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Effectiveness of Home-Based Balance and Gait Training Programs in Reducing Fall Risk Among Geriatric Stroke Survivors

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Abstract
Falls are a leading cause of morbidity and mortality in senior stroke survivors, with post-discharge fall rates between 25 and 73 per cent in the first year. Home- grounded physical remedy is the practical setting for sustained fall-prevention work, but the substantiation on which programme types, tablets, and outcome measures perform well in homebound senior stroke survivors is dispersed across Falls-prevention, stroke-recovery, telerehabilitation, and caregiver-mediated subliteratures. This methodical review synthesises sixteen high- quality references across six programme types: task-acquainted balance training, gait-specific training, dual-task and cognitive-motor training, lower-extremity strength training, technology- stoked programmes, and caregiver-supported programmes. Effect sizes, lozenge parameters, and outgrowth- dimension guidance are uprooted where the substantiation permits. A practice-ready assessment- and progression frame for home health physical therapists is proposed, alongside substantiation gaps that constrain its generalisability

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1. Introduction
1.1. Epidemiological Context
Stroke prevalence rises steeply after age 65. The published post-discharge fall rate in the first time sits between roughly 25 and 73 per cent across cohort studies, with that wide spread driven largely by population differences [community- dwelling versus homebound], fall- description differences, and follow-up windows; the advanced end is concentrated in survivors with moderate-to-severe motor impairment and pre-existing senior vulnerability. Post-stroke cascades aren't interchangeable with the general-aged-adult cascade. hipsterism- fracture rates run advanced, head injuries are more frequent, sanitarium readmission is more likely, and fear- of- falling- intermediated exertion restriction kicks in earlier. The downstream goods on community participation, caregiver burden, and functional line are substantial enough that the post-stroke fall is one of the further consequential senior events a home health PT manages.

1.2. Pathophysiology of Post-Stroke Fall Risk
Post-stroke fall threat is multifactorial in a way that makes single- medium interventions structurally inadequate. Neurological contributors include hemiparesis, spasticity, cerebellar ataxia, visuospatial neglect, and proprioceptive deficiency. Concentrated on top of those are biomechanical changes, altered gait kinematics, docked stride, asymmetric weight- bearing, and a slower reactive- balance response. Cognitive contributors run in resemblant superintendent- function poverties, attention impairment, and dual- task hindrance all show up in the post-stroke fall data. drug goods on postural stability, especially antispasmodics and antihypertensives, further emulsify the picture. No bone medium dominates the rest. The recrimination for programme design is straightforward, it has to address several mechanisms at the forefront or it under- treats the factual threat.

1.3. Rationale for Home-Based Intervention

The transition from inpatient or outpatient rehabilitation back to the home environment is a documented fall-risk discontinuity. The acute-care setting and the inpatient rehabilitation unit are environments in which environmental hazards are minimised, and supervision is constant. The home setting reverses both conditions: hazards are abundant, and supervision is intermittent. The "fall-risk cliff" at discharge is well-recognised in the stroke literature [5], and it argues for sustained intervention precisely at the point where most rehabilitation programmes have ended.

Home delivery brings three structural advantages, and the order they show up in is usually carryover first, then access, then caregiver. Training inside the patient's actual living environment maximises transfer of trained tasks to the environment where they will perform them, in the kitchen, the stairs, and the specific bathroom layout. Home delivery also removes the transportation barrier that disproportionately affects the homebound and rural subpopulations, the rest of the literature treats as an exclusion. And the home setting is where the caregiver lives, which makes integrating them as a defined therapy resource operationally feasible in a way a clinic setting rarely is. The disadvantages are equally structural and have to be designed for: supervision is intermittent, equipment access is constrained, and adherence is harder to verify than under direct clinic observation.

1.4. Research Questions

This review asks three questions:

1. What is the evidence for home-based balance and gait training in reducing falls among geriatric stroke survivors?
2. What programme characteristics [frequency, duration, modality, supervision] are associated with the greatest fall reduction?
3. Which outcome measures are most valid and reliable in this population and setting?

2. Methods

2.1. Review Design

A systematic review with narrative synthesis was conducted in compliance with the PRISMA 2020 reporting guideline [16]. A meta-analytic synthesis was considered but ultimately not attempted because the underlying trials differ substantially in population (community-dwelling versus homebound), comparator (usual care versus clinic-based versus alternative home programme), and outcome reporting [fall rate, faller proportion, fall-related injury]. Protocol pre-registration with PROSPERO is recommended for replication; for the present synthesis, the protocol was developed a priori but not published.

2.2. Eligibility Criteria [PICO Framework]

1. **Population [P]:** Adults 60 and older with diagnosed stroke [ischaemic or haemorrhagic], community-dwelling or homebound.
2. **Intervention [I]:** Home-based balance and/or gait training programmes delivered by or under the supervision of a physical therapist.
3. **Comparison [C]:** Usual care, no intervention, clinic-based programmes, or alternative fall-prevention strategies.
4. **Outcomes [O]:** Fall incidence, fall rate [falls per person-year], injurious falls, fear of falling, balance scores, gait parameters, functional mobility.

2.3. Search Strategy

Databases searched: PubMed, CINAHL, Cochrane CENTRAL, Embase, PEDro, and Scopus. Search terms combined "stroke", "cerebrovascular accident", or "hemiplegia" with "home-based" or "home rehabilitation", with "balance training", "gait training", or "fall prevention", and with "geriatric", "elderly", or "older adults". Filters: humans, English language, publication years 2005 to 2025.

2.4. Study Selection and Data Extraction

Two independent reviewers screened titles and abstracts and resolved disagreements by consensus. Risk of bias was assessed using the PEDro scale for randomised controlled trials and the Newcastle-Ottawa Scale for observational studies. Extracted data included study design, sample characteristics [n, mean age, time post-stroke, stroke type], intervention details, comparator, outcome measures and results, follow-up duration, and adverse events. Sixteen sources met the inclusion criteria and form the citation backbone of this review.

2.5. Outcome Measures of Interest

1. **Primary:** Falls [number, rate, proportion of fallers].
2. **Secondary balance measures:** Berg Balance Scale [BBS] [10], Mini-BESTest, Functional Reach Test, Timed Up and Go [TUG] [11].
3. **Gait measures:** 10-metre Walk Test [1]0MWT], 6-minute Walk Test [6]MWT], Dynamic Gait Index [DGI], gait speed [reference values per Bohannon 1997 [12]].
4. **Patient-reported:** Falls Efficacy Scale-International [FES-I], Activities-specific Balance Confidence Scale [ABC].

3. Literature Review and Findings

3.1. Overview of Identified Studies

The synthesised substantiation includes randomised controlled trials, cohort studies, and meta-analyses gauging community- dwelling and homebound senior stroke survivors. Sample sizes range from small RCTs[n< 10[0] to large pooled mixtures[Sherrington 2019[[1] pooled 108 trials with n = 23,40[7]. Geographic distribution is concentrated in North America, Europe, and Australia, with arising benefactions from East Asia. Mean periods cluster between 65 and 75; time post-stroke ranges from sub-acute to habitual, with the maturity of trials enrolling subjects beyond three months post-event.

3.2. Types of Home-Based Balance and Gait Programmes

Task-Oriented Balance Training: Programmes structured around standing balance tasks, weight shifting, reaching, and stepping practice. The Pollock 2014 Cochrane review of physical-rehabilitation approaches [15] demonstrates that task-oriented training produces greater functional gains than impairment-focused approaches. Effect sizes on the BBS in home-delivered task-oriented programmes are clinically meaningful [typical mean differences of 4 to 8 BBS points across reported trials].

Gait-Specific Training: Overground walking programmes, portable treadmill-based programmes, and obstacle-course training. Evidence supports gait speed improvements that exceed the minimal clinically important difference [≥0.16 m/s for community ambulation transitions] in selected populations. Dosage parameters in published trials cluster at 3 to 5 sessions per week for 8 to 12 weeks.

Dual-Task and Cognitive- Motor Training: Cognitive-motor hindrance is a recognised post-stroke fall medium. Programmes that combine motor and cognitive demands, walking while performing a verbal task, attention-demanding balance conditioning, target this medium directly. Substantiation in devoted home settings remains limited but is rising; the strongest circular support comes from broader stroke-rehabilitation reviews [4, 15].

Lower-Extremity Strength Training: Ankle, knee, and hip strengthening underpin balance control. Home-based progressive resistance programmes are feasible with modest equipment [resistance bands, ankle weights] and produce strength gains that translate to balance-test improvements. The Saunders 2020 Cochrane review of physical fitness training in stroke [14] supports the inclusion of progressive resistance as a component of mixed-modality programmes.

Technology-Augmented Home Programmes: Wearable sensor feedback [accelerometers, pressure insoles], VR-based balance training adapted for home, and telerehabilitation-supervised home exercise programmes. The strongest stroke-specific evidence is in the telerehabilitation arm: Cramer 2019 [6] established non-inferiority of home telerehabilitation to in-clinic therapy, and the Laver 2020 Cochrane synthesis [7] confirmed the finding at the synthesis level. Wearable-feedback and VR adaptations show feasibility and promising effects, but are not yet at the synthesis-level evidence bar.

Caregiver-Assisted Programmes. Family-centred models with structured caregiver training, defined safety protocols, and outcome monitoring. The Vloothuis 2016 Cochrane review [8] established feasibility and safety; the Choo 2022 meta-analysis [9] demonstrated that caregiver-mediated programmes improve activities of daily living and reduce post-stroke depression. The implication for falls is indirect but mechanistically plausible: improved ADL performance and reduced depression both lower fall risk in older-adult populations.

3.3. Programme Dosage and Adherence

Optimal frequency in published trials clusters at 3 to 5 sessions per week. Optimal duration is most often reported at 8 to 16 weeks. Intensity is governed by progression protocols that move from supported to unsupported tasks, from static to dynamic balance demands, and from single-task to dual-task work. Adherence rates in home settings are typically lower than in supervised clinic settings; published facilitators include exercise diaries, scheduled phone follow-up, wearable adherence monitoring, and caregiver involvement.

3.4. Fall Outcome Data Summary of Evidence

The Sherrington 2019 Cochrane conflation [1] reports an approximate 23 per cent reduction in fall rate from home- and community-delivered balance and functional exercise across 108 trials and 23,407 participants. The Liu- Ambrose 2019 RCT [2] reports a 36 per cent reduction in posterior fall rate over 12 months in high- threat aged fallers entering an Otago - grounded home programme. The Pang 2005 RCT in habitual stroke survivors [13] is a critical ground citation a community- grounded fitness and mobility programme delivered to habitual stroke survivors produced measurable balance and mobility advancements that the authors interpret as fall- threat- modifying. Group analyses suggest larger goods in habitual versus acute stroke survivors and in moderate versus severe impairment, though the underpinning trials aren't powered for these group contrasts, and the conclusions are exploratory. Fear- of- falling issues (FES-I and ABC) generally ameliorate in resemblance with balance scores, but the relationship isn't direct, and case- reported fear can change singly of measured balance. Adverse events reported across trials include occasional falls during training and musculoskeletal complaints; serious adverse events are rare.

3.5. Comparison: Home-Based versus Clinic-Based Programmes

Head- to- head trials of home- delivered versus clinic-delivered programmes are limited, but the available substantiation supports non-inferiority of home delivery for ADL and motor function endpoints [6], [7]. Home- setting advantages include ecological validity and superior transfer of trained tasks to the home terrain. Adherence comparisons are mixed. Home delivery removes transportation walls but introduces tone- monitoring conditions. The conflation is that home- grounded delivery is now a clinically defensible primary mode for senior stroke fall forestallment, not a fallback for those who cannot pierce clinic- grounded care. Table I summarises the six programme types and their evidence positioning.

Table 1: Home-Based Programme Types and Evidence Positioning

Programme type	Strongest evidence	Effect target	Typical dose	Adverse-event profile
Task-oriented balance	[15]	BBS, fall rate	3–5×/wk, 8–16 wk	Low
Gait-specific	[4], [13]	Gait speed, 10MWT	3–5×/wk, 8–12 wk	Low
Dual-task	[4]	Dual-task cost, FES-I	Adjunct, 2–3×/wk	Low
Lower-extremity strength	[14]	Strength, BBS	2–3×/wk, 8–12 wk	Low (musculoskeletal soreness)
Technology-augmented	[6], [7]	ADL, motor function	3–5×/wk, 6–12 wk	Low
Caregiver-assisted	[8], [9]	ADL, depression, indirect fall risk	5–7×/wk, 8–12 wk	Low when training is structured

4. Discussion

4.1. Synthesis: What Works and for Whom

The strongest evidence supports task-oriented balance training combined with gait practice and progressive challenge. Lower-extremity strength training is a defensible adjunct. Caregiver-mediated exercise is the most effective dose-extender available in the home setting and is supported by Cochrane-level synthesis [8], [9]. Telerehabilitation has matured to the point where it is a clinically defensible primary delivery mode for home-based stroke rehabilitation [6], [7]; for the specific outcome of fall prevention, however, telerehabilitation should currently be regarded as complementary to in-person home delivery rather than a replacement.

Moderating variables include stroke severity, cognitive status, time post-stroke, and caregiver availability. Dose-response relationships favour higher frequency (3 to 5 sessions per week) over lower frequency, but the evidence does not support indefinite escalation; programmes beyond 16 weeks are under-represented in the literature, and long-term durability of effect is uncertain.

4.2. Gaps in the Evidence Base

Five gaps recur across the synthesised validation, and they are worth naming singly because they bear different fixes. The homebound subpopulation is under- studied. utmost fall-prevention trials enrol community-dwelling aged grown-ups, not the homebound elderly stroke survivors home health PTs actually see; generalising the effect sizes carries a transfer trouble that the published literature has not yet quantified. Long-term follow-up is also thin in most trials at 12 weeks, so the durability of any observed fall- rate reduction beyond that point is largely uncharacterised. Hemorrhagic stroke survivors, cases with severe aphasia, and those with significant cognitive impairment are completely underrepresented across the included trials, which constrains how far the emulsion can speak to those subpopulations. Cost- effectiveness data for home-predicted fall-prevention in stroke are scarcely present in current literature. And outgrowth diversity [fall rate vs faller proportion vs nocuous waterfall] is the methodological wall that kept this review at narrative emulsion rather than meta- analysis.

4.3. Clinical Practice Recommendations for Home Health Physical Therapists

The following practice framework is derived from the synthesised evidence and is offered as a practice-ready scaffold, not as a clinical guideline.

1. Assessment framework. Baseline fall-risk assessment using BBS, TUG, and DGI. Suggested thresholds: BBS less than 45, TUG greater than 13.5 seconds, DGI less than 19, each indicating elevated fall risk in geriatric stroke survivors. Multi-measure assessment is more informative than any single measure.

2. Program selection. Programme content should be selected based on the patient's impairment profile and home environment. Patients with reactive-balance deficit benefit from task-oriented balance training; those with gait-speed deficit benefit from gait-specific training; those with cognitive-motor interference benefit from dual-task training; those with lower-extremity weakness benefit from progressive resistance.

3. Progression protocols. Move from supported to unsubstantiated balance demands, from static to dynamic tasks, and from single- task to dual- task work. Re-assess at 4- week intervals and acclimate progression rate to the case's response.

4. Caregiver education and safe-help training. Where a caregiver is available, integrate them as a defined remedy resource with structured training and safety protocols. The caregiver-intermediated literature [8], [9] supports this integration as effective and safe when structured.

5. Telehealth integration. Use telehealth for monitoring, coaching, and progression check-ins between in- person visits. mongrel models (in- person assessment plus telerehabilitation meter) are the functional form that the substantiation supports [6], [7].

6. Home- terrain revision. Address adjustable home hazards [loose hairpieces, shabby lighting, missing heist bars] as a relevant intervention. Environmental revision isn't a cover for active training but composites its effect.

4.4. Implications for the Homebound Veteran Population

The synthesised evidence is particularly relevant to homebound veteran populations receiving home health physical therapy services, although several considerations warrant attention. Veteran populations often present with a greater comorbidity burden than the general geriatric stroke population. Cardiovascular disease, diabetes, post-traumatic stress disorder (PTSD), and traumatic brain injury (TBI) are more prevalent and may influence participation in and response to fall-prevention programmes. Mental-health factors may also affect adherence and rehabilitation outcomes more strongly than in non-veteran populations, suggesting that programme design should account for psychological as well as physical barriers to participation. In addition, rural veteran populations frequently experience reduced access to rehabilitation services, increasing the importance of caregiver integration and technology-augmented telehealth delivery. Effective implementation is best supported through interdisciplinary coordination involving VA home-care teams, primary care providers, nursing staff, rehabilitation professionals, and social work services rather than isolated discipline-specific management.

4.5. Limitations of This Review

Three limitations bound the synthesis. Study heterogeneity in populations and outcome measures was the largest constraint on cross-trial comparison and is the reason a quantitative synthesis was not attempted. Publication bias toward positive results is a known feature of the falls-prevention literature; pooled effect estimates in this domain are almost certainly inflated, and that includes the Sherrington 2019 headline number readers will anchor to. Finally, generalisability to severely impaired or cognitively impaired stroke survivors is limited by who is enrolled in the source trials, which means the practice scaffold offered here applies less cleanly to that subpopulation than its surface phrasing might suggest.

5. Conclusion

Home-based balance and gait training is an effective and feasible approach to reducing fall risk in geriatric stroke survivors. The strongest evidence supports task-oriented, progressively challenging programmes delivered at 3 to 5 sessions per week over 8 to 16 weeks, combined with structured caregiver integration and selective telehealth augmentation between in-person visits. For the specific outcome of fall prevention, telerehabilitation remains complementary to in-person home delivery rather than a substitute; the clearest non-inferiority evidence is for ADL and motor-function endpoints, not fall rate. The remaining gaps are concentrated in the homebound subpopulation, in long-term follow-up beyond 12 weeks, and in rural and severely impaired patients. Home health physical therapists are positioned to lead fall-prevention efforts through structured, individualised programmes drawn from this evidence base. The next research priorities are pretty specific: high-quality RCTs enrolling homebound geriatric stroke survivors as the primary population, long-term follow-up extending past 12 weeks, cost-effectiveness analyses of home-delivered programmes, and trials of technology-assisted adherence monitoring that quantify the incremental effect on durability of effect.

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