CANADIAN STROKE BEST PRACTICE RECOMMENDATIONS

Rehabilitation, Recovery and Community Participation Following Stroke

Part Two: Delivery of Stroke Rehabilitation to Optimize Functional Recovery Evidence Tables

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Falls Prevention & Management

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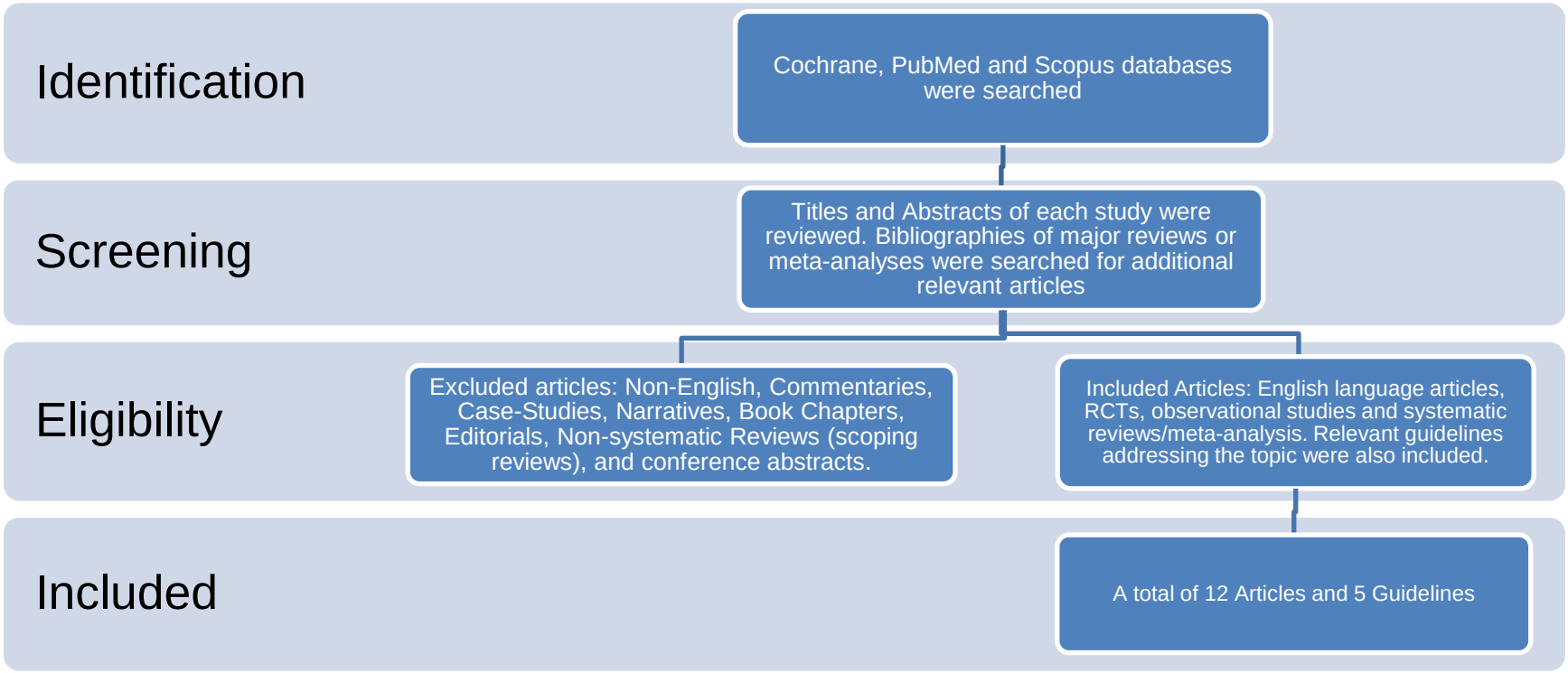
Search Strategy



Cochrane, PubMed and Scopus databases were searched using terms such as (Stroke OR cerebrovascular disease) AND (lower limb OR lower extremity) AND falls OR balance. Titles and abstract of each article were reviewed for relevance. Bibliographies were reviewed to find additional relevant articles. Articles were excluded if they were: non-English, commentaries, case-studies, narrative, book chapters, editorials, non-systematic review, or conference abstracts. Additional searches for relevant best practice guidelines were completed and included in a separate section of the review. A total of 12 articles and 5 guidelines were included and were separated into categories designed to answer specific questions.

Published Guidelines

Guideline	Recommendations
National Clinical Guideline for Stroke for the UK and Ireland. London: Intercollegiate Stroke Working Party; 2023 May 4. **Available at:** www.strokeguideline.org.	People with stroke should be offered a falls risk assessment and management as part of their stroke rehabilitation, including training for them and their family/carers in how to get up after a fall. Assessment should include physical, sensory, psychological, pharmacological and environmental factors. [2023] People with stroke should be offered an assessment of fear of falling as part of their falls risk assessment and receive psychological support if identified. [2016] People at high risk of falls after stroke should be offered a standardised assessment of fragility fracture risk as part of their stroke rehabilitation. [2016] People with stroke with symptoms of vitamin D deficiency, or those who are considered to be at high risk (e.g. housebound) should be offered calcium and vitamin D supplements. [2016] People at high risk of falls after stroke should be advised to participate in physical activity/exercise which incorporates balance and co-ordination at least twice per week. [2016] People with stroke and limitations of dorsiflexion or ankle instability causing impaired balance and risk or fear of falling should be considered for referral to orthotics for an ankle-foot orthosis and/or functional electrical stimulation. The person with stroke, their family/carers and clinicians in all settings should be trained in the safe use and application of orthoses and electrical stimulation devices. [2023]
Schoberer D, Breimaier HE, Zuschnegg J, Findling T, Schaffer S, Archan T. **Fall prevention in hospitals and nursing homes: Clinical practice guideline.** ***Worldviews Evid Based Nurs.* 2022 Apr;19(2):86-93.** **(selected)**	**Strong Recommendations for residents of LTC facilities** For patients at risk of falling, plan multifactorial interventions based on individual risk factors should include the following components: \Body exercises, review of medication, adaptation of the environment, patient education on fall risks and preventive measures, staff education on fall prevention measures. In order to reduce falls and fear of falling, residents should be informed *about fall risks and be trained and advised* about fall prevention measures. Multimedia or written information can be used to support and strengthen verbal training and counselling. For residents at risk of falling, body exercises should be supported by the use of aids such as treadmills or game consoles. For residents at risk of falling, body exercises should be instructed by therapists, such as physiotherapists. Exercise should be offered over a period of at least six months. Residents at risk of falling with cognitive and visual impairments should be offered body exercises (unless they are frail). (Certainty of the evidence was low or very low for these recommendations).

Guideline	Recommendations
Zhang T, Zhao J, Li X, Bai Y, Wang B, Qu Y et al. **Chinese Stroke Association guidelines for clinical management of cerebrovascular disorders: executive summary and 2019 update of clinical management of stroke rehabilitation.** ***Stroke Vasc Neurol.* 2020 Sep;5(3):250-259.** **(selected)**	1. During the hospitalisation period, each patient with a stroke should be assessed for fall risks and provided with an individualised fall prevention programme. Patients who are in the community are recommended to participate in balance training, such as Tai Chi, to prevent falls (Class I recommendation, Level B evidence). 2. Patients with poor balance, low self-confidence, fear of falling or risks of falling should receive balance function training (Class IIa recommendation, Level C evidence). 3. An annual assessment of the risk of falls should be conducted to improve the life and home environment in patients who had a stroke, and to reduce the accident (Class IIa recommendation, Level B evidence).
Clinical Guidelines for Stroke Management 2022. Melbourne (Australia): National Stroke Foundation. Section 5. Rehabilitation	For stroke patients, a falls risk assessment, including fear of falling, should be undertaken on admission to hospital. A management plan should be initiated for all patients identified as at risk of falls. For stroke survivors at high risk of falls, a comprehensive home assessment for the purposes of reducing falling hazards should be carried out by a qualified health professional. Appropriate home modifications (as determined by a health professional) for example installation of grab rails and ramps may further reduce falls risk. For stroke survivors who are at risk of falling, multifactorial interventions in the community, including an individually prescribed exercise program and advice on safety, should be provided. (weak recommendation).
Winstein CJ, Stein J, Arena R, Bates B, Cherney LR, Cramer SC et al; on behalf of the American Heart Association Stroke Council, Council on Cardiovascular and Stroke Nursing, Council on Clinical Cardiology, and Council on Quality of Care and Outcomes Research. **Guidelines for adult stroke rehabilitation and recovery: A guideline for healthcare professionals from the American Heart Association/American Stroke Association.** ***Stroke* 2016;47:e98–e169**	Prevention of falls recommendations: It is recommended that individuals with stroke discharged to the community participate in exercise programs with balance training to reduce falls. (B) It is recommended that individuals with stroke be provided a formal fall prevention program during hospitalization.(A) It is reasonable that individuals with stroke be evaluated for fall risk annually with an established instrument appropriate to the setting. (B) It is reasonable that individuals with stroke and their caregivers receive information targeted to home and environmental modifications designed to reduce falls.(B) Tai Chi training may be reasonable for fall prevention.(B)

Evidence Tables

Incidence and Risk Factors for Falls Post Stroke

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Xie et al. 2022 **China** **Systematic review & meta-analysis**	NOS scores ranged from 7 to 9 (high quality); in the 2 cross-sectional studies, AHRQ scores ranged from 4 to 6, (moderate quality)	8 studies involving 1,597 participants recovering from stroke. Mean age ranged from 52 to 78 years, the percentage of women ranged from 27% to 51%. Th time since stroke ranged from inpatient rehabilitation to > 6 months.	Risk factors for fear of falling (FoF) were identified and the results, pooled.	**Primary outcome:** FoF risk factors	*Risk factors for FoF (OR, 95% CI)* Women: 2.13, 1.47 to 3.09 Impaired balance ability: 5.54, 3.48 to 8.81 Lower mobility: 1.12, 1.05 to 1.19 History of falls: 2.33, 1.54 to 3.53 Use of a walking aid: 1.98, CI 1.37 to 2.88 Anxiety: 2.29, 1.43 to 3.67 Depression: 1.80, 1.22 to 2.67 Poor lower limb motor function: 1.14, 1.00 to 1.29 Physically inactiveness: 2.04, 1.01 to 4.12
Xu et al. 2018 **Australia** **Systematic review & meta-analysis**	Using the Q-Coh tool, 7 studies were appraised as good, 9 were acceptable and 5 were low quality	21 trials (19 cohort studies and 2 case-control studies) including persons with first or recurrent stroke residing in the community. Mean age was 69 years. Mean time since stroke ranged from 3 days to 6.1 years.	Potential risk factors for falling were examined. including age, sex, falls before stroke, falls in the hospital, length of stay in the hospital, and rehabilitation before and during the study. The duration of follow-up ranged from 4 to 24 months.	**Primary outcome:** Risk factors for fallers **Secondary outcome:** Risk factors for recurrent fallers	The proportion of all fallers across studies ranged from 23% to 55% and recurrent fallers from 5% to 42%. *Risk factors for all fallers:* The risk of falling increased in persons with impaired mobility OR=1.36, 95% CI 2.68 to 7.10, n=3), reduced balance (OR=3.87, 95% CI 2.39 to 6.26, n=3), use of sedative & psychotropic medications (OR=3.19, 955 CI 1.36 to 7.48, n=3) disability in self-care (OR=2.30, 95% CI 1.51 to 3.49,n=4), depression (OR=2.11, 95% CI 1.18 to 3.75, n=3), cognitive impairment (OR=1.75, 95% CI 1.02 to 2.99, n=3) and a history of falls (OR=1.67, 95% CI 1.03 to 2.72, n=3). Non-significant factors included age, sex, duration of stroke, visual impairment, multiple strokes, motor impairment, and urinary incontinence. *Risk factors for recurrent fallers:* Persons with a history of falls (OR=4.19, 95% CI 2.50 to 7.01, n=3).

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Pinto et al. 2016 **Brazil** **Observational study**	N/A	131 patients recruited from an outpatient stroke clinic with ischemic or hemorrhagic stroke, who could walk independently, with or without a walking aid. Mean age was 55.8 years, 48% were men. Median time since stroke was 13.5 months.	Risk factors for recurrence of falls (within previous year) were identified. Potential risk factors included demographic and clinical data, NIHSS score, Barthel Index, Timed Up and Go Test (TUG), and EQ-5D. Participants were followed prospectively for 2 years for the occurrence of recurrent (≥2) falls.	**Primary outcome:** Predictors of recurrent falls	Falls occurred in 17% of patients, within a median of 23 months of follow-up (interquartile range = 16-26 months). Independent predictors of recurrent falls were TUG (adj HR=1.69 per 1 quartile increase, 95% CI 1.07-2.69), female sex (adj HR=2.80, 95% CI 1.08-7.30) and posterior circulation territory involvement (adj HR=3.37, 95% CI 1.47-7.7).2
Callaly et al. 2015 **Ireland** **Prospective study**	N/A	567 adults included in the North Dublin Population Stroke Stud from hospital and community sources. Mean age was 70.6 years, 5.2% were men.	The risk of falls over 2 years and the incidence of fracture and suffering other serious injury was estimated.	**Primary outcome:** Risk factors for falling within 2 years of stroke Timing of assessment: Participants were interviewed at 72 h, 7 days, 28 days, 90 days, 1- and 2-year time points post-stroke.	Of 332 survivors at 2 years, 107 (32.2%) had fallen, of whom 60.7% (65/107) had 2 or more falls and 23.4% (25/ 107) had a fracture. Independent predictors of falling were alpha and beta blocker medications (OR=8.16, 95% CI 2.03 to 32.78, and OR=0.53, 95% CI 0.32 to 0.89, respectively), impaired mobility (OR=2.30, 95% CI 1.3 to 4.00), and mRS 4-5 (OR=2.02, 95% CI 1.09 to 3.76). Age and gender were not significant factors.
Czernuszenko & Czlonkowska 2009 **Poland** **Retrospective study**	N/A	1,155 stroke patients consecutively admitted to a neurological rehabilitation unit over 4 years. Mean age was 61.5 years, 56.5% were men. Median time since stroke was 36.5 days.	Documented fall incident reports, as reported by a witness of the faller, were identified. The site, circumstances, and consequences of the fall were noted.	**Primary outcome:** Fall occurrence, Scandinavian Stroke Scale (SSS), BI Timing of Assessment: Admission to and discharge form rehabilitation.	253 falls involving 189 (16%) patients were reported during the study period. The incident rate for a first fall was 6.5/1000 patient days (95% CI 5.6 to 7.4) and 14.5/1000 patient days (95% CI 11.0 to 18.1) for a subsequent fall. The majority of falls took place during the day (82%) in the patient's room (59%). 28% of falls resulted in injuries. Significant associations were found between the occurrence of a fall and admission BI<15 (HR=8.9), SSS<46 (HR=5.0), time from onset to admission<12 weeks (HR=3.0), presence of neglect (HR=2.1), left-sided motor deficit (HR=1.4), and age over 65 (HR=1.7), all at p<0.001 (except left-sided motor deficit, p<0.05). Patients who experienced greater gain in BI score and greater rehabilitation efficiency (BI gain/weeks in rehabilitation) were significantly more likely to experience a fall.

Screening Tools

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Breisinger et al. 2014 **USA** **Retrospective study**	N/A	419 patients with acute ischemic or hemorrhagic stroke admitted for inpatient rehabilitation. Mean age was 67.5 years, 48% were women.	The accuracy of the Stroke Assessment of Fall Risk (SAFR) for classifying fallers and non-fallers was compared with a more generic, local health system fall risk screening tool, the Fall Harm Risk Screen. SAFR is composed of 4 impairment items (impulsivity, hemi-neglect, static, and dynamic sitting balance) and 3 functional limitations items (lowest score on three FIM: transfers, problem solving, and memory). Possible scores range from 0 (low risk) to 49 (high risk). The Fall Harm Risk Screen is a 3-item scale that assesses 3 levels of fall risk (low, medium, and high) based on functional ability, history of falls, and the nurse's clinical judgement of fall risk	**Primary outcomes:** Sensitivity, specificity, positive predictive value, negative predictive value and area under ROC	68 patients (16%) experienced at least one fall during their inpatient rehabilitation stay, 10 people fell more than once. The area under the curve for Fall Harm Risk Screen was 0.56 (95% CI (0.50, 0.62), and 0.73 (95% CI (0.67, 0.79) for SAFR, which was significantly more accurate. Area under the curve values ranged from 0.55–0.69 for individual items of SAFR. At a cut-point of 27, the sensitivity and specificity of SAFR were 0.78 and 0.63, respectively, compared with 0.57 and 0.48 for the Fall Harm Risk Screen (cut-point of 2). The positive predictive value for the SAFR was 0.29 and the negative predictive value was 0.94, compared with 0.19 (PPV) and 0.86 (NPV), for the Fall Harm Risk Screen
Nystrom & Hellstrom 2013 **Sweden** **Prospective study**	N/A	68 participants recruited between 1-4 days post stroke.	An assessment was completed at baseline using the Modified Motor Assessment Scale and Predict FIRST. All falls occurring on the acute stroke unit were recorded and a call was placed after discharge to obtain if any falls occurred at home.	**Primary outcomes:** Fall rates, Predict FIRST scores, Modified Motor Assessment Scale (M-MAS) – version 99. Predict FIRST scores correlation with risk of falling (e.g., 0=2%, 1=4%, 2=9%, 3=18%, 4=33%, and 5=52%)	21% of participants had ≥1 fall. A total of 36 falls occurred, with 72% of those falls occurring for a male patient. Majority (63.9%) of falls occurred on the unit. Predict FIRST scores were as follows: 0 points, n=3; 1 point, n=19; 2 points, n=21; 3 points, n=18; and 4 points, n=7. For predicting falls, the significant variables were the Predict FIRST score (OR=5.21, 95% CI = 1.10 to 24.78, p=0.038) and the M-MAS section C-E

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
					(OR=0.65, 95% CI = 0.44 to 0.95, p=0.026).

Falls Prevention and Management

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Yang et al. 2021 **USA** **Systematic review & meta-analysis**	10 trials had a PEDro score of 8, 2 had a score of 7 and one had a score of 6.	13 RCTs including 1,352 participants with stroke who were in the acute/subacute stage (between 2 weeks and 6 months) or the chronic stage (≥ 6 months) of recovery. Mean age ranged from 51 to 76 years, 60% were men. Mean time since strike was 40.3 months (chronic 10 trials, acute/subacute 3 trials).	Interventions assessed included: treadmill walking (n=1), multifactorial falls prevention (n=1), fall prevention exercise with a home exercise program (n=1), physical therapy with virtual reality (n=1), traditional physical therapy (n=1), foot drop stimulators (n=1), intensive exercise (n=1), exercise with whole-body vibration (n=1), perturbation-based balance training (n=1), agility training(n=1), exercise (n=1), dual-task mobility with cognitive exercise (n=1), single-task mobility with cognitive exercise (n=1) Tai Chi (n=1) and the and Silver Sneakers program (n=1). Control conditions included no treatment, usual care, ankle-foot orthotics, conventional physical therapy], conventional balance training, upper limb exercise with HEP or with cognitive exercise, self-initiated exercise, exercise without vibration, weight	**Primary outcome:** Number of fallers	Overall, falls prevention interventions were not associated with a significant reduction in falls (OR=0.88, 95 % CI 0.64 to 1.21, n=15 interventions). In subgroups analysis, no category of intervention was associated with a reduction in falls (walking-based training, physical therapy-based interventions, or exercise-based interventions) In 8 trials where balance was assessed as an outcome, falls interventions were not associated with a significant improvement in measures of balance (SMD=-0.01, 95% CI -0.15 to 0.12). In 11 trials where mobility was assessed as an outcome, falls interventions were not associated with a significant improvement in measures of mobility (SMD=-0.06, 95% CI -0.07 to 0.19).

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
			shifting and stretching and relaxation. The interventions were provided for 6 weeks to 12 months, and the falls tracking period ranged from 10 weeks to 12 months.		
Denissen et al. 2019 **Belgium** **Cochrane review**	Most trials were at low risk of bias for 4-5 of 6 domains assessed	14 RCTs including 1,358 participants recovering from stroke, at any stage (<24 hours to 6 months). Mean age was 57 years. Sex breakdown was not reported.	Studies evaluated the effectiveness of interventions for preventing falls. In 8 trials exercise compared was a control condition. A single trial included home visits compared to control, Single lens distance glasses compared to usual (multifocal) glasses, Servo-assistive rollator compared to control and tDCS compared to sham tDCS.	**Primary outcome:** Risk of falls, number of fallers **Secondary Outcomes:** Number of fall related fractures and hospital admissions, near-fall events, quality of life and adverse events	Exercise was associated with a significantly reduced risk of falling (RR=0.72, 95% CI 0.54 to 0.94; 765 participants), GRADE: Low Exercise was not associated with a significantly reduced number of fallers (RR=1.03, 95% CI 0.90 to 1.19; 969 participants), GRADE: Very low None of the other 4 interventions were associated with a significant reduction in the risk of falls or the number of fallers (GRADE: very low for all 4 interventions) Sex as an interaction term, was not explored.
Mansfield et al. 2018 **Canada** **RCT**	CA: ☑ Blinding: Patient ☒ Assessor☑ ITT: ☑	83 participants recruited from the community in the chronic stage of stroke who could stand independently without upper limb support for >30s and tolerate at least 10 postural perturbations. Mean age was 66.5 years, 67% were men. Mean time since stroke was 1.7 years.	Participants were randomized to a Perturbation Balance Training (PBT) group, delivered one-on-one by a physical therapist and tailored to participants' ability and balance impairments or to a conventional balance training group including balance and mobility interventions. Therapy was provided for 60 minutes/session, 2 sessions/week for 6 weeks.	**Primary outcome:** Falls during 12 months **Secondary outcomes:** Berg Balance Scale (BBS), mini-Balance Evaluation Systems test (mini-BEST), Timed Up & Go (TUG) and The Activities-specific Balance Confidence (ABC) questionnaire. Outcomes were assessed post intervention and at 6-and 12-month follow-up.	There was no significant difference between groups in the rate of falls. There were 53 falls (1.45 falls/ person-year) in the PBT group and 64 falls (1.72 falls/person-year) in the control group. Rate ratio=0.85, 95% CI 0.42 to 1.69; p=0.63. Post intervention, there were no significant differences in mean scores between groups except for 2 subscores of mini-BEST (reactive and sensory). At 6 months, there were no significant differences in mean scores between groups except for the reactive subscore of mini-BEST. At 12 months, the mean total mini-BEST score was significantly higher in the PBT group (20.6 vs. 18.7, p=0.049). The reactive subscore was also significantly higher in the PBT group.

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Batchelor et al. 2012 **Australia** **RCT**	CA: ☑ Blinding: Patient ☒ Assessor☑ ITT: ☑	156 stroke patients at high risk of falls (in-hospital fall, BBS score <50, or Step Test<7) within 2-weeks of discharge home from inpatient rehabilitation. Mean age was 71 years, 63% were men. Mean time since stroke was 3 months.	Participants were randomized to a tailored multifactorial falls prevention program plus usual care (71) or usual care alone (n=85) for 12 months. The intervention involved an individualized home exercise program (based on the Otago Exercise Program), falls risk and injury risk minimization strategies, and education.	**Primary Outcomes:** Rate of falls and proportion of fallers. **Secondary Outcomes**: Injurious falls, falls risk, participation, activity, leg strength, gait speed, balance, functional independence, and fear of falling. Baseline and 12-month follow-up.	There was no difference between groups in the rate of falls (1.89 per person-year in the intervention group vs. 1.76 in the control group; incidence rate ratio=1.10, 95% CI 0.63–1.90) or in the number of injurious falls (0.74 per person-year in the intervention group vs. 0.49 in the control group; incidence rate ratio=1.57, 95% CI 0.73–3.4). There were no significant differences between groups on any of the secondary outcomes. Lost to follow-up: intervention group=12%; control=20%.
Dean et al. 2012 **Australia** **RCT**	CA: ☑ Blinding: Patient ☒ Assessor☑ ITT: ☑	151 participants of the NSW Stroke Recovery Association residing in the community who were able to walk 10 m independently with or without a mobility. Mean age was 67 years, 51.6% were men. Mean time since stroke was 5.9 years.	Participants were randomized to receive either an experimental exercise program (lower limb exercises designed to improve walking, physical activity and reduce falls; n=76) or a control exercise program (designed to improve upper limb and cognitive functions; n=75). Both groups completed at least 3, 45-60-minute sessions per week in addition to receiving advice and a home program. The intervention was delivered for 40-weeks over 1-year.	**Primary Outcomes:** Walking capacity (6-minute walk test), walking speed (10-meter walk test), and fall rate. **Secondary Outcomes:** Falls risk, quality of life, community participation, and physical inactivity. Baseline and at the end of the 12-month program, with falls reported monthly over the study period.	At the end of the 12-month program, participants in the intervention group improved significantly more than those in the control group in terms of walking capacity (mean difference=34 meters, 95% CI 19 to 50; p<0.001) and walking speed (mean difference=0.07 m/s, 95% CI 0.01 to 0.14; p<0.5). However, no difference was found between the two groups with respect to proportion of fallers (62% vs. 51%; RR=1.22, 95% CI 0.91 to 1.62) or fall rate (1.7 vs. 1.8; IRR=0.96, 95% CI 0.59 to 1.51). The two groups also demonstrated non-significant differences in falls risk, physical activity, and quality of life. Lost to follow-up: intervention group=14%; control group=9%.

Abbreviations

AHRQ: The instrument Agency for Healthcare Research and Quality	BI: Barthel Index
CA: Concealed Allocation	CI: Confidence Interval
FAC: Functional Ambulation Categories	IQR: Interquartile Range
ITT: Intention to treat	NA: Not Applicable
NIHSS: National Institutes of Health Stroke Scale	NOS: Newcastle-Ottawa Scale
OR: Odds Ratio	RCT: Randomized Controlled Trial
SMD: Standardized Mean Difference	

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