JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Effects of Pilates Training on Balance, Gait speed and Fear of Fall in Older Adults with Low Back Pain: A Randomized Controlled Trial

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ABSTRACT:

Background and Purpose- Low back pain (LBP) in older persons is associated with specific age-related vlnerabilities. Among those 60 years of age or older, low back pain (LBP) is a notable health concern that frequently results in impairment. Because of age-related physical and psychological changes, older persons are more vulnerable to the development of specific LBP conditions or chronic LBP, even though the majority of LBP cases in this population lack specific identifiable reasons and tend to resolve on their own. Pain is a common problem in the elderly population and has been identified as a major risk factor for falls in this population. Individuals suffering from Low Back Pain (LBP) experience poor balance, which is an essential component of daily tasks. Therefore, the purpose of this study is to identify the effect of Pilates training on fear of fall, balance and gait speed in older adult with low back pain.

Methods- 6O participants were included both male and female between 60 to 75 years of age. Divided into 2 groups, Pilate training group (n-30) and control group (n- 30). Experimental group will receive the intervention, i.e., the Pilates training in the form of 35-40 minutes of multicomponent exercise programme .The training session will commence with a 5 minutes warm-up session and end with a 5 minutes cool-down session. The total duration of the programme is 45-50 min and given 3 times/week over a period of 6 weeks. The control group receive the 'Fall Preventive Guidelines' handouts as control. Outcome measure include BBS, TUG, FES-I , VAS. They were recorded before treatment and 6 weeks after training.

Results- The average age of the enrolled participants was (Mean±SD): 66.38±4.16 years with a higher proportion of males, 37(61.70%) than females, 23(38.30%). The average (Mean±SD) body mass index of the participants was 26.62±2.28,(Table 1). The effect of Pilates training significantly improved balance (significant increase in Berg Balance Scale score, $p<0.01$), gait speed (significant decrease in time up and go rest, $p<0.01$), and fear of fall (significant decrease in Fall Efficacy Scale score, $p<0.01$) for both, Group A and Group B. Additionally, the pain assessed using the Visual Analogue Scale score significantly decreased for both groups (Group A and Group B). At the baseline, randomization of the participants to the intervention results in similar (non-significant) balance, gate speed, fear of fall and pain scores. However, a statistically significant increase in balance was observed for those given intervention (Group A, $p<0.01$), compared to controls (Group B). Moreover, a significant decrease in gait speed, fear of falls and pain was observed among those given Pilates training.

Conclusion- This study demonstrates that a 6-week Swiss ball-based Pilates programme improves older individuals' postural stability, gait, balance and pain when compared to a control group. Additionally, this study suggests that for persons over 65, Pilates training may be crucial in reducing the risk of falls and the injuries that follow.

Key word: Older adult ,Pilate training, balance , gait speed, fear of fall, pain

I.INTRODUCTION

Among those 60 years of age or older, low back pain (LBP) is a notable health concern that frequently results in impairment. Because of age-related physical and psychological changes, older persons are more vulnerable to the development of specific LBP conditions or chronic LBP, even though the majority of LBP cases in this population lack specific identifiable
reasons and tend to resolve on their own.[1]

Low back pain (LBP) in older persons is associated with specific age-related vulnerabilities. Seniors have lower pain thresholds and impaired endogenous pain modulation processing, which makes them more sensitive to pain than younger people.[2]

There is currently a lack of knowledge regarding the role that low back pain plays in age-related disability. While back pain is also common in older persons, most research on the condition has concentrated on younger and middle-aged groups. Estimates of the prevalence of back pain in older persons are quite variable. The prevalence was observed to be 24% among older women and 18% among older men in a research done in a rural area.[3]

Functional changes brought about by ageing include a decrease in muscle mass and strength, an increase in joint stiffness, and instability in posture. Ageing typically leads to incapacity when combined with ongoing medical issues. Among the group of chronic illnesses, low back pain in the elderly has the capacity to cause substantial disability. Chronic low back pain is typically classified according to how it feels, with nonspecific low back pain being the most common variety. Every year, at least one episode of low back pain affects about 36% of older adults.[4]

Back pain affects those 65 years of age and beyond at a prevalence of 12% to 42%, making it a significant predictor of health status and functional ability in the senior population. Low back pain (LBP) has been linked to a twofold increase in difficulties with activities of daily living as well as an increased risk of falling. Age-related declines in postural control may be exacerbated by the neurophysiological changes that episodic chronic low back pain (CLBP) might cause.[5] Pain is a common problem in the elderly population and has been identified as a major risk factor for falls in this population. Furthermore, research suggests that hip and/or lower back discomfort is associated with less than ideal performance on fall-related tests, like the one-leg standing and timed up-and-go tests. Moreover, postural sway in older persons has been linked to increased knee and/or foot pain.[6]

Individuals suffering from Low Back Pain (LBP) experience poor balance, which is an essential component of daily tasks. Effective horizontal and vertical balance management is necessary for many daily tasks. Reduced motor control is associated with impaired balance, which impacts a person's ability to maintain balance and body alignment when moving. According to earlier studies, people with low back pain (LBP) may have impaired motor control, which might worsen their balance and impair their ability to perform motor tasks.
Balance dysfunction in the ageing population is a result of reduced musculoskeletal function, loss of sensory components, and knowledge of normal ageing processes. Aging-related biologic al changes, like decreased mobility and physical inactivity, may make it harder for people to maintain their balance and raise their chance of falling. Recurrent falls are known to be independently correlated with lower back pain (LBP), especially in older women.[7]
Pilates exercises are a type of organised mind-body workouts designed to enhance posture, breathing, strength, flexibility, and core stability. These workouts are performed with equipment or on a mat.[8] Pilates is a well-liked fitness regimen that has recently gained popularity in the field of rehabilitative therapy. Pilates has been

shown in a comprehensive study to have beneficial effects on people with CLBP, including pain reduction and improved functional status.[9]

Pilates is more effective at relieving pain in people with persistent low back pain than basic treatments, according to comprehensive evaluations of RCTs . Pilates provides more short-term pain and functional ability improvement than standard therapy and exercise, according to another comprehensive evaluation.[10]

Although these studies demonstrated the immense effectiveness of Pilates training on gait speed, balance, fall risk and pain . It is observed that there is no exact dose response relationship between total training hours and effectiveness of intervention on balance outcomes. Therefore, the purpose of this study is to identify the effect of Pilates training on fear of fall, balance and gait speed in older adult with low back pain.

2.MATERIAL AND METHODOLOGY

Study Design

This study is Randomised control trial. Simple randomization is done using the 'coin flip method'. The heads of the coin is assigned to the experimental group and the tails is assigned to the control group. In a sequential pattern, one by one the participants were asked to flip the coin and show it to the assessor only, then assign them to their group based on the side of coin chosen. On this basis divided into 2 group. Pilate training group (n=30) and control group (n=30). The blinding of the participants to their assigned group is intended to minimise experiment contamination and promote unbiased participation in this study. All the participants will be provided a written consent form for their voluntary participation.

Subjects-

The sample size for this study is 60 subjects 30 in each group. The sample size was calculated with the help of following formulae. Effect size (ẟ) = 0.75. The inclusion criteria were determined as follows: 1. We consider both gender male or female 2. Age will be 60 to 75 years 3. Able to walk 4. Patient with low back pain 5. Individuals who voluntarily participated in the study. The exclusion criteria were defined as follows: 1. History of any musculoskeletal injury in lower extremity and trunk 2. History of any other neurological conditions 3.Alcohol and drug abuse 4. Presence of mental disorders 5. Individuals who participate in any other rehabilitation program or research study.

Intervention-

Potential participants (elderly 60-75 years; both, Males and Females) living autonomously or in community-dwelling facilities, were invited to attend an informational session where the content of the interventional study and its benefits was explained. The participants assigned to the experimental group were received the intervention, i.e., the Pilates training in the form of 35-40 minutes of multicomponent exercise programme .The training session commence with a 5 minutes warm-up session and end with a 5 minutes cool-down session, both focused on general flexibility training-mild stretching and relaxation for upper and lower extremities. The

Table 1:

PERIODS	EXERCISES	DURATION (min)	REPETITIONS	SETS
Warm up	General flexibility: relaxation, stretching, and breathing exercises	5 min		
Pilates Exercise Program	• Bridge: mobilize pelvis and spine, and strengthen gluteus, hamstring and gastrocnemius muscles.	30- 45min	Repetitions of 10 s with 1 min of recovery between repetitions	2
	• Roll up: Rolling Back Down/Up (knees extended and rolling forward.)		8- 10	2
	• Hamstring Stretch Variant (crossed legs)		8- 10	2
	• Hamstring Stretch (ball)		4	2
	• Leg Circle		3	2
	• One Leg Up and Down (with the ball)		3	2
	• Squatting with the ball on the wall		3	2
	• The Hundred (pumping arms and stretching legs)		3	2
	• Bridge with knees and feet supported		3	2
Cool- down	General flexibility	5 min		

[Table 1]

Fig: 1

total duration of the programme is about 45-50 min and that is given 3 times/week over a period of 6 weeks. The details of the whole training session with respect to the types of exercise and their administered dosage is provided in the Table 1 and Fig:1 given below. Exercise protocol decided on the basis of previous research.[11] The control group were receive the 'Fall Preventive Guidelines' handouts as control. The participants of this group is asked to read the handout carefully and implement the provided guidelines for upcoming 6 weeks into the various aspects of their daily activities and lifestyle. The contents of the handouts were explained to the participants on the day of distribution. Any query with respect to guidelines or individual concern were entertained and open to discussion anytime.

Outcome Measure

Time Up and Go test: The Time Up and Go test is administered to individuals who sit in a chair with their arms securely resting at their sides or on their laps (not on the armrests). With their hips positioned all the way to the back of the seat, the participants were sat correctly. The participant rises from the chair, moves three metres, turns around, goes back to the chair, and sits down as the test starts when the therapist says, "Go," and the timer starts. The stopwatch's recorded time equals the TUG score.[12]

Berg Balance Scale(BBS) : The Berg Balance Scale (BBS), a clinical evaluation instrument intended to quantify while an individual's static and dynamic balance, was used to examine the participants' balance. There were fourteen items in the survey, and responses were recorded using a five-point Likert scale. For each item, a score of four denoted the best performance, and a score of zero denoted the worst performance. The total score for all 14 elements was added up, yielding an overall scale score that ranged from zero to 56.[13]

Fall efficacy scale - International (FES-I)

Ten self-reported items make up the FES-I, a questionnaire designed to gauge individuals' level of anxiety about falling engaging in 16 daily activities. The FES-I includes doing the housework, putting on and taking off clothes, cooking, and taking a bath or shower. Each questionnaire topic assesses the respondent's fear of falling while engaging in different activities, and responses are graded on a 10-point scale from very uncertain to very confident. Higher scores indicate a greater anxiety of falling. The total score runs from 10 to 100. Concerns about falling are moderately and highly concerned when a score is between 50 and 70, respectively. [14]

Visual analogue scale (VAS):

VAS is measured along a horizontal line of 100 mm. The patient is told that "no pain" is represented by the left end of the scale, while "the most severe pain imaginable" is represented by the right. The patient is then asked to indicate on the line how much pain they are experiencing at the moment.[15]

3.STATISTICAL ANALYSIS

Statistical analysis was done using SPSS 25. Quantitative variables were reported as Mean±SD and gender was reported as frequency (%). The normality of the distribution was tested using the Shapiro-Wilk test. The effect of Pilates training on the variables with normal distribution was tested using a paired t-test and non-normal variables were tested using Wilcoxon Signed Ranks Test. The comparison of balance score, fear of fall score, gait speed and pain between group A (With Pilates training) and group B (Without Pilates training) was tested using 2-sample t test or Mann-Whitney U test wherever applicable. $p<0.05$ was considered statistically significant

4.RESULT

28 of the 88 volunteers were excluded from the study because they did not meet the inclusion criteria. The remaining 60 participants were randomly divided into 2 groups: PTG (n = 30) and CG (n = 30), Fig: 2. There was no statistical difference between the groups in terms of age, sex, education, height, and body mass index averages (P > .05). At baseline, the BBS, gait speed , FES and VAS scores of the groups were similar. The average age of the enrolled participants was (Mean±SD): 66.38±4.16 years with a higher proportion of males, 37(61.70%) than females, 23(38.30%). The average (Mean±SD) body mass index of the participants was 26.62±2.28. (Table 2) The effect of Pilates training significantly improved balance (significant increase in Berg Balance Scale score, $p<0.01$), gait speed (significant decrease in time up and go rest, $p<0.01$), and fear of fall (significant decrease in Fall Efficacy Scale score, $p<0.01$) for both, Group A and Group B. Additionally, the pain assessed using the Visual Analogue Scale score significantly decreased for both groups (Group A and Group B). [Table 3 and Table 4]

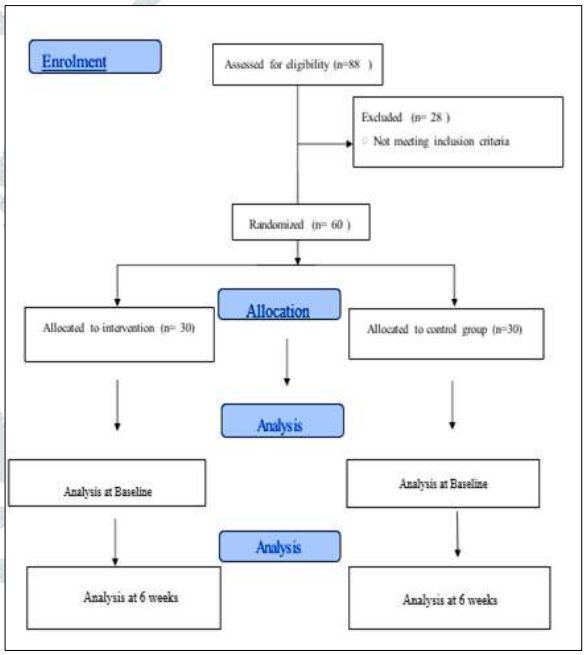

Fig:2

At the baseline, randomisation of the participants to the intervention results in similar (non-significant) balance, gate speed, fear of fall and pain scores. However, a statistically significant increase in balance was observed for those given intervention (Group A, $p<0.01$), compared to controls (Group B). Moreover, a significant decrease in gait speed, fear of falls and pain was observed among those given Pilates training. [Table 5 and fig: 3] For balance, on Berg balance scale Pilate training show significant improvement than control group , for gait speed, on Time Up and Go test Pilate training show significant improvement than control group, for Fear of fall on Fall efficacy scale- international Pilate training show significant improvement than control group and For Pain, on Visal analogue scale Pilate training show significant improvement than control group.

Table 2: Demographic characteristics of the study participants

	(N=60)
Age(in years), Mean±SD	66.38±4.16
Gender, n(%)	
Male	37(61.70)
Female	23(38.30)
Height (in cm), Mean±SD	161.55±6.53
Weight (in cm), Mean±SD	69.60±8.35
Body Mass Index (in Kg/m²), Mean±SD	26.62±2.28

The average age of the enrolled participants was (Mean±SD): 66.38±4.16 years with a higher proportion of males, 37(61.70%) than females, 23(38.30%). The average (Mean±SD) body mass index of the participants was 26.62±2.28

Table 3: The effect of Pilates training on balance, fear of falls, gait speed and pain among Group A participants

Group A	Pre-test	Post-test	P value
Berg Balance Scale (Mean±SD)	47.77±2.96	49.73±2.56	<0.01
Time up and go rest	16.38±3.96	14.58±2.80	<0.01
Fall Efficacy Scale-International	26.47±4.69	23.80±3.93	<0.01

Table 3 show that the effect of Pilates training significantly improved balance (significant increase in Berg Balance Scale score, p<0.01), gait speed (significant decrease in time up and go rest, p<0.01), and fear of fall (significant decrease in Fall Efficacy Scale score, p<0.01)

Table 4: The effect of Pilates training on balance, fear of falls, gait speed and pain among Group B participants

Group B	Pre-test	Post-test	P value
Berg Balance Scale (Mean±SD)	47.30±3.24	47.63±2.74	<0.01
Time up and go rest	17.08±3.88	16.86±3.83	<0.01
Fall Efficacy Scale-International (Mean±SD)	28.07±4.56	27.40±4.37	<0.01
Visual Analogue Scale (Mean±SD)	5.57±1.04	5.23±0.86	<0.01

Table 4 show that the effect of Pilates training significantly improved balance (significant increase in Berg Balance Scale score, p<0.01), gait speed (significant decrease in time up and go rest, p<0.01), and fear of fall (significant decrease in Fall Efficacy Scale score, p<0.01)

Table 5: Comparison Between group

Variables		Group A	Group B	Mean Difference (A-B)	P value
Berg Balance Scale (Mean±SD)	Pre-test	47.77±2.96	47.30±3.24	0.47	0.60
	Post-test	49.73±2.56	47.63±2.74	2.10	<0.01
Time up and go rest	Pre-test	16.38±3.96	17.08±3.88	-0.7	0.40
	Post-test	14.58±2.80	16.86±3.83	-2.28	0.02
Fall Efficacy Scale-International (Mean±SD)	Pre-test	26.47±4.69	28.07±4.56	-1.60	0.23
	Post-test	23.80±3.93	27.40±4.37	-3.60	<0.01
Visual Analogue Scale (Mean±SD)	Pre-test	5.90±1.03	5.57±1.04	0.33	0.22
	Post-test	4.17±1.02	5.23±0.86	-1.06	<0.01

Statistically significant increase in balance was observed for those given intervention (Group A, $p<0.01$), compared to controls (Group B). Moreover, a significant decrease in gait speed, fear of falls and pain was observed among those given Pilates training.

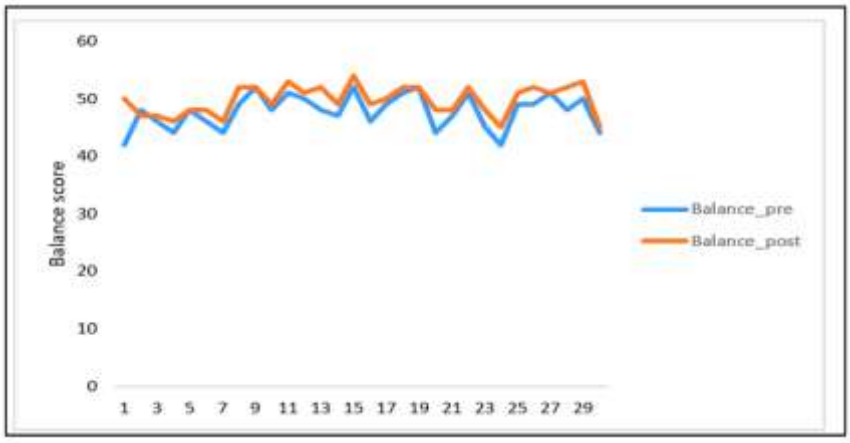

Fig 3: Balance score pre and post Pilates training group

5.DISCUSSION

The aim of this study was to assess the effect of Pilates exercises on balance, gait speed and fall risk in older adult with low back pain. The obtained results confirm the effectiveness of Pilates in improving balance, gait and minimizing fall risk and pain. Tatiana Sampaio et al., [Dec 2023] state that the present systematic review and meta-analysis highlight the potential benefits of Pilates training for improving balance in the senior population. With the goal of reducing the risk of falls and enhancing the functionality and quality of life of older individuals, these findings add to the body of research on Pilates instruction and the integration of interventional programmes into geriatric health and wellness efforts.[16]

Junzhen Huang et al., [March 2023] conclude that Pilates training is statistically considerably better in improving pain disability and outcome when compared to the least intervention, according to the findings of this systematic review and meta-analysis. This finding has practical implications. For those with CLBP, Pilates is a useful therapeutic approach. For individuals suffering from persistent low back pain, Pilates training may be a useful tactic for reducing pain and impairment.[17] Małgorzata Długosz-Boś et al., [April 2021] conclude that Pilates training increased the assessed women's mean velocity, stability limits, and surface area of the ellipse substantially.

Pilates training significantly increased the Modified Clinical Test of Sensory Interaction on Balance (m-CTSIB) outcomes with eyes closed on an unstable surface, which decreased fall risk in the studied women. Lower fall risk is crucial for daily functioning as it provides a sense of stability and flexibility of movement.[18] Various studies have indicated that performance on combined agility/dynamic balance tasks is a predictor of recurrent Falling , and physical exercise is an important factor in maintaining agility and balance .

In conclusion, the results of this study suggest that a Pilate training program is associated with significant improvements in balance , gair speed, pain and functional balance, and it can reduce the risk of falling in people aged 60 years and older. A 6-week proprioceptive training program, with 45minute sessions (3 days per week) leads to positive effects on balance . gait speed, pain and fear of fall in older adults. The current study is very unique in its type, so we can do a lot in future research. This study was conducted for a short period of time and with small sample size; future research involving long time period and larger sample size and comparing of two different interventions is also possible. The result of this study will help the physiotherapist to choose whether which intervention is best for the treatment of coordination in cerebral palsy patient.

There are several potential limitation to this study that must be considered. Firstly, the study was conducted at the community centre itself and not in a specialized rehabilitation environment. Next, the study was limited due to small sample size and shorter study duration and no any follow-up were taken after completion of treatment.

6.CONCLUSION

This study demonstrates that a 6-week Swiss ball-based Pilates programme improves older individuals' postural stability, gait, and balance when compared to a control group. Additionally, this study suggests that for persons over 65, Pilates training may be crucial in reducing the risk of falls and the injuries that follow. It is advised that individuals in this group perform consistent, long-term Pilates exercises to improve their gait and ability to balance. Evaluating balance could have a significant impact on the quality of rehabilitation services provided to older adults with postural balance issues, both in their home environment and in other settings.

7.ACKNOWLEDGMENT

The authors would like to thank the direction and staff members of Sanskriti university and old age home or retirement home for their collaboration in this study.

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