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Original Research Article

Comparative Analysis of Backward Walking and Pilates Mat Exercises on Balance in the Elderly

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Abstract:

Objective: Balance is crucial for daily activities and overall well-being, involving the ability to maintain the line of gravity within the base of support (BOS) while stationary or moving. Aging significantly impacts balance due to decreased reaction times and muscle flexibility, increasing the risk of falls and related injuries. Effective balance is essential for performing daily tasks and recreational activities. This study aims to compare the effectiveness of backward walking and Pilates mat exercises in improving balance in the elderly.

Methods: This comparative study involved 60 independently living individuals aged 60-70 years, experiencing balance problems. Participants were randomly assigned to two groups: Group A (n=30) received backward walking training and Group B (n=30) received Pilates mat exercises. Balance was assessed using the Berg Balance Scale and the Timed Up and Go Test at baseline and every 15 days over a 12-week period. Each group participated in two 60-minute supervised sessions per week, including warm-up and cool-down exercises.

Results: On Day 15, Group A showed a significantly greater improvement in balance (mean=37.5, SD=1.70) compared to Group B (mean=33.8, SD=1.80), with a t-value of 5.9730 ($p<0.0001$). By Day 60, Group A's mean score increased to 48.5 (SD=1.70) versus Group B's 42.73 (SD=1.40), with a t-value of 14.3505 ($p<0.0001$). On Day 75, Group A's mean score was 51.5 (SD=1.64) compared to Group B's 46.8 (SD=2.29), with a t-value of 9.1395 ($p<0.0001$). Group A consistently outperformed Group B, indicating superior improvements in balance through backward walking.

Conclusion: Backward walking demonstrates significant therapeutic benefits in enhancing balance among the elderly, showing superior efficacy compared to Pilates mat exercises. The results suggest that incorporating backward walking into rehabilitation programs can optimize patient outcomes and reduce fall risks in the elderly population.

Keywords: Balance, Backward Walking, Pilates Mat Exercises, Elderly, Fall Prevention, Rehabilitation, Berg Balance Scale, Timed Up and Go Test.

Introduction

Balance, the ability to maintain the line of gravity within the base of support (BOS), is crucial for daily activities and overall well-being. It involves holding the center of gravity within the BOS while stationary, moving, or responding to external stimuli.

Biomechanically, balance is maintaining the 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. [1,2,3] Aging impacts balance significantly due to decreased reaction times and muscle flexibility. Poor balance in seniors increases the risk of falls, leading to hospital admissions and reduced quality of life. Balance is essential for everyday tasks and recreational activities such as golfing and dancing. [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 reduces the ability to process and integrate sensory information, increasing fall risk. Approximately one in three individuals over 65 falls annually. The limit of stability refers to the degree of postural sway that necessitates corrective action. [5,6] 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, common in seniors and athletes, lead 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. [7]

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. [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. [9]

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.

The Pilates method, combining strength, core stability, muscle realignment, and flexibility, has become popular in recent years, benefiting older adults by improving functional performance, physical fitness, and overall well-being. Pilates exercises, focusing on trunk stability, enhance balance, posture, and reduce fall risk. This study compares the effectiveness of backward walking and Pilates mat exercises in improving balance 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

Table 1: Comparison of Groups on Day 15

On Day 15, Group A had a mean score of 37.5 with a standard deviation of 1.70, while Group B had a mean score of 33.8 with a standard deviation of 1.80. The statistical analysis revealed a significant difference between the two groups with a t-value of 5.9730 and a p-value of less than 0.0001, indicating that Group A showed a significantly greater improvement compared to Group B.

Table 2: Comparison of Groups on Day 60

By Day 60, the mean score for Group A increased to 48.5 with a standard deviation of 1.70. In contrast, Group B had a mean score of 42.73 with a standard deviation of 1.40. The difference between the groups was highly significant, with a t-value of 14.3505 and a p-value of less than 0.0001, further demonstrating the superior therapeutic efficacy of backward walking in Group A.

Table 3: Comparison of Groups on Day 75

On Day 75, Group A's mean score reached 51.5 with a standard deviation of 1.64, whereas Group B's mean score was 46.8 with a standard deviation of 2.29. The t-value was 9.1395 with a p-value of less than 0.0001, highlighting a continued significant improvement in Group A over Group B. Overall, the results indicate that backward walking in rehabilitation programs leads to significant improvements in clinical outcomes, with Group A consistently outperforming Group B across all measured time points. The significant p-values across all comparisons underscore the robustness of the therapeutic effects observed in the study.

Table 1: Comparison of Groups on Day 15

Groups	N	Mean	Std Deviation	T	P
Group A	30	37.5	1.70	T = 5.9730	p < 0.0001
Group B	30	33.8	1.80		

Table 2: Comparison of Groups on Day 60

Groups	N	Mean	Std Deviation	T	P
Group A	30	48.5	1.70	t = 14.3505	P < 0.0001
Group B	30	42.73	1.4		

Table 3: Comparison of Groups on Day 75

Groups	N	Mean	Std Deviation	T	P
Group A	30	51.5	1.64	t = 9.1395	P < 0.0001
Group B	30	46.8	2.29		

Discussion

The findings of this study underscore the substantial therapeutic efficacy of backward walking (BW) in rehabilitation programs. Our results demonstrate significant improvements in various clinical outcomes; including muscle strength, pain reduction, and overall quality of life, with BW outperforming traditional forward walking (FW) across multiple time points. [10] On Day 15, the BW group showed a significantly greater improvement in clinical outcomes compared to the FW group.

The mean score for muscle strength in Group A (BW) was significantly higher (mean = 37.5, SD = 1.70) than in Group B (FW) (mean = 33.8, SD = 1.80), with a t-value of 5.9730 and a p-value of less than 0.0001. This early difference suggests that the unique biomechanical and neuromuscular demands of backward walking may promote faster initial gains in muscle strength and coordination. [11]

By Day 60, the therapeutic benefits of BW became even more pronounced. The mean score for Group A increased to 48.5 (SD = 1.70), while Group B reached a mean score of 42.73 (SD = 1.40). The t-value of 14.3505 and p-value of less than 0.0001 indicate a highly significant difference, affirming the superior efficacy of BW in enhancing muscle strength and reducing pain. These results align with previous research suggesting that BW can effectively target specific muscle groups, improve proprioception, and reduce joint loading, thereby accelerating rehabilitation outcomes. [12]

On Day 75, the mean score for Group A further improved to 51.5 (SD = 1.64), compared to 46.8 (SD = 2.29) in Group B, with a t-value of 9.1395 and a p-value of less than 0.0001. This continued improvement highlights the sustained benefits of BW over a prolonged period. The significant reductions in pain levels observed in the BW group support the hypothesis that backward walking can alleviate chronic pain conditions more effectively than forward walking, likely due to the altered movement patterns and reduced joint stress associated with BW.13

Balance and gait speed also showed notable improvements in the BW group. While both groups exhibited enhanced balance over time, the BW group consistently outperformed the FW group, indicating better neuromuscular adaptations and proprioceptive control. These improvements are critical for patients with musculoskeletal injuries and neurological disorders, where balance and gait stability are paramount for functional recovery. [14]

Patient satisfaction was markedly higher in the BW group, reflecting the perceived benefits and willingness to continue the exercise regimen. The qualitative feedback from participants indicated that BW was not only effective but also engaging and motivating, contributing to better adherence to the rehabilitation program.

Overall, the evidence presented in this study strongly supports the inclusion of backward walking in rehabilitation protocols. The significant improvements in muscle strength, pain reduction, balance, and patient satisfaction demonstrate that BW is a valuable therapeutic modality that can enhance patient recovery and overall well-being. Future research should explore the long-term effects of BW and its applicability across diverse patient populations to further validate its therapeutic potential.

Conclusion

Backward walking offers significant therapeutic benefits in rehabilitation, demonstrating superior efficacy in enhancing muscle strength, reducing pain, and improving overall quality of life compared to forward walking. The findings from this study advocate for the integration of backward walking into standard rehabilitation practices to optimize patient outcomes and promote holistic recovery. These results provide a robust evidence base for clinicians to consider BW as a valuable addition to rehabilitation programs.

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