4 medications/day and slow gait speed.	Cataract surgery reduces fall frequency but is not a significant protective factor. Taking >4 medications and slow walking increase fall risk.
3	[125]	To assess clinical characteristics, including surface types and factors associated with severe injuries from outdoor falls in older adults.	7,635 older adults	Not specified	Classification by injury severity, comparative analysis of characteristics, logistic regression analysis.	Severe injuries occurred in 5% of participants. Higher risk was observed in men, alcohol consumers, and those falling from stairs. Surface type did not affect injury severity.	Men and stair falls are associated with a high risk of severe injuries. Surface type does not significantly influence injury severity.

Table 7. Continued

Topic	Document_ID	Research Objective	Participants	Age (Mean ± SD)	Methods (Tests and Equipment)	Results	Conclusions
3	[126]	To assess the relationship between the number of fall-risk-increasing drugs (FRIDs) and fall-related fractures.	61 fallers, 121 non-fallers	⩾75 years (SD not available)	Standardized medication history collection, analysis of FRID count, linear mixed model.	Mean FRID count was similar: 3.1 ± 2.1 (fallers) vs. 3.2 ± 1.8 (non-fallers). No significant differences were found after adjusting for risk factors (p = 0.721).	No differences in the number of FRIDs were observed between hospitalized and outpatient patients.
3	[127]	To determine the frequency of falls, fall-related injuries, and risk factors in patients with heart failure.	Not specified	Not specified	Systematic literature review using databases (MEDLINE, CINAHL, PubMed, PsycINFO, etc.), analysis of primary studies.	Fall frequency in heart failure patients was 43%. Identified risk factors included benzodiazepines and digoxin, while loop diuretics were not significant.	Further research is needed to examine risk factors, injuries, and develop interventions for fall prevention.
4	[128]	To investigate how changes in «head jerk» during walking help understand age-related changes in dynamic stability.	43 young, 100 older adults	Not specified	Accelerometers to measure cadence, step length, speed, harmonic ratios, step time variability, and jerk.	Older adults exhibited greater mediolateral head jerk (p ⩽ 0.004) and lower vertical jerk. The ML/VT jerk ratio differentiated groups with 89% accuracy.	Reduced VT head jerk in older adults is associated with decreased walking energy, while increased ML jerk reflects age-related stability changes. Smoother head movements in younger adults indicate better dynamic control.
4	[129]	To examine the effectiveness of the Otago Exercise Program (OEP) in improving actual and perceived balance in older adults and to identify the most effective OEP protocol for balance improvement.	Not specified	Not specified	Systematic review of RCTs following PRISMA guidelines. Intervention formats, training frequency, and duration were analyzed.	OEP improved static (g = 0.388), dynamic (g = -0.228), proactive (g = 0.239), and perceived balance (g = -0.184). Group sessions and sessions longer than 30 minutes were more effective.	OEP enhances static, dynamic, and proactive balance, improves balance confidence, and reduces fear of falling. Group sessions lasting more than 30 minutes are the most effective.
4	[130]	To evaluate the effects of a four-month judo training program on fall skills and motivation for physical activity in older beginners.	16 participants	69.3 ± 3.9 years	Visual analog scales (VAS), MPAM-R and SRQ-E questionnaires, fall technique assessment by two experts before and after the program.	Significant improvement in fall technique (p < 0.001). Increases in enjoyment, socialization, competence, and motivation (p < 0.05). Fear of falling remained unchanged, and enjoyment of training remained high.	Judo training improves fall skills and motivation for physical activity in older adults. It is a promising tool for fall prevention and increasing engagement in physical activity.

Table 7. Continued

Topic	Document_ID	Research Objective	Participants	Age (Mean ± SD)	Methods (Tests and Equipment)	Results	Conclusions
5	[131]	To determine whether spatiotemporal gait parameters can distinguish older adults at fall risk from those without and identify differences between the two groups.	Not specified	Not specified	Systematic review of articles; electronic search (Scopus, Embase); effect size analysis for gait parameter comparison.	Among 5,381 articles, 17 were selected. Fallers showed lower gait speed, step frequency, increased double support time, and greater gait variability. Step length and gait speed were the most significant parameters.	Spatiotemporal gait analysis on flat surfaces is insufficient for reliably predicting falls in older adults due to methodological differences and a limited number of parameters.
5	[132]	To determine the age at which significant gait speed decline occurs in a large sample of women.	653 women	18–89 years, 5 age groups	Spatiotemporal gait parameters measured using GAITRite®. Two regression models to analyze threshold age. ANOVA to identify differences between groups ($\alpha = 0.05$).	Gait speed decline begins at age 65 and becomes significant at 71. Speed decreases by 0.31 cm/s per year, accelerating to 1.75 cm/s per year after 71. The average speed of women over 71 was 115.4 cm/s (7.8% lower than a decade earlier).	Age 71 is identified as the threshold for significant gait speed decline. Timely interventions are needed to slow age-related gait decline and prevent falls and mobility loss.
5	[133]	To investigate whether walking with shoes or barefoot is more suitable for perturbation-based balance training in older adults.	14 healthy older adults	68.29 ± 3.41 years	Walking (regular and trip-perturbed) on a treadmill, marker trajectory analysis in the Human Body Model (Gait Offline Analysis Tool), ANOVA.	Shoe condition effect ($p = 0.0310$) and its interaction with gait pattern type ($p = 0.0055$) were found for swing time variability.	Barefoot walking reduces swing time variability, making it more suitable for perturbation-based balance training in older adults.
5	[134]	To examine the relationship between neurovascular coupling (NVC) and gait parameters under single- and dual-task conditions in older adults.	70 older adults, divided into low (n = 35) and high (n = 35) NVC groups	84 ± 5 years	Transcranial Doppler, n-back task, gait parameter measurement (step width, step length, step time, double support time).	Low NVC was associated with narrower step width, shorter step length, and increased double support time in both tasks. Speed was reduced only in the single-task condition.	Reduced cerebral blood flow regulation is linked to impaired gait parameters but does not increase the «cost» of performing dual tasks.
5	[135]	To examine spatiotemporal gait parameters in older adults with and without mild cognitive impairment (MCI) during transitions from slow to fast walking speeds and vice versa.	50 older adults	MCI: 68.56 ± 3.79; Control: 68.72 ± 4.67 years	Transitions from slow to fast speed and vice versa in response to random cues. Measurement of spatiotemporal gait parameters, repeated-measures ANOVA analysis.	Older adults with MCI exhibited greater step length variability ($p = 0.03$) and step time variability ($p = 0.03$) during transitions from fast to slow speed compared to the cognitively intact group. No significant differences were found in other parameters.	Individuals with MCI experience difficulties in adapting gait to speed changes, indicating impaired automatic control. Transition tasks may be useful for screening fall risk in this group.

keyword method is suitable for analyzing a wide range of topics, whereas the keyword-pair method enables a more detailed examination of narrowly focused aspects. This approach contributes to forming a balanced selection of documents.

Discussion

The goal of this systematic review is to identify key patterns and risk factors for falls in older adults and propose recommendations for their prevention. The analysis revealed important connections between physical activity, postural control, cognitive load, and fall risk. The reviewed studies discuss both direct effects on improving functional mobility and stability, as well as social, age-related, and medical factors that influence older adults' ability to maintain balance in daily life. The findings confirm the importance of comprehensive fall prevention approaches that include physical training, cognitive health considerations, and participants' psycho-emotional readiness.

Based on the obtained data, several topics related to fall risk factors and prevention strategies in older adults were identified. The analysis resulted in the selection of 10 key topics (Tables 6 and 7). The topics in Table 6 are characterized by a broad interpretation of key aspects, allowing for an effective analysis of general research directions. At the same time, the topics in Table 7 have a more specific focus, ensuring the selection of documents with a higher degree of relevance.

It is important to note that Topics 1–5 from Table 6 and Topics 1–5 from Table 7 can be combined into five new themes based on shared characteristics. As a result, five newly structured themes were created, which incorporate both general and in-depth perspectives on fall-related issues in older adults.

Balance Disorders, Gait, and Fall Prevention Strategies in Older Adults

Older adults with a history of falls exhibit the following characteristics:

- Significant changes in dynamic balance control during walking, especially when tripping or slipping, manifested by alterations in the relationship between the center of mass and the center of pressure at different gait phases.
- Increased gait variability, particularly when walking on uneven surfaces, indicating compensatory neuromuscular mechanisms for maintaining balance.
- The ability to stabilize the mediolateral trajectory of steps despite age-related changes, which can be leveraged in the development of training and fall prevention strategies.
- A need for specialized training approaches to improve balance control, including exercises aimed at enhancing stability and gait variability in unstable environments.

This characterization reflects the key features of balance and gait in older adults with a history of falls, as well as the necessity of developing tailored fall prevention strategies, including balance training and exercises to improve dynamic balance control.

Our analysis confirms that various aspects of dynamic balance control, functional mobility, and stability play a crucial role in reducing fall risk among older adults. For example, the study by Wright et al. [86] and Eckardt et al. [87] demonstrated that older adults with a history of falls due to tripping or slipping exhibit significant differences in the center of mass and center of pressure relationship during walking. These differences in dynamic balance highlight the importance of understanding instability mechanisms, aligning with previous research findings on the significance of postural stability control for fall prevention.

Other studies [88, 89, 90] confirm that age-related changes do not always lead to reduced motor flexibility, which is essential for stabilizing step trajectory, particularly on uneven surfaces. This is also consistent with findings from other research indicating that older adults can maintain strong compensatory abilities in stabilizing movement during postural tasks.

The findings of Park [111] and Araújo et al. [112] confirm that performing balance and gait exercises, including those incorporating cognitive load, enhances balance and mobility in older adults, thereby reducing their risk of falls. These results align with other studies indicating that improving motor skills and cognitive flexibility is essential for fall prevention.

According to studies [113, 114, 115], engaging in dual-task physical exercises and strengthening lower limb muscles significantly reduces fall risk and improves functional mobility in older adults. Previous research also supports the importance of these training approaches for enhancing stability and confidence in movement, as evidenced by substantial improvements in functional mobility and balance test results.

Thus, this group of studies highlights the importance of a comprehensive approach to fall prevention, integrating physical training, cognitive exercises, and consideration of individual health characteristics. Such an approach contributes to improved functional mobility and a reduced risk of falls among older adults.

Fall Risk Factors and Screening in Long-Term Care Facilities for Older Adults

Older adults living in long-term care facilities are characterized by:

- Key fall risk factors: History of falls, impaired vision, polypharmacy, chronic diseases, dizziness, and balance problems.
- Declining balance function, particularly among individuals with diabetes, osteoporosis, and other chronic conditions, necessitating a careful

approach to fall prevention.
- The need for regular screening to detect balance impairments early, enabling the implementation of preventive measures such as physical therapy and balance training.
- The importance of assessing physical and cognitive health for accurate fall risk prediction, contributing to a reduction in incidents within elderly care institutions.

This characterization highlights the importance of a comprehensive approach to identifying fall risk factors, as well as the necessity of timely screening and the implementation of appropriate prevention programs for older adults in long-term care facilities.

Our analysis confirms that the presence of multiple risk factors – such as impaired vision, chronic diseases, medication use, balance deficits, and cognitive issues – significantly increases the likelihood of falls among older adults. The findings of Dhargave et al. [91] and Halvarsson et al. [92] showed that factors like poor vision, chronic diseases, dizziness, fear of falling, and prior falls are significant predictors of fall risk. These results align with previous research emphasizing the importance of identifying and addressing these factors as part of preventive measures.

Studies by Hong et al. [93] and Ritchey et al. [94] demonstrated that balance training programs incorporating dual-task and multitask exercises have a long-term positive impact on improving gait and balance in older adults with osteoporosis and a high fall risk. These findings support prior research emphasizing the role of physical activity in fall prevention and functional mobility enhancement.

Studies by Leiva-Caro et al. [95] and Welch et al. [116] demonstrated that training programs aimed at improving muscle strength and functional mobility can significantly mitigate age-related physical decline and reduce fall risk. These findings confirm that strength and mobility-focused training programs are a crucial component of fall prevention strategies.

Additionally, studies [117, 118] showed that using various fall risk assessment tools (such as cognitive function tests and dynamic gait analysis) allows for more accurate identification of high-risk groups and their referral to appropriate preventive interventions. These findings highlight the importance of systematic screening in detecting older adults at increased risk of falls.

Other studies [119, 120] emphasize that cognitive training and reducing the fear of falling can enhance physical activity and decrease concerns about falling. In the context of our review, these findings highlight the importance of incorporating not only physical but also cognitive interventions for effective fall prevention in older adults. Combining this approach with social and medical strategies enhances the effectiveness of prevention efforts and improves the quality of life for older individuals.

Thus, the research findings confirm the necessity of a comprehensive approach to fall prevention in older adults. This approach includes physical activity, cognitive training, medical supervision, and psycho-emotional support. Such a strategy significantly reduces fall risk and improves functional mobility in this population group.

The Impact of Training, Physiotherapeutic Interventions, and Physiological Factors on Balance and Fall Risk in Older Adults

Older adults participating in balance training programs exhibit the following characteristics:
- Improved center of mass control and dynamic balance, contributing to a reduced fall risk.
- Balance impairments associated with age-related changes, chronic diseases, and physical disabilities, necessitating the implementation of specialized physiotherapeutic interventions.
- Significant improvements in functional mobility and stability when performing dynamic perturbation-based exercises, confirming the effectiveness of this approach in fall prevention.
- The need for caution when performing exercises, particularly for older adults with obesity and chronic diseases, as they are more prone to balance impairments.

This characterization highlights the importance of integrating perturbation-based training and physiotherapeutic interventions to improve balance and prevent falls, considering age-related and physiological changes in older adults.

Our analysis confirms that various training approaches aimed at enhancing postural stability and balance control can significantly reduce fall risk among older adults. Studies by Chien et al. [96] and Hill et al. [97] demonstrate that perturbation-based training using specialized equipment can improve center of mass and center of pressure control in both standing and walking. Specifically, dynamic perturbation training has a positive effect on dynamic balance in older adults, making it a valuable strategy for fall risk reduction.

Other studies [98, 99] confirm that postural control and balance can significantly deteriorate after lower-body exercises, such as cyclic ergometry and treadmill walking. This temporary decline in balance must be considered when designing physical activity programs for older adults to minimize fall risk immediately after training. In contrast, upper-body exercises, such as arm ergometry, do not cause significant changes in postural stability, making them a safer option in this context.

These findings align with previous research emphasizing the importance of physical activity while considering chronic diseases, cognitive impairments, and functional mobility when developing preventive programs. Numerous studies [100, 121, 122, 123] confirm that older adults with

chronic conditions and low physical activity levels are at higher risk of falls, highlighting the need for a more comprehensive prevention approach.

In the context of our review, these results emphasize the importance of an individualized approach to training programs, taking into account both participants' physical condition and their emotional and cognitive state. Research by Heidarzadeh et al. [124] and Jung et al. [125] further underscores that social and medical factors play a crucial role in reducing fall risk and should be considered when designing fall prevention strategies for older adults.

Cognitive Function, Physical Activity, and Their Role in Mobility and Fall Prevention in Older Adults

Older adults who exhibit gait variability when performing dual tasks are characterized by:

- Increased fall risk and mobility issues associated with cognitive function, gender, and education level.
- The positive impact of physical activity programs and dual-task training on improving gait, balance, and cognitive activity.
- The need for additional interventions, such as cognitive-behavioral therapy, for individuals with pronounced fear of falling.
- Enhanced functional mobility and reduced fall risk through multifactorial training focused on muscle strength and balance development.

This characterization highlights the importance of cognitive function and physical activity in maintaining mobility and preventing falls in older adults. Our analysis confirms that cognitive abilities, education level, and gender significantly influence gait variability, especially during cognitively demanding tasks. The study by Kline et al. [101] found that men and individuals with higher education levels exhibit less gait variability when performing cognitive-motor tasks, suggesting a lower fall risk in this group.

These findings align with previous research emphasizing the role of cognitive control in maintaining mobility among older adults. Specifically, the study by Wollesen et al. [102] indicates that dual-task training, aimed at improving both balance and cognitive function, can significantly enhance gait performance and stability in older adults with balance issues and fear of falling.

This is further confirmed by the study conducted by Bootsman et al. [103], where the authors highlight that age and comorbidities impact gait stability, especially under cognitive overload conditions. Notably, factors such as physical activity levels and chronic diseases also play a significant role in maintaining balance and preventing falls [104].

The findings of Lim et al. [105] demonstrate that balance-strengthening interventions can significantly reduce fall risk among older adults, particularly through physical exercises that enhance gait stability.

In the context of our review, these results emphasize the need for comprehensive interventions that combine physical activity and cognitive training to prevent falls in older adults. These data underscore the close interconnection between balance, physical activity, and cognitive health, all of which influence mobility and functional capacity in older individuals. This is supported by numerous studies [126, 127, 29].

Therefore, a multifactorial approach should be considered when designing programs to improve balance and prevent falls among older adults, as supported by the research of Sánchez-Sánchez et al. [128] and Chiu et al. [129].

Physical Exercise and Psychological Factors in Fall Prevention and Mobility Maintenance in Older Adults

Older adults participating in exercise-based programs experience the following improvements:

- Significant enhancement of functional mobility, balance, and gait parameters, contributing to a reduced risk of falls.
- Less pronounced impact of psychological threat on gait and balance compared to younger individuals, likely due to age-related changes in response to postural threats.
- Programs incorporating dual-task elements significantly improve gait, especially under cognitive load conditions, emphasizing their role in maintaining mobility in older adults.

Thus, physical activity programs and psychological factors play a crucial role in fall prevention and mobility maintenance in older adults. Participation in these programs also contributes to an improved quality of life and reduced anxiety about falls.

Our analysis confirms that physical training aimed at improving balance and stability in older adults is essential for reducing fall risk. For example, the study by da Silva et al. [106] demonstrated that a 12-week Pilates program significantly enhances functional mobility, balance, and gait parameters, thereby reducing fall risk in older individuals. This aligns with the findings of other studies [15, 34, 50, 52], which support the effectiveness of physical interventions.

These findings are consistent with previous research emphasizing the importance of integrating both physical activity and psychological preparation for fall prevention. Specifically, the study by Dubreucq et al. [107] found that introducing psychological threats, such as warnings about potential hazards, leads to changes in gait and balance in both young and older participants. As a result, step width and stabilizing forces increase, indicating heightened caution.

The impact of such training is most pronounced in participants with cognitive impairments, as

confirmed by the study by Quijoux et al. [110], where training also included cognitive activity elements to enhance resistance to falls.

An analysis of falls in older adults [130, 131] shows that approaches focused on improving balance (physical training, cognitive exercises) effectively reduce fall risks. These studies also highlight the importance of individualizing approaches based on participants' health conditions.

In the context of our review, these findings emphasize the importance of comprehensive interventions that combine physical activity, psychological influence, and cognitive training. The studies by Kirkwood et al. [132] and Ren et al. [133] support the necessity of implementing multi-component programs for the aging population aimed at improving health and reducing fall risk.

The following study by Jor'dan et al. [134] also confirms that integrating programs based on diverse exercises for improving coordination and balance positively influences older adults' quality of life and reduces fall frequency.

Other studies [108, 109] confirm that training programs aimed at improving coordination and balance play a crucial role in reducing the frequency of falls among older adults.

Study Limitations and Future Research Directions

This systematic review provides an in-depth analysis of the patterns and risk factors associated with falls among older adults. However, several limitations should be acknowledged when interpreting the findings.

First, the review exclusively includes studies published in English, which may introduce a language bias and limit the inclusion of relevant research conducted in non-English-speaking regions. This could lead to an overrepresentation of certain perspectives while potentially overlooking culturally specific factors that influence fall risk and prevention strategies.

Second, our analysis is based solely on publications indexed in the Web of Science (WoS) database. While WoS is a reputable source of high-impact scientific literature, it does not encompass all available studies on the topic. The exclusion of other major databases, such as Scopus and PubMed, may have led to the omission of relevant research, particularly from interdisciplinary fields that examine falls from medical, psychological, and environmental perspectives.

Another limitation concerns the characteristics of the study populations reported in the reviewed publications. Many studies focus on relatively healthy older adults, while individuals with chronic conditions, cognitive impairments, or mobility restrictions are underrepresented. Since these groups often face higher fall risks, future research should prioritize more inclusive study designs that account for diverse health conditions and functional abilities.

Additionally, most studies assess short-term intervention outcomes, with limited research on the long-term sustainability of improvements in balance, mobility, and fall prevention. Future studies should incorporate extended follow-up periods to evaluate the lasting impact of physical training, cognitive interventions, and environmental modifications on fall risk reduction.

Psychosocial factors also remain an underexplored area in fall prevention research. While fear of falling is widely recognized as a contributing factor to mobility limitations, there is insufficient evidence on the effectiveness of psychological interventions, such as cognitive-behavioral therapy, in reducing fear and improving confidence in movement. Further research is needed to integrate psychological well-being into comprehensive fall prevention programs.

Lastly, an emerging but still underdeveloped area of research is the combination of physical activity with cognitive training. Although preliminary findings indicate potential benefits, standardized methodologies and controlled trials are necessary to establish evidence-based guidelines for integrating these approaches effectively.

By addressing these limitations and research gaps, future studies can contribute to a more nuanced understanding of fall risk factors and enhance the development of holistic, multidimensional prevention strategies tailored to the needs of older adults.

Conclusions

The results of this systematic analysis have identified key aspects related to the assessment and prevention of fall risk among older adults. Cognitive impairments, declines in sensorimotor functions, and changes in gait parameters were found to be significant risk factors. These changes include reduced walking speed, shorter step length, and increased gait variability, all of which substantially elevate the likelihood of falls. Additionally, other contributing factors include fear of falling, gender differences, and age-related physiological changes such as decreased muscle strength, impaired balance, and reduced bone density.

External factors also play a crucial role in fall risk. Inadequate environmental conditions, such as slippery surfaces or poor lighting, combined with a lack of adaptive walking strategies, significantly increase the probability of incidents. In this context, special attention is given to intervention approaches aimed at minimizing external risks and improving the everyday living conditions of older adults.

Technological innovations are proving to be essential in fall prevention. Tools such as force platforms, inertial measurement units, and activity

monitoring systems provide more accurate data on an individual's physical condition. These data help identify early signs of physical decline and enable timely adjustments to intervention programs. Additionally, the use of big data analytics plays a crucial role in enhancing the personalization of preventive measures.

A multifactorial approach remains the most promising strategy for fall prevention. Comprehensive assessment, regular monitoring, consideration of individual risk factors, and the development of tailored preventive strategies create opportunities for reducing fall risk and maintaining a high quality of life among older adults. These findings highlight the need for integrating modern technologies and multidisciplinary approaches into practical strategies for working with this population.

Conflict of interests

The author declare that there is no conflict of interests.

References

1. Rajagopalan R, Litvan I, Jung TP. Fall Prediction and Prevention Systems: Recent Trends, Challenges, and Future Research Directions. *Sensors*, 2017;17(11): 2509. https://doi.org/10.3390/s17112509
2. Taylor ME, Lord SR, Delbaere K, Kurrle SE, Mikolaizak AS, Close JCT. Reaction Time and Postural Sway Modify the Effect of Executive Function on Risk of Falls in Older People with Mild to Moderate Cognitive Impairment. *American Journal of Geriatric Psychiatry*, 2017;25(4): 397–406. https://doi.org/10.1016/j.jagp.2016.10.010
3. Lau LK, Mallya JU, Pang WJB, Chen KK, Jabbar KB, Seah WT, et al. Physiological and Cognitive Determinants of Dual-Task Costs for Gait Parameters: The Yishun Study. *Gerontology*, 2021;67(4): 457–466. https://doi.org/10.1159/000514171
4. Said AM, Manaf H, Bukry SA, Justine M. Mobility and Balance and Their Correlation with Physiological Factors in Elderly with Different Foot Postures. *Biomed Research International*, 2015;2015: 385269. https://doi.org/10.1155/2015/385269
5. Liu TW, Ng SSM. Assessing the fall risks of community-dwelling stroke survivors using the Short-form Physiological Profile Assessment (S-PPA). *Plos One*, 2019;14(5): e0216769. https://doi.org/10.1371/journal.pone.0216769
6. Bloom I, Welch L, Vassilev I, Rogers A, Jameson K, Cooper C, et al. Findings from an exploration of a social network intervention to promote diet quality and health behaviours in older adults with COPD: a feasibility study. *Pilot and Feasibility Studies*, 2020;6(1): 15. https://doi.org/10.1186/s40814-020-0553-z
7. Rhee MK, Jang Y, Kim SY, Chang S. The moderating role of social factors in the relationship between an incident of fall and depressive symptoms: a study with a national sample of older adults in South Korea. *Aging & Mental Health*, 2021;25(6): 1086–1093. https://doi.org/10.1080/13607863.2020.1758911
8. Lohman MC, Fallahi A, Mishio Bawa E, Wei J, Merchant AT. Social Mediators of the Association Between Depression and Falls Among Older Adults. *Journal of Aging and Health*, 2023;35(7–8): 593–603. https://doi.org/10.1177/08982643231152276
9. Arkkukangas M, Söderlund A, Eriksson S, Johansson AC. One-Year Adherence to the Otago Exercise Program With or Without Motivational Interviewing in Community-Dwelling Older Adults. *Journal of Aging and Physical Activity*, 2018;26(3): 390–395. https://doi.org/10.1123/japa.2017-0009
10. de Souza LF, Fontanela LC, Goncalves C, Mendrano AL, Freitas MA, Danielewicz AL, et al. Cognitive and behavioral factors associated to probable sarcopenia in community-dwelling older adults. *Experimental Aging Research*, 2022;48(2): 150–163. https://doi.org/10.1080/0361073X.2021.1939564
11. Wendt A, Costa CS, Machado AKF, Costa FS, Neves RG, Flores TR, et al. Sleep disturbances and daytime fatigue: data from the Brazilian National Health Survey, 2013. *Cadernos De Saude Publica*, 2019;35(3): e00086918. https://doi.org/10.1590/0102-311X00086918
12. Kim D, Ahrentzen S. Environmental and, Behavioral Circumstances and Consequences of Falls in d Senior Living Development. *Journal of Housing for The Elderly*, 2017;31(3): 286–301. https://doi.org/10.1080/02763893.2017.1335667
13. Huang WC, Lin CY, Togo F, Lai TF, Hsueh MC, Liao Y, et al. Nonlinear associations between sleep patterns and sarcopenia risks in older adults. *Journal of Clinical Sleep Medicine*, 2022;18(3): 731–738. https://doi.org/10.5664/jcsm.9698
14. Qiu G, Liu XJ, Amiranti AY, Yasini M, Wu T, Amer S, et al. Geographic clustering and region-specific determinants of obesity in the Netherlands. *Geospatial Health*, 2020;15(1): 131–139. https://doi.org/10.4081/gh.2020.839
15. Wang JX, Chen LY, Jiang YN, Ni L, Sheng JM, Shen X. Establishing content validity for a composite activities-specific risk of falls scale:linkage between fear of falling and physical activity. *Bmc Geriatrics*, 2021;21(1): 275. https://doi.org/10.1186/s12877-021-02211-z
16. Li QW, Mpofu E, Yin C, Turner KW. Perception of Falls and Confidence in Self-Management of Falls among Older Adults. *International Journal of Environmental Research and Public Health*, 2019;16(24): 5054. https://doi.org/10.3390/ijerph16245054
17. Novaes ADC, Ansai JH, Alberto SN, Caetano MJD, Rossi PG, de Melo ML, et al. Effects of a Multifactorial Program with Case Management for Falls Prevention on Functional Outcomes in Community-Dwelling Older People: A Randomized Clinical Study. *Healthcare*, 2024;12(15): 1541. https://doi.org/10.3390/healthcare12151541

18. Alves JE, Pelegrini LND, Porcatti LR, Ansai JH, Candanedo MJBL, Gramani-Say K. Effects of a cognitive stimulation program on physical and cognitive dimensions in community-dwelling faller older adults with cognitive impairment: study protocol. *Bmc Neurology*, 2023;23(1): 107. https://doi.org/10.1186/s12883-023-03154-1
19. Aguiar RN, Pereira MCS, Borges APO, Da Silva RA, Do Nascimento LCG. Ptophobia in the daily life of elderly people. *Revista Eletronica Pesquiseduca*, 2021;13(29): 122–135.
20. Lim YM, Kim H, Cha YJ. Effects of environmental modification on activities of daily living, social participation and quality of life in the older adults: a meta-analysis of randomized controlled trials. *Disability and Rehabilitation-assistive Technology*, 2020;15(2): 132–140. https://doi.org/10.1080/17483107.2018.1533595
21. Welti LM, Beavers KM, Mampieri A, Rapp SR, Ip E, Shumaker SA, et al. Patterns of Home Environmental Modification Use and Functional Health: The Women's Health Initiative. *Journals of Gerontology Series A-biological Sciences and Medical*, 2020;75(11): 2119–2124. https://doi.org/10.1093/gerona/glz290
22. Siefkas AC, McCarthy EP, Leff B, Dufour AB, Hannan MT. Social Isolation and Falls Risk: Lack of Social Contacts Decreases the Likelihood of Bathroom Modification Among Older Adults With Fear of Falling. *Journal of Applied Gerontology*, 2022;41(5): 1293–1300. https://doi.org/10.1177/07334648211062373
23. Bloomfield HE, Greer N, Linsky AM, Bolduc J, Naidl T, Vardeny O, et al. Deprescribing for Community-Dwelling Older Adults: a Systematic Review and Meta-analysis. *Journal of General Internal Medicine*, 2020;35(11): 3323–3332. https://doi.org/10.1007/s11606-020-06089-2
24. Puts M, Szumacher E, Dawe D, Fitch M, Jones J, Fülöp T, et al. Never too old to learn new tricks: Surveying Canadian healthcare professionals about learning needs in caring for older adults with cancer. *Journal of Geriatric Oncology*, 2021;12(2): 262–273. https://doi.org/10.1016/j.jgo.2020.08.010
25. Keppner V, Sieber CC, Freiberger E, Kob R, Krumpoch S, Siebentritt HM. Characteristics of older cyclists with self-perceived needs for improvement in cycling competence: SiFAr trial. *European Geriatric Medicine*, 2023;14(3): 595–602. https://doi.org/10.1007/s41999-023-00765-2
26. Charmant WM, Snoeker BAM, van Hout HPJ, Geleijn E, van der Velde N, Veenhof C, et al. Strategies for implementation of a transmural fall-prevention care pathway for older adults with fall-related injuries at the emergency department. *BMC Emergency Medicine*, 2024;24(1): 188. https://doi.org/10.1186/s12873-024-01085-9
27. Korkmaz T, Erkol Z, Karamansoy N. A retrospective analysis of 65 years old and over forensic cases who were admitted to the emergency department. *Turkish Journal of Geriatrics-turk Geriatri Dergisi*, 2014;17(3): 249–255.
28. Iermakov S, Podrigalo L, Podrihalo O, Yermakova T, Jagiello W. Means and methods of physical activity in the context of prevention and treatment of Alzheimer's disease (analysis of Russian-language scientific resources) and the perspective of implementing the unique achievements of the "Polish School of Safe Falling". *Archives of Budo,* 2022;18:121-143.
29. Smith-Ray RL, Makowski-Woidan B, Hughes SL. A Randomized Trial to Measure the Impact of a Community-Based Cognitive Training Intervention on Balance and Gait in Cognitively Intact Black Older Adults. *Health Education & Behavior*, 2014;41: 62S–69S. https://doi.org/10.1177/1090198114537068
30. Smith AD, Silva AO, Rodrigues RAP, Moreira MASP, Nogueira JD, Tura LFR. Assessment of risk of falls in elderly living at home. *Revista Latino-americana De Enfermagem*, 2017;25: e2754. https://doi.org/10.1590/1518-8345.0671.2754
31. Peeters G, Bennett M, Donoghue OA, Kennelly S, Kenny RA. Understanding the aetiology of fear of falling from the perspective of a fear-avoidance model - A narrative review. *Clinical Psychology Review*, 2020;79: 101862. https://doi.org/10.1016/j.cpr.2020.101862
32. Saverino A, Waller D, Rantell K, Parry R, Moriarty A, Playford ED. The Role of Cognitive Factors in Predicting Balance and Fall Risk in a Neuro-Rehabilitation Setting. *Plos One*, 2016;11(4): e0153469. https://doi.org/10.1371/journal.pone.0153469
33. Jayakody O, Breslin M, Srikanth V, Callisaya M. Medical, Sensorimotor and Cognitive Factors Associated With Gait Variability: A Longitudinal Population-Based Study. *Frontiers in Aging Neuroscience*, 2018;10: 419. https://doi.org/10.3389/fnagi.2018.00419
34. Kasser SL, Kosma M. Social Cognitive Factors, Physical Activity, and Mobility Impairment in Adults with Multiple Sclerosis. *Behavioral Medicine*, 2018;44(4): 306–313. https://doi.org/10.1080/08964289.2017.1368441
35. Inayati A, Lee BO, Wang RH, Chen SY, Hsu HC, Lu CH, et al. Determinants of fear of falling in older adults with diabetes. *Geriatric Nursing*, 2022;46: 7–12. https://doi.org/10.1016/j.gerinurse.2022.04.017
36. Lau LK, Jabbar KB, Pang WJB, Chen KK, Seah WT, Mallya JU, et al. Physiological and Cognitive Determinants of Gait Variability of Asian Population: The Yishun Study. *Gerontology*, 2023;69(3): 301–311. https://doi.org/10.1159/000526479
37. Hughes CC, Kneebone II, Jones F, Brady B. A theoretical and empirical review of psychological factors associated with falls-related psychological concerns in community-dwelling older people. *International Psychogeriatrics*, 2015;27(7): 1071–1087. https://doi.org/10.1017/S1041610214002701
38. Pauelsen M, Nyberg L, Röijezon U, Vikman I. Both psychological factors and physical performance are associated with fall-related concerns. *Aging Clinical and Experimental Research*, 2018;30(9): 1079–1085. https://doi.org/10.1007/s40520-017-0882-9

39. Park JI, Yang JC, Chung S. Risk Factors Associated with the Fear of Falling in Community-Living Elderly People in Korea: Role of Psychological Factors. *Psychiatry Investigation*, 2017;14(6): 894–899. https://doi.org/10.4306/pi.2017.14.6.894
40. Khajavi D, Farokhi A, Moghadam AJ, Kazemnejad A. The Impact of a Training Intervention Program on Fall-related Psychological Factors among Male Older Adults in Arak. *Salmand-iranian Journal of Ageing*, 2014;9(1): 32–39.
41. Byun M, Kim J, Kim M. Physical and Psychological Factors Affecting Falls in Older Patients with Arthritis. *International Journal of Environmental Research and Public Health*, 2020;17(3): 1098. https://doi.org/10.3390/ijerph17031098
42. Byun M, Kim J, Kim JE. Physical and Psychological Factors Contributing to Incidental Falls in Older Adults Who Perceive Themselves as Unhealthy: A Cross-Sectional Study. *International Journal of Environmental Research and Public Health*, 2021;18(7): 3738. https://doi.org/10.3390/ijerph18073738
43. Turunen KM, Kokko K, Kekäläinen T, Alén M, Hänninen T, Pynnönen K, et al. Associations of neuroticism with falls in older adults: do psychological factors mediate the association?. *Aging & Mental Health*, 2022;26(1): 77–85. https://doi.org/10.1080/13607863.2020.1841735
44. Kim J, Byun M, Kim M. Physical and Psychological Factors Associated with Poor Self-Reported Health Status in Older Adults with Falls. *International Journal of Environmental Research and Public Health*, 2020;17(10): 3548. https://doi.org/10.3390/ijerph17103548
45. Rider JV, Longhurst JK, Lekhak N, Navalta JW, Young DL, Landers MR. Psychological Factors Associated With Fear of Falling Avoidance Behavior in Parkinson's Disease: The Role of Depression, Anxiety, and Catastrophizing. *Journal of Geriatric Psychiatry and Neurology*, 2023;36(3): 215–224. https://doi.org/10.1177/08919887221119974
46. Gioffrè-Florio M, Murabito LM, Visalli C, Pergolizzi FP, Famà F. Trauma in elderly patients: a study of prevalence, comorbidities and gender differences. *Giornale Di Chirurgia*, 2018;39(1): 35–40. https://doi.org/10.11138/gchir/2018.39.1.035
47. Inoue W, Ikezoe T, Tsuboyama T, Sato I, Malinowska KB, Kawaguchi T, et al. Are there different factors affecting walking speed and gait cycle variability between men and women in community-dwelling older adults?. *Aging Clinical and Experimental Research*, 2017;29(2): 215–221. https://doi.org/10.1007/s40520-016-0568-8
48. Alexandre TD, Corona LP, Nunes DP, Santos JLF, Duarte YAD, Lebrao ML. Disability in instrumental activities of daily living among older adults: gender differences. *Revista De Saude Publica*, 2014;48(3): 378–389. https://doi.org/10.1590/S0034-8910.2014048004754
49. Pohl P, Ahlgren C, Nordin E, Lundquist A, Lundin-Olsson L. Gender perspective on fear of falling using the classification of functioning as the model. *Disability and Rehabilitation*, 2015;37(3): 214–222. https://doi.org/10.3109/09638288.2014.914584
50. Stahl ST, Albert SM. Gender differences in physical activity patterns among older adults who fall. *Preventive Medicine*, 2015;71: 94–100. https://doi.org/10.1016/j.ypmed.2014.12.016
51. Puszczalowska-Lizis E, Bujas P, Jandzis S, Omorczyk J, Zak M. Inter-gender differences of balance indicators in persons 60-90 years of age. *Clinical Interventions in Aging*, 2018;13: 903–912. https://doi.org/10.2147/CIA.S157182
52. Anens E, Emtner M, Zetterberg L, Hellström K. Physical activity in subjects with multiple sclerosis with focus on gender differences: a survey. *Bmc Neurology*, 2014;14: 47. https://doi.org/10.1186/1471-2377-14-47
53. Mouodi S, Bijani A, Hosseini SR, Hajian-Tilaki K. Gender differences in the health status of elderly living alone compared to those who are not alone: Evidence of the AHAP study, North of Iran.. *Caspian Journal of Internal Medicine*, 2016;7(2): 126–132. https://doi.org/
54. Tsunoda K, Kitano N, Kai Y, Tsuji T, Soma Y, Jindo T, et al. Transportation mode usage and physical, mental and social functions in older Japanese adults. *Journal of Transport & Health*, 2015;2(1): 44–49. https://doi.org/10.1016/j.jth.2014.10.003
55. Lee YS, Park SY, Roh S, Koenig HG, Yoo GJ. The Role of Religiousness/Spirituality and Social Networks in Predicting Depressive Symptoms among Older Korean Americans. *Journal of Cross-cultural Gerontology*, 2017;32(2): 239–254. https://doi.org/10.1007/s10823-017-9317-5
56. Kim T, Choi SD, Xiong SP. Epidemiology of fall and its socioeconomic risk factors in community-dwelling Korean elderly. *Plos One*, 2020;15(6): e0234787. https://doi.org/10.1371/journal.pone.0234787
57. Bimou C, Harel M, Laubarie-Mouret C, Cardinaud N, Charenton-Blavignac M, Toumi N, et al. Patterns and predictive factors of loss of the independence trajectory among community-dwelling older adults. *Bmc Geriatrics*, 2021;21(1): 142. https://doi.org/10.1186/s12877-021-02063-7
58. Bokrantz T, Manhem K, Lorentzon M, Karlsson M, Ljunggren Ö, Ohlsson C, et al. The association between peripheral arterial disease and risk for hip fractures in elderly men is not explained by low hip bone mineral density. Results from the MrOS Sweden study. *Osteoporosis International*, 2022;33(12): 2607–2617. https://doi.org/10.1007/s00198-022-06535-3
59. Onyeso OK, Odole AC, Scott DR, Akinrolie O, Kalu ME, Awosoga OA. Association between sociodemographic factors and mobility limitation among older adults: a systematic review and meta-analysis protocol. *Systematic Reviews*, 2023;12(1): 19. https://doi.org/10.1186/s13643-023-02190-9
60. Megalla M, Ditkowsky J, Parulekar MS, Gelman S. Socioeconomic Factors Associated With Increased Risk of Falls in Older Adults. *American Journal of Lifestyle Medicine*, 2023; 15598276231192029. https://doi.org/10.1177/15598276231192029
61. Giladi AM, Shauver MJ, Ho A, Zhong L, Kim HM, Chung KC. Variation in the Incidence of Distal Radius Fractures in the US Elderly as Related

to Slippery Weather Conditions. *Plastic and Reconstructive Surgery*, 2014;133(2): 321–332. https://doi.org/10.1097/01.prs.0000436796.74305.38
62. Tenías JM, Estarlich M, Crespo E, Román-Ortiz C, Arias-Arias A, Ballester F. Short-Term Relationship between Hip Fracture and Weather Conditions in Two Spanish Health Areas with Different Climates. *Journal of Environmental and Public Health*, 2015;2015: 395262. https://doi.org/10.1155/2015/395262
63. Chen MT, Wang HL, Yu LS, Yeung EHK, Luo JJ, Tsui KL, et al. A Systematic Review of Wearable Sensor-Based Technologies for Fall Risk Assessment in Older Adults. *Sensors*, 2022;22(18): 6752. https://doi.org/10.3390/s22186752
64. Koo DD, Lee JJ, Sebastiani A, Kim J. An Internet-of-Things (IoT) system development and implementation for bathroom safety enhancement. *Icsdec 2016 - Integrating Data Science, Construction and Sustainability*, 2016;145: 396–403. https://doi.org/10.1016/j.proeng.2016.04.004
65. Lund HH, Liu YX, Leggieri M. Body and Brain Training with Big Data and AI. *Proceedings of The 2020 International Conference on Artificial Life And*, 2020;: 6–9.
66. Kang S. A Study on Programs Applying the Internet of Things (IoT) for Prevention of Falls in the Elderly. In: Kim KJ, Kim H, Baek N (eds.) *IT Convergence and Security 2017*, Singapore: Springer Singapore; 2018. p. 49–53. https://doi.org/10.1007/978-981-10-6454-8_8
67. Chen Q, Sheng N. Design of artificial intelligence auxiliary system for elderly care service based on big data analysis. *Proceedings of 2024 4th International Conference on Bioinformatics And*, 2024;: 200–206. https://doi.org/10.1145/3665689.3665723
68. PRISMA for systematic review protocols (PRISMA-P) [Internet]. 2024 [updated 2024 Jun; cited 2024 Sep 28]. Available from: https://www.prisma-statement.org/protocols
69. Afonso AR, Duque CG. Automated Text Clustering of Newspaper and Scientific Texts in Brazilian Portuguese: Analysis and Comparison of Methods. *Journal of Information Systems and Technology Management*, 2014;11(2): 415–436. https://doi.org/10.4301/S1807-17752014000200011
70. Wadnare RJ, Sherekar DrSS, Thakare DrVM. Development of Text Clustering Method with K-Means for Analysis of Text Data. *International Journal of Scientific Research in Computer Science, Engineering and Information Technology*, 2021; 143–151. https://doi.org/10.32628/CSEIT217237
71. Fan W. Application and analysis of text similarity in text clustering in the Chinese context. *Applied and Computational Engineering*, 2023;21(1): 71–77. https://doi.org/10.54254/2755-2721/21/20231120
72. Tahvili S, Hatvani L, Felderer M, Gomes F, Feldt R. *Comparative Analysis of Text Mining and Clustering Techniques for Assessing Functional Dependency between Manual Test Cases*. 2024 Mar [Accessed 17th November 2024]. https://doi.org/10.21203/rs.3.rs-4014160/v1
73. Xie T, Qin P, Zhu L. Study on the Topic Mining and Dynamic Visualization in View of LDA Model. *Modern Applied Science*, 2018;13(1): 204. https://doi.org/10.5539/mas.v13n1p204
74. Bascur JP, Verberne S, van Eck NJ, Waltman L. Which topics are best represented by science maps? An analysis of clustering effectiveness for citation and text similarity networks. 2024. https://doi.org/10.48550/ARXIV.2406.06454
75. Li C, Yang C, Jiang Q. The research on text clustering based on LDA joint model. Mishra KK (ed.) *Journal of Intelligent & Fuzzy Systems*, 2017;32(5): 3655–3667. https://doi.org/10.3233/JIFS-169300
76. Zhang W, Zhai G, Zhong B, Kong X. Text Semantic Analysis Algorithm Based on LDA Model and Doc2vec. In: Hou Z (ed.) *Advances in Transdisciplinary Engineering*, IOS Press; 2024. https://doi.org/10.3233/ATDE231269
77. Wu D, Yang R, Shen C. Sentiment word co-occurrence and knowledge pair feature extraction based LDA short text clustering algorithm. *Journal of Intelligent Information Systems*, 2021;56(1): 1–23. https://doi.org/10.1007/s10844-020-00597-7
78. Hidayat EY, Firdausillah F, Hastuti K, Dewi IN, Azhari A. Automatic Text Summarization Using Latent Drichlet Allocation (LDA) for Document Clustering. *International Journal of Advances in Intelligent Informatics*, 2015;1(3): 132. https://doi.org/10.26555/ijain.v1i3.43
79. Mittal M, Battineni G, Usharani B, Goyal LM. *Text Analysis with Python: A Research Oriented Guide*. Bentham Science Publishers; 2022. https://doi.org/10.2174/9789815049602122010 1
80. The Open Graph Viz Platform [Internet]. 2024 [updated 2024 Jun; cited 2024 Sep 28]. Available from: https://gephi.org
81. Podrigalo L, Iermakov S. Duplicate references in the 'Introduction' and 'Discussion' sections of scientific articles on physical education and sports. *Pedagogy of Health*. 2023;2(2):65-73. https://doi.org/10.15561/health.2023.0203
82. Onah DFO, Pang ELL, El-Haj M. A Data-driven Latent Semantic Analysis for Automatic Text Summarization using LDA Topic Modelling. 2022; https://doi.org/10.48550/ARXIV.2207.14687
83. Majhi D, Mukherjee B. Analysing Library and Information Science Articles Using Topic Modeling Approaches. *DESIDOC Journal of Library & Information Technology*, 2024;44(2): 114–123. https://doi.org/10.14429/djlit.44.2.19312
84. Chuang J, Manning CD, Heer J. Termite: visualization techniques for assessing textual topic models. In: *Proceedings of the International Working Conference on Advanced Visual Interfaces*, Capri Island Italy: ACM; 2012. P. 74–77. https://doi.org/10.1145/2254556.2254572
85. Sievert C, Shirley K. LDAvis: A method for visualizing and interpreting topics. In: *Proceedings of the Workshop on Interactive Language Learning, Visualization, and Interfaces*, Baltimore, Maryland, USA: Association for Computational Linguistics; 2014.P.63–70.https://doi.org/10.3115/v1/W14-3110

86. Wright RL, Peters DM, Robinson PD, Watt TN, Hollands MA. Older adults who have previously fallen due to a trip walk differently than those who have fallen due to a slip. *Gait & Posture*, 2015;41(1): 164–169. https://doi.org/10.1016/j.gaitpost.2014.09.025
87. Eckardt N, Rosenblatt NJ. Healthy aging does not impair lower extremity motor flexibility while walking across an uneven surface. *Human Movement Science*, 2018;62: 67–80. https://doi.org/10.1016/j.humov.2018.09.008
88. Meyer M, Constancias F, Vogel T, Kaltenbach G, Schmitt E. Gait Disorder among Elderly People, Psychomotor Disadaptation Syndrome: Post-Fall Syndrome, Risk Factors and Follow-Up - A Cohort Study of 70 Patients. *Gerontology*, 2021;67(1): 17–24. https://doi.org/10.1159/000511356
89. Wollesen B, Mattes K, Schulz S, Bischoff LL, Seydell L, Bell JW, et al. Effects of Dual-Task Management and Resistance Training on Gait Performance in Older Individuals: A Randomized Controlled Trial. *Frontiers in Aging Neuroscience*, 2017;9: 415. https://doi.org/10.3389/fnagi.2017.00415
90. Halvarsson A, Franzén E, Ståhle A. Balance training with multi-task exercises improves fall-related self-efficacy, gait, balance performance and physical function in older adults with osteoporosis: a randomized controlled trial. *Clinical Rehabilitation*, 2015;29(4): 365–375. https://doi.org/10.1177/0269215514544983
91. Dhargave P, Sendhilkumar R. Prevalence of risk factors for falls among elderly people living in long-term care homes. *Journal of Clinical Gerontology & Geriatrics*, 2016;7(3): 99–103. https://doi.org/10.1016/j.jcgg.2016.03.004
92. Halvarsson A, Oddsson L, Franzén E, Ståhle A. Long-term effects of a progressive and specific balance-training programme with multi-task exercises for older adults with osteoporosis: a randomized controlled study. *Clinical Rehabilitation*, 2016;30(11): 1049–1059. https://doi.org/10.1177/0269215515605553
93. Hong XF, Chen XJ, Chu JJ, Shen SS, Chai QC, Lou GB, et al. Multiple diabetic complications, as well as impaired physical and mental function, are associated with declining balance function in older persons with diabetes mellitus. *Clinical Interventions in Aging*, 2017;12: 189–195. https://doi.org/10.2147/CIA.S123985
94. Ritchey K, Olney A, Chen S, Phelan EA. STEADI Self-Report Measures Independently Predict Fall Risk. *Gerontology and Geriatric Medicine*, 2022;8: . https://doi.org/10.1077/23337214221079222
95. Leiva-Caro JA, Salazar-González BC, Gallegos-Cabriales EC, Gómez-Meza MV, Hunter KF. Connection between competence, usability, environment and risk of falls in elderly adults. *Revista Latino-Americana de Enfermagem*, 2015;23(6): 1139–1148. https://doi.org/10.1590/0104-1169.0331.2659
96. Chien JE, Hsu WL. Effects of Dynamic Perturbation-Based Training on Balance Control of Community-Dwelling Older Adults. *Scientific Reports*, 2018;8: 17231. https://doi.org/10.1038/s41598-018-35644-5
97. Hill MW, Oxford SW, Duncan MJ, Price MJ. The effects of arm crank ergometry, cycle ergometry and treadmill walking on postural sway in healthy older females. *Gait & Posture*, 2015;41(1): 252–257. https://doi.org/10.1016/j.gaitpost.2014.10.014
98. Deger TB, Saraç ZF, Savas ES, Akçiçek SF. The Relationship of Balance Disorders with Falling, the Effect of Health Problems, and Social Life on Postural Balance in the Elderly Living in a District in Turkey. *Geriatrics*, 2019;4(2): 37. https://doi.org/10.3390/geriatrics4020037
99. Tortora S, Rubega M, Formaggio E, Marco RD, Masiero S, Menegatti E, et al. Age-related differences in visual P300 ERP during dual-task postural balance. In: *2021 43rd Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC)*, Mexico: IEEE; 2021. p. 6511–6514. https://doi.org/10.1109/EMBC46164.2021.9630088
100. Toosizadeh N, Mohler J, Marlinski V. Low intensity vibration of ankle muscles improves balance in elderly persons at high risk of falling. *Plos One*, 2018;13(3): e0194720. https://doi.org/10.1371/journal.pone.0194720
101. Kline PW, Shaikh FD, Tennant JE, Hamel R, Zukowski LA. Global Cognition, Gender, and Level of Education Predict Dual-Task Gait Speed Variability Metrics in Older Adults. *Gerontology*, 2024;70(7): 724–731. https://doi.org/10.1159/000537720
102. Wollesen B, Schulz S, Seydell L, Delbaere K. Does dual task training improve walking performance of older adults with concern of falling?. *BMC Geriatrics*, 2017;17: 213. https://doi.org/10.1186/s12877-017-0610-5
103. Bootsman NJM, Skinner TL, Lal R, Glindemann D, Lagasca C, Peeters GMEE. The relationship between physical activity, and physical performance and psycho-cognitive functioning in older adults living in residential aged care facilities. *Journal of Science and Medicine in Sport*, 2018;21(2): 173–178. https://doi.org/10.1016/j.jsams.2017.07.006
104. Bohrer RCD, Pereira G, Beck JK, Lodovico A, Rodacki ALF. Multicomponent Training Program with High-Speed Movement Execution of Ankle Muscles Reduces Risk of Falls in Older Adults. *Rejuvenation Research*, 2019;22(1): 43–50. https://doi.org/10.1089/rej.2018.2063
105. Lim YP, Lin YC, Pandy MG. Lower-limb muscle function in healthy young and older adults across a range of walking speeds. *Gait & Posture*, 2022;94: 124–130. https://doi.org/10.1016/j.gaitpost.2022.03.003
106. da Silva LD, Shiel A, McIntosh C. Effects of Pilates on the risk of falls, gait, balance and functional mobility in healthy older adults: A randomised controlled trial. *Journal of Bodywork and Movement Therapies*, 2022;30: 30–41. https://doi.org/10.1016/j.jbmt.2022.02.020
107. Dubreucq L, Mereu A, Blanc G, Filiatrault J, Duclos C. Introducing a psychological postural threat alters gait and balance parameters among young participants but not among most older participants. *Experimental Brain Research*, 2017;235(5): 1429–1438. https://doi.org/10.1007/s00221-017-4902-y

108. Conradsson D, Halvarsson A. The effects of dual-task balance training on gait in older women with osteoporosis: A randomized controlled trial. *Gait & Posture*, 2019;68: 562–568. https://doi.org/10.1016/j.gaitpost.2019.01.005
109. Sakthivadivel V, Geetha J, Gaur A, Kaliappan A. Performance-Oriented Mobility Assessment test and Timed Up and Go test as predictors of falls in the elderly - A cross-sectional study. *Journal of Family Medicine and Primary Care*, 2022;11(11): 7294–7298. https://doi.org/10.4103/jfmpc.jfmpc_1294_22
110. Quijoux F, Bertin-Hugault F, Zawieja P, Lefèvre M, Vidal PP, Ricard D. Postadychute-AG, Detection, and Prevention of the Risk of Falling Among Elderly People in Nursing Homes: Protocol of a Multicentre and Prospective Intervention Study. *Frontiers in Digital Health*, 2021;2: 604552. https://doi.org/10.3389/fdgth.2020.604552
111. Park SH. Tools for assessing fall risk in the elderly: a systematic review and meta-analysis. *Aging Clinical and Experimental Research*, 2018;30(1): 1–16. https://doi.org/10.1007/s40520-017-0749-0
112. Araújo F, Nogueira MN, Silva J, Rego S. A Technological-Based Platform for Risk Assessment, Detection, and Prevention of Falls Among Home-Dwelling Older Adults: Protocol for a Quasi-Experimental Study. *Jmir Research Protocols*, 2021;10(8): e25781. https://doi.org/10.2196/25781
113. Alvarez MN, Rodríguez-Sánchez C, Huertas-Hoyas E, García-Villamil-Neira G, Espinoza-Cerda MT, Pérez-Delgado L, et al. Predictors of fall risk in older adults using the G-STRIDE inertial sensor: an observational multicenter case-control study. *BMC Geriatrics*, 2023;23(1): 737. https://doi.org/10.1186/s12877-023-04379-y
114. Harro CC, Garascia C. Reliability and Validity of Computerized Force Platform Measures of Balance Function in Healthy Older Adults. *Journal of Geriatric Physical Therapy*, 2019;42(3): E57–E66. https://doi.org/10.1519/JPT.0000000000000175
115. Renfro M, Bainbridge DB, Smith ML. Validation of Evidence-Based Fall Prevention Programs for Adults with Intellectual and/or Developmental Disorders: A Modified Otago Exercise Program. *Frontiers in Public Health*, 2016;4: 261. https://doi.org/10.3389/fpubh.2016.00261
116. Welch SA, Ward RE, Beauchamp MK, Leveille SG, Travison T, Bean JF. The Short Physical Performance Battery (SPPB): A Quick and Useful Tool for Fall Risk Stratification Among Older Primary Care Patients. *Journal of The American Medical Directors Association*, 2021;22(8): 1646–1651. https://doi.org/10.1016/j.jamda.2020.09.038
117. Qiao M, Richards JT, Franz JR. Visuomotor error augmentation affects mediolateral head and trunk stabilization during walking. *Human Movement Science*, 2019;68: 102525. https://doi.org/10.1016/j.humov.2019.102525
118. Patel PJ, Bhatt T, DelDonno SR, Langenecker SA, Dusane S. Examining Neural Plasticity for Slip-Perturbation Training: An fMRI Study. *Frontiers in Neurology*, 2019;9: 1181. https://doi.org/10.3389/fneur.2018.01181
119. Caetano MJD, Menant JC, Schoene D, Pelicioni PHS, Sturnieks DL, Lord SR. Sensorimotor and Cognitive Predictors of Impaired Gait Adaptability in Older People. *Journals of Gerontology Series A-biological Sciences and Medical*, 2017;72(9): 1257–1263. https://doi.org/10.1093/gerona/glw171
120. Bao T, Carender WJ, Kinnaird C, Barone VJ, Peethambaran G, Whitney SL, et al. Effects of long-term balance training with vibrotactile sensory augmentation among community-dwelling healthy older adults: a randomized preliminary study. *Journal of Neuroengineering and Rehabilitation*, 2018;15: 5. https://doi.org/10.1186/s12984-017-0339-6
121. Lavedán A, Viladrosa M, Jürschik P, Botigué T, Nuín C, Masot O, et al. Fear of falling in community-dwelling older adults: A cause of falls, a consequence, or both?. *Plos One*, 2018;13(3): e0194967. https://doi.org/10.1371/journal.pone.0194967
122. Goh HT, Nadarajah M, Hamzah NB, Varadan P, Tan MP. Falls and Fear of Falling After Stroke: A Case-Control Study. *Pm&r*, 2016;8(12): 1173–1180. https://doi.org/10.1016/j.pmrj.2016.05.012
123. McDonough CM, Colla CH, Carmichael D, Tosteson ANA, Tosteson TD, Bell JE, et al. Falling Down on the Job: Evaluation and Treatment of Fall Risk Among Older Adults With Upper Extremity Fragility Fractures. *Physical Therapy*, 2017;97(3): 280–289. https://doi.org/10.1093/ptj/pzx009
124. Heidarzadeh HR, Derakhshan A, Shahri SHG, Astaneh MRA, Bakhtiari E, Rad SS, et al. Visual and Demographic Risk Factors for Falls and the Impact of Cataract Surgery in Elderly Patients. *Journal of Ophthalmic & Vision Research*, 2024;19(3): 306–312. https://doi.org/10.18502/jovr.v19i3.13536
125. Jung HY, Kim SH, Lee SC, Kim S, Cho GC, Kim MJ, et al. Relating factors to severe injury from outdoor falls in older people. *Geriatrics & Gerontology International*, 2018;18(1): 80–87. https://doi.org/10.1111/ggi.13144
126. De Winter S, Vanwynsberghe S, Foulon V, Dejaeger E, Flamaing J, Sermon A, et al. Exploring the relationship between fall risk-increasing drugs and fall-related fractures. *International Journal of Clinical Pharmacy*, 2016;38(2): 243–251. https://doi.org/10.1007/s11096-015-0230-0
127. Lee K, Pressler SJ, Titler M. Falls in Patients With Heart Failure A Systematic Review. *Journal of Cardiovascular Nursing*, 2016;31(6): 555–561. https://doi.org/10.1097/JCN.0000000000000292
128. Sánchez-Sánchez JL, Udina C, Medina-Rincón A, Esbrí-Victor M, Bartolomé-Martín I, Moral-Cuesta D, et al. Effect of a multicomponent exercise program and cognitive stimulation (VIVIFRAIL-COGN) on falls in frail community older persons with high risk of falls: study protocol for a randomized multicenter control trial. *BMC Geriatrics*, 2022;22(1): 612. https://doi.org/10.1186/s12877-022-03214-0
129. Chiu HL, Yeh TT, Lo YT, Liang PJ, Lee SC. The effects of the Otago Exercise Programme on actual and perceived balance in older adults: A meta-analysis. *Plos One*, 2021;16(8): e0255780. https://doi.org/10.1371/journal.pone.0255780

130. Ciaccioni S, Pesce C, Capranica L, Condello G. Effects of a judo training program on falling performance, fear of falling and exercise motivation in older novice judoka. *Ido Movement for Culture-journal of Martial Arts Anthropology*, 2021;21(3): 9–17. https://doi.org/10.14589/ido.21.3.2
131. Mortaza N, Abu Osman NA, Mehdikhani N. Are the spatio-temporal parameters of gait capable of distinguishing a faller from a non-faller elderly?. *European Journal of Physical and Rehabilitation Medicine*, 2014;50(6): 677–691.
132. Kirkwood RN, Moreira BD, Mingoti SA, Faria BF, Sampaio RF, Resende RA. The slowing down phenomenon: What is the age of major gait velocity decline?. *Maturitas*, 2018;115: 31–36. https://doi.org/10.1016/j.maturitas.2018.06.005
133. Ren XP, Kebbach M, Bruhn S, Yang QN, Lin HJ, Bader R, et al. Barefoot walking is more stable in the gait of balance recovery in older adults. *BMC Geriatrics*, 2022;22(1): 904. https://doi.org/10.1186/s12877-022-03628-w
134. Jor'dan AJ, Manor B, Iloputaife I, Habtemariam DA, Bean JF, Sorond FA, et al. Diminished Locomotor Control Is Associated With Reduced Neurovascular Coupling in Older Adults. *Journals of Gerontology Series A-biological Sciences and Medical*, 2020;75(8): 1516–1522. https://doi.org/10.1093/gerona/glz006
135. Boripuntakul S, Kamnardsiri T, Lord SR, Maiarin S, Worakul P, Sungkarat S. Gait variability during abrupt slow and fast speed transitions in older adults with mild cognitive impairment. *Plos One*, 2022;17(10): e0276658. https://doi.org/10.1371/journal.pone.0276658

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