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Original Article

Improvements in cognition, quality of life, and physical performance with clinical Pilates in multiple sclerosis: a randomized controlled trial

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Abstract. [Purpose] The aim of this study was to determine the effects of clinical Pilates in multiple sclerosis patients. [Subjects and Methods] Twenty multiple sclerosis patients were enrolled in this study. The participants were divided into two groups as the clinical Pilates and control groups. Cognition (Multiple Sclerosis Functional Composite), balance (Berg Balance Scale), physical performance (timed performance tests, Timed up and go test), tiredness (Modified Fatigue Impact scale), depression (Beck Depression Inventory), and quality of life (Multiple Sclerosis International Quality of Life Questionnaire) were measured before and after treatment in all participants. [Results] There were statistically significant differences in balance, timed performance, tiredness and Multiple Sclerosis Functional Composite tests between before and after treatment in the clinical Pilates group. We also found significant differences in timed performance tests, the Timed up and go test and the Multiple Sclerosis Functional Composite between before and after treatment in the control group. According to the difference analyses, there were significant differences in Multiple Sclerosis Functional Composite and Multiple Sclerosis International Quality of Life Questionnaire scores between the two groups in favor of the clinical Pilates group. There were statistically significant clinical differences in favor of the clinical Pilates group in comparison of measurements between the groups. Clinical Pilates improved cognitive functions and quality of life compared with traditional exercise. [Conclusion] In Multiple Sclerosis treatment, clinical Pilates should be used as a holistic approach by physical therapists.
Key words: Multiple sclerosis, Clinical Pilates, Cognition

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INTRODUCTION

Multiple Sclerosis (MS) is an inflammatory, neurodegenerative disease of the central nervous system that results in demyelination and transaction of axons in the brain, spinal cord, and optic nerves[1]. Due to the changing distribution throughout central nervous system demyelination in MS, many different symptoms like fatigue, weakness, posture, and movement and cognitive disorders can be seen. Exercise is used in the treatment of MS patients.

Effects of exercise on function and quality of life have been examined in MS, and previous studies have recorded significant improvements in muscle strength, exercise tolerance and mobility levels in MS patients performing exercise[2–4]. The majority of studies in literature were conducted in the area of strengthening and aerobic exercises.

Clinical Pilates is an exercise model that has become very popular in recent years and it has beneficial effects on both

ore stabilization and the whole body. Clinical Pilates is different from other exercise programs, as it includes respiratory component. A meta-analysis of clinical Pilates performed in healthy individuals revealed that clinical Pilates appeared to be effective in improving flexibility (strong evidence), dynamic balance (strong evidence), and muscular endurance (moderate evidence) in healthy people[2]. Core stabilization in terms of maintaining functional independence is very important in MS. Clinical Pilates-based exercise incorporates the principles of trunk stability, which is also referred to as core stability or core control[3].

There are only a few studies in the literature concerning clinical Pilates in MS. Clinical studies in the literature have examined the impact of Pilates on physical parameters such as balance, mobility, and strength in patients with MS[5–7]. However, there are no studies in the literature that have investigated the effects of clinical Pilates on cognitive function and quality of life as well as physical parameters. In this respect, the present study carries the distinction of being the first.

The aim of this study was to analyze the effects of clinical Pilates on body control, balance, quality of life, fatigue, and cognition in MS patients.

SUBJECTS AND METHODS

In the current study, 37 MS patients living in Izmir were recruited. There were no changes in the medication regimes of the MS patients during the survey period.

The inclusion criteria were as follows: over 18 years of age, diagnosed with MS, an Expanded Disability Status Scale (EDSS) score of six or lower, and able to act, or move independently, able to walk alone or with support. The exclusion criteria were as follows: an MS-related acute attack, cardiovascular diseases, thyroid disorders, gout or orthopedic limitation or irregular attendance.

Demographic and clinical characteristics of the participants are shown in Table 1. Thirty-seven MS patients originally agreed to participate in the study, but 17 dropped out of the study due to health, transportation, or other problems. Among the 20 MS patients who completed the study, 65% (n=13) were female and 34% (n=7) were male (Fig. 1).

Participants were randomly assigned to two groups, the clinical Pilates (n=11) and the control group (traditional exercise program; n=9). Randomization was performed by the card method (red or blue card). Patients were given two days of exercise training per week for a total of eight weeks. In order to understand the rate of benefit related to clinical Pilates in terms of cognition, disability, balance, coordination, mobility, physical performance, fatigue, depression, and quality of life, relevant measurements were conducted. All measurements were repeated before and after eight weeks of treatment.

The study was approved by the Local Ethics Committee (date, 16.01.2014, protocol number, 1287-GOA and decision number, 2014/03-19). Written informed consent was obtained from all patients who participated in the study.

The Pilates key elements were taught to the patients before the clinical Pilates exercise lessons. These key elements were breathing, focus, and placement of the rib cage, shoulder, head, and neck. All Pilates movements were checked, and necessary corrections were made by a physical therapist during Pilates exercise sessions. The exercises were repeated 8–10 times. When the Pilates exercises could be done by the patients with maintaining the key elements, the level of exercise was increased. Exercises were started with closed chain exercises, and advanced to open chain exercises. On the other hand, exercises started at level 1 and advanced to level 3. The exercises were studied as group exercises. Each exercise session was planned to be 45–60 minutes long. Each session was comprised of a 10 min warm-up, 25–45 min of mat exercises, and 10 min cool-down.

Pilates warm-up exercises consisted of Cleopatra, the Chest stretch, the Toy soldier, Upper extremity proprioceptive neuromuscular facilitation patterns, and Roll down. Pilates mat exercises performed in 5 different positions. 1. The One leg stretch, Hundreds, the Double leg stretch, Scissors, the Shoulder bridge, Oblique preparation, and the Hip twist were performed in the supine position. 2. The Clare, the Side kick, Arm openings, the Lower lift, Leg lifts, and the Side bend were performed in the side-lying position. 3. The Swan dive, the One leg kick, Swimming, the Breast stroke preparations, the Breast stroke, and the Cobra were performed in the prone position. 4. The Half roll back, Oblique roll up were performed in the sitting position. 5. Swimming was performed in the kneeling position. The Pilates cooldown exercises were the Spine stretch, Saw, Mermaid, Cleopatra, Chest stretch, Toy soldier.

Traditional exercises including strength, balance and coordination exercises were, applied to the control group.

EDSS is used by neurologists for assessment of disability in patients with MS. Grading by this instrument was done on a scale of 0–10, with the disability rate increasing as the grade increased. Patients were classified into five stages of disability: Stage I (EDSS = 0, the patient is not disabled but has been diagnosed of a chronic disease), Stage II (EDSS = 1–3, minimally disabled), Stage III (EDSS = 3.5–5.5, rather disabled), Stage IV (EDSS = 6–7, patient still capable of walking with aid), and Stage V (EDSS =< 7, patient is unable to walk at all)[4].

The cognitive impairments of participants were evaluated using the Multiple Sclerosis Functional Composite (MSFC). The MSFC is a three-part performance scale for evaluating the degree of impairment in MS patients. It includes assessment of leg function by moving a short walking distance (Timed 25-Foot Walk), assessment of arm function using the Nine-Hole Peg Test (NHPT), and assessment of cognitive functions with an attention/concentration test (Paced Auditory Serial Addition Test, PASAT)[7]. The MSFC assesses upper-motor function with the NHPT, lower-motor function with the Timed 25-Foot Walk Test, and cognitive functions with the PASAT.

The Berg Balance Scale (BBS) was used for evaluating static and dynamic balance. The BBS is a clinical scale that evalu-

Table 1. Demographic and clinical characteristics of the participants

Variables	Pilates group (n=11)		Control group (n=9)	
	Mean ± SD		Mean ± SD	
Age (years)	47.2 ± 9.5		49.7 ± 8.9	
Body Mass Index (BMI) (kg/m^2)	23.7 ± 3.2		24.9 ± 5.2	
Illness duration (years)	14.8 ± 7.4		14.2 ± 9.5	
EDSS	3.2 ± 2.2		2.8 ± 1.4	
	n	%	n	%
Education level				
Primary education	2	18.2	4	44.4
Secondary education	4	36.4	1	11.1
Higher education	5	45.5	4	44.4
Number of falls*				
None				
Once	4	36.4	2	22.2
Twice	2	18.2	1	11.1
3 times or more	5	45.5	6	66.7
Marital status				
Married	5	55.5	6	54.5
Single	4	44.5	5	45.4
Employment				
Employed	3	27.3	1	11.1
Unemployed	8	72.7	8	88.9
Assistive Device				
Using	3	27.3	2	22.2
Not-using	8	72.7	7	77.8
Gender				
Female	7	63.6	6	66.7
Male	4	36.4	3	33.3

* In the last 6 months

ates balance in sitting and standing positions and rates performance from 0 (cannot perform) to 4 (normal performance). The scale has fifteen items that explore the ability to sit, stand, lean, turn, and maintain an upright position on one leg. The BBS has been validated for use in patients with MS[8]. The BBS includes 14 items, giving a maximum score of 56. It is a valid and reliable tool for people with MS[9].

Timed performance tests were used to assess physical performance. Measurements were recorded with a stopwatch in seconds. The tests were conducted three times, and maximum values were recorded. The tests were as follows:

1. Time to roll from right to left: While lying in a supine position on a mat, the patient was asked to roll to one side and return to the supine position as quickly as possible. The patient repeated the roll to the opposite side.

2. Lie/sit test: Starting from a back-lying position, the patients were asked to move into their usual sitting position by turning a side their swinging feet.

3. Sit/stand test: Patients were asked to sit on a bed set at a standard height from the floor and stand up once.

4. Repeated sit/stand (on/from a chair): The patients were asked to sit on a chair set at a standard height and stand up 3 times.

5. 50-foot walking test: The patients were timed while they walked 25 feet as fast as possible, turned, and walked rapidly back to the starting point. The 50-foot walking test was recorded in seconds[6].

The Timed Up and Go test (TUG) was used for assessing walking performance. The TUG test is a commonly used instrument that measures the time taken to rise from a chair, walk 3 meters, turn, walk back, and sit down again. It is a valid and reliable tool for patients with MS, and one measurement is sufficient. In the present study, the participants were encouraged to walk safely but as quickly as possible. One practice attempt was allowed before the actual testing[7]. Test results were recorded for left and right turning. Lower values were considered better scores.

The Trunk Impairment Scale (TIS) was used to assess static and dynamic sitting balance and trunk coordination and control in a sitting position. The static subscale investigates the ability of the subject to maintain the sitting position with the feet supported, while the legs are passively crossed, and when the subject crosses the legs actively. Subjects with MS crossed the strongest leg over the weakest leg[10]. Results were analyzed under three headings, namely static, dynamic, and coordination[8].
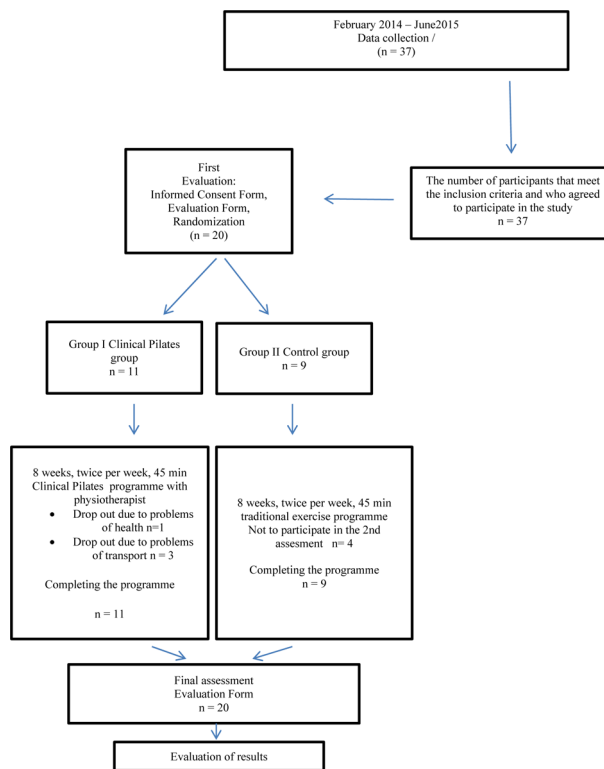
Fig. 1. Flowchart of the study

The Modified Fatigue Impact Scale (MFIS) was used for evaluation of fatigue. The MFIS is a 21-item scale used to evaluate the impact of fatigue with regard to psychosocial, cognitive, and physical functioning. The self-reported ratings of each item range from 0 (never) to 4 (almost always), for a total possible score ranging from 0 to 84 points. Higher scores indicate a stronger impact of fatigue on activities of daily living[11]. Higher scores indicate a stronger impact of fatigue.

The Multiple Sclerosis International Quality of Life Questionnaire (MusiQoL) was used for measurement of quality of life. The MusiQoL questionnaire comprises 31 questions in 9 dimensions (subscales): activities of daily living (8 items), psychological well-being (4 items), symptoms (4 items), relationships with friends (3 items), relationships with family (3 items), sentimental and sexual life (2 items), coping (2 items), rejection (2 items), and relationships with healthcare system (3 items). The index score is computed as the mean of these subscale scores. All 9 dimensions and the index score are linearly transformed and standardized on a 0 to 100 scale, where 0 indicates the worst possible level of quality of life (QoL) and 100 indicates the best level. Differential item functioning analysis was performed in an initial validation study showing satisfactory results across countries[12].

Each patient completed the Beck Depression Inventory (BDI), which is a 4-point Likert-type self-rating scale developed by Beck. The validity and reliability of the scale was assessed by Hisli (1989), and the Cronbach's alpha coefficient of the scale was found to be 0.80. Assesment of the validity and reliability study of the Turkish version of the scale revealed that the cutoff point was 17. The total score ranges from 0–63. Higher results indicate depression.

The SPSS 16.0 software was used to analyze data. Descriptive statistics were calculated for demographic characteristics, and the Wilcoxon test was used to evaluate scores obtained before and after the intervention, while the Mann-Whitney U test was used for testing the differences between groups.

RESULTS

Demographic and clinical characteristics of the participants are shown in Table 1. There were statistically significant differences in the clinical Pilates group in terms of BBS, timed performance tests, MFIS and PASAT step of the MFCS between before and after the intervention (p<0.05).

On the other hand, in the control group, we also found statistically significant differences in timed performance tests (except time to left), the Timed Up and Go Test, and the NHPT step of the MFSC between before and after the intervention (p<0.05).

To test our hypothesis, we conducted a difference analysis between the clinical Pilates and control groups. We found statistically significant differences in PASAT (MFSC) and MusiQol in favor of the clinical Pilates group (p<0.05) (Tables 2, and 3).

Table 2. Balance, gross motor coordination, and mobility scores before and after exercise

		Pilates group (n=11) Mean±SD	Control group (n=9) Mean±SD
Berg Balance Test			
	Before	50.64 ± 6.41	44.67 ± 10.99
	After	53.55 ± 4.16*	47.78 ± 13.89
Trunk Impairment Scale			
Static	Before	6.09 ± 2.07	5.89 ± 1.36
	After	6.73 ± 0.47	6.33 ± 0.71
Dynamic	Before	718 ± 2.99	7.33 ± 3.35
	After	9 ± 1.67	7.33 ± 3.08
Core	Before	6 ± 0.89	5.44 ± 1.33
	After	5.91 ± 0.3	5.56 ± 0.88
Pyical performance tests			
Rling to right	Before	5 ± 1.22	5.68 ± 1.58
	After	3.3 ± 1.21*	3.65 ± 0.94*
Rolling to left	Before	4.56 ± 1.13	5.77 ± 1.96
	After	3.07 ± 0.54*	3.64 ± 1.15*
Lie/sit test	Before	5.78 ± 4.53	7.29 ± 3.97
	After	3.56 ± 1.47*	4.13 ± 2.11*
Sit/stand	Before	3.12 ± 1.39	3.61 ± 1.23
	After	1.98 ± 0.96*	2.35 ± 1.61*
Repeated sit/stand	Before	9.73 ± 2.66	9.74 ± 3.38
	After	7.52 ± 1.93*	6.37 ± 2.86*
50-foot walking	Before	30.2 ± 7.29	26.36 ± 10.1
	After	26.45 ± 5.13*	24.07 ± 9.56*
Timed Up and Go test			
Right	Before	9.62 ± 5.61	10.44 ± 5.04
	After	10.74 ± 7.51	9.47 ± 4.30*
Left	Before	9.6 ± 5	11.33 ± 5.27
	After	12.2 ± 8.74	9.13 ± 4.25*

*Statistically significant differences
Mann-Whitney U test (difference between independent groups)

DISCUSSION

In this controlled randomized study, the effects of clinical Pilates on body control, balance, QoL, fatigue, and cognition were investigated in MS patients.

Physical performance tests have been studied in a geriatric group, and these tests represent a measurement system commonly used in physiotherapy evaluations. Parameters such as rotation and moving to a sitting position from a supine position, which are examined in physical performance tests, evaluate activities of daily living. Activities such as rotation, sitting up, and standing up from a sitting position require successful countering of gravity and better use of the trunk muscles. These measurements are important for determining failure of body muscle control. The target muscle groups of clinical Pilates training are the trunk muscles. Clinical Pilates is an effective form of training for the postural muscles. In this respect, making these measurements is thought to have a great importance in terms of manifest clinical Pilates effects. Dorado et al. studied the effects of Pilates on the volume of the rectus abdominis, obliques, and transversus abdominis, with the last two considered conjointly with magnetic resonance imaging. Their study revealed the existence of asymmetries in the muscles of the abdominal wall in nonactive healthy women. Performance of Pilates exercises twice a week for nine months elicited hypertrophy of the abdominal wall muscles, particularly of the rectus abdominis, and eliminated preexisting asymmetries of the obliques and transversus abdominis. They concluded that Pilates can be recommended as an effective method to reinforce the muscles of the abdominal wall and to compensate for preexisting asymmetric developments[13]. The effects of Pilates on limb movements are discussed in other Pilates studies. However, we used physical performance tests requiring body control because of the primarily major muscle groups are body muscles in the Activities of Daily Living (ADL). According to the results of our study, clinical Pilates is an effective exercise method in patients with MS for improving the ability to perform ADL.

Table 3. Fatigue, depression, impairment, and quality of life before and after exercises

		Pilates group (n=11)	Control group (n=9)
		Mean±SD	Mean±SD
Modified fatigue impact scale			
Cognitive	Before	8.82 ± 5.49	8.11 ± 10.73
	After	5.82 ± 5.04*	7.33 ± 6.60
Physical	Before	9.73 ± 4.43	11.56 ± 9.33
	After	7.18 ± 3.63*	7.44 ± 5.27
Social	Before	15.45 ± 12.88	17.33 ± 13.09
	After	7.64 ± 9.60*	13.11 ± 10.24
Beck depression inventory	Before	10.18 ± 5.23	11.44 ± 6.52
	After	7.91 ± 6.86	9.78 ± 5.26
MSFC – PASAT	Before	44.91 ± 11.63	27 ± 16.91
	After	47.82 ± 11.21*	27.89 ± 13.17*
HPT dominant	Before	21.51 ± 6.39	29.29 ± 13.33
	After	21.49 ± 5.24	26.37 ± 10.93*
HPT nondominant	Before	24.75 ± 5.68	38.98 ± 35.55
	After	23.5 ± 4.74	35.59 ± 35.56*
25-foot walking	Before	7.41 ± 4.15	9.76 ± 8.23
	After	7.18 ± 4.74	9.36 ± 8.05*
MusiQol	Before	28.22 ± 9.06	44.44 ± 16.06
	After	23.82 ± 7.53	40.05 ± 17.96*

*Statistically significant ($p < 0.05$)
Mann-Whitney U test (difference between independent groups)

Clinical Pilates is an exercise program basically affecting the trunk muscles, and it has characteristics similar to daily activities and includes exercises in different positions and with progressive features[14]. Clinical Pilates primarily affects core stabilization, running posture, and muscles[15]. In this regard, we believe that it is important to evaluate different tests of the trunk muscles beyond the physical performance tests and introduce changes. In previous studies, the clinical effects of Pilates on parameters such as stability were generally investigated[16]. In the present study, we used the TIS, which evaluated the control of body muscles other than those mentioned in previous studies. The TIS is a scale that is used in stroke patients, but it can also be used in patients with MS for assessing trunk impairment[10]. Clinical Pilates is a system focused on the correct use of four core muscles, the diaphragm, transverses abdominis, multifidus, and pelvic floor muscles. However, there were no meaningful changes in the TIS in the patients who participated in this study. It is thought that this may be related to the training period. In previous studies on clinical Pilates, the training period was between 12 to 16 weeks[17]. The finding can be explained by an insufficient number of cases in studies that had a training period of 8 weeks, as in our study. Future studies with more cases and longer training periods should investigate this association.

Clinical Pilates, is an exercise program based on the trunk muscles that affects the level of proficiency in ADL. Competency in ADL would also affect quality of life. In this respect, a specific MS QoL questionnaire was used in assessing the effects of exercise therapy. The MusiQol is a widely used scale. The results of our study revealed that clinical Pilates has significantly positive effects on QoL based on comparison with our control group. In the literature, there are no studies that have investigated the effect of clinical Pilates on QoL in MS patients. The present study is noteworthy because it demonstrated the effect of clinical Pilates on QoL in MS patients. The PASAT is a measure of cognition and is included in the MSFC. In the present study, the possible association between cognition and exercise was examined. In the literature, there are only a small number of studies that have investigated the effects of exercise and particularly aerobic exercise, on cognition. There are no studies examining the effects of Clinical Pilates on cognition. In this respect, the current study is the first study to examine such an association.

In the literature, the effects of exercise on cognition were studied with different groups. In a randomized study by Sun et al.; Tai chi exercises were shown to be effective in the cognitive functions on elderly[18]. On the other hand, in a study on cerebral palsy it's shown that there are relationships between physical and cognitive functions[19]. A study by Laitman showed the effect of exercise on cognitive integrity in the aging brain. Notably, the study further linked the protective effects of chronic exercise on cognition to neurovascular integrity during aging[20].

Cognitive impairment may occur in up to 70% of all patients with MS. The prevalence of cognitive impairment is about 40–65% in patients with MS. Neuropsychological assessments are important in MS to predict prognosis and cognitive outcome in treatment trials. In particular, cognitive impairment may lead to a reduced QoL, loss of work, and problems with the

social environment. Today, there are three avenues for treatment: disease modifying therapies, symptomatic treatments, and cognitive rehabilitation[21]. Our results revealed that clinical Pilates leads to positive changes in cognition within MS therapy; this effect of Clinical Pilates was demonstrated for the first time in this study. We think that this is very important.

According to the results of this study, clinical Pilates can be used as an effective treatment method in MS due to its positive effects on physical parameters, such as balance, performance, and fatigue; cognitive problems; and QoL. The literature includes studies on balance and fatigue. A study by Güçlü-Gündüz et al. investigated the effects of clinical Pilates training on balance, mobility, and strength in MS patients. The authors found that clinical Pilates training may develop balance, mobility, and muscle strength in MS Patients[3].

Freeman and his friends conducted a multicenter, double blind, block randomized, controlled trial. Similar to our study, they used clinical Pilates based core stability training in one group and standardized physiotherapy exercise in their other group[22]. In a study by Marandi and co-researchers[23], clinical Pilates exercises were performed by MS patients. Pilates interventions can significantly increase the dynamic balance of the examinees in the post-experiment stage[24]. The results of our study seem to be consistent with these findings.

In a single blind randomized study by Tarakçı et al., MS patients received group exercises. In the results of their study, it was concluded that group exercise had positive effects on balance, functional status, spasticity, fatigue, and QoL[25]. In our study, the exercise programs in the clinical Pilates and control groups were applied in a group format. However, although both exercise programs were applied as group exercise, different effects on balance, fatigue, and QoL were found. The significant differences found in the clinical Pilates group were thought to derive from clinical Pilates rather than group exercises. Clinical Pilates led to significant changes in the PASAT, MusiQol, physical performance tests, and balance parameters, so it can be used for MS patients reliably. Furthermore, the results obtained from our study were the results of an 8-week exercise program. The effects of longer periods of clinical Pilates are of interest, and we plan to investigate this in the future. The study is going on with more subjects.

A strength of our study was that it was an interdisciplinary. It was also the first study investigating the effects of exercise on cognitive functions in people with MS.

A limitation of our study is the low number of patients. We started the study with 35 people, but not all could complete the study.

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