

## Featured Falls Research – January

### **Effectiveness of Balance- and Strength-Based Exercise Interventions for Fall Prevention in Community-Dwelling Older Adults: A Systematic Review of Randomized Controlled Trials**

Choudhary PK, Choudhary S, Saha S, Katanić B, Ilbak I, Tornóczy GJ. *Life (Basel)*. 2025 Dec 26;16(1):41.

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#### **Abstract**

**Background:** Falls are a leading cause of injury, disability, and loss of independence among community-dwelling older adults. Although exercise-based interventions are widely recommended for fall prevention, the comparative effectiveness of different exercise modalities remains insufficiently synthesized.

**Methods:** This systematic review was conducted in accordance with PRISMA 2020 guidelines. Randomized and controlled trials were identified through searches of PubMed, Scopus, Web of Science, and CINAHL, including studies involving adults aged  $\geq 60$  years who participated in balance-based, strength-based, multimodal, Tai Ji Quan, Otago Exercise Program, or perturbation-based reactive balance training interventions. Methodological quality was assessed using the Cochrane Risk of Bias 2 (ROB-2) tool. Due to substantial clinical and methodological heterogeneity across interventions and outcome measures, a narrative synthesis was undertaken.

**Results:** Twenty-seven trials met the inclusion criteria. Exercise interventions consistently reduced fall incidence across studies. Tai Ji Quan interventions were associated with approximately 31-58% reductions in falls, the Otago Exercise Program with 23-40% reductions, and multimodal strength-balance training with 20-45% reductions. Perturbation-based reactive balance training demonstrated particularly strong effects on laboratory-induced falls, with reductions ranging from 50-75%. Functional outcomes also improved across intervention types, including faster Timed Up and Go performance, increased gait speed, improvements of approximately 1.2-2.5 points in Short Physical Performance Battery scores, 15-35% gains in lower-limb strength, and enhanced reactive balance responses. Longer-duration interventions (12-24 months) generally demonstrated sustained reductions in fall risk.

**Conclusions:** Evidence from randomized and controlled trials indicates that structured exercise interventions, particularly Tai Ji Quan, the Otago Exercise Program, multimodal strength-balance training, and perturbation-based reactive balance training, are effective in reducing falls and improving balance, mobility, and strength in community-dwelling older adults. These findings support the use of targeted, evidence-based exercise programs as central components of fall-prevention strategies in older populations.

**Keywords:** aging population; balance training; fall risk reduction; mobility; reactive balance; strength training.

## Effects of Tai Chi on balance and fall prevention in healthy older adults: a randomized controlled meta-analysis

Dong R, Hamzah MSGB, Awang MMB, Qiu J, Chen S. Front Public Health. 2026 Jan 6;13:1638006.

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### Abstract

**Objective:** This study aimed to evaluate the effects of Tai Chi on balance and fall risk in healthy older adults through a systematic review and meta-analysis of randomized controlled trials (RCTs).

**Methods:** A comprehensive literature search was conducted across international and Chinese databases to identify relevant studies published between 2004 and 2024. A total of 21 RCTs were included in the analysis, comparing Tai Chi with non-exercise control groups. Various balance measures, such as balance performance and fall risk, were assessed.

**Results:** The meta-analysis revealed that Tai Chi significantly improved balance and reduced fall risk among older adults. Specifically, improvements were observed in several key measures, including balance ability, walking speed, and confidence in preventing falls.

**Conclusion:** These findings suggest that Tai Chi is an effective intervention for enhancing balance and reducing fall risk in healthy older adults, highlighting its potential as a valuable preventive strategy for falls in the aging population.

**Systematic review registration:** <https://www.crd.york.ac.uk/prospero/>, identifier CRD420251004905.

**Keywords:** Tai Chi; balance; fall prevention; healthy older adults; meta-analysis.

## Falls Research – January

### **Neural control of anticipatory braking and lateral balance predicts fall risk in older adults: BMI-dependent mechanisms**

Choi Y, Jeong J, Lee H, Lee HJ, Han JW, Kim KW. Front Aging Neurosci. 2026 Jan 12;17:1699584.

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#### **Abstract**

**Introduction:** Falls are a leading cause of disability among older adults, and neural control is increasingly recognized as a critical risk factor. In this prospective cohort study, we investigated whether deceleration during terminal swing (DCEL), and medial-lateral velocity zero crossing count (VZCC), reflecting anticipatory braking and lateral balance control, predict future falls, and whether body mass index (BMI) moderates these associations. A total of 380 older adults were assessed and stratified by BMI (overweight:  $\geq 25$  kg/m<sup>2</sup>).

**Methods:** Fallers ( $n = 68$ ) and non-fallers ( $n = 312$ ) were identified prospectively over a 24-month follow-up period. Gait was measured using inertial measurement units (IMUs) during 14-meter walks.

**Results:** Compared to non-fallers, fallers were older ( $75.1 \pm 4.31$  vs.  $73.4 \pm 4.51$  years,  $p = 0.002$ ), had more prior falls, more negative DCEL values ( $-10.57 \pm 15.61$  vs.  $-5.08 \pm 16.39$  cm/s,  $p = 0.010$ ), and higher VZCC ( $4.96 \pm 2.59$  vs.  $4.29 \pm 1.31$ ,  $p = 0.023$ ). In multivariate models, age, prior falls, DCEL, VZCC, and the BMI  $\times$  DCEL interaction predicted fall risk. DCEL predicted falls only in individuals with normal weight (OR = 0.533, 95% CI = 0.368-0.770,  $p = 0.001$ ), whereas VZCC predicted falls across all BMI levels. Gait parameters reflecting neural control predict fall risk, with effects moderated by BMI.

**Discussion:** Anticipatory braking control is critical for individuals with normal weight, whereas lateral instability elevates fall risk regardless of BMI. These findings highlight the value of BMI-stratified fall assessments and targeted interventions.

**Keywords:** body composition; gait biomechanics; neural control; preventative health care; prospective cohort.

## Frailty as a Predictor of Falls in Older Adults with Type 2 Diabetes: Evidence from Vietnam

Dinh HT, Ha LVH, Luu NM, Do TTT, Nguyen TTH, Nguyen TX, Nguyen AT, Nguyen AL, Nguyen HTT, Phan HH, Nguyen TN, Vu HTT. Clin Interv Aging. 2025 Dec 23;20:2641-2650.

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### Abstract

**Background:** Frailty and falls significantly impact the health and quality of life of older adults with type 2 diabetes (T2D), increasing morbidity and dependency. However, their association in Vietnamese populations remains understudied. This study aimed to examine the association between frailty and fall risk and identify additional fall-related factors among older Vietnamese outpatients with T2D.

**Methods:** A cross-sectional study was conducted among 740 outpatients with T2D aged  $\geq 60$  years at a geriatric hospital in Hanoi, Vietnam, from March 2024 to December 2024. Fall risk was assessed using the 21-item Fall Risk Index (21-FRI), and frailty was determined by the Clinical Frailty Scale (CFS). Four multivariable logistic regression models evaluated frailty's association with falls, adjusting for demographics, diabetes-related factors, and geriatric syndromes.

**Results:** Among 740 older participants with T2D, 17.8% were frail, and 16.8% reported at least one fall in the past year. Frailty was strongly associated with a higher fall rate ( $p < 0.001$ ). In the fully adjusted logistic regression model, frailty emerged as a powerful and independent predictor of falls, increasing the odds by over four-fold (AOR 4.47, 95% CI 2.00-5.29). Other significant risk factors included advanced age, poor glycemic control, diabetic complications, and co-existing geriatric syndromes (depression, urinary incontinence, cognitive impairment, and sarcopenia).

**Conclusion:** Routine frailty screening should be integrated into T2D care to identify high-risk older adults and implement tailored fall prevention strategies.

**Keywords:** Vietnam; fall risk; falls; frailty; geriatric syndromes; older adults; type 2 diabetes.

## The neuromechanics of the soleus for fall prevention in aging

Fletcher JR, Strzalkowski NDJ. Front Physiol. 2026 Jan 7;16:1743559.

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### Abstract

Falls are a leading cause of injury-related hospitalization, morbidity, and mortality in older adults, with impaired postural control serving as a key predictor of fall risk. The triceps surae, and particularly the soleus, plays a central role in maintaining upright stance by generating continuous plantarflexion moments that stabilize the body's center of mass. This mini-review summarizes evidence for the neuromechanical contributions of the soleus to postural stability and how these functions decline with age. Mechanically, the soleus acts as a brace for balance, providing sustained torque through fatigue-resistant type I fibers and a compliant Achilles tendon that buffers perturbations and contributes to ankle stiffness. Age-related reductions in tendon stiffness and rate of torque development compromise these stabilizing properties, increasing fall susceptibility. When passive stiffness is insufficient, the soleus compensates through active contraction, trading energy cost of activation for joint stability. Reflexively, the soleus serves as a stabilizer of balance through strong coupling to spinal, cutaneous, vestibular, and transcortical pathways that rapidly adjust muscle activation in response to perturbations. These reflex mechanisms also degrade with aging, leading to delayed, less adaptable responses. Together, age-related mechanical and neural deterioration reduce the soleus' ability to sustain balance and contribute to fall recovery. Preserving soleus strength, tendon stiffness, and reflex adaptability through targeted neuromuscular and perturbation-based training may represent an underrecognized but effective strategy to mitigate fall risk and maintain postural control in older adults.

**Keywords:** balance; fall prevention; fall risk; postural stability; tendon stiffness.

## A Comparative Overview of Technological Advances in Fall Detection Systems for Elderly People

Flor-Unda O, Arcos-Reina R, Estrella-Caicedo C, Toapanta C, Villao F, Palacios-Cabrera H, Nunez-Nagy S, Alarcos B. *Sensors* (Basel). 2025 Dec 5;25(24):7423.

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### Abstract

Population ageing is a growing global trend. It was estimated that by 2050, people over 60 years of age will represent 35% of the population in industrialised countries. This context demands strategies that incorporate technologies, such as fall detection systems, to facilitate remote monitoring and the automatic activation of risk alarms, thus improving quality of life. This article presents a scoping review of the leading technological solutions developed over the last decade for detecting falls in older adults, describing their principles of operation, effectiveness, advantages, limitations, and future trends in their development. The review was conducted under the PRISMA<sup>®</sup> methodology, including articles indexed in SCOPUS, ScienceDirect, Web of Science, PubMed, IEEE Xplore and Taylor & Francis. There is a predominance in the use of inertial systems that use accelerometers and gyroscopes, valued for their low cost and wide availability. However, those approaches that combine image analysis with artificial intelligence and machine learning algorithms show superiority in terms of accuracy and robustness. Similarly, progress has been made in the development of multisensory solutions based on IoT technologies, capable of integrating information from various sources, which optimises decision-making in real time.

**Keywords:** artificial intelligence; elderly; fall detection; inertial measurement units; machine learning; wearable sensors.

## Expanding the reach of a fall prevention intervention for older adult emergency department patients through telehealth: a trial protocol

Keleman A, Bounds M, Mundo W, Gomez-Picazo J, Mealer M, Linnebur SA, Ferozan B, Dunn J, Stevens-Lapsley J, Goldberg E. *Front Public Health*. 2025 Dec 17;13:1720938.

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### Abstract

**Background:** Falls are a leading cause of emergency department (ED) visits among older adults, yet many patients are discharged without a clear understanding of their fall risk factors or access to timely prevention services. The Geriatric Acute and Post-Acute Fall Prevention (GAPcare) intervention has demonstrated efficacy in reducing fall-related ED revisits by addressing these factors during the ED visit. Still, its reliance on in-person specialists limits scalability to smaller and lower-resourced EDs.

**Methods:** This study outlines a protocol for adapting GAPcare into a telehealth-enabled model (e-GAPcare) using a two-phase implementation science approach. Phase 1 engages ED staff, patients, and caregivers in structured workgroups to guide the adaptation of telehealth while preserving core intervention components. Phase 2 involves a single-arm trial at one ED with 40 older adults presenting after a fall, evaluating feasibility and acceptability. The intervention includes remote consultations with a pharmacist and physical therapist, tailored assessments to address individual fall risk factors, and a standardized checklist integrated into discharge planning that is shared with primary care clinicians.

**Outcomes:** Data will be collected through surveys and electronic health records over a 6-month follow-up period. Trial outcomes include usability, care transition quality, healthcare utilization, and uptake of recommendations.

**Conclusion:** By leveraging hospital-based telehealth infrastructure and eliciting end-user perspectives on needed adaptations, e-GAPcare aims to extend the reach of evidence-based fall prevention programs to smaller EDs or those that lack in-person pharmacists and physical therapists.

**Keywords:** adaptations; emergency department; fall prevention; falls; remote; rural; telehealth.

## Associations of accelerometer-derived 'weekend warrior' physical activity pattern with incident sarcopenia and falls

Liu HY, Liu YY, Li QM, Liu L, Wen TJ, Gong TT, Wu QJ, Gao SY. Age Ageing. 2026 Jan 3;55(1):afaf370.

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### Abstract

**Background:** To examine associations between accelerometer-derived active weekend warrior (WW) pattern [most moderate to vigorous-intensity physical activity (MVPA) achieved over 1-2 days] vs. MVPA spread more evenly with risks of incident probable sarcopenia, sarcopenia and falls.

**Methods and findings:** This prospective cohort study comprises three substudies (probable sarcopenia, confirmed sarcopenia and falls). Objective physical activity data were collected from Axivity AX3 wrist-worn triaxial accelerometers on their dominant wrist for 7 consecutive days. Three MVPA patterns were compared: active WW ( $\geq 150$  min/week and  $\geq 50\%$  of total MVPA over 1-2 days), active regular ( $\geq 150$  min/week but not meeting active WW), and inactive ( $< 150$  min/week). Over 7.8 years median follow-up, there were 1785 (8.4%) incident (probable) sarcopenia, 1855 (8.7%) incident sarcopenia and 4166 (4.9%) incident falls. Compared to inactive participants, the effect sizes for active WW pattern at the guideline-based threshold with  $\geq 50\%$  of total MVPA over 1-2 days were: probable sarcopenia {hazard ratio [HR], 0.79 [95% confidence interval (CI), 0.70-0.89],  $P = 1.5 \times 10^{-4}$ }, sarcopenia [HR, 0.74 (95% CI, 0.63-0.87),  $P = 6.6 \times 10^{-4}$ ], falls [HR, 0.79 (95% CI, 0.72-0.85),  $P = 7.4 \times 10^{-8}$ ] and recurrent falls [HR, 0.82 (95% CI, 0.75-0.90),  $P = 9.1 \times 10^{-5}$ ]. The active WW pattern was associated with a 24%-32% reduction in the risk of (probable) sarcopenia, while active regular pattern was associated with a 12%-23% reduction in the risk. Regardless of the thresholds defining the active WW group, both activity patterns (active regular and active WW) showed a lower risk of falls.

**Conclusions:** Weekly physical activity concentrated in 1-2 days had a similarly low risk of sarcopenia and falls as a regular active pattern. Even resistance training 1-2 days per week can serve as an effective public-health strategy for preventing sarcopenia and falls.

**Keywords:** accelerometers; falls; older people; physical activity; sarcopenia; weekend warrior.

## Effectiveness of home safety training and balance exercises in reducing fear of falling among older women: A quasi-experimental study in southern Iran

Nazari S, Boraghi F, Karimi M, Kamalinia M, Faloye ST, Asadollahi A. *Prev Med Rep.* 2025 Dec 15;61:103351.

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PMCID: [PMC12771351](https://pubmed.ncbi.nlm.nih.gov/41503258/)

### Abstract

**Objectives:** This study examined whether a combined home-safety training and balance-exercise program could reduce fear of falling and improve ergonomic risks.

**Methods:** This quasi-experimental study included 336 Iranian women aged  $\geq 60$  who were non-randomly assigned to four groups based on the pre-existing type of anti-slip flooring in their homes. Over a two-month period in 2024, participants received home-safety training focused on practical ergonomic modifications, along with supervised balance and strength exercises. Outcomes included the Fear of Falling questionnaire, Berg Balance Scale, Timed Up and Go test, and an ergonomic home-risk checklist.

**Results:** The intervention significantly reduced fear of falling and improved home ergonomic safety ( $p = 0.01$ ). No significant changes were observed in balance performance (Berg:  $p = 0.82$ ; TUG:  $p = 0.34$ ) or fall frequency ( $p = 0.46$ ). Among flooring types, the Sonia group showed the largest reduction in fear of falling ( $p = 0.02$ ), while the Selda group showed a small decrease in fall frequency ( $p = 0.01$ ). Ergonomic improvements were most evident in bathrooms and kitchens, where grab bars and non-slip surfaces were implemented.

**Conclusions:** Home safety training combined with targeted ergonomic changes effectively reduced fear of falling and improved home safety.

**Keywords:** Accidental falls; Aged; Balance exercises; Ergonomics; Exercise therapy; Fear; Fear of falling; Female; Home ergonomic indicators; Home safety; Human; Iran; Older women; Quasi-experimental studies.

## Balance and fall-risk assessment in older adults using wearable plantar pressure and semi-supervised learning

Ou J, Chen F, Liao C, Song Z, Liu L, Song X, Bi W, Wang L, Shu L, Chen Z. Front Bioeng Biotechnol. 2026 Jan 12;13:1703500.

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### Abstract

Falls are a major public health concern among older adults, leading to disability, reduced independence, and high healthcare costs. Conventional balance assessments such as the Berg Balance Scale are limited by subjectivity, time requirements, and dependence on trained evaluators, creating barriers for large-scale community application. To address these challenges, we developed an intelligent footwear system combined with a semi-supervised learning framework to objectively predict Berg Balance Scale scores and assess fall risk. In a study of 136 older adults aged 60-90, plantar pressure signals from smart insoles with eight sensors per foot were collected, and 156 biomechanical features were extracted. A multi-model error consistency approach was applied to mitigate label noise, and feature selection identified ten interpretable predictors related to pressure duration, peak intensity, and inter-limb symmetry. The model achieved root mean square errors of 3.99 in validation and 3.13 in an independent test group. This wearable-based, interpretable, and scalable approach provides a practical solution for early detection of fall risk, enabling timely community interventions and supporting healthy aging strategies in public health.

**Keywords:** balance assessment; elderly adults; fall risk; intelligent shoe; plantar pressure; semi-supervised learning.

## Accuracy of Physical Function-based Fall Risk Assessments Among Community-Dwelling Older Adults: An ROC Analysis

Zamarripa E, Lafontant K, Fukuda DH, Stout JR, Thiamwong L. Res Health Med. 2025;5(1):142.

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### Abstract

**Introduction:** Physical function assessments, such as the Timed-Up-and-Go (TUG) and Short Physical Performance Battery (SPPB), are commonly used to evaluate fall risk among older adults, yet they may misclassify individuals. Center-of-pressure postural sway path length (PS) is a criterion for assessing fall risk, but it is unclear how TUG and SPPB compare. This study examined the sensitivity, specificity, and accuracy of these three assessments in classifying older adults as high or low fall risk.

**Methods:** We conducted a cross-sectional study of 234 community-dwelling older adults (women=203, age=75.0±7.0 years, height=159±7.9cm, Body Mass Index=30.0±6.3kg/m<sup>2</sup>). Cut off values for SPPB (<7 out of 12), TUG (≥20 seconds), and PS (>30 cm) were used to categorize participants as high or low fall risk. McNemar tests were used to compare fall risk assessment between assessments.

**Results:** Participants had a mean TUG time of 10.2±6.3 seconds, SPPB score of 8.7±2.3, and PS of 34.7±21.3cm. Both TUG (high risk=10, low risk=224;  $\chi^2=95.9$ ,  $p<0.001$ ) and SPPB (high risk=40, low risk=194;  $\chi^2=55.7$ ,  $p<0.001$ ) significantly differed in fall risk assessment compared to PS (high risk=115, low risk=119). Compared to postural sway, TUG had a sensitivity of 4.3%, specificity of 95.8%, and accuracy of 50.9%. Similarly, SPPB had a sensitivity of 23.5%, specificity of 89.1%, and accuracy of 56.8%.

**Conclusions:** TUG and SPPB both demonstrated low sensitivity and accuracy, suggesting that they may be better as measures of physical function rather than fall risk. Clinicians may benefit from using PS or other criterion measures to screen for fall risk.

**Keywords:** Balance; Fall Prevention; Screening.