

Effectiveness of Backward Walking Training on Gait, Balance & Functional Mobility in Middle-Aged Adults with Chronic Stroke: A Literature Review

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ABSTRACT

Background: Chronic stroke survivors frequently experience persistent deficits in gait, balance, and functional mobility despite receiving conventional rehabilitation. These impairments reduce independence, increase the risk of falls, and limit participation in daily and community activities. Backward walking training (BWT) has emerged as a promising supplementary rehabilitation approach because it places greater demands on neuromuscular coordination, postural control, and lower-limb muscle activation than conventional forward walking.

Objective: To review the effectiveness of backward walking training on gait, balance, and functional mobility in middle-aged adults with chronic stroke.

Methods: A narrative literature review was conducted using electronic databases including PubMed, Google Scholar, PEDro, ScienceDirect, Cochrane Library, and PubMed Central. Studies published in English between 2020 and 2025 involving middle-aged adults with chronic stroke (≥ 6 months post-stroke) were included. Eligible studies evaluated backward walking training as the primary intervention and assessed gait, balance, or functional mobility outcomes. A

total of nine studies, including randomized controlled trials, prospective studies, and meta-analyses, met the inclusion criteria.

Results: Backward walking training consistently improved gait speed, stride length, step length, gait symmetry, balance, and functional mobility among middle-aged adults with chronic stroke. Improvements were reported in outcome measures such as the Berg Balance Scale (BBS), Timed Up and Go (TUG) test, and 10-Meter Walk Test (10MWT). Individuals with severe walking impairment also demonstrated meaningful functional gains following backward walking training. Evidence further suggested that improvements achieved through backward walking may transfer to forward walking performance.

Conclusion: Backward walking training appears to be an effective and feasible intervention for improving gait, balance, and functional mobility in middle-aged adults with chronic stroke when combined with conventional rehabilitation. However, further high-quality randomized controlled trials with standardized intervention protocols and longer follow-up periods are required to strengthen the current evidence and support wider clinical application.

Keywords: Backward walking training, chronic stroke, gait, balance, functional mobility, stroke rehabilitation.

INTRODUCTION

Backward walking, also known as retro walking, is a modified form of gait in which the direction of movement and the sequence of limb motion are reversed compared to normal forward walking. Due to reduced visual feedback and altered movement patterns, backward walking requires greater neuromuscular coordination, balance control, and body awareness. Because of these unique biomechanical and physiological demands, backward walking is increasingly being used in rehabilitation programs to improve gait performance, muscle strength, posture, and functional mobility. [1]

Stroke remains one of the leading causes of long-term disability worldwide and represents a major public health concern, affecting millions of people each year. [2] The consequences are devastating for survivors, resulting in substantial loss of functional independence and life roles. [2] Among the most severely affected abilities following stroke are gait and mobility, with approximately 75% of post-stroke individuals reporting difficulty walking in community settings. [6]

Stroke survivors typically demonstrate altered gait patterns characterized by slow walking speed, asymmetrical stride lengths, and reduced step length on the affected side. [7] These gait impairments reduce functional independence, limit community participation, diminish quality of life, and increase the risk of falls and secondary medical complications. [9] The recovery of walking ability represents a critical rehabilitation goal because restoration of independent ambulation directly enhances functional independence and enables participation in meaningful activities of daily living. [4]

Approximately 20% of stroke survivors experience severe residual walking impairment, defined as self-selected walking

speed ≤ 0.4 m/s. [1] These individuals are more likely to be homebound and experience substantially greater risk of falls, fractures, and rehospitalization. [2] Current standard rehabilitation approaches using conventional forward walking training provide limited benefit to individuals with chronic stroke with severe walking impairment. [2] There is a critical need to develop comprehensive rehabilitation strategies that can improve gait performance and functional mobility in this population. [3]

Backward walking training (BWT) has emerged as a promising rehabilitation approach for improving gait and functional mobility in adults with chronic stroke (≥ 6 months post-stroke). [5] Because backward walking requires greater neuromuscular coordination and enhanced postural control compared to forward walking, it may improve balance, walking speed, stride characteristics, and functional walking ability in individuals with stroke. [7] Physiologic studies demonstrate that BWT activates trunk, hip, and knee stability muscles to a greater extent than forward walking, creating greater neuromuscular demands and improved gait symmetry. [7]

From a neurological perspective, BWT may facilitate motor control by alleviating maladaptive flexor-synergy gait patterns typical after brain injury. [2] Assessment of backward walking may also serve as a sensitive clinical measure of mobility and fall risk in post-stroke individuals, with evidence suggesting its value for detecting residual gait and balance impairments not revealed by standard forward walking assessment. [6] Recent meta-analytic evidence indicates that BWT improves balance performance and walking speed, and has been recommended as a supplemental tool with conventional training for improving walking outcomes in stroke patients. [5]

Multiple standardized outcome measures have been used to evaluate gait, balance and functional mobility following backward walking training, including the Berg Balance Scale (BBS) for balance assessment, Timed Up and Go (TUG) test for dynamic balance

and mobility, 10-Meter Walk Test (10MWT) for gait speed walking capacity such as stride length, step length, and cadence. [7] However, considerable heterogeneity exists in how these measures are reported across studies examining backward walking training effectiveness in stroke populations. [11]

Despite promising preliminary evidence, critical research gaps remain regarding whether baseline impairment severity differentially impacts gait and functional mobility outcomes following backward walking training.[3] Therefore, a comprehensive review of the existing literature is essential to synthesize evidence regarding backward walking training's effectiveness on gait parameters (walking speed, stride length, step length, cadence), balance (Berg Balance Scale, Timed Up and Go), and functional mobility (10-Meter Walk Test) in middle-aged adults with chronic stroke (≥ 6 months post-stroke) and to provide evidence-based guidance for clinical practice.

AIM: To review the effectiveness of backward walking training on gait, balance, and functional mobility in middle-aged adults with chronic stroke.

LITERATURE REVIEW

Naidu et al. (2025)

Naidu et al. (2025) conducted a single-center pilot randomized controlled trial to evaluate the impact of backward and forward locomotor treadmill training on chronic stroke survivors who had significant walking difficulties after their stroke. A total of 14 individuals with severe walking impairment—defined as a self-selected walking speed of less than or equal to 0.4 meters per second—were divided into two groups: one received backward locomotor treadmill training (BLTT) and the other received forward locomotor treadmill training (FLTT). Each participant completed 12 training sessions with increasing speeds, adjusted according to their comfort and safety

levels. The study measured walking speed, step length symmetry, single support time symmetry, and performance on the 3-Meter Timed Up and Go test. The results showed that both groups experienced improved gait symmetry, walking speed, and functional mobility, though individual improvements varied in extent. The authors concluded that backward locomotor treadmill training is a safe and effective intervention for people with severe chronic stroke, potentially improving gait performance and functional mobility.

Menezes et al. (2024)

Menezes et al. (2024) performed a systematic review and meta-analysis to compare the effects of backward walking training with forward walking training in middle aged adults with stroke. The review included randomized controlled trials that evaluated walking speed, cadence, and stride length. The findings demonstrated that backward walking training was equally effective or slightly superior to forward walking training in improving walking speed. However, adding backward walking to conventional forward walking resulted in only minimal additional improvements. The authors concluded that backward walking training is an effective intervention for improving gait performance after stroke and recommended further large-scale randomized controlled trials to strengthen the available evidence (Menezes et al., 2024).

Kalyana et al. (2023)

Kalyana et al. (2023) conducted a randomized controlled trial to examine the effectiveness of backward walking training combined with conventional physiotherapy in individuals with stroke. Forty participants were randomly assigned to either an experimental group, which received backward walking training along with conventional therapy, or a control group that received conventional therapy alone. Balance and functional outcomes were assessed using the Berg Balance Scale and the Barthel Index. The study reported significantly greater improvements in

balance and functional independence among participants who received backward walking training. The authors concluded that incorporating backward walking into conventional stroke rehabilitation can effectively enhance balance and functional recovery (Kalyana et al., 2023).

Awosika et al. (2022)

Awosika et al. (2022) carried out a prospective cohort study to examine the impact of serial backward locomotor treadmill training on bidirectional walking performance in chronic stroke survivors. Thirty-nine participants completed six sessions of backward locomotor treadmill training on an instrumented motorized treadmill, with speed gradually increasing. The study evaluated backward walking speed, step length for both the affected and unaffected legs, forward walking speed, and gait symmetry. The findings indicated improvements in both backward and forward walking, including increased speed, better step characteristics, and improved gait symmetry after the training. The authors concluded that backward locomotor treadmill training leads to enhanced gait performance in both directions, suggesting that improvements from backward training can transfer to forward walking.

Wen and Wang (2022)

Wen and Wang (2022) performed a meta-analysis to assess the effectiveness of backward walking training in stroke patients. The study looked at several outcomes, including Berg Balance Scale scores, gait symmetry, gait cycle, stride length, step length, and walking speed. When compared to traditional therapy, the pooled results showed that backward walking training significantly improved gait speed, balance, stride length, gait symmetry, and functional walking performance. The authors concluded that backward walking training is a valuable addition to traditional therapy for improving gait and balance in stroke patients.

Awosika et al. (2022)

Awosika conducted a secondary analysis to explore how backward locomotor treadmill training affects walking performance across different levels of stroke-related walking impairment. The study included 39 chronic stroke survivors, divided into two groups: those with mild-to-moderate impairment ($n = 28$) and those with severe impairment ($n = 11$). All participants underwent six sessions of backward locomotor treadmill training with progressively increasing speeds. The study measured walking speed, stride length, step length, and gait symmetry. Results showed clinically meaningful improvements in walking speed and step characteristics in both groups. Participants with severe baseline walking impairment experienced significant functional gains. The authors concluded that backward locomotor treadmill training is an effective intervention for improving walking performance, even in those with severe residual walking impairment, regardless of stroke severity.

Chang et al. (2021)

Chang investigated the effects of backward treadmill walking on functional outcomes, walking speed, and balance in patients with chronic stroke through a pilot randomized controlled trial. Over a four-week period, the experimental group ($n = 8$) received backward walking training on an inclined treadmill alongside conventional physical therapy, while the control group ($n = 8$) only received conventional therapy. The study assessed the Berg Balance Scale (BBS), the 10-Meter Walk Test (10MWT), gait performance, functional mobility, and pulmonary function. The backward walking group performed significantly better than the control group in terms of balance, walking speed, and functional mobility. The authors concluded that backward walking training is a simple and beneficial supplementary intervention that can be incorporated into traditional stroke rehabilitation to enhance balance, gait performance, and functional mobility.

Moon and Bae (2021)

Moon and Bae (2021) conducted a meta-analysis to evaluate the effectiveness of backward walking training in stroke patients. The study measured outcomes such as Berg Balance Scale scores, gait symmetry, gait cycle, stride length, step length, and walking speed. When compared to traditional therapy, the pooled results demonstrated that backward walking training significantly improved gait speed, balance, stride length, gait symmetry, and functional walking performance. The authors concluded that backward walking training is a valuable addition to traditional stroke rehabilitation for enhancing both gait and balance.

Chen et al. (2020)

Chen et al. (2020) reviewed the effectiveness of backward walking training in stroke patients through a systematic review and meta-analysis. The review included ten randomized controlled trials involving 255 participants, predominantly middle-aged adults who had experienced a stroke. The study measured various outcomes, including gait velocity, cadence, stride length, paretic step length, gait symmetry, Berg Balance Scale, Timed Up and Go Test, and walking performance. When compared to traditional rehabilitation, the pooled results indicated that backward walking training significantly increased gait speed, cadence, paretic step length, balance, and functional walking ability. However, there was no noticeable improvement in gait symmetry. The authors concluded that backward walking training is a useful addition to traditional stroke rehabilitation for enhancing balance and gait, but more high-quality randomized controlled trials are needed to support the findings.

MATERIALS & METHODS

The present study was conducted as a narrative literature review to evaluate the effectiveness of backward walking training on gait, balance, and functional mobility in middle-aged adults with chronic stroke. Relevant studies were identified through a comprehensive search of electronic

databases, including PubMed, Google Scholar, PEDro (Physiotherapy Evidence Database), ScienceDirect, Cochrane Library, and PubMed Central (PMC). The search was performed using the keywords backward walking training, backward walking, retro walking, stroke rehabilitation, chronic stroke, gait training, balance, and functional mobility, either individually or in combination. Studies were included if they involved middle-aged adults with chronic stroke (≥ 6 months post-stroke), evaluated backward walking training as the primary intervention, assessed gait, balance, or functional mobility using standardized outcome measures, and were published in English between 2020 and 2025. Randomized controlled trials, prospective studies, systematic reviews, and meta-analyses were considered for inclusion. Studies involving acute or subacute stroke, pediatric populations, case reports, conference abstracts, editorials, narrative reviews, studies focusing primarily on upper-limb function or cognition, and those lacking standardized outcome measures related to gait, balance, or functional mobility were excluded. A total of nine eligible studies meeting the inclusion criteria were selected, and relevant information regarding study design, participant characteristics, interventions, outcome measures, and key findings was extracted and qualitatively synthesized.

RESULT

A total of nine studies published between 2020 and 2025 met the inclusion criteria and were included in this narrative review. The selected studies comprised randomized controlled trials, prospective cohort studies, systematic reviews, and meta-analyses that evaluated the effectiveness of backward walking training in middle-aged adults with chronic stroke. [2] Overall, the findings consistently demonstrated that backward walking training, when combined with conventional rehabilitation, has a positive effect on gait, balance, and functional mobility. [3]

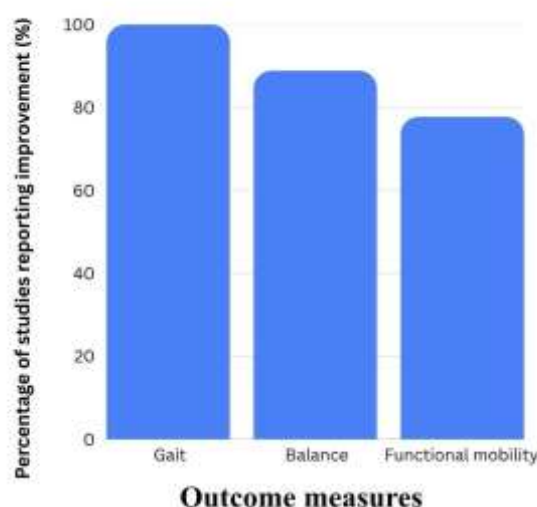
Improvement in gait performance was the most consistent outcome reported across the included studies. [4] Most studies demonstrated significant increases in gait speed, stride length, and step length following backward walking training. [5] Improvements in gait symmetry and weight-bearing on the affected limb were also observed, indicating enhanced walking mechanics and more symmetrical gait patterns. [6]

Balance outcomes showed consistent improvement, with several studies reporting higher Berg Balance Scale scores along with better static and dynamic postural control. [8] Improved weight distribution on the affected limb and enhanced postural stability were also observed following backward walking training. [9] The systematic reviews and meta-analyses further supported these findings by demonstrating overall

improvements in gait speed, balance, and gait performance across multiple randomized controlled trials. [10]

Functional mobility also improved following backward walking training. [1] Studies using outcome measures such as the Timed Up and Go Test and walking performance assessments reported significant improvements in functional mobility. [2] Furthermore, individuals with severe walking impairment demonstrated meaningful functional gains, suggesting that backward walking training is beneficial across different levels of disability. [11]

Overall, the available evidence indicates that backward walking training is an effective adjunct to conventional rehabilitation for improving gait, balance, and functional mobility in middle-aged adults with chronic stroke. [4]



Graph 1- Effectiveness of Backward Walking Training on Clinical Outcomes in Chronic Stroke (n=9)

DISCUSSION

The findings of the present review indicate that backward walking training is a useful addition to conventional rehabilitation for improving gait and functional mobility in middle-aged adults with chronic stroke. [5] Most of the included studies reported improvements in walking speed, balance, stride length, and gait symmetry following backward walking training. [4]

The positive effects observed may be related to the greater neuromuscular demands of backward walking. [7] Compared with forward walking, backward walking requires increased balance control, proprioceptive input, postural stability, and coordinated activation of the lower-limb muscles. [10] These factors may promote motor relearning and improve overall walking performance in middle-aged adults with chronic stroke. [9]

Another important finding was the improvement in balance. [2] Since backward walking is performed with limited visual feedback, individuals rely more on proprioceptive and vestibular inputs to maintain stability. [6] This may explain the consistent improvements in balance and weight-bearing symmetry reported in several studies. [3] Improved balance is clinically important because it contributes to safer mobility and may reduce the risk of falls in middle-aged stroke survivors. [11]

Studies by Awosika et al. (2022) and Naidu et al. (2025) reported functional improvements in participants with marked gait limitations, indicating that backward walking training can be incorporated into rehabilitation across different levels of stroke severity. [2]

Despite these encouraging findings, certain limitations should be considered. [12] Most studies included relatively small sample sizes, and there were differences in training duration, exercise intensity, intervention protocols, and outcome measures. [5] These variations make direct comparison between studies difficult. [11] In addition, most studies evaluated only short-term outcomes, making it difficult to determine whether the improvements are maintained over the long term. Therefore, further well-designed randomized controlled trials involving middle-aged adults with chronic stroke are needed to establish standardized clinical guidelines.

CONCLUSION

Based on the available evidence, backward walking training appears to be an effective supplementary intervention for improving gait, balance, and functional mobility in middle-aged adults with chronic stroke. The reviewed studies consistently reported improvements in gait speed, stride length, step length, gait symmetry, balance, and overall walking performance when backward walking training was combined with conventional rehabilitation.

Although the current evidence is promising, variations in intervention protocols and

relatively small sample sizes limit the strength of the available evidence. Further high-quality randomized controlled trials involving middle-aged adults with chronic stroke, using standardized training protocols and longer follow-up periods, are required to establish clear clinical guidelines. Therefore, backward walking training may be incorporated as an evidence-based adjunct to conventional physiotherapy for improving gait, balance, and functional mobility in adults with chronic stroke.

Declaration by Authors

Ethical Approval: The present research work does not contain any studies performed on animals or human subjects by any of the authors.

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