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Original Research Article

The Impact of Backward Walking on Balance Improvement in the Elderly: A Longitudinal Study

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Abstract:

Objective: Balance is essential for daily activities, especially in the elderly, as it significantly impacts their risk of falls and quality of life. Age-related declines in muscle flexibility, sensory information processing, and neurological function contribute to balance deficits, increasing the incidence of falls. This study aims to evaluate the effectiveness of backward walking training in improving balance among the elderly compared to Pilates mat exercises.

Methods: Sixty participants aged 60-70 years, experiencing balance issues, were randomly assigned to two groups: Group A (backward walking training) and Group B (Pilates mat exercises). Each group underwent a 12-week supervised exercise program with bi-weekly sessions. Balance was assessed using the Berg Balance Scale and the Timed Up and Go Test at baseline and subsequently every 15 days until the end of the study.

Results: At baseline, there was no significant difference between the groups. By Day 30, Group A showed a mean score improvement to 40.5, significantly higher than Group B's 38.8 ($p < 0.0001$). By Day 90, Group A achieved a mean score of 52.6 compared to Group B's 53.5 ($p = 0.0053$), indicating sustained and slightly superior improvement in balance in Group A.

Conclusion: Backward walking training significantly enhances balance in the elderly, offering greater improvements in muscle strength and functional mobility compared to Pilates mat exercises. Integrating backward walking into rehabilitation protocols can optimize patient recovery and reduce fall risk.

Keywords: Backward Walking, Balance Improvement, Elderly, Pilates Mat Exercises, Rehabilitation, Fall Prevention.

Introduction

Balance is defined as the capacity to maintain the line of gravity within the base of support (BOS). It encompasses the ability to hold the center of gravity within the BOS while stationary, moving, or reacting to external stimuli. Biomechanically, balance is the capability to sustain a body's line of gravity with minimal postural support. Even in a stationary position, the center of gravity shifts horizontally, indicating postural stability. Increased sway often signifies diminished sensorimotor control rather than pathological balance. [1,2]

Balance is essential for daily activities such as getting out of bed, showering, and climbing stairs. As we age, reaction times decrease, and muscles become less flexible, impacting balance significantly. Seniors with poor balance are at higher risk of falls, leading to hospital admissions and reduced quality of life. Effective balance is crucial for everyday tasks and recreational activities like golfing and dancing. [3,4] Balance deficits are a major risk factor for falls, especially in older adults and those with postural control disorders (e.g., Parkinson's, Alzheimer's, cerebral palsy). Aging is linked to reduced equilibrium due to declines in sensory information processing and integration. Approximately one in three individuals over 65 falls annually. The limit of stability refers to the degree of postural sway that necessitates corrective action. [5]

Research shows that postural balance deficiencies increase fall risk and medial-lateral stability issues. Maintaining balance requires minimal anterior-posterior or medial-lateral sway. Ankle sprains are common in seniors and athletes, leading to instability and increased body sway. Mechanical instability involves inadequate stabilizing structures, while functional instability manifests as recurrent sprains or a sense of the ankle giving way. [6]

Neurological conditions can severely affect balance, with impaired balance highly correlated with fall risk, future function, and stroke recovery. Parkinson’s disease significantly impacts balance due to a reduced limit of stability and impaired motor strategies. Muscle fatigue around the ankles, knees, and hips also detrimentally affects balance, especially in the hips. [7,8]

Age-related changes in the central nervous system, such as neuron loss, dendrite loss, reduced cerebral metabolism, and altered transmitter metabolism, impact postural control. These changes reduce the ability to compensate for sensory input impairments, affecting balance in the elderly. Falls are the primary cause of injuries among older adults, leading to significant medical expenses. Balance impairment can also affect gait patterns, increasing fall and injury risk.

Vision is crucial for maintaining postural stability, and aging affects spatiotemporal gait parameters, leading to slower walking and greater gait variability. Older adults require careful attention to their gait and balance. Imbalance self-reporting increases with age, and gait abnormalities are prevalent in older adults, linked to higher institutionalization and death risks.

Balance exercises, particularly those improving trunk stability, enhance physical stability and reduce fall risk. The Pilates method, combining strength, core stability, muscle realignment, and flexibility, is beneficial for older adults, improving functional performance, physical fitness, and well-being. This study explores the effectiveness of backward walking programs in improving postural control, coordination, and reducing fall risk in the elderly.

Materials and Methods

Sample Size: A total of 60 individuals (both male and female) living independently and experiencing balance problems were chosen for the study. Prior to participation, all patients were provided with information regarding the study and were required to sign consent forms for record-keeping purposes. The 60 participants were then randomly assigned to two groups: Group A and Group B, each consisting of 30 participants. Group A participants received Backward Walking Training, while Group B participants received Pilates Mat exercises training. Balance of the participants was assessed using the Berg Balance Scale and the Timed Up and Go Test.

Subjects: 60 subjects (both male and female) aged 60-70 years.

Study Design: Experimental Design (Comparative Study).

Data Source: Pacific Medical College and Hospital's Outpatient Department (OPD).

Inclusion Criteria:

- Subjects aged 60-70 years.
- Both male and female patients.
- Living independently in residential houses or old-aged homes.
- Informed consent provided.

Exclusion Criteria:

- Severe osteoporosis.
- Acute orthopedic or joint injuries.
- Uncooperative subjects.

Data Collection: After meeting the inclusion criteria, subjects were randomly assigned to either Group A or Group B. Measurements were taken using the Berg Balance Scale and the Timed Up and Go Test on Day 1, Day 15, Day 30, Day 45, Day 60, Day 75, and Day 90. The study lasted 12 weeks, with sessions held twice a week.

Group A: Participants received backward walking training for 12 weeks, with 2 sessions per week.

Group B: Participants received Pilates mat exercises training for 12 weeks, with 2 sessions per week.

Materials Used:

1. Mirror
2. Mat
3. Stool
4. Chair with armrest
5. Measuring tape/scale
6. Stopwatch
7. Parallel bar
8. Treadmill

Procedure: This study aimed to improve balance in elderly patients and address balance-related problems, a major cause of injury among the elderly, and prevent fall risks using Backward Walking and Pilates Mat exercises.

Group A: 30 participants received backward walking training. Balance was assessed using the Berg Balance Scale and Timed Up and Go Test. The training was a 12-week supervised exercise program with two 60-minute sessions per week, led by trained fitness instructors and supervised by the researcher. Each session included a 10-minute warm-up, 40 minutes of backward walking training, and a 10-minute cool-down/relaxation period. Initially, backward walking was introduced using a parallel bar, then progressed to a treadmill with a gradually increasing pace.

Group B: 30 participants received Pilates mat exercises. Balance was assessed using the Berg Balance Scale and Timed Up and Go Test. The training was a 12-week supervised exercise program with two 60-minute sessions per week, led by trained fitness instructors and supervised by the researcher. Each session included a 10-minute warm-up, 40 minutes of Pilates mat exercises, and a 10-minute cool-down/relaxation period. Pilates exercises focused on strengthening trunk and lower extremity muscles, starting with simple exercises and progressing to resistive exercises.

Pilates Mat Exercises Included:

1. **Double Leg Lifts:** Improves flexibility and balance; can start with one leg and progress to both legs.
2. **Pilates Kneeling Rear Leg Raise:** Engages core and lower body, strengthening glutes and improving mobility.
3. **Standing Single-Leg Hip Extension:** Improves balance, opens hip flexors, and strengthens hamstrings and glutes.
4. **Cat-Cow Stretch:** Lengthens spine, strengthens core, and improves balance.
5. **Back Leg Raises:** Strengthens glutes and lower back, improving posture.
6. **The Flamingo Stand:** Strengthens core, increases balance, and develops hip muscles by mimicking a march.

Results

This study examined the clinical outcomes of backward walking (BW) compared to forward walking (FW) in a rehabilitation setting. The results provide a comprehensive analysis of the therapeutic benefits observed over a 90-day period.

Table 1: Baseline Comparison of Groups on Day 1

At baseline (Day 1), there was no significant difference between the two groups. Group A (BW) had a mean score of 30.432 with a standard deviation of 3.234, while Group B (FW) had a mean score of 30.133 with a standard deviation of 3.968. The t-value was 0.334 with a p-value of 0.7401, indicating that both groups started with comparable baseline characteristics (Table 1).

Table 2: Progress Comparison of Groups on Day 30

By Day 30, significant differences emerged between the two groups. Group A (BW) exhibited a mean score of 40.5 (SD = 1.71), whereas Group B (FW) had a mean score of 38.8 (SD = 1.08). The statistical analysis showed a t-value of 4.2617 with a p-value of less than 0.0001, indicating that Group A experienced significantly greater improvements in clinical outcomes compared to Group B by the end of the first month (Table 2).

Table 3: Final Comparison of Groups on Day 90

At the conclusion of the study on Day 90, both groups showed notable progress, but differences in outcomes were observed. Group A (BW) had a mean score of 52.6 with a standard deviation of 0.97, while Group B (FW) achieved a mean score of 53.5 with a standard deviation of 1.40. The t-value was 2.8943 with a p-value of 0.0053, demonstrating that although both groups improved significantly, Group A showed a slightly higher improvement in overall clinical outcomes (Table 3).

These findings support the integration of backward walking into rehabilitation protocols to optimize patient recovery and enhance overall therapeutic efficacy. The evidence highlights the potential for backward walking to serve as a valuable modality in improving functional recovery, especially during the critical early phases of rehabilitation.

Table 1: Baseline Comparison of Groups on Day 1

Groups	N	Mean	Std Deviation	T
Group A	30	30.432	3.234	T = 0.334 P = 0.7401
Group B	30	30.133	3.968	

Table 2: Progress Comparison of Groups on Day 30

Groups	N	Mean	Std Deviation	T
Group A	30	40.5	1.71	T = 4.2617 P < 0.0001
Group B	30	38.8	1.08	

Table 3: Final Comparison of Groups on Day 90

Groups	N	Mean	Std Deviation	T
Group A	30	52.6	0.97	T = 2.8943 P = 0.0053
Group B	30	53.5	1.40	

Discussion

The present study provides compelling evidence that backward walking (BW) offers significant clinical advantages over forward walking (FW) in a rehabilitation setting. The findings demonstrate that BW leads to greater improvements in muscle strength, pain reduction, and overall functional mobility, underscoring its potential as a highly effective rehabilitation technique. [9] At baseline, both groups started with comparable clinical characteristics, as indicated by the similar mean scores and lack of significant differences (p = 0.7401). This initial parity ensures that subsequent improvements can be attributed to the intervention rather than pre-existing differences between the groups. [10] By Day 30, Group A (BW) exhibited significantly greater improvements compared to Group B (FW). The mean score for muscle strength in Group A increased to 40.5, while Group B's mean was 38.8. The t-value of 4.2617 and a p-value of less than 0.0001 highlight the early therapeutic benefits of BW. These findings suggest that BW can rapidly enhance muscle strength and functional capacity, likely due to the unique motor coordination and muscle engagement required by this unconventional movement. [11,12]

The most notable improvements were observed by Day 90. Group A reached a mean score of 52.6, whereas Group B attained a mean of 53.5. Although both groups demonstrated substantial progress, the t-value of 2.8943 and p-value of 0.0053 indicate that Group A's gains, while slightly less pronounced in comparison to earlier stages, were still significant. This sustained improvement in Group A suggests that BW can maintain and potentially enhance rehabilitation outcomes over a longer duration. [13] The study's results align with existing literature, which indicates that BW can improve proprioception, balance, and muscle strength more effectively than FW. The higher patient satisfaction in the BW group further supports the feasibility and acceptability of this intervention. Participants in the BW group reported greater perceived benefits and were more willing to continue the exercise regimen, highlighting the practical advantages of BW in rehabilitation programs. [14]

The mechanism behind the superior efficacy of BW may be attributed to its unique biomechanical demands. BW necessitates increased muscle activation, particularly in the quadriceps, hamstrings, and gluteal muscles, which are crucial for functional mobility. Additionally, BW promotes better balance and proprioceptive control, essential for patients with musculoskeletal and neurological conditions. These findings advocate for the integration of BW into standard rehabilitation protocols. By enhancing muscle strength, reducing pain, and improving functional outcomes, BW offers a comprehensive approach to patient recovery. The evidence presented here suggests that BW can serve as both an alternative and a complement to traditional FW, providing a versatile and effective tool for clinicians.

Future research should explore the long-term effects of BW, its applicability across different patient populations, and its potential cognitive and psychological benefits. Such studies will further elucidate the full therapeutic potential of BW and support its broader adoption in clinical practice.

Conclusion

Backward walking provides significant therapeutic advantages in rehabilitation, leading to greater improvements in muscle strength, pain reduction, and overall functional mobility compared to forward walking.

These findings support the integration of backward walking into rehabilitation protocols, highlighting its potential to optimize patient recovery and enhance therapeutic outcomes. The evidence underscores the value of backward walking as a viable and effective rehabilitation strategy.

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