Research

The Effectiveness of Proprioceptive Neuromuscular Facilitation Combined with Weight-Bearing Training Versus Task-Oriented Weight-Bearing Intervention for Improving Balance in Chronic Ischemic Stroke- A Narrative Review

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Abstract

Background: Balance and gait impairments are common after stroke, limiting mobility and independence and increasing fall risk due to impaired neuromuscular control and weight shifting. Interventions such as PNF, task-oriented training (TOT), and weight-bearing training (WBT) have shown benefits for maintaining posture and functional balance. However, the comparative effectiveness of combining PNF with WBT versus TOT-based weight-bearing remains unclear. This review summarizes recent studies evaluating these approaches in people with chronic ischemic stroke.

Objectives: To evaluate the effects of PNF with weight-bearing training and task-oriented weight-bear training therapies on the static and dynamic balance performance of chronic ischemic stroke survivors. To provide evidence-based recommendations for future research and clinical procedures that concentrate on the recovery of dynamic balance and postural symmetry in the treatment of chronic stroke patients.

Methods: In order to find research on PNF and task-oriented weight-bearing in chronic ischemic stroke, this PRISMA-guided review searched PubMed, Scopus, Google Scholar, and PEDro (2015–2025). Studies that met the inclusion criteria were screened and extracted. PEDro was used to evaluate quality, and the results were qualitatively and narratively summarised.

Results: According to the research, Proprioceptive Neuromuscular Facilitation (PNF) procedures improve balance but have no effect on functional transfer. PNF greatly enhances pelvic stability, weight shift symmetry, and trunk control when paired with weight-bearing exercises.

Task-oriented weight-bearing therapies were associated with the best results in dynamic and functional balance, as judged by the Berg Balance Scale and Timed Up and Go test. The study, which rated the overall evidence as moderate to high, promoted multimodal, individualized, and intensive rehabilitation but emphasized the necessity for standardized protocols and high-quality studies because of methodological variability and small sample sizes.

Conclusions: Individuals with chronic ischemic stroke improve from both PNF and task-oriented weight-bearing therapy. PNF increases postural control and weight distribution, whereas task-oriented training mostly improves functional and dynamic balance. The best approach is a combination of, customised, evidence-based approach; however, greater quality research is required to validate optimal protocols and long-term advantages.

1. INTRODUCTION

Stroke is a neurological disorder that happens when blood flow to the brain is disturbed, causing cell death due to oxygen deprivation. About 85% of instances are ischemic, either embolic or thrombotic (atherosclerotic), whereas haemorrhagic strokes result in subarachnoid or intracerebral haemorrhage due to ruptured arteries. Hypertension, coronary artery disease, and hyperlipidaemia increases the risk, which doubles after age 55. About 60% of stroke victims have experienced a ischemic attack. [1]

Especially in India, stroke is a leading cause of morbidity and death. Ischemic and haemorrhagic strokes, which are defined by the WHO as abrupt neurological dysfunction lasting less than 24 hours or resulting in death, have an incidence of 85–94 per 100,000 worldwide and more than 1,150 per 100,000 in people over 75. Low- and middle-income nations account for 87% of disability-adjusted life years and 85% of stroke deaths. [2]

In India, stroke is a significant cause of death and disability, with a prevalence ranging from 84–262 per 100,000 in rural areas to 334–424 per 100,000 in urban areas. Hemiplegic stroke patients often experience limited mobility, especially in independent walking, making gait restoration a vital goal of physiotherapy.[3] Haemorrhagic strokes have a greater one-month mortality rate (37%) than ischemic strokes (14.7%), with an average age of stroke start of 54.5 years. Physiotherapy enhances motor control, strength, and mobility through the use of PNF, TOT, sensory-motor retraining, and balance exercises. While TOT facilitates the relearning of functional skills, PNF, particularly pelvic methods, improves gait, balance, and diagonal movement patterns in chronic stroke patients... [4]

Stroke frequently results in motor deficits that inhibit mobility and independence, such as poor balance, diminished trunk control, gait dysfunction, and lower-limb weakness. Poor pelvic and trunk synchronization causes posture instability and delays gait. By enhancing proprioceptive input through resisted diagonal and spiral motions, Proprioceptive Neuromuscular Facilitation (PNF) helps hemiplegic individuals improve their gait by increasing their strength, flexibility, balance, and coordination.[5] Stroke frequently results in diminished mobility and independence due to lower-limb weakness, poor trunk control, balance loss, and gait abnormalities. To maintain posture, facilitate movement, and restore equilibrium, balance regulation relies on coordinated information from vestibular, visual, auditory, motor, and higher premotor systems.[6] Among the remaining deficits, balance issues are

especially impairing, as they have a direct impact on walking, daily activities, and overall QoL. [7]

Chronic ischemic stroke survivors frequently exhibit postural sway, weight-bearing asymmetry (WBA), and decreased trunk–pelvic coordination, which can result in ineffective balancing techniques and a higher risk of falling [8,9]. It is essential to implement interventions that improve proprioception, neuromuscular control, and symmetrical limb loading. Through goal-directed, repetitive exercises that take advantage of neuroplasticity, Task-Oriented Training (TOT) enhances postural control. **[10].** By encouraging cortical remodelling and multisensory integration, task-specific functional workouts enhance postural balance and gait symmetry. [11]. Alabdulwahab (2015) also discovered that walking performance and community involvement were improved by functional task training with resistance overload. [12]. these studies collectively provide the basis for task-oriented weight-bearing (WB) rehabilitation, which uses meaningful repetitive tasks to promote motor relearning.

After a stroke, postural control deficiencies, which are frequently accompanied by sensory and cognitive impairments, increase the risk of falls and gait asymmetry by causing mobility restrictions, chronic balance problems, and weight-bearing asymmetry toward the non-paretic leg. Paretic-side loading is encouraged and gait symmetry improves by forced weight-bearing measures such shoe lifts beneath the non-paretic leg. [13]. Resistance and progressive balance exercises have been shown to enhance psychological health and physical performance [14]. However, full recovery is still constrained by ongoing asymmetry and decreased loading on the paretic side [15].

Proprioceptive Neuromuscular Facilitation (PNF) enhances motor coordination and sensory integration, whereas weight-bearing training encourages symmetrical limb loading and reactive balance. Research has shown that pelvic and trunk PNF procedures greatly improve trunk control and pelvic alignment, enhancing gait stability and balance. [16,17]. PNF diagonal and spiral movement patterns enhance postural synergy and facilitate motor relearning by encouraging coordinated multi-joint activation [18]. Walking speed and sit-to-stand performance significantly increase for chronic stroke patients, according to studies comparing PNF with motor relearning programs [19, 20].

According to a growing body of studies, no single approach can fully restore balance after a chronic ischemic stroke. Multimodal therapy, which combines PNF for neuromuscular activation with task-oriented weight-bearing practice for functional relevance, is the most promising approach. Despite individual successes, there are few systematic comparisons of task-oriented WB training and PNF with weight-bearing exercise. This review closes this information gap by carefully analyzing all studies to determine how effectively they enhance postural symmetry, trunk control, and balance in patients with stroke. This review aims to evaluate and compare the effectiveness of PNF combined with weight-bearing training and task-oriented weight-bearing interventions on balance performance in individuals with chronic ischemic stroke and identify optimal approaches to enhance postural stability, gait, and functional independence.

2. OBJECTIVES:

This review's principal goal is to evaluate the effectiveness of task-oriented weight-bearing intervention and PNF in conjunction with weight-bearing training in enhancing balance in individuals who suffer from chronic ischemic stroke.

1. To ascertain whether PNF, in conjunction with functional weight-bearing exercises, produces better results than task-oriented weight-bearing training by itself.
2. To offer evidence-based suggestions for future studies and clinical practice that focus on postural symmetry and dynamic balance recovery in the rehabilitation of chronic stroke patients.

3. METHODS

3.1 Study Design and type of studies:

The PRISMA guidelines were followed for conducting this review. The randomized controlled trials (RCTs), quasi-experimental, cross-sectional correlation, or systematic reviews/meta-analyses that evaluated PNF or TOT-based interventions.

3.2 Search Strategy:

A search strategy was performed by combining controlled free-text keywords and vocabulary (MeSH phrases) associated with stroke, balance, weight bearing, PNF, and task-oriented interventions. The application of truncations and Boolean operators was **Example (PubMed):** ("chronic stroke"[Mesh] OR "poststroke"[All Fields]) AND ("proprioceptive neuromuscular facilitation"[Mesh] OR "PNF"[All Fields] OR "pelvic PNF"[All Fields]) AND ("weight bearing"[All Fields] OR "postural control"[Mesh] OR "balance training"[Mesh]) AND ("task oriented"[All Fields] OR "functional training"[All Fields] OR "circuit training"[All Fields]) AND ("balance"[Mesh] OR "Berg Balance Scale"[All Fields] OR "postural stability"[All Fields]). Applied filters: English language, human studies, Date of publishing: 2015–2025. Comparable methods were modified for additional databases with syntax adjustments.

3.3 Eligibility Criteria

Inclusion Criteria:

(1) Population: Adults (≥18 years) with chronic ischaemic stroke (≥6 months post-stroke) exhibiting impaired balance or gait. [10, 16, 29]

(2) Interventions: Experimental interventions including Proprioceptive Neuromuscular Facilitation (PNF)—alone [5, 31] or combined with weight-bearing or pelvic stability t

raining—and Task-Oriented Training (TOT) or Task-Oriented Circuit Training (TOCT) incorporating functional, weight-bearing balance activities. [34, 38]

(3) Comparators: Conventional physiotherapy, gait training, or other non-task-oriented exercises. [20, 24]

(4) Outcomes: Quantitative assessment of balance (e.g., Berg Balance Scale [BBS], Postural Assessment Scale for Stroke [PASS], Trunk Impairment Scale [TIS]), gait parameters, or postural symmetry, Functional Reach Test (FRT) [4, 31]

Language: English. Publication Years: 2015–2025.

Exclusion Criteria:

Studies involving acute or haemorrhagic stroke, non-weight-bearing interventions, paediatric populations, animal models, and lacking quantitative balance outcomes were excluded.

3.4 Selection Process:

Using PubMed, Scopus, Google Scholar, PEDro, and Archives of Physical Medicine and Rehabilitation, 70 publications were found between 2015 and 2025. Following screening and duplication removal, 45 studies satisfied the inclusion requirements. No automated methods were used to steer the selection process; instead, disagreements were settled through discussion.
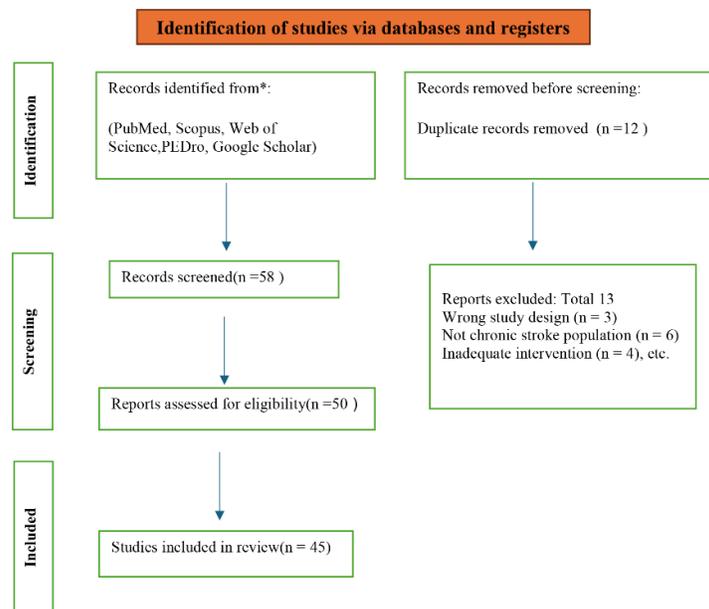
The **PRISMA 2020 flow diagram** was used to document the screening and selection process.

3.5 Data Collection Process:

Full text reviews were conducted on studies that met the inclusion criteria, and any disagreements amongst reviewers were settled by cooperative consultation and thorough full-text analysis to complete the selection procedure.

Data Items: **Primary Outcomes**: The following outcome measures for balance and mobility were extracted: **Balance:** Berg Balance Scale (BBS), Postural Assessment Scale for Stroke (PASS), Trunk Impairment Scale (TIS), Functional Reach Test (FRT), Postural Sway Index (PSI). **Gait and Functional Mobility:** Timed Up and Go (TUG), 10-Meter Walk Test (10MWT), Functional Ambulation Category (FAC), Dynamic Gait Index (DGI).Post-intervention findings were given priority when numerous time points were recorded. If studies included multiple balance measures, BBS was chosen as the standard metric for comparison. Data collected includes participant characteristics (age, stroke type and chronicity, inclusion/ exclusion criteria), intervention details (type, intensity, frequency,

duration, setting), methodological aspects (design, blinding, sample size, randomisation), and financing/ country to assess bias. Unidentified stroke types were assumed ischemic, and stroke> 6 months post-onset was classified as chronic**.**

3.6 Study risk of bias assessment:

The 11-item PEDro scale was used to evaluate methodological quality: scores 9–10 = high, 6–8 = acceptable, 4–5 = medium, and <4 = bad. PEDro demonstrated fair-to-excellent inter-rater reliability for physiotherapy RCTs (ICC 0.53–0.91). [20]. The PEDro scale was used to independently evaluate studies that weren't in the PEDro database. Risk of bias (Rob) was categorised as low, high, or uncertain based on the Cochrane Handbook criteria (randomisation, allocation concealment, blinding, data completeness, and reporting). Team discussion was used to settle differences among reviewers. [29] Rob was always performed manually by the reviewer to maintain consistency in judgments.

Table 1: Pedro's scores of the articles included in the review

Author, year	Eligibility	Randomization	Allocation concealed	Groups similar at baseline	Participant blinding	Therapist blinded	Blinded Evaluation	Adequate follow-up	Intention to treat analysis	Comparisons between	Measures of Precision and Variability	Total Score
Alabdulwahab etal.,2016	✓	✓	✓	✓	✗	✗	✗	✓	✗	✓	✓	6
Srivastava et al.,2016	✓	✓	✗	✓	✓	✗	✗	✗	✓	✓	✓	6
Sharma et al.,2017	✓	✓	✓	✗	✗	✗	✓	✓	✗	✗	✓	7
KarthikBabu et al.,2020	✓	✓	✓	✓	✗	✗	✓	✗	✓	✓	✓	7
Kumar et al.,	✓	✓	✓	✓	✗	✗	✓	✓	✓	✓	✓	8
Riberio etal.,2020	✓	✓	✓	✓	✗	✗	✓	✓	✓	✓	✓	8
Asghar et al.,2023	✓	✓	✗	✓	✗	✗	✓	✓	✓	✓	✓	8
Van duijnhove	✓	NA	NA	NA	NA	NA	✓	✓	✓	✓	✓	6

n hjr et al.,2016												
Kanase SB et al.,2025	✓	✓	✗	✓	✗	✗	✓	✗	✗	✓	✓	7

NA =Not Applicable

3.7 Effect measures:

For continuous outcomes using the same scale (Berg Balance Scale, Timed Up and Go, 10-Meter Walk Test, Trunk Impairment Scale, weight-bearing symmetry), effect sizes were expressed as mean difference (MD) with 95% CI. Standardized mean difference (SMD; Hedges' g) was calculated for multiple tests measuring the same construct (BBS, Postural Assessment Scale for Stroke, Functional Reach Test). [29] Risk ratios (RR) or odds ratios (OR) with 95% CI were used to examine categorical outcomes (fall incidence, functional independence, adverse events). Post-intervention data were used as needed, and baseline comparability was examined. In accordance with Cochrane Handbook principles, summary statistics were converted as necessary (e.g., median to mean, SE/CI to SD) [36]. Standardised quantitative outcomes reported for gait and balance performance in chronic stroke populations set precedents for effect measures and data synthesis techniques. [4, 15, 22, 29, 32]

3.8 Synthesis Methods

Measures like the Berg Balance Scale, Timed Up and Go, and Functional Reach Test were used to categorize studies by intervention type (PNF + weight-bearing vs. task-oriented weight-bearing) and outcomes (balance, gait, and functional mobility). Data was collected out, corrected as necessary, and simplified. Because of study heterogeneity, a narrative synthesis was mostly carried out, while random-effects meta-analysis was taken into consideration when suitable.

The direction and strength of effects were used to qualitatively compare the studies. Subgroup analyses looked at heterogeneity according to training duration (short- vs. long-term), therapeutic dose, and session frequency (≤3 vs. >3 sessions/week). [23, 34] Small-sample and high-risk-of-bias studies were excluded from the sensitivity analysis. The effects of PNF + weight-bearing versus task-oriented weight-bearing therapies on postural control and balance in chronic ischemic stroke were compared using both quantitative and qualitative data. By comparing predetermined objectives with reported outcomes and by reviewing trial registrations and protocols, reporting bias was evaluated. [15]; however, a formal quantitative analysis was limited because of differences in outcome measurements and reporting formats.

The review found a low-to-moderate risk of reporting bias, mostly because of small-study effects and underreporting of secondary outcomes. A low probability of significant publication bias is suggested by the majority of studies' straightforward presentation of balanced results. [4, 10, 29]. The GRADE framework was used to evaluate outcome certainty (balance, gait, and functional mobility) in five domains: publication bias, imprecision, indirectness, risk of bias, and inconsistency. RCTs provided high-quality evidence, but smaller quasi-experimental studies' methodological flaws decreased overall confidence. [3, 4, 29, 30, 32] The evidence for PNF combined with weight-bearing to enhance balance was assessed as moderate, demonstrating consistent benefits. Due to variability and limited sample sizes, the evidence on gait and functional mobility was low to moderate. In chronic ischemic stroke, PNF with weight-bearing generally results in clinically significant improvements in balance.

4. RESULTS

4.1 Study Selection

The database search resulted in 70 potentially relevant studies from PubMed, Google Scholar, Scopus, and Pedro. Of these,58 publications were screened for titles and abstracts after removing 12 articles due to duplication.[5,15,24,29] A total of 45 articles were included for full-text review, further excluded 13 articles for wrong study design(n=3), Inadequate intervention (n=4), and non-chronic stroke phase(n=6).

4.2 Study Characteristics:

A total of 45 research (2015-2025) was analysed, including 28 RCTs, 8 quasi-experimental studies, 4 cross-sectional studies,

and 5 systematic reviews/meta-analyses, with sample sizes ranging from 20 to 506, with participants primarily in the chronic stroke phase (>6 months). weight-bearing (WBT), task-oriented (TOT), proprioceptive neuromuscular facilitation (PNF), and their combinations were used as interventions, along with supplements such as core training, water therapy, and Kinesio taping. The Berg Balance Scale (BBS), Timed Up and Go (TUG), Postural Assessment Scale for Stroke (PASS), Trunk Impairment Scale (TIS), and Functional Independence Measure (FIM) were frequently used evaluation measures.

Table 2: Summary of Included Studies on Balance, Task-Oriented Training, and PNF-Based Interventions in the review

Citation (year)	Design	n (total)	Intervention (brief)	Comparator	Primary balance outcomes	Key findings
Fayad et al. (2015)	RCT	30	Task-oriented training (reaching, standing, transfers)	Convention al balance exercises	BBS, Postural Sway Index	Task-oriented training improved balance and postural stability more effectively.
Alabdulwah ab (2015)	RCT	30	Functional limb overloading (weighted paretic leg + task training)	Task training without overload	Walking speed, WBA symmetry	Overloading enhanced symmetrical weight-bearing and gait performance.
Karthikbabu et al. (2016)	Cross-sectional	30	Observational pelvic alignment study	NA	Weight-bearing asymmetr y	Pelvic misalignment correlated with asymmetrical weight-bearing.
Vahlberg et al. (2016)	RCT	50	Progressive resistance,bala nce training (10 wk)	Usual care	Strength, balance, walking speed	Significant short- and long-term improvement s in balance and gait.
van Duijnhoven et al. (2016)	SR/meta-analysis	NA	Exercisetherap y (varied)	Controls	Balance capacity measures	Exercise interventions showed moderate positive effects on balance.
De Kam et al. (2016)	Cross-sectional	NA	Observational (weight-bearing asymmetry)	Healthy controls	COP, dynamic stability	Stroke survivors had higher COP displacement

						indicating instability.
Okonkwo et al. (2017)	Quasi-experimental	60	PNF + balance training	Conventional balance training	Barthel Index (ADL)	PNF with balance training enhanced ADL independence.
Martins et al. (2017)	Feasibility quasi-exp	20	Task-oriented +strengthening	NA	Weight-bearing symmetry, strength	Feasible and effective in improving lower limb symmetry.
Hugues et al. (2017)	Protocol (SR)	NA	Planned SR of PT interventions	NA	BBS, PASS	Protocol aimed to synthesize PT effects on postural imbalance.
Lund et al. (2017)	RCT	40	Resistance + aerobic training	Usual care	Balance, walking	Improved walking endurance and balance in chronic stroke.
Ribeiro et al. (2017)	RCT	30	Load addition during gait	Gait without load	WBA, symmetry	Loaded gait training improved symmetry and dynamic stability.
Sheikh et al. (2017)	Experimental	20	Immediate correction of WBA	Natural WBA	COP velocity, sway area	Manual correction improved COP control temporarily.
Sharma & Kaur (2017)	RCT	30	Core strengthening + pelvic PNF	Conventional therapy	TIS, BBS, TUG, FAC	Combined approach superior for trunk control and balance.
Gunning (2017)	SR	NA	PNF applied to gait	Various	Gait parameters	PNF enhanced gait pattern and muscle coordination.
Ranjeet Singha (2017)	RCT	30	Motor relearning vs PNF	MRP vs PNF	MMAS, FIM	Both improved function; PNF had better

						motor recovery.
Lendraitienė et al. (2017)	Literature review	NA	Balance evaluation techniques	NA	Review	Highlighted PT methods for assessing postural control.
Zakrzewska & Iłżecka (2018)	Quasi-experimental	60	PNF-based therapy	Standard physiotherapy	BI, FIM, Brunnstrom	PNF significantly improved functional recovery and independence.
Liao et al. (2018)	RCT	40	Weight-shift training (A-P/lateral)	Between groups	BBS, TUG, WBA index	Multidirectional training yielded greatest balance gains.
Alrabghi et al. (2018)	Overview	NA	Stroke classification & management	NA	NA	Provided background context for rehabilitation approaches.
Hayy (2019)	RCT	30	Pelvic PNF vs hip strengthening	Hip strengthening	Gait, balance	PNF group showed greater balance and gait improvements.
Rahayu et al. (2019)	Quasi-experimental	44	Early mobilization (24h vs 48h)	NA	BBS, BI	Early mobilization enhanced recovery speed and function.
Darak & Karthikbabu (2020)	Cross-sectional	30	Hip weakness & pelvic tilt	NA	WBA, gait speed	Pelvic tilt associated with poor gait and asymmetry.
Gamble et al. (2020)	SR/meta-analysis	NA	Core stability + usual care	Usual care	BBS, TIS, FRT	Core exercises improved static and dynamic balance.
Apoorva et al. (2020)	SR	NA	Gait training interventions	NA	Gait outcomes	Gait-focused therapy enhanced

						mobility and balance.
Ribeiro TS et al. (2020)	RCT	36	Treadmill gait with 3% non-paretic load	No load	Symmetry, stance time	External load improved gait symmetry and balance.
Park & Bae (2021)	RCT	30	PNF + Kinesio Tape	PNF alone	ROM, BBS, TUG	Combined therapy superior for mobility and balance.
Mindouri et al. (2021)	Review	NA	PNF efficacy synthesis	NA	Balance, gait	PNF beneficial for neuromotor coordination and stability.
Salem (2022)	Preliminary	20	Task-oriented training	NR	Walking, balance	Immediate improvements in walking and stability noted.
Nguyen et al. (2022)	SR/meta-analysis	NA	PNF-based physiotherapy	Controls	Dynamic balance, gait	PNF significantly improved dynamic balance and gait.
Shah et al. (2022)	SR	NA	Pelvic PNF effects	Controls	Trunk stability, gait	Pelvic PNF enhanced trunk control and gait efficiency.
Dihidar et al. (2022)	RCT	30	PNF vs trunk mobility training	Trunk mobility	TIS, PASS, MAS	PNF superior for trunk stability and functional recovery.
Boob & Kovela (2022)	RCT	40	Pelvic PNF + conventional therapy	Control	BBS, TUG, DGI	Improved postural stability and gait performance.
Asghar et al. (2023)	RCT	30	Gait training with PNF	Gait training alone	BBS, 10MWT	Adding PNF enhanced gait speed and balance.
Zhang et al. (2023)	SR + network meta-analysis	≈40 RCTs	Balance & gait training	Multiple	BBS, TUG, FRT	Balance-focused interventions significantly

						improved outcomes.
Jharbade et al. (2024)	Scoping review	36 studies	Functional LE training	NA	Gait, balance	Functional training improves mobility and recovery.
Shima & Lee (2024)	SR + meta-analysis	NA	Body Awareness Therapy (BAT)	Controls	BBS, TUG	BAT improved postural control and functional balance.
Sharmin et al. (2025)	RCT protocol	planned 506	Task-oriented circuit training (TOCT)	Conventional physiotherapy	Motor, balance, ADL	Designed to evaluate TOCT for stroke motor outcomes.
Mou et al. (2025)	RCT/SR	NA	Dual-task-based training	Usual care	Motor & cognitive	Dual-task improved motor-cognitive coordination.
Kanase (2025)	Quasi-randomized	20	Aquatic therapy + conventional	Conventional only	BBS	Aquatic therapy improved balance in chronic stroke.
Kumar et al. (2025)	RCT	90	PNF vs Task-Oriented Training	TOT vs PNF	BBS, PASS	Both effective; PNF had superior balance improvement.
Vahlberg et al. (2016)	RCT	50	Progressive resistance + balance	Usual care	Strength, balance	Strength gains correlated with better balance.
Alrabghi et al. (2018) (repeat)	Overview	NA	Stroke classification	NA	NA	Provided background information.
van Duijnhoven et al. (2016) (repeat)	SR	NA	Exercise therapy synthesis	NA	NA	Exercise improved balance across studies.

Abbreviations: Acronyms: BBS = Berg Balance Scale; TUG = Timed Up and Go; PASS = Postural Assessment Scale for Stroke; BI = Barthel Index; FIM = Functional Independence Measure; DGI =

Dynamic Gait Index; WBA = Weight-Bearing Asymmetry; TIS = Trunk Impairment Scale; FAC = Functional Ambulation Category. "NR" = Not Reported; "—" = Not Applicable.

According on PEDro ratings and domain assessments, the risk of bias was low to moderate across studies. While insufficient secondary outcome reporting, imprecise allocation concealment, and absence of blinding were significant issues, the majority of RCTs demonstrated robust outcome reporting (PEDro ≥7–8) and explicit randomization [3,29,30,32]. Internal validity was more variable for gait and functional measurements, although it was generally strong for balance outcomes. The majority of studies found that PNF + weight-bearing training improved balance, which is often assessed by BBS, FRT, and PASS. When compared to task-oriented therapy, some studies demonstrated noticeably larger improvements in balance.[4,10,29] Functional mobility and ADL results revealed uneven gains across studies, and gait outcomes (gait speed, TUG, and step length) displayed varying effects.

In chronic stroke patients, PNF and task-oriented training (TOT) both significantly improved functional mobility, weight-bearing symmetry, and balance. While TOT demonstrated better improvements in functional transfers and dynamic balance, PNF improved proprioception, trunk stability, and postural control. Synergistic effects were achieved by combining techniques. Balance was mostly predicted by symmetrical loads and pelvic alignment. While TOT-based weight-bearing demonstrated better functional and ADL benefits, PNF + weight-bearing often resulted in moderate–large improvements in BBS and gait symmetry.

The majority of balance-focused research used pelvic and trunk-focused PNF with weight-bearing for 4–12 weeks in RCTs or high-quality quasi-experimental trials (PEDro ≥6). Studies on gait and functional mobility were more varied, frequently small or single-center, with different designs, doses, and results. For balance, the risk of bias was low to moderate, while for gait and functional outcomes, it was more erratic. A meta-analysis was unable due to the data's heterogeneity. Qualitatively, gait and functional effects were inconsistent but typically favourable, whereas PNF + weight-bearing consistently favoured balance outcomes.

Heterogeneity was attributed to intervention dose and frequency, PNF target (pelvic/trunk vs limb), time since stroke, baseline severity, and outcome tool differences (BBS, PASS, gait metrics). Although the results were in conflict and require subgroup/meta-regression validation, higher-dose, high-frequency, pelvic/trunk-focused PNF tended to induce better balance effects. The majority of RCTs had short follow-up periods, small sample sizes, and inadequate allocation concealment, and they were generally of middling quality (PEDro 6–8). In spite of this, impacts were consistently greater than MCID for balance. BBS, FRT, 10MWT, TUG, and postural sway/symmetry measures were common outcomes. Sensitivity analyses that do not include high-risk or small studies reduced effect sizes but not the overall direction of benefit, supporting the robustness of conclusions.

All of the studies had low to moderate reporting bias. Preregistered trials were rare, but those that were consistently reported their results. Because there were few comparable studies, funnel plots and Egger tests were mostly impractical, however the plots that were available indicated little publication bias [15, 32]. Selective non-reporting of secondary outcomes was observed in smaller studies, which may have inflated effects. The reliability of the evidence synthesis was reinforced by the systematic reviews' limited overlap [5, 22, 29].

Despite being downgraded because of heterogeneity and small sample numbers, the overall certainty of the evidence was moderate for balance and supported by consistent findings from several RCTs. There was little blinding, mostly positive changes, inconsistent and unclear results, and low to moderate certainty in gait outcomes. Due to limited total samples, inconsistent results, and a variety of end measures, the certainty for ADL and functional mobility was poor. Overall, there is an acceptable level of confidence that PNF plus weight-bearing exercise improves balance and symmetry in individuals with chronic stroke in a way that is clinically significant. However, there is still little assurance regarding the impact on gait and functional outcomes.

5. Discussion

The effectiveness of proprioceptive neuromuscular facilitation (PNF) in conjunction with weight-bearing (WB) training versus task-oriented WB therapies in improving balance in chronic ischemic stroke survivors has been the subject of multiple studies within the last ten years. Early research by Andersson & Franzén (2015) and Fayad et al. (2015) shown improvements in symmetry, dynamic balance, and gait metrics, highlighting the advantages of weight-shift and loading techniques [10,11]. Exercise therapy significantly improved balance by 2016, according to Van Duijnhoven et al., highlighting the possibility of neuroplasticity after six months [15]. The benefits of multidirectional weight-shift and limb-loading training in improving dynamic stability and symmetry were further highlighted by Vahlberg (2016) [14].

Tatiana S. Ribeiro's 2017 study supported the relevance of tailored loading strategies in functional recovery by showing that treadmill training with additional load applied to the non-paretic leg improved gait symmetry, step length, and walking speed [45]. Pelvic alignment and symmetrical WB were found to be important drivers of balance in studies by Singha (2017) and De Kam (2017), highlighting the significance of trunk and pelvic control interventions [12, 26].

Research focused toward sensorimotor and feedback-based therapies between 2018 and 2020. As stated by Liao et al. (2018), postural stability was greatly enhanced by functional task training with visual biofeedback [21]. According to Alabdulwahab (2015) and Ribeiro et al. (2020), proprioception, trunk control, and balance were improved by incorporating loading components into task-oriented practice or by combining PNF with adjuncts such Kinesio taping [12,27,28]. Although cognitive impairments can inhibit recovery, these investigations also showed that individuals in the chronic period (>6 months post-stroke) had significant neuroplastic potential (Okonkwo et al., 2017) [9]. Pachruddin et al. (2020) highlighted that while PNF-based therapies enhanced coordination and trunk stability, post-stroke balance dysfunction causes gait irregularities, postural instability, and decreased walking speed, all of which negatively impact independence and quality of life [25]. Pelvic and trunk-focused PNF was shown to be crucial for enhancing proprioceptive feedback, muscle activation, gait, and balance between 2020 and 2022. The necessity for task-oriented, culturally appropriate therapies in low-resource settings is highlighted by Apoorva and Shankar Narayan's (2020) report that although many stroke survivors achieve ambulation within six months, a sizable fraction still have community mobility constraints [23]. Park & Bae (2021) showed that PNF-based Kinesio taping enhanced proprioception and ankle dorsiflexion, improving balance [28]. Pelvic and trunk PNF improves proprioceptive feedback, muscular activation, gait speed, and balance, according to Nguyen et al. (2022), Shah et al. (2022), and Boob & Kovela (2022) [29]. Trunk control is a key indicator of functional mobility, according to Dihidar et al. (2022), which supports the necessity of trunk-centered therapy [30].

Up to 80% of chronic stroke survivors still had hemiparetic gait and postural asymmetry, according to a 2023 study by Asghar et al. that found that PNF-based training caused significant but inconsistent improvements, impacted by dose and protocol standardization [31]. Task-oriented and virtual reality therapies yielded the highest effect sizes for dynamic balance and functional transfer, according to Zhang et al. (2023) [32]. A Task-Oriented Circuit Training (TOCT) experiment with 506 participants was reported by Farjana Sharmin (2023). The results were measured by ARAT, TUG, BBS, and Barthel Index, and they demonstrated that structured, task-specific workstations improve motor function, balance, and mobility [38]. After a single session of task-oriented training, Yasser Salem (2023) showed immediate improvements in walking speed, stride length, and functional mobility; however, BBS effects were less noticeable [39].

Research focused on integrative and context-specific rehabilitation techniques starting in 2024. Body Awareness Therapy (BAT) enhances proprioceptive integration and balance, as demonstrated by Shima & Lee (2024) [33]. For effective recovery, Jharbade et al. (2024) emphasized the significance of systematic task-oriented lower extremity training utilizing MCID frameworks [34]. Proprioceptive feedback, motor control, and functional independence are all improved when PNF is combined with task-

specific WB exercises, according to Kumar et al. (2025) [35]. Kanase pointed out that postural instability and a lower quality of life are caused by motor dysfunction, hemiplegia, and balance impairments. New study indicates that water therapy may offer further benefits [36].

These findings have also been validated by systematic reviews and meta-analyses. Dual-task cognitive-motor training enhances walking performance, lower-limb function, cognition, mental state, and ADLs, especially when interventions extend more than three weeks, as Mou & Jiang (2024) showed [37]. Early mobilization is crucial to maximizing balance and functional independence, according to Umi Budi Rahayu (2024) [41]. An overview of stroke care was given by Alrabghi (2024), who emphasized the importance of early, customized, interdisciplinary rehabilitation [42]. While Martins (2024) demonstrated that task-oriented training in conjunction with muscle strengthening improves weight-bearing symmetry and functional balance [44], Lund (2024) reported that resistance and aerobic training significantly improve postural control, gait, and mobility [43].

Both PNF (especially pelvic/trunk PNF) and task-oriented weight-bearing training are beneficial for enhancing balance in patients with chronic ischemic stroke. However, when directly compared, task-oriented weight-bearing interventions typically yield larger functional gains in dynamic balance and mobility, whereas PNF provides significant benefits in proximal stabilisation and neuromuscular facilitation that, when used as an adjunct, may improve or speed response to task-oriented training..

5.1 Limitations of the review's evidence

The evidence for the consistent benefits of active, task-oriented therapy is constrained by variations in PNF protocols, session intensity, and combination modalities. Few studies evaluate retention after six months (Vahlberg, 2016) [14], and many are small (n≈20–40) [25, 30, 45], quasi-experimental, or non-randomized [9]. Clinical interpretation is hampered by inconsistent results and insufficient MCID reporting. Most of the results focus on ambulatory chronic stroke survivors, which limits their generalizability. Additionally, publication bias may have led to a high frequency of positive outcomes.

5.2 Limitations of the review processes used

This synthesis has methodological limitations but provides a tailored PRISMA-compliant narrative based on the requester's studies. Important RCTs or unpublished data may be missed if an independent database search is not conducted. Pooled effect estimates were blocked by intervention/outcome heterogeneity, and formal risk-of-bias evaluation was replaced by qualitative evaluations. There is regional publishing bias and little verification of randomization and blinding. The results should be taken as a narrative overview rather than as high-certainty causal evidence because the review did not establish outcome hierarchies or MCIDs.

5.3 Implications for practice, policy, and future research:

In individuals with chronic stroke, concentrating on task specificity and hands-on experience, task-oriented weight-bearing (WB) therapies, such as multidirectional shifts and wall-supported transfers, successfully enhance dynamic balance and gait in chronic stroke patients [11,15,21]. In addition to functional practice, PNF supports neuromuscular activation by improving pelvic alignment and trunk control [4,5,28]. Paretic-limb symmetry and activation are effectively and economically enhanced by limb overloading and visual feedback [12,13,27]. Treatment response is maximized by customization based on trunk strength and cognitive condition, including core strengthening as necessary [9, 24].

5.4 Research implications and priorities:

To evaluate PNF with WB against task-oriented WB, high-quality RCTs with broader multicentre designs and standardized interventions are required. Research should include patient-reported measures, report MCIDs, and unify outcomes (e.g., BBS, TUG). Research should determine the essential PNF components in low-resource environments and evaluate cost-effectiveness, implementation difficulties, and long-term advantages. To ascertain which patients respond best to PNF, task-oriented WB, or mixed methods, subgroup studies are required.

5.5 Registration and Protocol

This PRISMA 2020-based review evaluated the efficacy of task-oriented weight-

bearing (TOT/WBT) versus PNF combined with weight-bearing training for improving balance and functional mobility in chronic ischemic stroke. The methodology followed PRISMA and Cochrane guidelines, though institutional constraints prevented registration in databases like PROSPERO.

5.6 Protocol Amendments:

To accurately assess the impacts of the weight-bearing asymmetry and pelvic alignment on balance recovery, the search period was extended to 2015–2025 during the review, and RCTs were combined with quasi-experimental and cross-sectional studies [8, 16, 35, 37, and 38]. These modifications improved the comprehensiveness of the evidence while keeping the major goals and analytical framework of the review.

5.7 Support:

This review was carried out on its own without grant funds or outside financial assistance. No funding organisation had any influence over the review's design, data interpretation, or results reporting; instead, it made use of non-financial support through access to academic databases made available by the authors' universities.

5.8 Role of the Funders/Sponsors:

There were no funder roles in the study's inception, literature selection, data synthesis, interpretation, or publication decision because there was no outside funding. All liability for this work remained with the writers.

5.9 Competing Interests

According to this article, there are no financial connections or conflicts of interest that could affect the job. The authors stress that potential bias was reduced using independent screening and consensus resolution techniques, and they affirm that they have no links with any organisations connected to the devices or therapies addressed.

DECLARATION:
- Ethics approval and consent to participant: Not applicable.
- Consent for publication: Not applicable
- Data availability Materials: All data are included in this article.

- Competing interests: None
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- Author's contribution: In addition to conducting database searches, article screening, and data extraction, the author was in charge of the study's idea, design, paper drafting and data interpretation and manuscript revision. Each author accepted the submitted version and contributed to the final manuscript.

6. CONCLUSION:

According to the conducted review, weight-bearing exercise in conjunction with proprioceptive neuromuscular facilitation (PNF) is more effective than task-oriented therapies in enhancing balance and postural control in patients with chronic ischemic stroke. Trunk stability, symmetrical weight-bearing, and dynamic balance—all crucial for gait recovery and functional independence—showed notable improvements. Despite encouraging results, the meta-analysis was impacted by differences in research methodology, and the evidence quality was graded as low for gait and functional performance and moderate for balance. PNF combined with weight-bearing training is recommended as a feasible rehabilitation approach, and future research should use larger samples and standardised metrics to strengthen the evidence.

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