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Modified Pilates versus Conventional Balance on Gait Training Performance and Functional Status in Elderly

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ABSTRACT

Background: Aging correlates to declining balance and physical performance and a decrease in cognitive capabilities combined with the deterioration of muscle strength, coordination, and balance, leading to a high risk of falling. Physical exercise is an essential intervention to minimize the deleterious influences of aging.

Objective: The aim of the current study was to compare Pilates intervention (PI) and Conventional Balance Training (CBT) efficacy on gait training performance and functional status in the elderly.

Subjects and methods: A total of 60 patients, of both genders aged from 60 to 70 years old, were selected from the National Institute of Neuromotor Systems. After clinical assessment, participants were allocated into *Group A* (Study group): 30 patients followed the intervention with a modified Pilate exercise program for 12 weeks. *Group B* (Control group): 30 patients with the traditional CBT program for 12 weeks. Pre- and post-treatment data from both groups regarding muscle quality index (MQI), Time Up and Go test (Ligotti Assessment), and Tinetti assessment were statistically analyzed and compared.

Results: Our findings revealed a significant advancement in functional balance and quality of life (QOL) in the elderly bound in old age homes due to PI and CBT programs, which are more significant for PI than CBT.

Conclusion: PI combined with other physical activities can enhance functional results and QOL in the elderly, allowing them to age gracefully and have a high QOL. PI is revealed to be more beneficial than CBT intervention.

Keywords: Exercise movement technics, Traditional training, Geriatrics, Physical performance.

INTRODUCTION

Compared to younger adults, the elderlies are more likely to struggle with significant health problems due to the effects of aging, which include a degradation of the sensory systems and a modification in the pattern of muscle activation that leads to impaired balance. One of the most prevalent health concerns among the aged population is the risk of falling and the injuries that might result from falling. It has been determined that the primary contributors to poor balance and falls are declining sensory function (including vision, vestibular, and proprioception), motor function (including strength, coordination, and endurance), and integration (including response time and multitask capability) [1].

Falls lead to morbidity and mortality in the elderly, which can result in both broken bones and other forms of disability and also death. Physical health, mental health, and socioeconomic status could all suffer as a result. As a population of older persons lives in the community, the number of falls that occur each year will rise [2].

Reduced physical activity is related to increased body fat and a corresponding decrease in lean body mass. Therefore, inactivity leads to a significant decrease in maximal force generation. Atrophy of the skeletal muscles is a hallmark of aging and physical inactivity. The aging process results in various structural and functional alterations, making it crucial for the elderly to engage in activities that aim to strengthen muscles and/or promote flexibility in large joints. Pilates, like other forms of exercise, has recently gained popularity as a means of delaying the effects of aging [3].

The aging process results in a variety of structural and functional alterations, making it crucial for the elderly to engage in activities that aim to strengthen muscles and/or promote flexibility in large joints. Pilates, like other forms of exercise, has recently gained popularity as a means of delaying the effects of aging [4]. PI has become an increasingly popular form of exercise to activate the core muscles in recent years. The practitioner can enhance their fitness, muscular tone, posture, and flexibility while maintaining their balance by employing this method, which focuses on toning the deep core stabilizer muscles using control and conscious movements. Exercises can be done on a mat using only body weight or with specialized exercise equipment [1,4].

Throughout physical inactivity due to mechanical unloading, muscle mass loss seems to precede bone loss. Age is related to a loss in muscle mass and strength in the elderly as well as across the adult lifetime, often beginning in the third or fourth decade of life. Despite that, the annual rate of muscle loss varied between 0.4% and 2.6% in cross-sectional research, and its drop throughout aging is estimated to be between 1 and 3% yearly, whereas the decrease in muscle power is estimated to be even more significant [5].

In the Health ABC study, maintaining muscle mass did not hinder muscle strength loss, highlighting the relevance of muscle quality by contributing to muscle strength in the elderly. Although a universally

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accepted definition or evaluation approach for muscle quality does not exist yet, there is a significant correlation between muscle quality and strength. Muscle quality can be referred to as muscle strength or power per unit of muscle mass. Both muscular strength and power are related to functional activities in the elderly [5].

The Timed Up and Go test (TUG) was utilized for measuring gait, motor speed, frailty, and physical function in the elderly, and as a predictor of the risk of falls, besides being used as a predictor of daily-life activities in the community groups. In other research, the TUG has been related to cognitive tests that increase the complexity of dual-task paradigms, as well as an elevation in the rate of falls and a reduction in the performance of cognitively impaired subjects [6].

The Tinetti mobility test or performance-oriented mobility assessment (POMA) is dependable and valid for measuring balance and gait in the elderly besides measuring static, dynamic, reactive, and anticipatory balance and ambulation and transfer ability. We used TMT in evaluating the walking and maintaining balance ability of patients. the highest-risk group got the lowest scores (≤18), the moderate-risk group got scores of 19–23 points, indicating moderate dependence and fall risk, while the low-risk group scores ≥24 points [7].

The aim of the current study was to compare Pilates intervention (PI) and Conventional Balance Training (CBT) efficacy on gait training performance and functional status in the elderly, with the assumption of no difference between them.

SUBJECTS AND AND METHODS

Participants

A randomized controlled intervention study was conducted between April 2022 and September 2022.
A total of 60 patients, of both genders aged from 60 to 70 years old, were selected from the National Institute of Neuromotor Systems. All patients were briefed about the aim and potential risks of the trial and signed a consent form declaring their participation.

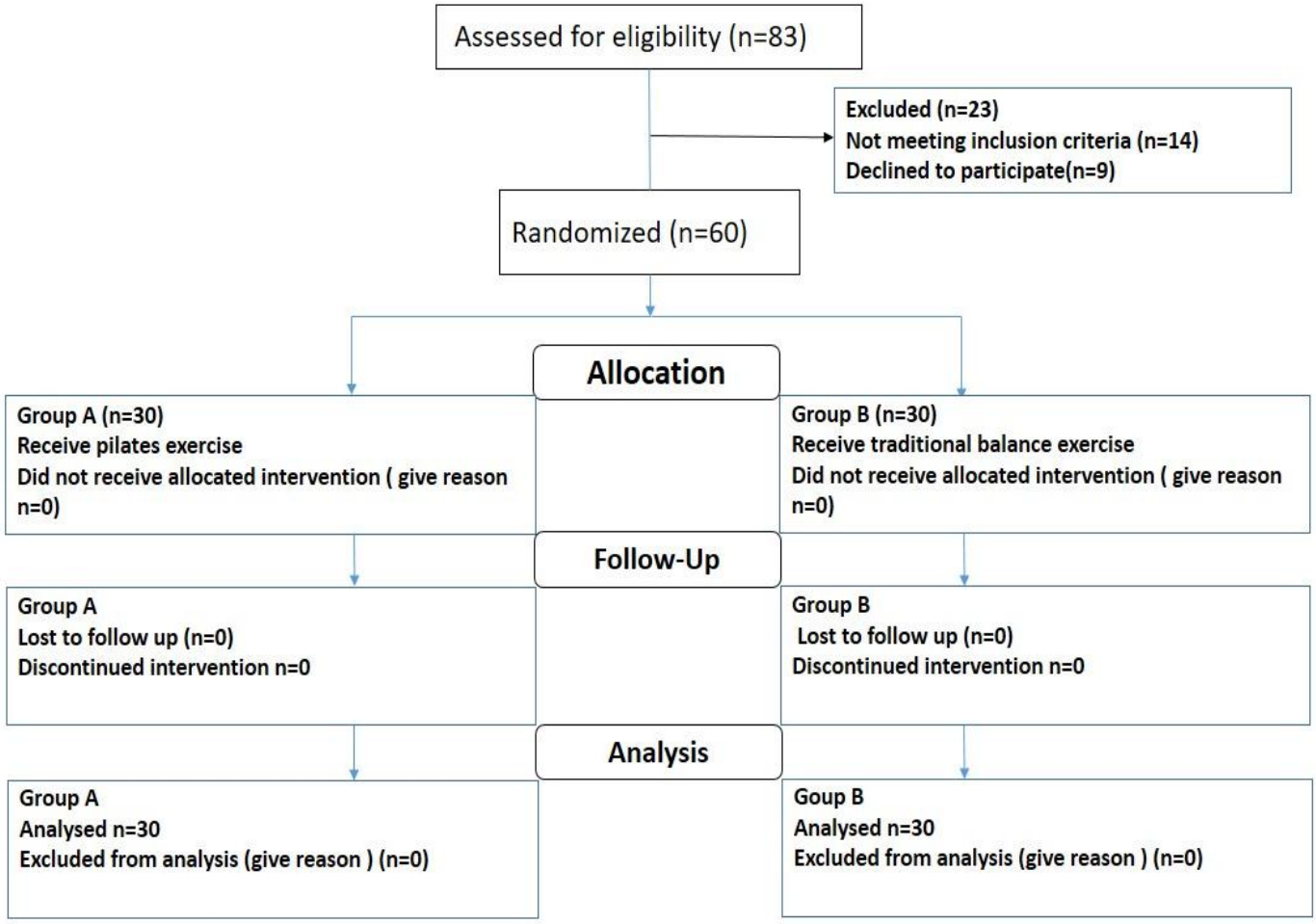

Figure (1): Flow Chart of the study (Randomization, Allocation, Follow up, and Analysis).

Procedures: In accordance with drawing lots (A or B) in the first session, we assigned participants to receive PI or CBT treatment. Using Microsoft Excel 2010, a random table of numbers (1–60) representing groups A or B was generated, and each patient received their numbers with being blind to the treatments; Group A: 30 patients with 3 PI sessions per week, while Group B: 30 patients with 3 CBT sessions per week.

Outcome measures: All participants were assessed for MQI as follows:

$[(L - 0.5) \times \text{body mass} \times g \times 5]/T_{\text{sit-to-stand}}$, where 0.5 (m), L (m), g (m/s^2), and T respectively represent the chair height, leg length, acceleration of gravity (9.8 m/s^2), and time required to complete the sit-to-stand test, to calculate a watts-based power index (W). A stopwatch calculated sit-to-stand time as the time to stand from a seated position and return to sitting consecutively five times. muscle quality index[8]. TUG test incorporating basic mobility components (i.e., standing up, walking, turning, and sitting) measures fall risk in the elderly. Participants who were instructed to rise from a seated position in an armchair, walk 3 meters, turn around, walk back to the chair, and then sit down again were single-TUG tested [9].

Tinetti assessment tool: The test involves a rigid, armless chair, a timer, and a 15-foot walkway that is even and uniform. One section evaluates balance in a chair and standing, while the other evaluates dynamic balance while walking on a 15-foot even walkway. The patient will be instructed to sit in an armless chair, stand and remain to stand, turn 360 degrees, and sit down again. This is to assess the patient's balance. Examining this, the evaluator will consider several essential factors, such as how the patient rises from and sits in his or her chair and whether or not the patient maintains an upright posture while sitting and standing. **Tenetti assessment**[10] was done before starting and after 12 weeks of the intervention.

Intervention: The interventions were conducted 3 times a week for 12 weeks, and the exercises consisted of 10 repetitions followed by a two-minute rest interval before beginning the following exercise and lasted approximately 30 minutes. For the PI group, PI exercises focused on strength, flexibility, and coordination while standing, emphasizing spinal and pelvic alignment, maintaining core contraction, and breathing rhythm. Exercises were conducted in small groups of only two or three individuals to ensure proper execution, and repetitions and complexity were increased as soon as possible [1]. Flexibility and strength training postural control exercises in different positions and surfaces, besides general endurance training, were performed for the CBT group. A blinded assessor evaluated the effectiveness of the intervention.

Exercise description for PI exercise:

a) Pelvic curl exercise: Performed on a plinth in a supine position, both lower limbs flexed and raised together with the lower back off the plinth as a bridging exercise.
b) Modified bird dog exercise: the patient exhibited a cat position and was requested to raise one limb, hold for 10 seconds then repeat for the 4 limbs.
c) Modified forearm plank exercise: by supporting weight on forearms on the floor, bend arms, so elbow beneath shoulder brought knees to the ground keeping the body in alignment, engaged core hold for 15 seconds.
d) Modified single leg stretch exercise: patient lying supine position brought knee to chest with by modifying grasping by patient both hands below knee joint.
e) Side circles: Performed in side-lying and making circles with the lower limb (one after another).
f) Chair seated PI: the patient was sitting on a chair, grasping straps bending trunk from side to side while sitting.

Exercise description for CBT exercise

1) Single leg balance: patient stands beside the chair, flexes hip and knee with repetition to the movement.
2) Tandem stance: Heel-to-toe stand in a straight line while the examiner gave several pushes from front and back and sides.
3) Hip abduction: patient stands behind the chair, abducts hip, and repeats the movement.
4) Calf raise exercise: patient behind the chair and repeat heel off the ground.
5) Sit to stand: patient sit to stand movement several times.
6) Tandem walking: Heel-to-toe walking in a straight line.

Ethical Consideration:

This study was ethically approved by the Ethical Committee of Cairo University's Faculty of Physical Therapy [No: P.T. REC/012/003758]. Written informed consent was obtained from all participants. This study was executed according to the code of ethics of the World Medical Association (Declaration of Helsinki) for studies on humans.

Statistical Analysis

The collected data were introduced and statistically analyzed by utilizing the Statistical Package for Social Sciences (SPSS) version 25 for Windows (IBM SPSS, Chicago, IL, USA). Qualitative data were defined as numbers and percentages. Chi-Square test and Fisher's exact test were used for comparison between categorical variables as appropriate. Shapiro-Wilk test checked the normal distribution of data. Normal distribution of variables was described as mean and standard deviation (SD). An unpaired t-test was utilized for comparing subject features between groups as well as comparing the mean values of TUG, Tinneti score and MQI between groups. Paired t-test compared pre- and post-treatment in each group. P value ≤ 0.05 was considered to be statistically significant.

RESULTS

Subject features: Table 1 shows the subject features of groups A and B. No significant differences were found in age, BMI, and HbA1c (P >0.05).

Table (1): Sociodemographic charactersitcis and anthropometric measures of participants.

Variable	Group A	Group B	MD	t- value	P-value
	Mean ± SD	Mean ± SD			
Age (years)	64.41 ± 3.5	65.08 ± 2.98	-0.67	-0.79	0.43
Weight (kg)	86.45 ± 11.7	88.98 ± 9.05	-2.53	-0.93	0.35
Height (cm)	166.73 ± 10.44	169.4 ± 9.52	-2.67	-1.03	0.31
BMI (kg/m²)	31.47 ± 5.74	31.14 ± 3.51	0.33	0.26	0.78
Leg length (cm)	81.29 ± 6.41	82.56 ± 5.08	-1.27	-0.85	0.39
Sex, N (%)					
Females	16 (53%)	15 (50%)	$\chi^2 = 0.06$		0.79
Males	14 (47%)	15 (50%)			

SD, standard deviation; MD, mean difference; χ^2, Chi squared value; P-value, probability value.

Effect of treatment on TUG, Tinneti score, and MQI:

- ***Within-group comparison:*** A significant reduction was observed in TUG post-treatment in groups A and B (20.37 and 11.45%, respectively) compared to pre-treatment (P <0.001). A significant elevation in Tinneti score and MQI post-treatment in *Group A* (20.76 and 23.56%, respectively) and *Group B* (13.66 and 8.52%, respectively) compared with pre-treatment (P <0.001) (**Table 2**).
- ***Between groups comparison:*** No significant difference was found between pre-treatment groups (P >0.05). In a comparison of post-treatment groups, *Group A* had a significant decrease in TUG and an increase in Tinneti score and MQI compared to *Group B* (P <0.01) (**Table 2**).

Table (2): Mean TUG, Tinneti score, and MQI pre and post-treatment of groups A and B.

Variable	Pre-treatment	Post-treatment	MD	% of change	t- value	P-value
	Mean ± SD	Mean ± SD				
TUG (sec)						
Group A	18.85 ± 3.01	15.01 ± 2.91	3.84	20.37	13.76	0.001
Group B	19.22 ± 2.45	17.02 ± 2.05	2.20	11.45	16.52	0.001
MD	-0.37	-2.01	---			
t- value	-0.51	-3.08				
	P-value 0.61	***P-value 0.003***				
Tinneti score						
Group A	18.93 ± 4.08	22.86 ± 3.25	-3.93	20.76	-13.49	0.001
Group B	17.86 ± 3.46	20.3 ± 3.27	-2.44	13.66	-18.31	0.001
MD	1.07	2.56	---			
t- value	1.09	3.04				
	P-value 0.28	***P-value 0.003***				
MQI						
Group A	49.71 ± 11.73	61.42 ± 12.01	-11.71	23.56	-12.8	0.001
Group B	46.36 ± 11.50	50.31 ± 10.94	-3.95	8.52	-12.99	0.001
MD	3.35	11.11	---			
t- value	0.82	2.53				
	P-value 0.41	***P-value 0.01***				

DISCUSSION

We present a controlled assessment of the influence of 12-week PI and CBT therapy on MQI, TUG, and tenetti assessment, revealing a significant improvement in functional balance and QOL. On the other hand, participation in PI led to statistically significant and clinically higher gains in balance when compared to CBT treatment and the control condition of regular exercise consistently with the results of previous studies. PI exercises are beneficial for the elderly because they help them keep their mobility, which is essential for performing their everyday activities, as was found in a study published in 2021. It was also our intention to investigate the gender in life satisfaction with supervised PA practice during the course of this research. The literature indicates that women showed the best results, i.e., higher degrees of satisfaction. Factors that positively influenced the quality of life (QOL) of the elderly thus, contributed to their satisfaction with life are more likely to be present among the elderly with greater levels of education and better economic conditions [11].

In earlier research on body composition, physical fitness, and exercise activities of the elderly, changes in body composition leading to chronic disorders in the elderly have turned into to be a primary concern. Throughout aging, the body experiences a reduction in physical capacities as well as alterations in fat and skeletal muscle mass as well as in metabolic rates. Body composition is an essential health indicator and predictor of comorbidities. As a result, elderly women's physical fitness is a good QOL indicator. Moreover, health and physical fitness have a correlation to body composition and physical fitness [12].

Bird *et al.* [13] also did not find any significant improvement in postural sway after five weeks of PI training in older adults. However, the same research group recently compared relatively young older adults (69 ± 7 years) who completed five weeks of PI exercise training with those who did not. They found that postural sway improved after five.

In older persons, a PI training program did not enhance objective measuring of balance control or self-reported health status. Additional study is required to evaluate the possible impact of PI training on a population of weak elderly with a history of falls [13].

Regarding a 12-week PI program, there were no improvements in body balance; it may be attributed to the fact that these patients do not have balance impairments and hence did not receive any additional benefits from the PI program. In contrast, this data, along with those of the present study, reveals conclusively that PI activities are quite beneficial for improving body balance in the elderly. The strengthening of the trunk and peripelvic muscles in the sense of the "powerhouse" is unquestionably an important measure to stabilize posture and gait pattern, with the concomitant effect of maintaining balance, when considering the mechanisms leading to improved body balance following PI exercise [14].

In 2022 A systematic review study revealed that 27 of 30 studies analyzed the stated benefits of PI for the elderly, especially in static or dynamic balance .4 studies revealed benefits in total strength, 3 in lower limb strength, and 2 in respiratory strength. 4 studies reported functional capacity and autonomy tendency for improvement with PI. The psychological and mental-health-related variables (e.g., perception of health, QOL, satisfaction with life, emotional health, and sleep quality) showed a significant improvement with PI. Each flexibility and resistance was improved in 2 experimental studies,. There was a reduction in BMI and waist perimeter. Gains in short-term memory were stated in cognitively disabled people [15].

The study also has certain drawbacks. Due to the fact that the research was conducted only on the elderly residing in institutions, the results cannot be extrapolated to community-dwelling elderly with an elevated risk of falls. In addition, blinding participants to the intervention was not possible. Thus it is possible that the social contact during group treatment, which positively affected outcomes, led to the belief that PI training is beneficial. In a non-research setting, delivering the interventions at various retirement communities may not have been possible, given the practical obstacles. A future study using cross-over designs may also be undertaken to evaluate which exercise program, PI or CBT, participants prefer. Additional controlled comparative studies with bigger sample sizes are necessary among elderly (80+ years) residing in the community and those with pathological conditions with an increase in the risk of falls and fall-related injuries.

CONCLUSION

Our findings indicate that PI and CBT programs result in significant improvements in functional balance and QOL for older adults confined to an aged care facility. However, the PI intervention has better advantages than CBT. Thus, PI combined with other physical workouts can enhance functional results and QOL in the elderly, enabling them to age gracefully and enjoy a high QOL.

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