Review Article

Strategies for Preventing Falls in the Elderly: Focus on Home Hazard Modification and Multifactorial Interventions

Anrick Savio Menezes[1], Sneha Mary Jacob[2], Cyanna Joseph Dsouza[1,3]

[1]Father Muller College of Physiotherapy, Mangalore, India
[2]Royal Devon University Healthcare NHS Foundation Trust, United Kingdom
[3]Institute of Physiotherapy, Srinivas University, Mangalore, India

Corresponding Author: Cyanna Joseph Dsouza

ABSTRACT

Background: Falls and fall-related injuries are a major public health concern among older adults, being a leading cause of morbidity and mortality in this population. Multiple intrinsic and extrinsic factors contribute to fall risk, necessitating effective prevention strategies. While various interventions exist, literature presents mixed findings regarding the effectiveness of home hazard modification alone versus multifactorial interventions that incorporate multiple strategies, including home safety improvements. Hence,

Objectives: To compare the effectiveness of home hazard modification and multifactorial intervention in preventing falls among the elderly and to evaluate the impact of home hazard modification as a standalone risk-reduction strategy.

Methods: An electronic literature search was performed using databases such as PubMed, Google Scholar, and ScienceDirect. Based on the PRISMA framework, 28 articles were initially retrieved. After applying inclusion and exclusion criteria, six randomized controlled trials were selected for review.

Results: Home hazard modification showed a positive outcome in reducing falls when compared to multifactorial interventions in terms of primary and secondary outcome measures. Although home hazard modification demonstrated effectiveness in fall reduction, it may not address other critical aspects such as balance, endurance, and physical activity levels.

Conclusion: A multifactorial intervention, incorporating home hazard modification along with other targeted strategies, may offer a more comprehensive and effective approach for fall prevention in older adults.

Keywords: aged, environmental modification, exercise therapy, fall prevention, home safety, risk factors.

INTRODUCTION

Falls are a common and serious health issue in the elderly population, representing a significant public health challenge due to their high prevalence, related complications, and the economic burden of care.[1-3] Falls are typically defined as a sudden, unintentional loss of balance that leads to the individual landing on the ground or a lower surface.[1] They can result from various intrinsic and

extrinsic factors, including physiological aging, sensory and neuromuscular decline, and environmental hazards.[4,5] These falls are not only associated with physical injuries such as fractures or head trauma but can also cause psychological distress, loss of independence, fear of falling, and increased risk of institutionalization or mortality.[1,3] According to the World Health Organization, the annual fall rate in people aged 65 and above ranges from 28% to 35%, and Indian data report a fall prevalence between 14% and 53% in individuals over 60 years.[3]

Home hazard modification refers to the process of identifying and altering potential environmental risks within the home to create a safer living space for the elderly. This includes adjustments such as improving lighting, securing loose carpets, installing grab bars and non-slip surfaces in bathrooms, elevating toilet seats, and removing clutter or unstable furniture.[6,7] These modifications aim to eliminate common environmental triggers for falls and enable safer mobility. Studies have shown that individuals, particularly those over 75 years with visual impairments, benefit significantly from targeted home safety adjustments, resulting in a measurable reduction in falls when appropriate changes are implemented.[7] As an independent strategy, home hazard modification has demonstrated effectiveness in mitigating risk and can play a key role in fall prevention programs.

Multifactorial interventions take a more comprehensive approach by addressing multiple fall risk factors simultaneously.[6] These interventions are individualized based on prior assessment and typically include a combination of exercise programs (targeting balance, strength, and flexibility), medication review, management of chronic conditions, surgical corrections (e.g., cataract surgery or podiatric procedures), cognitive and behavioral therapy, environmental modifications, use of assistive devices, and educational strategies.[7] The rationale behind such approaches is that fall risk stems from a combination of physiological, medical, psychological, and environmental factors, and therefore, a single-pronged approach may not suffice. Tailoring interventions to the individual's needs is believed to maximize effectiveness and sustainability of fall prevention outcomes.

This review aims to critically explore whether home hazard modification alone can be an effective and sufficient strategy in reducing fall risk among older adults, or if multifactorial interventions provide superior outcomes. Given the increasing elderly population and the associated healthcare demands, it is essential to evaluate the comparative effectiveness of simpler, more focused interventions like home modifications versus complex, resource-intensive multifactorial programs. By synthesizing available evidence, this review seeks to inform healthcare providers and policymakers on the feasibility, impact, and practicality of both approaches in elderly fall prevention.

MATERIALS & METHODS

Search strategy: The literature search for this review was conducted using the databases PubMed, Google Scholar, and ScienceDirect. A combination of relevant MeSH (Medical Subject Headings) terms was used, including: "aged", "environmental modification", "exercise therapy", "fall prevention", "home safety", "patient safety", "postural balance", "randomized controlled trials" and "risk factors". Additionally, Boolean operators such as AND, OR, and NOT were applied to refine and broaden the search strategy, ensuring a comprehensive retrieval of relevant studies.

Study Selection: Studies were considered for inclusion if they met the following criteria: (a) published in English language; (b) conducted on community dwelling older adults aged 60 and above; (c) implemented home hazard modification and/or multifactorial fall prevention interventions;

(d) evaluated fall risk, incidence of falls or balance related outcomes; (e) follow-up duration of at least three months; (e) followed a randomized controlled trial design; (f) articles published after 2013; (g) available in full text format. Studies were considered for exclusion if they met the following criteria: (a) not focusing on fall prevention or lacking specific data on home hazard modification or multifactorial interventions; (b) observational studies, case reports, reviews, editorials, conference abstracts, or qualitative studies without a control group; (c) studies involving participants under the age of 60 or those with conditions unrelated to age-related fall risk e.g., trauma or post-operative falls; (d) interventions where home modifications were not a central or structured component; (e) duplicate studies or studies with insufficient methodological details.

Data Extraction: The literature search through the database showed 1280 articles, out of which 995 duplicates were ruled out. Following a title and abstract screening, 150 full-text articles were selected for detailed evaluation based on the predefined inclusion and exclusion criteria (Figure 1). Ultimately, only six studies met all criteria and were included in the final review.
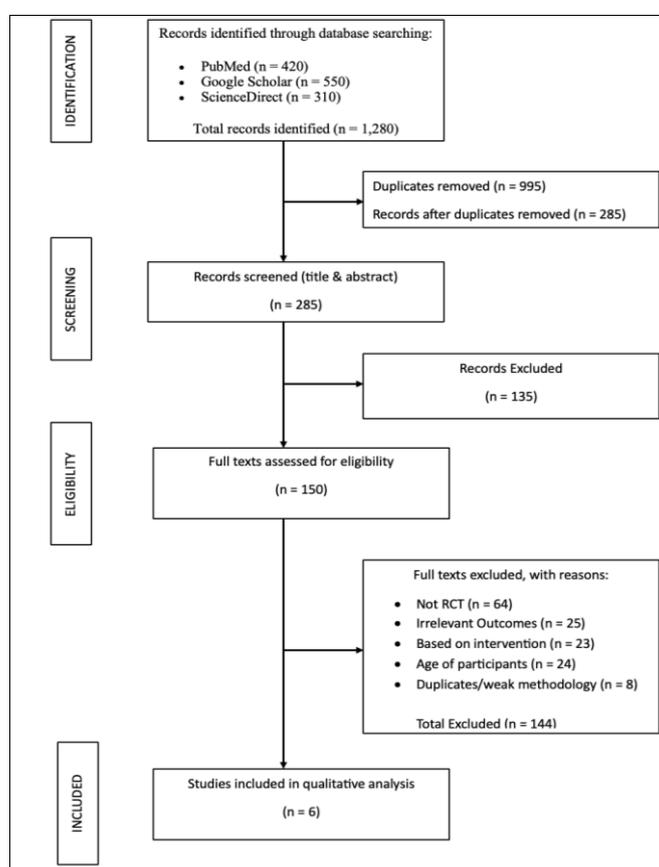

Figure. 1: The PRISMA flow diagram, illustrating each step in the selection of studies to be reviewed.

RESULTS
Methodological Quality: The methodological quality of the six articles was evaluated using the PEDro (Physiotherapy Evidence Database) scale. The studies demonstrated an average quality score of 6.05 out of 10. Of the six, four were classified as having moderate methodological quality, while the remaining two were considered to be of high quality (Table 1).

Population: The studies reviewed predominantly involved community-dwelling older adults aged 65 years and above, with most samples comprising

participants in their late 70s to early 80s. While not all studies reported detailed demographic data, the populations generally included individuals at high risk for falls, often with multiple comorbidities such as hypertension, diabetes, visual impairments, and polypharmacy. The inclusion of interventions such as medication review, vision assessment, and cardiovascular checks across studies suggests a recognition of the complex, multifactorial health profiles commonly seen in this population.

Interventions: The interventions used across the studies were predominantly multifactorial, combining structured exercise programs, home environment modifications, medical assessments, and educational components (Table 2). Exercise interventions focused on strength, balance, endurance, and mobility training, typically performed two to five times per week, with session durations ranging from 30 minutes to 2 hours, and program lengths extending from 3 to 12 months. Several studies incorporated home hazard assessments and modifications to address environmental risk factors for falls. Additional components included medication reviews to address polypharmacy, vision and cardiovascular assessments, and health education sessions aimed at improving awareness and promoting behavioral changes related to fall prevention. The interventions were often tailored based on the participants' functional levels and individual risk profiles, reflecting a personalized and holistic approach to fall reduction in older adults.

Outcome Measures: Outcome measures were broad and targeted multiple domains: fall incidence and recurrence were primary outcomes in all studies, while physical function was assessed using tools like the Timed Up and Go (TUG), Functional Reach (FR), and Short Physical Performance Battery (SPPB). Psychological and cognitive outcomes were also frequently measured using scales such as the Falls Efficacy Scale-International (FES-I), Geriatric Depression Scale (GDS), and Montreal Cognitive Assessment (MoCA), reflecting the comprehensive approach needed to evaluate fall risk in older adults (Table 2).

DISCUSSION

This review highlights the role of multifactorial interventions in fall prevention among older adults, focusing on combinations of exercise training, home hazard modifications, medical reviews, and health education. While exercise-based programs remain a central element of fall prevention strategies, their effectiveness appears inconsistent across studies. Interventions that incorporated balance, strength, and mobility training varied in duration and intensity, ranging from 3 to 12 months and from two to five sessions per week. Although some studies reported modest improvements in fall outcomes, particularly in reducing injurious falls,[9] others found no significant difference compared to usual care.[8] This variability suggests that exercise alone may not be sufficient for all populations and must be tailored to individual risk profiles.

Adding home hazard modification to exercise and education appears to offer several benefits. Studies that included environmental assessments and home modifications showed positive behavioral changes, improved fall prevention awareness, and in some cases, reduced overall and indoor falls.[10,11] A recent meta-analysis supports these findings, showing that home hazard interventions can lead to a 7% reduction in fall rates overall and a 26% reduction among high-risk individuals.[14] These interventions are relatively low-cost, easy to implement, and can be personalized to individual living environments, making them a practical addition to standard fall prevention programs. They also address risks that exercise cannot, such as poor lighting, loose rugs, or uneven flooring, which are common contributors to falls at home.

Table 1. Methodological quality of selected articles

Sl. No	Authors	Criteria of PEDro Scale											Total Score
		1*	2	3	4	5	6	7	8	9	10*	11	
1	Tan PJ et al.[8]	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	7/10
2	Matchar DB et al.[9]	Yes	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes	7/10
3	Stark S et al.[10]	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	8/10
4	Kamei T et al.[11]	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	7/10
5	Palvanen M et al.[12]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	7/10
6	Lee HC et al.[13]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	10/10

1.Eligibility criteria specified (*not included in the total score); 2. Random allocation; 3. Concealed allocation; 4. Groups similar at baseline; 5. Participant blinding; 6. Therapist blinding; 7. Assessor blinding; 8. ≥1 key outcome obtained from >85% of participants; 9. Intention-to-treat analysis; 10. Between-group statistical comparison; 11. Point estimates and variability provided.

Table 2. Summary of selected articles

Sl. No.	Authors & (Year)	Sample Size	Intervention	Duration, Frequency & Intensity of Intervention	Outcome	Outcome Measures	Follow-up	Result
1	Tan PJ et al.[8] (2018)	N = 268 EG = 134 CG = 134	EG = Modified Otago exercise program, HOMEFAST home hazards modification, visual & cardiovascular intervention, medication review & falls education CG = conventional treatment	12 Months; 4 times hospital visit one at baseline and monthly for 3 months; Home exercises performed 5 times per week; 5-8 tailored strength/balance exercises with 500g weights.	Fall occurrence, Gait & balance; Visual acuity; cardiovascular assessment; psychological assessment	TUG; FR; Snellen chart; ECG; short FES-I; DASS-21;	12 months	EG showed no benefit over conventional treatment in reducing fall recurrence, rate, or time to first fall over 12 months.
2	Matchar DB et al.[9] (2017)	N = 323 EG = 162 CG = 161	EG = Endurance training, Balance training, Integrative mobility training, Lower limb strength training (Functional & resistance), Polypharmacy, CDC Home checklist, Vision assessment CG = Usual care not involving specialised fall prevention training	Both groups = 9months If SPPB > 6 = 24 sessions (2 times per week); If SPPB < 7 = 12 sessions (3 times per week); If SPPB < 6 = group exercise program;	Fall occurrence; Lower extremity mobility; Cognitive function; History & nature of falls; Quality of life	SPPB; 2MWT; MoCA; MFES; EQ-5D-5L; EQ-VAS	3 months and 9 months	No significant reduction in overall falls but resulted in lower number of injurious fallers in EG
3	Stark S et al.[10] (2017)	N = 300 EG = 150 CG = 150	EG = home modification intervention in addition to usual care. CG = Usual care which	Session 1 – baseline; Sessions 2-3 – follow up 2 weeks after baseline Booster session – 6	Time to the first fall; Daily activity performance, fall self-efficacy;	OARS-ADL scale; short FES-I; SF-36	2 weeks, 6 months, 12 months	EG participants benefited from home modifications

			includes annual home evaluation.	months following baseline	health related quality of life.			that may enhance safety and independence.
4	Kamei T et al.[11] (2015)	N = 130 EG = 67 CG = 63	EG = fall prevention multifactorial program and home hazard modification CG = fall prevention multifactorial program	Once a year in four class sessions; each session lasting 120 minutes	Occurrence of overall and indoor fall events	Daily falls calendar and self-report	12 and 52 weeks	EG improved fall prevention awareness, home modification behaviors, and reduced overall and indoor falls.
5	Palvanen M et al.[12] (2014)	N = 1314 EG = 661 CG = 653	EG = strength and balance training, medical review and referrals, medication review, proper nutrition (calcium, vitamin D), and home hazard assessment and modification CG = general injury prevention program	12 Months; at least 3times per week and each session lasting for 30 minutes	Rates of falls; Fallers; Fall-induced injuries; Lower extremity mobility; Reaction time; isometric quadriceps strength; grip strength	Incidence rates; SPPB; TUG; hand-eye reaction test; dynamometer	12 months	Reduction in the rate of falls and fall related injuries in EG
6	Lee HC et al.[13] (2013)	N = 616 EG = 313 CG = 303	EG = exercise training, health education, home hazards evaluation/modification, medication review, ophthalmology consultation CG = health education brochures, referrals, no direct exercise intervention	3 months, including 8 weeks of exercise training	Fall incidence; overall PPA risk index; Quality of life; psychological assessment; balance; physical activity; cognition	PPA; EQ-5D-5L; GDS; FES-I; BI; IPAQ; MMSE	12 months	Fall incidence reduced in both groups.

ADL – Activities of Daily Living; BI – Barthel Index; CDC – Centre for Disease Control & Prevention; CG – Control group; DASS-21 – Depression, Anxiety and Stress scale; ECG – electrocardiogram; EG – Experimental group; EQ-5D-5L – EuroQol utility based quality of life; EQ-VAS – EuroQol Visual Analogue Scale; FES-I – Falls Efficacy scale International; FR – Functional Reach; GDS – Geriatric Depression scale; IPAQ – International Physical Activity Questionnaire; MFES- Modified fall Efficacy Scale (MFES); MMSE – Mini Mental State Examination; N – Total number of Participants; MoCA – Montreal Cognitive Assessment; OARS – Older Americans Resources and Services; PPA – Physiological Profile Assessment; SF-36 – 36-item Short Form Survey; SPPB - Short Physical Performance Battery; TUG – Timed Up and Go; 2MWT – 2 Minute Walk Test

However, there are limitations to relying solely on home modifications. In one large trial, a non-significant increase in fall rate was observed, possibly due to overconfidence or increased reporting.[15] Adherence to recommendations remains a significant challenge, with some studies reporting that less than half of participants followed through with suggested modifications.[10] Factors such as personal resistance to altering one's home, lack of family support, or limited resources can impede implementation. Furthermore, the effectiveness of these interventions may diminish over time if not reinforced through booster sessions or follow-up visits.

Several methodological drawbacks were observed across the reviewed studies. Many lacked blinding and objective outcome assessments, relied heavily on self-reported fall data, and had variations in intervention protocols. This heterogeneity, both in terms of intervention components and outcome measures, limits the ability to draw firm conclusions or directly compare results. Additionally, real-world implementation challenges such as workforce sustainability, participant retention, and coordination between providers may affect the translation of clinical trial findings into practice. The STRIDE trial, for example, highlighted the logistical complexity of delivering multifactorial interventions at scale, despite having a well-designed protocol.[13]

The findings of this review suggest that while exercise remains foundational in fall prevention, it is most effective when integrated with home hazard modification and other individualized interventions such as medication review and vision assessment. Multifactorial approaches acknowledge the complex nature of fall risk and offer a more comprehensive solution, particularly for community-dwelling older adults with multiple comorbidities. However, the effectiveness of these interventions hinges on sustained adherence and support systems that ensure environmental changes are made and maintained.

Looking forward, future research should focus on enhancing adherence to home modifications through behavioural strategies, such as motivational interviewing or digital reminders. Integration of technology, such as smart sensors, vision-based monitoring, or wearable devices could offer objective data on environmental risks and real-time alerts, thus enhancing both prevention and evaluation.[14] Moreover, there is a need for trials targeting populations with cognitive impairment, where evidence is currently limited but emerging studies suggest that home modifications may significantly reduce falls in this vulnerable group.[18] Finally, pragmatic trials that evaluate large-scale implementation of these interventions in real-world settings will be essential to understand their long-term sustainability and cost-effectiveness.

CONCLUSION
Fall prevention in older adults requires a comprehensive, multifactorial approach that goes beyond exercise alone. This review highlights that while structured exercise programs are foundational, their effectiveness is significantly enhanced when combined with home hazard modifications, medication reviews, and health education. Among these, home modifications stand out as a practical, low-cost intervention that not only addresses environmental risks but also empowers older adults to adopt safer behaviors. However, challenges such as inconsistent adherence, varied implementation protocols, and limited long-term follow-up data remain. The evidence also points to the need for personalized interventions tailored to individual risk profiles and functional capacity. Future research should focus on optimizing delivery methods, improving adherence strategies, and evaluating the sustainability and cost-effectiveness of these interventions in real-world settings.

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