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Regain, Rebalance, Recover: The Role of Physiotherapy-Based Balance Training in Stroke Rehabilitation

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Abstract

Background: Stroke is a major cause of long-term disability and frequently results in impaired balance, postural control, gait, and functional mobility. These impairments can restrict independence and increase the risk of falls. Balance training is therefore an important component of physiotherapy rehabilitation following stroke.

Objective: To review the effectiveness of physiotherapy-based balance training interventions in improving balance, postural control, functional mobility, gait performance, and motor function in stroke patients.

Methodology: A literature search was conducted using PubMed and Google Scholar. Relevant randomized controlled trials evaluating balance-related physiotherapy interventions in stroke patients were identified and screened according to predefined eligibility criteria. Ten randomized controlled trials were included in the review. The interventions included perturbation-based training, Otago exercises, neuromuscular balance training, trunk proprioceptive training, treadmill training, trunk exercises, electrical stimulation, virtual reality, and whole-body vibration. Outcome measures included the Berg Balance Scale, Mini-BESTest, Fugl-Meyer Assessment, Timed Up and Go, 10-Meter Walk Test, 6-Minute Walk Test, and other measures of postural stability and functional performance.

Results: The reviewed studies demonstrated that balance-focused physiotherapy interventions produced significant improvements in balance, postural control, functional mobility, gait, and lower-limb motor performance. Combined and progressive interventions, particularly neuromuscular, perturbation-based, proprioceptive, and technology-assisted balance training, showed greater improvements than conventional rehabilitation or alternative interventions in several studies. Treadmill training improved walking capacity, while trunk-focused interventions enhanced trunk control and functional balance. However, improvements in fall risk were less consistent across interventions.

Conclusion: Balance training is an effective component of physiotherapy rehabilitation for stroke patients. Progressive, repetitive, task-specific, and individualized interventions can improve postural control,

mobility, gait, and functional performance. Integrating balance training with complementary physiotherapy techniques may further enhance recovery and promote greater functional independence following stroke.

Keywords: Stroke; Balance Training; Physiotherapy; Postural Control; Functional Mobility; Gait; Rehabilitation; Balance.

1. Introduction

Stroke is a major neurological condition that can cause long-term disability, particularly affecting balance, postural control, mobility, and functional independence.[1] Balance and gait training (BGT) is commonly used in stroke rehabilitation to improve postural control, walking ability, and functional performance.[2,12] Physiotherapy management includes neurophysiological, motor learning, and orthopaedic approaches tailored to individual needs.[3]

Balance impairment is common after stroke and may negatively affect mobility, independence, and safety during daily activities.[4] Structured exercise programs involving agility, flexibility, and weight shifting may improve postural control, balance, mobility, and reduce fall risk.[5] Promoting physical activity and improving cardiovascular fitness, strength, and endurance are also important for long-term recovery.[6]

Whole-body vibration may not provide additional benefits over conventional exercise for balance and activities of daily living.[7] Short-form Tai Chi may improve standing balance, with benefits potentially persisting after training.[8] Tai Chi combined with conventional physiotherapy may also improve balance, gait, confidence, and independence.[9]

Virtual reality-based balance training may improve postural stability and functional reaching compared with conventional task-oriented training.[10] VR and interactive gaming provide engaging, repetitive, task-oriented exercises with immediate feedback and may support balance and functional recovery.[11] However, evidence regarding the effectiveness of VR for improving sitting balance remains limited.[2,12]

Balance and gait training involves repeated practice of standing, weight shifting, stepping, and walking to improve balance, mobility, and functional independence.[13] Gait training may improve dynamic balance and mobility, although the most effective gait-training method remains uncertain.[13,14] Core-strengthening exercises may improve trunk control and postural balance, although their effects on gait may be limited.[14,15]

Virtual reality-based exercise may be a safe and beneficial approach for improving balance in chronic stroke, particularly when delivered over longer periods.[16] Fully immersive virtual reality with touch controllers may improve balance and gait while providing engaging, task-oriented practice.[17] Weight-shift-triggered electrical stimulation may improve postural control, lower-limb motor function, and functional independence.[18]

Balance Exercise Assist Robot (BEAR) training combined with conventional rehabilitation has been investigated as a technology-assisted approach for improving balance and functional performance after hemiparetic stroke.[19] Proprioceptive training may improve postural control, trunk stability, walking, and functional mobility.[20] Dual-task training may improve gait characteristics such as step length and cadence, although its additional effects on overall balance remain uncertain.[21]

Core stability exercises may support trunk control, postural stability, and functional movement and should be selected according to individual rehabilitation goals.[22] Conventional balance exercises and device-

assisted balance training may produce comparable improvements in postural stability during subacute stroke recovery.[22,23] Task-specific training may improve functional balance, but further research using objective biomechanical and posturographic measures is needed to determine its long-term effectiveness.[23]

2. Methodology

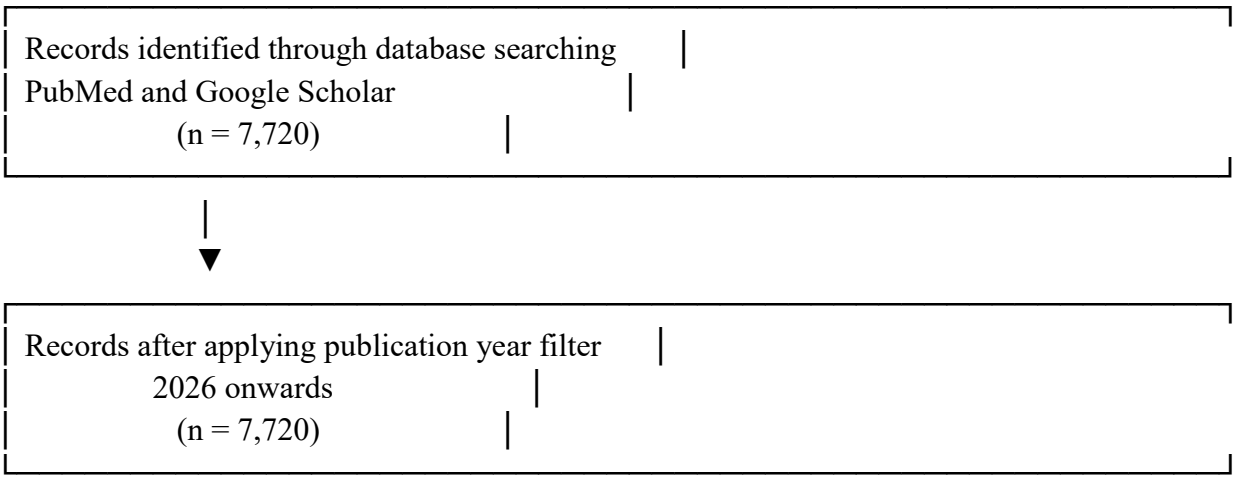
A literature search was conducted to identify studies investigating the effectiveness of **balance training in stroke patients within physiotherapy rehabilitation**. Relevant research articles were searched from two electronic databases: **PubMed and Google Scholar**. A total of **9 relevant articles** were selected for the present review based on their relevance to balance training, postural control, functional mobility, and rehabilitation outcomes in individuals with stroke.

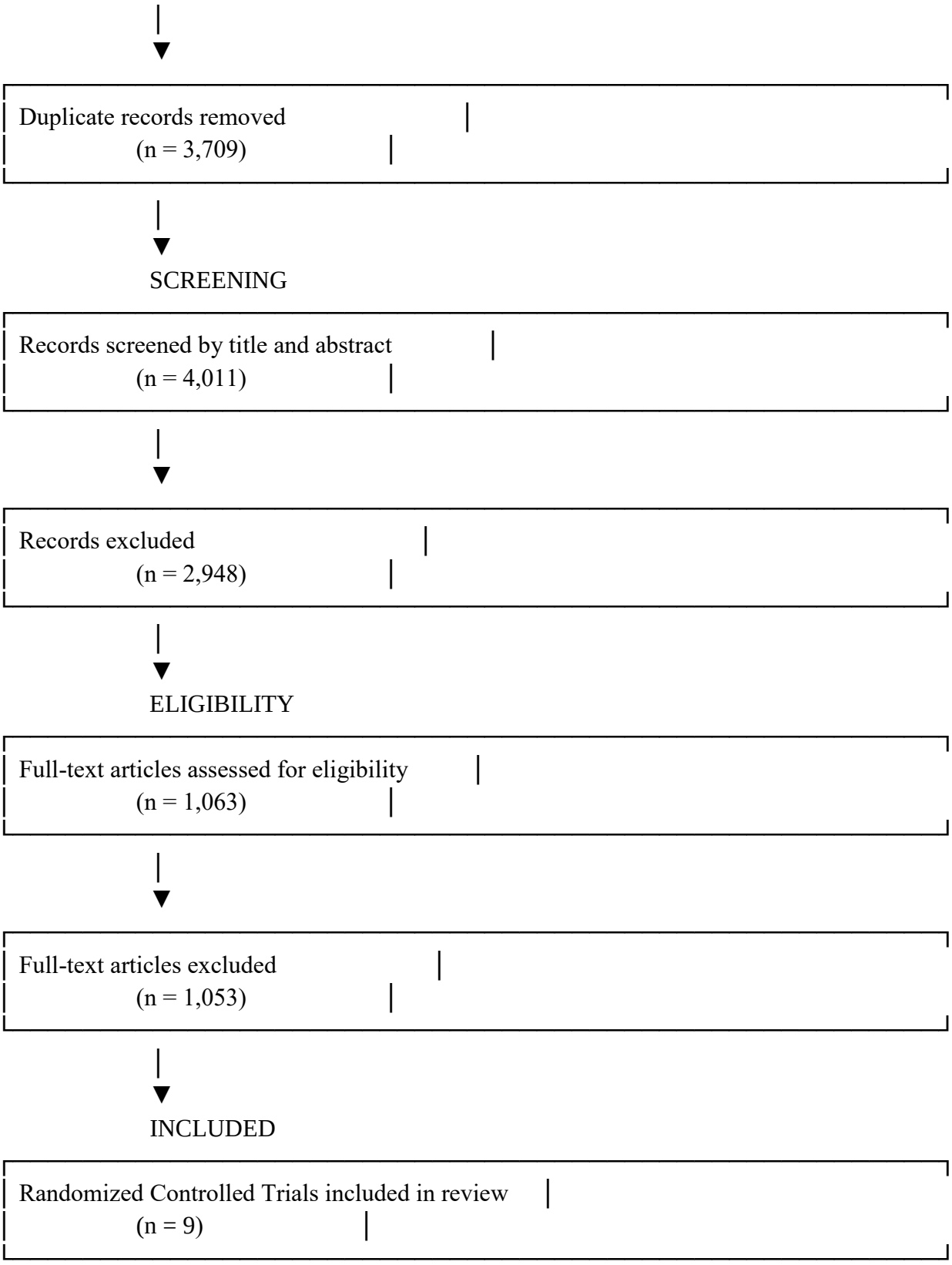
Boolean operators were used to combine keywords and improve the specificity of the literature search. The main Boolean operators used were **AND, OR, and NOT**.

“Stroke Patients” AND “Balance Exercise” AND “Physiotherapy”

Inclusion Criteria	**Exclusion Criteria**
Studies published from **2026 onwards**	Studies published **before 2026**
Randomized Controlled Trials (RCTs)	Study designs other than RCTs, such as observational studies, case reports, reviews, systematic reviews, or qualitative studies
Participants diagnosed with **stroke**	Participants without a diagnosis of stroke
Any age group of stroke patients	Studies where the age group does not meet the study requirements
Any gender (male and female)	Studies not reporting or involving the target population
Studies investigating **balance training or balance-related physiotherapy interventions**	Studies not involving balance training or relevant physiotherapy interventions

PRISMA Flow Diagram




Duplicate records removed
(n = 3,709)
SCREENING
Records screened by title and abstract
(n = 4,011)
Records excluded
(n = 2,948)
ELIGIBILITY
Full-text articles assessed for eligibility
(n = 1,063)
Full-text articles excluded
(n = 1,053)
INCLUDED
Randomized Controlled Trials included in review
(n = 9)

Article Name	Outcome Measures	Intervention	Results
Effects of Combined Otago Exercises and Perturbation-Based Training versus Mirror-Based Cawthorne-Cooksey Exercises on Balance and Anticipatory Control in Post-Stroke Patients: A Randomized Clinical Trial	**Berg Balance Scale (BBS)** and **Mini-Balance Evaluation Systems Test (Mini-BESTest)**	**Experimental group:** Combined Otago exercises and perturbation-based training. **Control group:** Mirror-based Cawthorne-Cooksey exercises. **Participants:** 34 stroke survivors (17 per group).	The combined Otago and perturbation-based training produced significantly greater improvements in balance and anticipatory postural control. BBS score was **43.41 ± 3.72** in the experimental group compared with **40.00 ± 3.42** in the control group (**p = 0.009**). Mini-BESTest score was **22.05 ± 1.81** versus **20.11 ± 1.72**, respectively (**p = 0.003**).
Comparative Effects of Trunk Proprioceptive Training versus Dual-Task Balance Training on Dynamic Balance, Functional Mobility, and Fall Risk in Chronic Stroke Survivors: A Randomized Controlled Trial	**Mini-BESTest** – dynamic balance; **Timed Up and Go (TUG)** – functional mobility; **Falls Efficacy Scale–International (FES-I)** – fear/concern of falling	**Experimental group:** Trunk proprioceptive training. **Control group:** Dual-task balance training. Both groups also received routine rehabilitation **3 times/week for 8 weeks**. **Sample:** 60 chronic stroke survivors, 30 in each group.	Both groups showed **significant improvements in all outcome measures (p < 0.001)**. However, the trunk proprioceptive training group demonstrated significantly greater improvements in **dynamic balance, functional mobility, and fall-related confidence** compared with the dual-task balance training group (**p < 0.05**).

Neuromuscular Balance Training Enhances Motor Coordination and Postural Control in Post-stroke Patients: A Randomized Controlled Trial	**Fugl-Meyer Assessment of Lower Extremity (FMLE)** – motor coordination; **Berg Balance Scale (BBS)** – balance; **Timed Up and Go (TUG)** – functional mobility; **10-Meter Walk Test (10MWT)** – gait speed	**Experimental group:** 8-week progressive, multi-component neuromuscular balance training program (n=26). **Control group:** Time-matched standard physiotherapy (n=26). Total sample: **52 chronic stroke patients**.	The intervention group showed significantly greater improvements in all outcomes. FMLE improved by **5.14 ± 1.63 vs 1.76 ± 0.69 points**, BBS by **7.91 ± 3.11 vs 2.25 ± 0.78 points**, TUG improved by **3.21 ± 1.39 vs 1.14 ± 0.58 seconds**, and 10MWT gait speed increased by **0.21 ± 0.06 vs 0.08 ± 0.04 m/s** (**$p < 0.001$** for all). Large effect sizes were reported, and improved motor coordination was strongly associated with better balance and functional mobility.

Article Name	Outcome Measures	Intervention	Results
Shockwave Therapy or Acupoint Stimulation Combined With Physiotherapy for Spasticity and Motor Function in Post-Stroke Recovery: A Randomized Controlled Trial	Modified Ashworth Scale (MAS), Modified Tardieu Scale (MTS), Fugl-Meyer Assessment (FMA), Stroke-Specific Quality of Life (SS-QOL), 10-Meter Walk Test (10MWT)	**120 post-stroke patients** were randomly divided into 3 groups: ESWT + usual physiotherapy (n=40), Acu-TENS + usual physiotherapy (n=40), and usual physiotherapy alone (n=40). Treatment was given **3 times/week for 6 weeks**, with follow-up at 18 weeks.	All three groups showed significant improvements over time (**$p < 0.001$**). Both ESWT and Acu-TENS combined with physiotherapy reduced spasticity and improved motor function, mobility, and quality of life. ESWT demonstrated greater improvements in upper-limb spasticity control and long-term upper-limb motor function, while most differences between ESWT and Acu-TENS were not statistically significant.

Article Name	Outcome Measures	Intervention	Results
Comparing Effect of Mat Exercise and Gym Ball Exercise Regime on Trunk Control and Functional Balance in Patients with Chronic Stroke	Trunk Impairment Scale (TIS), functional balance, weight-bearing symmetry, balance confidence, trunk strength and functional outcomes	Mat/plinth-based trunk exercises and gym/Swiss-ball-based trunk exercises were compared with conventional physiotherapy in adults with chronic stroke. Exercises emphasized selective trunk movement, multidirectional weight shifting, postural control and progressive task-specific practice.	Both mat and gym-ball training produced improvements in **trunk control, functional balance, trunk strength, weight-bearing symmetry and balance confidence** compared with standard physiotherapy. Improvements between the stable mat and unstable gym-ball groups were generally **not significantly different**. Direct evidence therefore does not establish gym-ball exercise as superior to mat-based training.

Article Name	Outcome Measures	Intervention	Results
Effects of Adding Treadmill Training to Conventional Physiotherapy on Lower-Limb Thermal Asymmetry, Motor Function, and Walking Capacity in Patients with Chronic Stroke: A Randomized Controlled Trial	Infrared thermography for lower-limb thermal asymmetry; Fugl-Meyer Assessment–Lower Extremity (FMA-LE); Six-Minute Walk Test (6MWT)	**22 chronic stroke patients** were randomized into intervention (n=12) and control (n=10). Both received conventional physiotherapy **2×/week for 12 weeks**; the intervention group additionally performed treadmill training.	Both groups showed reduced thermal asymmetry, but the between-group difference was not significant. The treadmill group demonstrated significant improvements in **motor function (p=0.016)** and **walking distance (p=0.016)**. Between-group analysis also showed greater motor improvement with treadmill training (**p=0.017**).

Article Name	Outcome Measures	Intervention	Results
Impact of Russian Current Therapy Targeting the Anterior Tibial Group on Balance and Fall Risk in Post-Stroke Patients: A Randomised Controlled Trial	Biodex Balance System: Overall Stability Index (OSI), Anterior-Posterior Stability Index (APSI), Medial-Lateral Stability Index (MLSI), and Fall Risk Index	**40 stroke patients** were divided into study (n=20) and control (n=20) groups. Both received a **40-minute physiotherapy programme, 3 times/week for 6 weeks**. The study group additionally received Russian current stimulation to the anterior tibial muscle group for **20 minutes/session**.	The Russian current group showed significantly greater improvements in **overall, anterior-posterior and medial-lateral postural stability** compared with controls (**$p < 0.05$**). However, there was **no significant between-group difference in fall risk under eyes-closed conditions ($p > 0.05$)**.

Article Name	Outcome Measures	Intervention	Results
Augmenting Stroke Rehabilitation: The Combined Effect of Virtual Reality Balance and Whole-Body Vibration Training on Balance and Gait	Berg Balance Scale (BBS), Fugl-Meyer Assessment–Lower Extremity (FMA-LE), Timed Up and Go Test (TUGT), 6-Minute Walk Test (6MWT), and biomechanical balance parameters	**100 stroke patients** were allocated to four groups: conventional rehabilitation, WBVT, dynamic balance trainer, and combined WBVT + balance trainer. Intervention was provided for **4 weeks**.	All groups demonstrated significant post-intervention improvements (**$p < 0.05$**). The **combined training group showed significantly greater improvements** than the other groups across all outcomes (**$p < 0.05$**). Improvements included **FMA-LE +17.84 points, BBS +14.68 points, and TUGT −3.64 seconds**, along with better biomechanical balance parameters.

3. Results

The reviewed randomized controlled trials demonstrated that **balance training is effective in improving postural control, functional mobility, gait, and lower-limb motor performance in stroke patients**. Combined approaches such as Otago exercises with perturbation training, neuromuscular balance training, trunk proprioceptive exercises, treadmill training, and technology-assisted balance training produced significant improvements in balance-related outcomes.

Overall, **Berg Balance Scale, Mini-BESTest, Fugl-Meyer Assessment, Timed Up and Go, 10-Meter Walk Test, and 6-Minute Walk Test** showed meaningful improvements following physiotherapy-based interventions. Trunk proprioceptive training and neuromuscular balance training appeared particularly effective for improving dynamic balance and postural control. Technology-assisted interventions, including **virtual reality and whole-body vibration combined with balance training**, also produced greater improvements than conventional rehabilitation alone.

Adjunct modalities such as **Russian current and extracorporeal shockwave therapy** demonstrated additional benefits for postural stability, motor function, and spasticity management, although their effects on fall risk were less consistent. Similarly, both mat-based and gym-ball trunk exercises improved trunk control and functional balance, with no clear superiority of unstable surfaces.

4. Discussion

The findings of the reviewed studies indicate that **balance training is an important component of physiotherapy rehabilitation following stroke**, particularly for improving postural control, functional mobility, gait performance, and lower-limb motor function. Across the included randomized controlled trials, most interventions produced meaningful improvements compared with conventional rehabilitation alone or alternative training approaches.

The combination of **Otago exercises and perturbation-based training** produced greater improvements in balance and anticipatory postural control than mirror-based Cawthorne-Cooksey exercises. This may be explained by the repeated exposure to controlled balance disturbances, which challenges the patient's ability to rapidly adjust the centre of mass and develop appropriate postural responses. Similarly, **neuromuscular balance training** demonstrated substantial improvements in lower-limb motor coordination, balance, gait speed, and functional mobility. These findings suggest that interventions involving repetitive, progressive and task-oriented movements may promote better motor control and postural adaptation in individuals recovering from stroke.

The comparison between **trunk proprioceptive training and dual-task balance training** further highlights the importance of trunk control during balance rehabilitation. Although both approaches were beneficial, trunk proprioceptive training produced greater improvements in dynamic balance, functional mobility and fall-related confidence. Effective trunk control provides a stable base for limb movement and weight transfer, which may explain its contribution to improved functional performance.

The reviewed studies also suggest that **technology-assisted and device-based interventions can enhance conventional physiotherapy**. The combination of virtual/dynamic balance training with whole-body vibration produced greater improvements in balance, lower-limb motor function and mobility than either intervention alone or conventional rehabilitation. Such approaches may provide increased sensory feedback, repetitive practice and opportunities for challenging postural tasks. However, the benefit of combining different technologies should be interpreted in relation to treatment feasibility, accessibility and patient tolerance.

Additional modalities showed promising but more specific effects. **Russian current stimulation** applied to the anterior tibial muscles improved overall, anteroposterior and mediolateral postural stability, although a significant improvement in fall risk was not consistently demonstrated. Likewise, the addition of **treadmill training** to conventional physiotherapy improved lower-limb motor function and walking capacity, supporting the role of repetitive gait practice in improving functional mobility. These findings indicate that interventions targeting specific impairments can complement balance-oriented rehabilitation.

The comparison of **mat-based and gym-ball trunk exercises** showed that both stable and unstable exercise surfaces could improve trunk control and functional balance. The absence of a clear advantage for the gym ball suggests that the therapeutic effect may depend more on the selection of appropriate exercises, repetition, progression, weight shifting and task-specific practice than on the instability of the exercise surface itself.

Overall, the evidence indicates that **progressive, repetitive, task-specific and multimodal physiotherapy interventions are more consistently associated with improvements in balance and functional performance after stroke**. Nevertheless, differences in intervention duration, stroke severity, chronicity, sample size and outcome measures make direct comparison between studies difficult. Future research should use larger samples, standardized rehabilitation protocols and objective measures of postural control, while also examining whether improvements are maintained over longer follow-up periods.

Conclusion

The reviewed evidence indicates that **balance training is an effective physiotherapy approach for improving postural control, functional mobility, gait performance, and lower-limb motor function in stroke patients**. Progressive and task-specific interventions such as perturbation training, trunk proprioceptive exercises, neuromuscular training, treadmill training, and technology-assisted balance exercises demonstrated meaningful functional benefits.

The findings also suggest that combining balance training with appropriate adjunctive techniques may provide additional improvements, although the effectiveness varies according to the intervention and patient characteristics. Therefore, **individualized, progressive, repetitive, and function-oriented balance training should be incorporated into stroke rehabilitation programs** to enhance independence, mobility, and overall functional recovery.

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