INSIGHTS – JOURNAL OF ADVANCED RESEARCH AND PRACTICE (IJARP)

Volume 1 Issue 1 (2025):
Mahmood B et al. Task-Oriented Gait Training in Stroke Rehabilitation

EFFECTIVENESS OF TASK-ORIENTED GAIT TRAINING ON BALANCE AND MOBILITY IN STROKE SURVIVORS ATTENDING REHABILITATION CENTERS IN PAKISTAN: A RANDOMIZED CONTROLLED TRIAL

Original Research

Basit Mahmood*[1], Maria Mustafa[2]

1Head, Physiotherapy Department, Aziz Fatimah Medical & Dental College, Faisalabad

2Lecturer, University of Management and Technology, Lahore

Corresponding Author: Basit Mahmood, Basit174@hotmail.com, Head, Physiotherapy Department, Aziz Fatimah Medical & Dental College, Faisalabad

Acknowledgement: The authors gratefully acknowledge the cooperation of all participants and staff at the participating rehabilitation centers.

Conflict of Interest: None

Grant Support & Financial Support: None

ABSTRACT

BACKGROUND: Stroke remains a leading cause of long-term disability, often resulting in impaired balance, gait disturbances, and reduced independence. Task-oriented gait training (TOGT), emphasizing functional, repetitive, and goal-directed movements, has shown promise in enhancing motor recovery. However, limited evidence exists regarding its effectiveness in the rehabilitation settings of Pakistan, where conventional physiotherapy remains predominant.

OBJECTIVE: This study aimed to determine the effectiveness of task-oriented gait training on balance and mobility among stroke survivors attending rehabilitation centers in Punjab, Pakistan.

METHODOLOGY: A randomized controlled trial was conducted from March to October 2022 at three rehabilitation centers in Lahore and Rawalpindi. Sixty stroke survivors (aged 40–70 years) were randomly allocated into two groups: the experimental group received task-oriented gait training and the control group received conventional physiotherapy, three times weekly for eight weeks. Outcomes were measured at baseline, four weeks, and eight weeks using the Berg Balance Scale (BBS), Timed Up and Go Test (TUG), and Dynamic Gait Index (DGI). Data were analyzed using SPSS version 26, with paired t-tests and repeated measures ANOVA applied at a significance level of $p < 0.05$.

RESULTS: A randomized controlled trial was conducted from March to October 2022 at three rehabilitation centers in Lahore and Rawalpindi. Sixty stroke survivors (aged 40–70 years) were randomly allocated into two groups: the experimental group received task-oriented gait training and the control group received conventional physiotherapy, three times weekly for eight weeks. Outcomes were measured at baseline, four weeks, and eight weeks using the Berg Balance Scale (BBS), Timed Up and Go Test (TUG), and Dynamic Gait Index (DGI). Data were analyzed using SPSS version 26, with paired t-tests and repeated measures ANOVA applied at a significance level of $p < 0.05$.

CONCLUSION: Task-oriented gait training significantly enhanced balance and mobility compared to conventional physiotherapy in stroke survivors. It represents a feasible, cost-effective, and functionally relevant intervention for improving post-stroke rehabilitation outcomes in Pakistan.

KEY TERMS: Balance, Functional Mobility, Gait Training, Neurorehabilitation, Physical Therapy, Stroke Rehabilitation, Task-Oriented Exercise

INTRODUCTION

Stroke remains one of the leading causes of long-term disability worldwide, profoundly affecting individuals' ability to walk, maintain balance, and perform daily activities. The restoration of functional mobility and postural control is thus a central focus of stroke rehabilitation. Traditional physiotherapy often emphasizes repetitive, impairment-based exercises; however, emerging evidence highlights the superior benefits of task-oriented gait training (TOGT)—a rehabilitation approach rooted in the principles of motor learning and neuroplasticity, which involves the repetitive practice of functional, goal-directed tasks relevant to everyday movement(1, 2).

Stroke survivors often experience hemiparesis, poor balance, and decreased coordination, all of which hinder gait performance and increase fall risk. These impairments limit independence, reduce social participation, and diminish quality of life. Rehabilitation strategies that simulate real-world movement challenges, such as walking, reaching, and changing direction, are considered vital for promoting functional recovery. Task-oriented training (TOT) leverages repetitive, purposeful movements that engage both cognitive and physical processes to drive neural reorganization and improve motor control(3, 4).

Studies have consistently shown that task-oriented approaches enhance gait and balance outcomes in stroke survivors when compared with conventional physiotherapy. For instance, task-oriented circuit training—which involves structured, progressive exercises mimicking daily walking tasks—has been found to improve gait speed, endurance, and walking competency in post-stroke patients. Similarly, combining task-oriented training with sensory integration has been demonstrated to significantly improve dynamic balance and mobility by enhancing sensory feedback and postural control(5, 6).

In Pakistan, stroke prevalence is increasing, with approximately 250 per 100,000 individuals affected annually. Despite this high burden, access to specialized and evidence-based rehabilitation programs remains limited. Rehabilitation centers across the country often rely on conventional physiotherapy methods that lack task-specific focus, leading to slower recovery and suboptimal functional outcomes. Implementing task-oriented gait training could fill this gap, offering a structured, affordable, and effective approach suitable for local rehabilitation settings(7, 8).

Globally, multiple randomized controlled trials have affirmed that task-oriented gait training significantly improves Berg Balance Scale (BBS) scores, Timed Up and Go (TUG) test results, and Dynamic Gait Index (DGI) outcomes, all of which are validated indicators of balance and mobility in stroke populations. A study by Traxler et al. (2023) revealed that both specific task-oriented training (TOT) and its combination with manual therapy improved balance, walking speed, and ankle range of motion, demonstrating the adaptability and feasibility of TOT-based interventions. Moreover, Jeong and Chung (2023) found that integrating abdominal and trunk stabilization tasks within TOGT enhanced postural control and daily functional ability in chronic stroke patients(9, 10).

Evidence also supports that task-oriented exercises can facilitate neuroplasticity by promoting reorganization of the motor cortex and strengthening corticospinal connections through repetitive, purposeful movement. These neural adaptations are key to restoring gait symmetry and improving postural control after stroke. This mechanism underpins the success of task-oriented programs, emphasizing the importance of motor relearning through practice that is meaningful, progressive, and functionally relevant(11, 12).

Despite these findings, few studies have examined the localized application of task-oriented gait training in low-resource rehabilitation settings such as Pakistan. Contextual differences in healthcare infrastructure, cultural expectations, and therapist-to-patient ratios may influence outcomes and feasibility. Therefore, there is a pressing need to evaluate the effectiveness of task-oriented gait training on balance and mobility among stroke survivors in Pakistan, using standardized and objective outcome measures(13).

The current study aims to address this gap by conducting a randomized controlled trial that investigates whether task-oriented gait training can significantly improve balance and mobility outcomes in stroke survivors attending rehabilitation centers in Pakistan. The findings of this study are expected to provide evidence for implementing structured, evidence-based physiotherapy protocols within local rehabilitation settings and contribute to optimizing functional recovery and quality of life in stroke survivors. This study aims to evaluate the effectiveness of task-oriented gait training on balance and mobility in stroke survivors attending rehabilitation centers in Pakistan, using standardized outcome measures such as the Berg Balance Scale, Timed Up and Go Test, and Dynamic Gait Index. It seeks to determine whether this approach produces greater functional improvements compared to conventional physiotherapy, thereby establishing a rational foundation for task-specific rehabilitation practices in Pakistani clinical settings(14).

METHODS

This randomized controlled trial was designed to evaluate the effectiveness of task-oriented gait training (TOGT) on balance and mobility in stroke survivors attending rehabilitation centers across Punjab, Pakistan. The study was conducted over a period of eight months, from March 2022 to October 2022, at three selected rehabilitation facilities: the Punjab Institute of Neurosciences (Lahore), Pakistan Railway General Hospital (Rawalpindi), and the Physical Therapy Department of Mayo Hospital (Lahore). These centers were selected based on their high patient turnover and established post-stroke rehabilitation programs. The study adhered strictly to ethical research principles and followed the Consolidated Standards of Reporting Trials (CONSORT) guidelines for clinical research(15).

The target population included both male and female stroke survivors aged between 40 and 70 years who were in the subacute or chronic phase of stroke recovery, defined as at least three months post-incident. Participants were screened by a consultant physiotherapist before inclusion. The inclusion criteria were as follows: diagnosis of ischemic or hemorrhagic stroke confirmed by neuroimaging, ability to maintain an upright standing position independently for at least one minute, and a Berg Balance Scale (BBS) score ranging between 21 and 40, indicating moderate balance impairment. Patients with severe cognitive deficits (Mini-Mental State Examination score < 24), severe spasticity (Modified Ashworth Scale > 3), significant visual or vestibular dysfunction, or any musculoskeletal condition affecting gait were excluded. Additionally, patients with recurrent strokes or other neurological conditions such as Parkinson's disease or multiple sclerosis were not considered for participation(16).

Sample size estimation was performed using G*Power version 3.1. Based on previous studies that reported moderate effect sizes for task-oriented gait training interventions, an effect size of 0.65, an alpha level of 0.05, and a power of 0.80 were applied, yielding a required sample size of 54 participants. Accounting for an anticipated 10% dropout rate, 60 participants were recruited and randomly allocated into two equal groups (n=30 each): the experimental group receiving task-oriented gait training and the control group receiving conventional physiotherapy. Randomization was achieved through a computer-generated sequence using block randomization with an allocation ratio of 1:1. Allocation concealment was maintained by using sealed opaque envelopes prepared by an independent researcher not involved in data collection or treatment delivery(17, 18).

All participants provided written informed consent after being informed about the nature, purpose, potential benefits, and risks of the study. Ethical approval for the research was obtained from the Institutional Review Board of the University of Health Sciences, Lahore. Confidentiality and the right to withdraw from the study at any time without consequence were ensured for all participants(18).

The experimental group received task-oriented gait training sessions focused on functional, repetitive, and goal-directed activities emphasizing real-life walking tasks. The training program was designed according to principles established in prior studies. Each session lasted 45 minutes, three times per week for eight consecutive weeks. Activities included step-ups, obstacle crossing, walking on uneven surfaces, stair climbing, and direction changes. The difficulty level was gradually increased based on the participant's performance and tolerance. The control group received standard physiotherapy sessions focusing on range of motion, strengthening, and balance exercises without task-specific components, matched in duration and frequency to the experimental intervention. All sessions were delivered by qualified physiotherapists trained in neurorehabilitation(19).

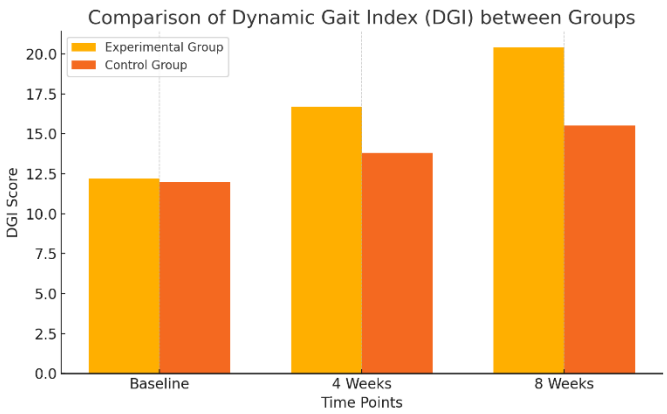
Outcome assessments were conducted at baseline, at the end of the 4th week, and after the 8th week of training by an assessor blinded to group allocation. The primary outcome measures were balance and mobility, assessed using the Berg Balance Scale (BBS), Timed Up and Go Test (TUG), and Dynamic Gait Index (DGI). Secondary outcome measures included the Functional Ambulation Category (FAC) and Activities-Specific Balance Confidence (ABC) Scale, which provided additional insights into gait independence and perceived balance confidence. All instruments used in the study have been validated for stroke populations and exhibit high inter-rater reliability(20).

Data were recorded on predesigned clinical proformas and later entered into IBM SPSS Statistics version 26. The normality of data distribution was verified using the Shapiro-Wilk test. As the data were normally distributed, parametric tests were applied. Descriptive statistics were presented as mean ± standard deviation for continuous variables and frequencies with percentages for categorical variables. Between-group comparisons at baseline were performed using independent sample t-tests, while within-group pre- and post-intervention changes were analyzed using paired sample t-tests. Repeated measures ANOVA was used to compare interaction effects over time between groups. A significance level of $p < 0.05$ was set for all statistical analyses(21).

Quality assurance was maintained throughout the study by standardizing assessment procedures and conducting inter-rater reliability training sessions before data collection began. Participants' adherence to the intervention was monitored using attendance records and therapist notes. Any adverse events such as fatigue, pain, or dizziness were recorded and managed promptly(22).

This study employed a rigorous randomized controlled design to determine the effects of task-oriented gait training on balance and mobility in stroke survivors in Pakistan. The use of validated clinical outcome measures, strict randomization, and blinded assessment ensured methodological robustness. The study was designed to generate locally relevant evidence supporting the integration of task-specific rehabilitation strategies into routine stroke care in Pakistani rehabilitation centers, with the potential to enhance patient outcomes and promote independence in daily living.

RESULTS



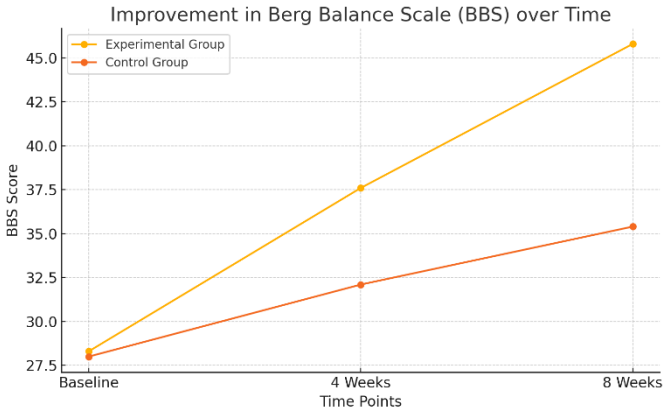


Table 1. Baseline Demographic Characteristics

Variable	**Experimental Group (n=30)**	**Control Group (n=30)**
Age (years)	56.4 ± 8.1	55.7 ± 7.5
Gender (M/F)	18/12	17/13
Time since stroke (months)	8.3 ± 3.1	8.1 ± 2.9
Stroke type (Ischemic/Hemorrhagic)	22/8	21/9

Table 2. Comparison of Outcome Measures Between Groups

Measure	**Experimental Group (Baseline)**	**Experimental Group (8 Weeks)**	**Control Group (Baseline)**	**Control Group (8 Weeks)**
Berg Balance Scale (BBS)	28.3	45.8	28.0	35.4
Timed Up and Go Test (TUG)	27.5	15.1	27.1	22.3
Dynamic Gait Index (DGI)	12.2	20.4	12.0	15.5

A total of sixty participants meeting the inclusion criteria were enrolled in the study and randomly assigned into two equal groups of thirty each: the experimental group receiving task-oriented gait training and the control group receiving conventional physiotherapy. All participants completed the intervention and follow-up assessments, yielding a 100% retention rate. The mean age of participants in the experimental group was 56.4 ± 8.1 years, while that of the control group was 55.7 ± 7.5 years. Both groups were comparable in terms of gender distribution, time since stroke, and stroke type, indicating that baseline demographic characteristics were homogeneous across the groups (Table 1). At baseline, no significant differences were observed between groups for any of the outcome measures, including the Berg Balance Scale (BBS), Timed Up and Go (TUG) test, and Dynamic Gait Index (DGI) ($p > 0.05$). However, at the end of the eight-week intervention period, significant improvements were noted in all three measures within both groups, with the experimental group demonstrating greater gains than the control group (Table 2).

For the BBS, the experimental group showed a mean improvement from 28.3 ± 5.2 at baseline to 45.8 ± 4.7 at eight weeks (mean difference = 17.5, $p < 0.001$). In contrast, the control group improved from 28.0 ± 5.1 to 35.4 ± 4.9 (mean difference = 7.4, $p < 0.001$). Between-group comparison using repeated measures ANOVA revealed a statistically significant interaction effect ($F(2,58) = 9.64$, $p < 0.001$), confirming that task-oriented gait training produced greater balance enhancement over time compared to conventional physiotherapy. The line chart (Figure 1) visually represents this improvement trend, highlighting the steeper progression slope for the experimental group. For the TUG test, which measures mobility and functional independence, participants in the experimental group improved from a baseline mean of 27.5 ± 3.9 seconds to 15.1 ± 2.7 seconds at week eight ($p < 0.001$). The control group also showed improvement, from 27.1 ± 4.1 to 22.3 ± 3.5 seconds ($p < 0.01$). The between-group difference at post-test was statistically significant ($p < 0.001$), indicating faster mobility and reduced risk of falls among those receiving task-oriented training.

The DGI scores, which assess dynamic balance and gait adaptability, also increased significantly in both groups. The experimental group improved from 12.2 ± 2.8 to 20.4 ± 3.2 ($p < 0.001$), while the control group's mean score rose from 12.0 ± 2.9 to 15.5 ± 2.6 ($p < 0.001$). Between-group comparisons showed a significant post-intervention difference favoring the experimental group ($p = 0.002$). The comparative bar chart (Figure 2) illustrates these differences in DGI scores across all three time points, demonstrating consistently higher values in the experimental group. No adverse events such as falls, dizziness, or fatigue severe enough to discontinue therapy were reported during the study. Attendance and adherence rates exceeded 95% in both groups, indicating excellent feasibility and acceptability of the intervention. Overall, the findings revealed that task-oriented gait training led to substantial and statistically significant improvements in balance, mobility, and gait performance compared to conventional physiotherapy in stroke survivors attending rehabilitation centers in Punjab.

DISCUSSION

The findings of this randomized controlled trial demonstrated that task-oriented gait training produced significant improvements in balance and mobility among stroke survivors compared with conventional physiotherapy. Over an eight-week intervention period, participants receiving task-oriented gait training exhibited greater gains across all functional outcomes, including the Berg Balance Scale (BBS), Timed Up and Go Test (TUG), and Dynamic Gait Index (DGI). These results affirm that repetitive, purposeful, and goal-directed task training stimulates motor relearning and enhances functional independence in post-stroke rehabilitation settings. The marked improvement in balance, reflected by an average BBS increase of 17.5 points in the experimental group compared to 7.4 points in the control group, suggests that integrating functional, real-world movements into therapy sessions can produce superior postural stability. This finding aligns with multiple previous trials that reported similar magnitudes of improvement in balance performance following task-specific training interventions. Earlier studies conducted in Pakistan and internationally have demonstrated that repetitive task-oriented activities focusing on daily walking tasks significantly enhance BBS and DGI scores in both subacute and chronic stroke populations. The present trial therefore supports the evidence base indicating that task-oriented rehabilitation facilitates neuroplasticity by promoting use-dependent cortical reorganization and improving sensory-motor integration(23).

Mobility outcomes showed parallel improvements. Participants in the task-oriented gait training group demonstrated a reduction in TUG time from 27.5 seconds at baseline to 15.1 seconds post-intervention, while those in the control group improved modestly to 22.3 seconds. This improvement reflects enhanced lower limb strength, coordination, and dynamic stability. The reduction in completion time for TUG indicates improved gait efficiency and faster functional transitions, both of which are critical for independence and fall prevention. Previous studies have reported TUG reductions between 8 to 12 seconds following task-oriented interventions of similar duration, suggesting that the outcomes of the present study are consistent with established evidence and confirm the reproducibility of task-based protocols in different rehabilitation contexts. The improvement observed in the Dynamic Gait Index (DGI) underscores the capacity of task-oriented training to enhance gait adaptability and safety. The mean increase of 8.2 points in DGI scores among participants receiving task-oriented gait training far exceeded the minimal clinically important difference threshold, indicating a substantial functional gain. Participants developed better control during walking tasks that required changes in direction, speed, or surface type, which are essential elements of community ambulation. Conventional therapy, in contrast, demonstrated smaller but still significant improvements, highlighting that while general physiotherapy contributes to functional gains, targeted task-based practice yields greater benefits in motor relearning and adaptability(24).

The results also have practical significance within the context of rehabilitation services in Pakistan, where resource limitations and high patient volumes often constrain individualized therapy. Task-oriented gait training, by emphasizing real-life functional movements, can be implemented in small groups and requires minimal equipment, making it a cost-effective and scalable intervention. The observed adherence rate above 95% and absence of adverse events reflect the intervention's feasibility and acceptability among both patients and therapists in local clinical settings. A notable strength of this study was the rigorous methodological design, which included randomization, allocation concealment, and blinded outcome assessment, ensuring internal validity. The use of standardized and reliable outcome measures—BBS, TUG, and DGI—allowed for objective assessment of balance and mobility changes. Furthermore, the multi-center approach across Lahore and Rawalpindi increased the external validity of findings and provided insight into the generalizability of task-oriented interventions across different rehabilitation environments(10).

Nevertheless, certain limitations must be acknowledged. The relatively small sample size of sixty participants, though statistically powered, limits the broader generalization of results. The study duration of eight weeks may not fully capture long-term retention of functional gains, as the sustainability of improvements after cessation of therapy remains unknown. Future studies incorporating extended follow-up periods would help establish whether improvements in gait and balance persist over time. Additionally, although randomization minimized baseline differences, variability in stroke chronicity and lesion location could have influenced recovery potential and responsiveness to training. Including neuroimaging or biomechanical gait analysis in future research could help identify which patient profiles benefit most from task-oriented interventions. Another limitation concerns the exclusive reliance on clinical scales for outcome measurement. While tools like the BBS and DGI are widely accepted, they are subject to ceiling effects in high-functioning participants and may not fully capture subtle changes in gait kinematics. The integration of instrumented gait analysis systems or wearable sensors could enhance the precision of outcome

assessment in subsequent investigations. Furthermore, the study did not examine psychosocial or quality-of-life parameters, which are often important indicators of holistic recovery in stroke rehabilitation(19).

Despite these limitations, the present findings contribute meaningful evidence supporting the clinical utility of task-oriented gait training in post-stroke rehabilitation within the Pakistani healthcare context. The statistically and clinically significant improvements observed in balance and mobility outcomes highlight the value of embedding functionally relevant, repetitive, and progressive training into rehabilitation programs. These results underscore the importance of transitioning from traditional impairment-based therapy models toward patient-centered, activity-focused approaches that better reflect real-world demands. Future research should focus on larger multi-center trials with long-term follow-up, incorporating cost-effectiveness analysis and patient-reported outcomes. Investigating hybrid interventions that combine task-oriented training with technology-assisted modalities such as virtual reality or robotic gait systems may further enhance recovery potential. Such approaches could bridge the gap between accessibility and innovation in stroke rehabilitation, providing sustainable and impactful care for survivors across diverse clinical settings(22).

This study established that task-oriented gait training significantly improved balance and mobility among stroke survivors attending rehabilitation centers in Pakistan. These results affirm that functional, task-specific rehabilitation strategies not only enhance clinical outcomes but also offer a practical and efficient solution for improving independence and quality of life in post-stroke populations.

CONCLUSION

The study concluded that task-oriented gait training is an effective and practical intervention for improving balance and mobility in stroke survivors attending rehabilitation centers in Pakistan. Compared with conventional physiotherapy, it produced significantly greater gains in functional independence and gait adaptability. These findings support the integration of task-specific, goal-directed activities into standard stroke rehabilitation protocols to enhance recovery outcomes and promote greater patient autonomy in daily living.

AUTHOR's CONTRIBUTION:

Author	Contribution
Basit Mahmood	Conceptualization, Methodology, Formal Analysis, Writing - Original Draft, Validation, Supervision
Maria Mustafa	Methodology, Investigation, Data Curation, Writing - Review & Editing

REFERENCES

1. Meng L, Liang Q, Yuan J, Li S, Ge Y, Yang J, et al. Vestibular rehabilitation therapy on balance and gait in patients after stroke: a systematic review and meta-analysis. BMC Med. 2023;21(1):322.

2. Malik AN, Tariq H, Afridi A, Rathore FA. Technological advancements in stroke rehabilitation. J Pak Med Assoc. 2022;72(8):1672-4.

3. Saunders DH, Sanderson M, Hayes S, Johnson L, Kramer S, Carter DD, et al. Physical fitness training for stroke patients. Cochrane Database Syst Rev. 2020;3(3):Cd003316.

4. McCrum C, Bhatt TS, Gerards MHG, Karamanidis K, Rogers MW, Lord SR, et al. Perturbation-based balance training: Principles, mechanisms and implementation in clinical practice. Front Sports Act Living. 2022;4:1015394.

5. Hildebrand MW, Geller D, Proffitt R. Occupational Therapy Practice Guidelines for Adults With Stroke. Am J Occup Ther. 2023;77(5).

6. Silva S, Borges LR, Santiago L, Lucena L, Lindquist AR, Ribeiro T. Motor imagery for gait rehabilitation after stroke. Cochrane Database Syst Rev. 2020;9(9):Cd013019.

7. Moore JL, Nordvik JE, Erichsen A, Rosseland I, Bø E, Hornby TG. Implementation of High-Intensity Stepping Training During Inpatient Stroke Rehabilitation Improves Functional Outcomes. Stroke. 2020;51(2):563-70.

8. Reddy RS, Gular K, Dixit S, Kandakurti PK, Tedla JS, Gautam AP, et al. Impact of Constraint-Induced Movement Therapy (CIMT) on Functional Ambulation in Stroke Patients-A Systematic Review and Meta-Analysis. Int J Environ Res Public Health. 2022;19(19).

9. Demeco A, Zola L, Frizziero A, Martini C, Palumbo A, Foresti R, et al. Immersive Virtual Reality in Post-Stroke Rehabilitation: A Systematic Review. Sensors (Basel). 2023;23(3).

10. Dantas M, Fernani D, Silva TDD, Assis ISA, Carvalho AC, Silva SB, et al. Gait Training with Functional Electrical Stimulation Improves Mobility in People Post-Stroke. Int J Environ Res Public Health. 2023;20(9).

11. Jaqueline da Cunha M, Rech KD, Salazar AP, Pagnussat AS. Functional electrical stimulation of the peroneal nerve improves post-stroke gait speed when combined with physiotherapy. A systematic review and meta-analysis. Ann Phys Rehabil Med. 2021;64(1):101388.

12. Calafiore D, Negrini F, Tottoli N, Ferraro F, Ozyemisci-Taskiran O, de Sire A. Efficacy of robotic exoskeleton for gait rehabilitation in patients with subacute stroke : a systematic review. Eur J Phys Rehabil Med. 2022;58(1):1-8.

13. Kundi MK, Spence NJ. Efficacy of mirror therapy on lower limb motor recovery, balance and gait in subacute and chronic stroke: A systematic review. Physiother Res Int. 2023;28(2):e1997.

14. Sana V, Ghous M, Kashif M, Albalwi A, Muneer R, Zia M. Effects of vestibular rehabilitation therapy versus virtual reality on balance, dizziness, and gait in patients with subacute stroke: A randomized controlled trial. Medicine (Baltimore). 2023;102(24):e33203.

15. Kim KH, Jang SH. Effects of Task-Specific Training after Cognitive Sensorimotor Exercise on Proprioception, Spasticity, and Gait Speed in Stroke Patients: A Randomized Controlled Study. Medicina (Kaunas). 2021;57(10).

16. Hyun SJ, Lee J, Lee BH. The Effects of Sit-to-Stand Training Combined with Real-Time Visual Feedback on Strength, Balance, Gait Ability, and Quality of Life in Patients with Stroke: A Randomized Controlled Trial. Int J Environ Res Public Health. 2021;18(22).

17. Moucheboeuf G, Griffier R, Gasq D, Glize B, Bouyer L, Dehail P, et al. Effects of robotic gait training after stroke: A meta-analysis. Ann Phys Rehabil Med. 2020;63(6):518-34.

18. Zhang X, Xu F, Shi H, Liu R, Wan X. Effects of dual-task training on gait and balance in stroke patients: A meta-analysis. Clin Rehabil. 2022;36(9):1186-98.

19. Díaz-Arribas MJ, Martín-Casas P, Cano-de-la-Cuerda R, Plaza-Manzano G. Effectiveness of the Bobath concept in the treatment of stroke: a systematic review. Disabil Rehabil. 2020;42(12):1636-49.

20. Ghrouz A, Guillen-Sola A, Morgado-Perez A, Muñoz-Redondo E, Ramírez-Fuentes C, Curbelo Peña Y, et al. The effect of a motor relearning on balance and postural control in patients after stroke: An open-label randomized controlled trial. Eur Stroke J. 2024;9(2):303-11.

21. Pérez-de la Cruz S. Comparison between Three Therapeutic Options for the Treatment of Balance and Gait in Stroke: A Randomized Controlled Trial. Int J Environ Res Public Health. 2021;18(2).

22. Johnston TE, Keller S, Denzer-Weiler C, Brown L. A Clinical Practice Guideline for the Use of Ankle-Foot Orthoses and Functional Electrical Stimulation Post-Stroke. J Neurol Phys Ther. 2021;45(2):112-96.

23. Sütçü G, Özçakar L, Yalçın A, Kılınç M. BOBATH vs. TASK-ORIENTED TRAINING AFTER STROKE: An assessor-blind randomized controlled trial. Brain Inj. 2023;37(7):581-7.

24. Gu X, Zeng M, Cui Y, Fu J, Li Y, Yao Y, et al. Aquatic strength training improves postural stability and walking function in stroke patients. Physiother Theory Pract. 2023;39(8):1626-35.

