Original Article

Effects of TaiChi and Pilates on the balances of elderly Parkinson's men

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Introduction: Parkinson's disease is associated with many problems, including decreased balance. This study was conducted to effects of TaiChi and Pilates on the balances of elderly Parkinson's men. Method: This study was carried out using field method and pre-test/post-test design in two training and one control groups. The statistical population were 106 men with Parkinson's disease. 45 subjects (aged 64.72 ± 7.29 years) were sampled through convenience and purposive method, and divided into two groups of TaiChi and Pilates training with one control group. Data were collected using a balance, stopwatch, balance testing device, Berg balance scale (BBS), Kurtzke expanded disability status scale (EDSS) and physical activity readiness questionnaire (PAR-Q). All groups were subjected to static and dynamic balance tests. The exercise groups trained three one-hour sessions weekly for 12 weeks. The data were analyzed using SPSS-21 softwar. Findings: The results showed that both TaiChi and Pilates exercises improved the balance of subjects with Parkinson's disease ($p = 0.001$). There were no significant differences between the effects of TaiChi and Pilates exercises on the dynamic balance of the Parkinson's men ($p = 0.980$). The two exercises, however, differently influenced the static balance ($p = 0.001$), with higher effects of Pilates training. Conclusion: According to the results of this study, due to the greater impact of Pilates exercises, this new method can be used to improve balance and increase the quality of life of the Parkinson's men.

Keywords: Parkinson's disease, TaiChi exercise, Pilates, Static and dynamic balance

Introduction

Parkinson's disease is a neurodegenerative disorder associated with such symptoms as slowness of bodily movements or bradykinesia, rigidity, and tremor. Parkinson's symptoms are observed with the impairment of neuronal transmission in the basal ganglia (especially in the substantia nigra) of the brain along with an 80% loss of dopaminergic cells in the midbrain [1].

Most studies have estimated Parkinson's disease prevalence to be between 100 and 200 individuals per 100,000 people [2]. Some studies estimated that the number of Parkinsonian people aged over 50 years will exceed 8.5 million worldwide over the next 25 years [3]. Research has indicated that between 0.05 and 0.10 percent of the population with Parkinson experience the disease before the age of 40 [4]. The comparisons between healthy individuals with their Parkinsonian peers showed that the mortality rate is two to five times higher in the latter [5, 6], suggesting a lower life expectancy in people with Parkinson's [7, 8]. In the absence of preventive measures that retard or prevent the spread of Parkinson's, the cost of Parkinson's treatment will likely rise in the future [9].

Parkinson's disease is associated with many motor and non-motor constraints. Instability and lack of balance are one of the motion aspects in Parkinson's disease, which can lead to increased falls and decreased mobility and functional capacity of the elderly, followed by other problems [10, 11]. Increasing fall risk in these elderly people leads to fracture, joint dislocation, and severe damage to soft tissues. Stature instability occurs as a result of reduced muscle strength and in combination with other disease complications following degeneration of dopaminergic

Access this article online	
Website: www.japer.in	**E-ISSN:** 2249-3379

How to cite this article: Khalil Alavi, Mahmoud Sheikh, Fazlullah Baqerzadeh. Effects of TaiChi and Pilates on the balances of elderly Parkinson's men. J Adv Pharm Edu Res 2020;10(S1):166-173.
Source of Support: Nil, Conflict of Interest: None declared.

cells in the basal ganglions. Besides, the concurrency of this disease with aging exacerbates its complications. Upon entry into the aging period under normal conditions, changes occur in the functioning of skeletomuscular, atrial, sensory-somatic, and visual systems as metabolic and physiological systems involved in balance exposing the elderly to serious damages, such as fractures and prolonged disabilities caused by imbalance [12].

Balance downfall in these elderly people occurs for a variety of reasons. Parkinsonian elderly suffer from impaired nerve control and, compared to their counterparts, are significantly facing fall risk [10]. Using TMS, Cantello et al. (2007) showed that Parkinsonian elderly, as compared to normal people, showed a peak period of long-latency cortical inhibition (LICI) [13]. Another study found that Parkinsonian elderly presented motor constraints and abnormalities in activating muscles during a simple task (e.g. quick elbow flexion) at different intervals [14]. The study showed that movements in Parkinsonian elderly have lower peak speeds than normal people, along with less ability to balance movement speed. Electromyographic data (EMG) revealed that old people with Parkinson's had certain limitations in adjusting the first agonist movement in response to task requirements; moreover, the timing of antagonist movement in the elderly with more severe disease was associated with further disorders [14].

Currently, the primary treatment of this disease is the use of anti-Parkinson's drugs, such as levodopa. Levodopa can be used to relieve such symptoms as tremor and slowness of movement or bradykinesia, but the effect of levodopa disappears over time, leading to the emergence of disability or dyskinesia. Accordingly, research has shown that in addition to medication interventions, exercise and kinesiotherapy as a complementary therapeutic approach have positive effects on controlling a part of the disease complications and improving routine performance of the elderly. The kinesiotherapy process is more advantageous to improve the performance of Parkinsonian elderly than medical and surgical treatments [15]. In fact, through a positive effect on dopamine levels, physical activity improves the neuromuscular system's function and anatomical adaptations, and also the breakdown of the disease's negative cycle, aging and immobility, thereby enhancing the performance of the elderly with Parkinson's disease. Exercise improves physical performance, health-related quality of life, power, balance, and walking speed in Parkinsonian elderly, and also reduces depression [16]. However, the type of exercise that can be useful and which is without side-effects is challenging. Tai Chi as a traditional sport predisposes increased mental activity, and improves cardiac function, and respiratory and digestive tracts by providing soft and gentle movements [17]. It also stimulates the parasympathetic nerves leading to increased vitality and mind relaxation, increasing concentration and volition, and discarding distracted thoughts. Among Tai Chi styles, Tai-Chi-Chuan style has softer, more uniform, and no explosive and intense movements, hence, it is recommended for the elderly, Parkinsonian aged people, and others [18]. It has been reported that short-term Tai-Chi-Chuan movements increase 34 percent of parasympathetic activity, and decrease 12 percent of sympathetic activity, and thus boost the calmness of the elderly. These effects were even more significant in comparison to fast hiking frequently recommended to the elderly [19]. Performing this sport, along with deep breathing exercises and increased concentration, improves the pulmonary system and increases flexibility and strength, which can be controlled depending on the age and abilities of the elderly [20]. This exercise is low-cost, does not require special sports equipment, and is even feasible for the majority of the community with movement disability or wheelchair dependency [21]. According to Schaller et al. (1996), ten weeks of moderate Tai-Chi exercise in women aged 70 years on average did not significantly change systolic and diastolic pressures, instead, it led to improved balance and psychological state [22]. Gao et al. (2014) investigated the impact of Tai Chi on the balance and the fall prevention in Parkinsonian subjects, and noticed positive effects of these exercises [23]. The effects of Tai Chi on Parkinsonian elderly people have been studied for years; however, there is still inadequate evidence to support its effectiveness, especially its effects on maintaining balance and preventing fall [24].

Performing exercises called Pilates is a new method of physical activity that has recently been taken into consideration. Pilates training is the focus of one's mind on the muscle and the way of performing the exercise. Over time and with repeated implementation of the movements, human mind better perceives the body and maintains it more capable and balanced. These exercises are a proper method to practice mind-body awareness and control postural movements with high-level neuromuscular requirements [25, 26]. Pilates improves flexibility and mental relaxation, increases muscle strength, and ultimately enhances the spinal control and restores balance [27]. Joseph Pilates believed that all bodily muscles should be strong and flexible in terms of strength and stretch, especially the trunk muscles as the powerhouse of the body. During the Pilates exercises, an individual has the control of all one's own muscles, and then, achieves a kind of natural harmony with frequent and gradual implementation [28]. Pilates exercises have a positive effect on the strength of the lower extremities and, consequently, on the dynamic balance of the elderly [26].

The impacts of Pilates exercises on balance and other motor attributes have been shown in various studies [25, 27, 29, 30]. Newell et al. (2012) and Hyun et al. (2014) demonstrated the effect of these exercises on the balance of the elderly [31, 32]. Many studies have also confirmed the effect of Pilates training on the balance of Parkinsonian aged people [15, 33]. However, Parkinsonian elderly have very rarely been investigated in Iran. It seems that if this training complex is proven to be effective because of its low cost, non-riskiness, and non-invasiveness, these exercises will be utilized by the Parkinsonian elderly community in particular, and other sections of the society in general. In Iran, few studies have examined the effects of Pilates and Tai chi trainings on the rehabilitation of motor functions in male Parkinsonian elderly, and a quantitative comparison was found between these two types of training. The present study, therefore, sought to compare the effects of Pilates and Tai Chi exercises on the static and dynamic balances of elderly men with Parkinson's disease.

Methodology

This field survey was carried out as a quasi-experimental pre-test/post-test study in two training and one control groups. The statistical population consisted of 106 men aged 59 - 75 years with Parkinson's disease which was confirmed by a neurologist. All the subjects were members of the Urmia Parkinson's Association affiliated to the Welfare Administration. The patients were first explained about the research plan, and the type, intensity, duration, frequency, and the way of training implementation. They then completed the PAR-Q medical questionnaire and the consent form. According to Shailja Pandya et al. (2017), the inclusion criteria were as follows: Parkinson's disease with documented approval; no history of cardiovascular diseases, epilepsy, metabolic, psychological and orthopedic diseases (e.g. knee pain); and having willingness to participate in the research project. Participants who did not attend at least two-thirds of the training sessions or had Parkinson's recurrence during the intervention were excluded from the study [33].

After the announcement in this plan, people who were willing to participate referred to the community in Urmia. After completing the medical forms and measuring their height and weight, these people announced their cooperation to implement the plan according to the researcher and physician's explanations about the effects of exercise on the prevention of the disease, as well as provision of their daily dressing and nutrition. All participants received such tests as static and dynamic balances. Based on the pre-test scores, the subjects were then divided into three homogeneous groups (two training and one control groups). The control group had no exercise activities and continued their routine life after the initial test. After 12 weeks, they re-performed balance tests. The training groups had Pilates and Tai chi exercises in 1-hour sessions, three times per week at 8-9 a.m according to the schedule for 12 weeks. The test was carried out again after 12 weeks of exercise and routine chores. All tests and exercises were conducted at the Sports Complex of Urmia University. The Pilates training program per session included initial warming up (5 min) followed by main movements including stretching, resistance, neuromuscular coordination, and balance, with a final ten-minute stretching training to cool down [34, 35]. Tai-chi exercises were also conducted as training, and short introductory forms and balance exercises were implemented in the gym. Tai Chi Chuan-Yang style was performed three times a week each for 45-60 min [36]. Post-test was carried out after 24 sessions of Tai Chi Chuan training.

Data collection tools were: 1) A digital scale (AND-EK3000I, Japan) for measuring the weight of the participants; 2) A ten-hour stopwatch (Q & Q, Japan) to record the time; 3) a tape meter for height measurements of participants and distances; 4) A 50-cm ruler and balance meter (Danesh Salar Iranian Co.) for balance test; 5) A stool (30 cm in height) for balance test; 5) Berg Balance Scale (BBS) questionnaire; 7) Kurtzke expanded disability status scale (EDSS) questionnaire; and 8) physical activity readiness questionnaire (PAR-Q).

The physical inability of the subjects was measured by EDSS questionnaire developed by Kurtzke (1983), which was conducted by a neurologist [37]. This test evaluated different states and functions of the central nervous system (CNS), including the functioning of the pyramidal pathways, the cerebellum, the brain, the sensory pathways, the intestinal and bladder pathways, the visual pathways, and the brain system. It measured a score of 0-10 for each Parkinsonian patient depending on the level of damage to the CNS. The higher the damage, the higher the score was. A score of 1 showed the lowest damage, and a score of 10 indicated one's death. This test has been standardized in Iran. It should be noted that the reliability of this test was validated by Fathi Rezaie (2010) [28]. Shanazari et al. (2012) also confirmed the validity and reliability of the test [34]. A reliability of 0.83 was obtained in the present study.

The physical condition of the Parkinsonian elderly for participation in the exercises was assessed by the health PAR-Q questionnaire [38] with seven questions of yes/no answers. The questionnaire has been validated in various research, with confirmed validity and reliability by Anbari and colleagues (2011) [35]. This study estimated a reliability of 0.89 through a test-retest method.

The data were analyzed by SPSS software (version 21). Descriptive analysis was performed by mean and standard deviation. Tukey's post hoc test, and repeated measures analysis of variance (ANOVA) were used for the inferential analysis of data.

Findings

Frequencies, means, and standard deviations of age, weight, height, and body mass index (BMI) of the subjects have been shown in Table 1.

Table 1. Average and standard deviation of age, height and body mass index of participants

Group	No.	Mean ± SD age (year)	Mean ± SD weight (kg)	Mean ± SD height (m)	Mean ± SD BMI
Tai Chi	15	64·16 ± 4·04	64·91 ± 8·10	1·67 ± 0·090	24·01 ± 2·57
Pilates	15	66·50 ± 2·93	63·58 ± 5·83	1·71 ± 0·058	22·62 ± 1·99
Control	15	67·50 ± 4·66	65·66 ± 7·94	1·66 ± 0·053	24·43 ± 3·06

Table 2. Average and standard deviation of participants' scores in static and dynamic balances in the pretest and posttest stages

Descriptive indices / Groups	Pretest Mean ± SD	Post-test Mean ± SD

	Static balance	Dynamic balance	Static balance	Dynamic balance
Tai Chi	10·646 ± 2·628	6·893 ± 1·351	15·166 ± 2·249	5·103 ± 0·894
Pilates	10·933 ± 2·538	7·393 ± 1·168	23·133 ± 3·153	5·160 ± 0·506
Control	9·998 ± 2·499	7·000 ± 0·953	10·586 ± 2·150	6·966 ± 0·847

The data were analyzed by the repeated measures ANOVA [2 (test stage) × 3 (group)], where the first (test stage: pretest-posttest) was a within-subject factor and the second (Tai Chi, Pilates, and control groups) was measured as a between-subject factor, as presented in table 2.

Table 3. Analysis of variance analysis results for dynamic balance analysis among groups

Statistics / Sources of variance	SS	df	MS	F	Sig.	ηp²
Stage	41·074	1	41·074	94·671	0·0001	0·693
Stage × group	20·284	2	10·142	23·377	0·0001	0·527
Error (stage)	18·222	42	0·434			
Group	15·429	2	7·714	5·047	0·011	0·194
Error	64·195	42	1·528			

As seen in Table 3, the main effects of the stage ($P < 0.05$), group ($P < 0.05$), and their interaction (stage × group) ($P < 0.05$) were significant in the dynamic balance test. This means that the scores of Tai Chi, Pilates, and Control groups differed significantly in the implementation of the dynamic balance test. Figure 1 shows different scores of dynamic balance test among the three groups. As can be seen, there is little difference between the groups in the pretest, with Tai Chi group showing the lowest score (6.893). In the post-test phase, however, the difference between the two training groups was much higher than the control group with the highest mean value (6.966).

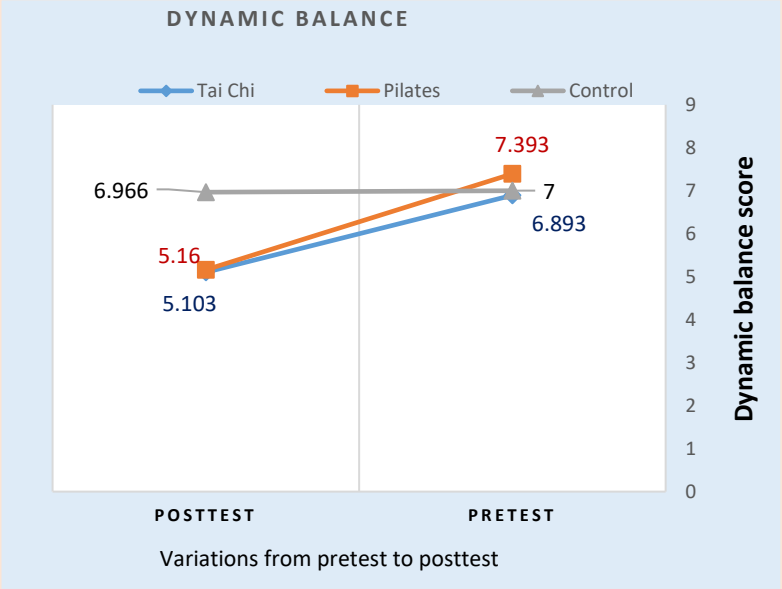

Figure 1. Average scores of dynamic balance test among the three groups in the pretest and posttest stages

ANOVA results showed significant differences ($P < 0.0005$) between the three groups in the dynamic balance test. According to Tukey's post hoc test for the source of variance, there was no significant difference between the Tai Chi and Pilates training groups ($P = 0.980$). The control group, on the other hand, had a better performance in the dynamic balance test than the other two groups. As shown in Figure 2, the Tai Chi (5.106) and Pilates (5.160) groups were not highly different, but both were significantly different from the control group ($p = 0.0001$).

The data were analyzed by the repeated measures ANOVA [2 (test stage) × 3 (group)], where the first (test stage: pretest-posttest) was a within-subject factor and the second (Tai Chi, Pilates, and control groups) was considered as a between-subject factor, as presented in Table 4.

Table 4. Repeated measures ANOVA with static balance test among the groups

Statistics / Sources of variance	SS	df	MS	F	Sig.	ηp²

Stage	750·533	1	750·533	230·500	0·000	0·846
Stage × group	521·755	2	260·877	80·119	0·000	0·792
Error (stage)	136·757	42	3·256			
Group	694·738	1	347·369	35·950	0·000	0·631
Error	405·822	42	9·662			

As shown in Table 4, the main effects of the stage ($P < 0.05$), the group ($P < 0.05$), and the interactive (stage × group) effect ($P < 0.05$) were significant in the static balance test. This indicated that the Tai Chi, Pilates, and control groups differently implemented the static balance test. Figure 2 depicts different scores of static balance test among the three groups. As can be seen, there were slight differences between the groups in the pretest, with the control group showing the lowest score (9.980). In the posttest stage, however, the difference between the two training groups was much higher than the control group, with Pilates group gaining the highest mean value (23.133).

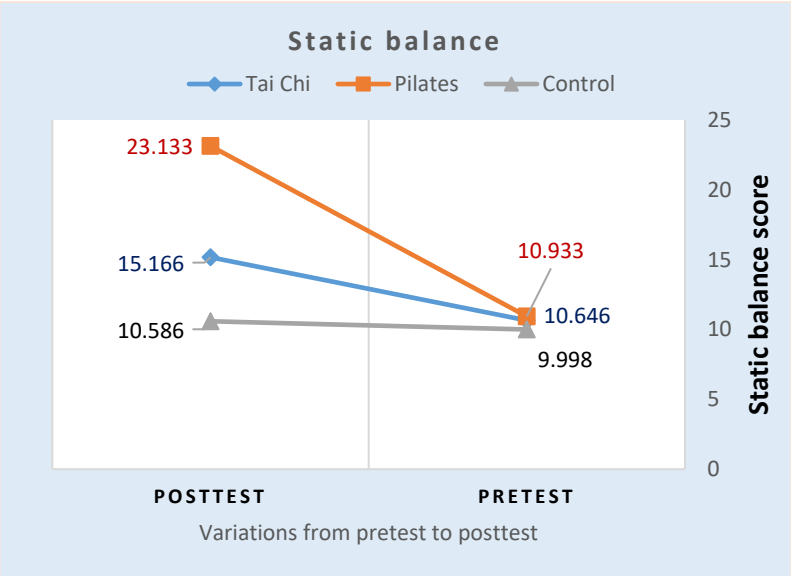

Figure 2. Average scores of static balance test among the three groups in the pretest and posttest stages

ANOVA results revealed significant differences ($P < 0.0001$) among the three groups in the static balance test. The source of variance was determined by Tukey's post hoc test. The results showed that there was a significant difference between Tai Chi and Pilates training groups ($P = 0.0001$). Also, both the Tai Chi and Pilates groups were significantly different from the control group ($p = 0.006$, $p = 0.0001$). The control group had the lowest mean (9.98) in the pretest stage. In the post-test phase, however, the highest mean score of the static balance test belonged to the Pilates group (23.133), which was significantly different from the other two groups. The Tai Chi group achieved greater average scores in the pre-test (10.933) and post-test (15.166) stages than the control group, which showed less variations from pretest (9.980) to post-test (10.586) stages.

Discussion and Conclusion

This study aimed to determine the effect of Pilates and Tai Chi training on the balance of Parkinsonian elderly, and the overall results showed positive effects of both of the exercises. There has been ample evidence suggesting that exercise is beneficial for Parkinsonian elderly [10, 39-42]. However, they need to be monitored with safety and be dependent on equipment.

The results showed that Tai Chi exercises had positive impacts on both static and dynamic balance of Parkinson's elderly, which is in line with those of Chen et al. (2008), Stephanie et al. (2009), Hackney and Earhart (2008), and Gao et al. (2014) [17, 21, 23, 43]. However, this finding was not consistent with that of Chen et al. (2006), which might be due to the differences in the ages of participants (> 40 years) in this research [44]. Various studies have demonstrated that healthy aged people who do Tai Chi exercises have a better balance than those who do not perform these exercises [45, 46]. It has been reported that Tai Chi could improve the scores of BBS scale [47], UPDRS, and TUG scales [48], as well as the two-way standing test, six-minute walking, and walking backward in the elderly with Parkinson's disease [43]. Li (2012) compared the effect of Tai Chi training, and resistance and stretching exercises on motor function and local stability in Parkinsonian elderly patients, with Tai Chi group showing better stride length and functionality than the other two groups [49].

Metabolism increases following physical exercise. Physical activity results in increasing blood and oxygen supply, better nutrition of the organs, and ultimately reducing muscle weakness and improving the nervous system function [34]. The present results indicated that there were no significant differences between the effects of Tai Chi and Pilates exercises on the

dynamic balance of the Parkinsonian elderly, the static balance was affected significantly, with a greater impact of Pilates exercises. This might be because of the fact that strength training has a special place in Pilates, and has been reported to strengthen the elderly [34]. Previous studies indicated that Pilates improves the balance and reduces the number of falls in aged people [50-52]. The results of this study about the positive effects of Pilates exercises on the balance were consistent with those of Daneshmandi et al. (2017), Bakhshayesh et al. (2017), Johnson (2007), and Hyun et al. (2014) [11, 15, 16, 32]. The static balance observations in this study, however, were not in agreement with that of Bird (2012), which was probably due to the differences in the exercise duration [53, 54]. Many studies have shown that regular Pilates exercises affect the improvement of motor and non-motor symptoms, functional autonomy, and quality of life in these patients [55, 56]. In this regard, Kibar et al. (2016) also showed that eight-week Pilates exercises had beneficial effects on static and dynamic balances [57]. Balance improvement as a result of Pilates exercises arose from an improvement of psychological factors (stress and anxiety) in the participants.

General conclusion

Increasing population of Parkinsonian elderly and the impact of this disease on motor functions, in particular balance, have created a heavy burden on practitioners. Based on the results, it can be concluded that both Tai Chi as a traditional exercise, and Pilates training as a new exercise with soft and calm physical movements impacting on different physical systems involved in the balance would predispose the balance improvement of Parkinsonian individuals. Performing physical exercises would improve the balance of Parkinsonian elderly by increasing metabolism, blood and oxygen supply, and improving organ nutrition, the nervous system function, and attention and concentration. However, Pilates training has a better effect on static balance by reducing muscle weakness than Tai Chi.

Acknowledgements

The authors would like to express their gratitude to the elderly participating in this research, and also the Urmia Welfare Office.

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