International Journal of Clinical Trials
Matsouki E et al. Int J Clin Trials. 2024 Aug;11(3):240-251
http://www.ijclinicaltrials.com
pISSN 2349-3240 | eISSN 2349-3259
DOI: https://dx.doi.org/10.18203/2349-3259.ijct20241618

Systematic Review

The effectiveness of the therapeutic exercise Clinical Pilates in adult patients with multiple sclerosis: a systematic review

Eleni Matsouki[1], Georgios Marios Kyriakatis[2]*

[1]Department of Physiotherapy, School of Health Rehabilitation Sciences, University of Patras, Rion, Achaia, Greece
[2]Department of Physiotherapy, School of Health Sciences, University of Thessaly, 3rd km Old National Road Lamia-Athens, Lamia, Greece

Received: 07 June 2024
Revised: 12 June 2024
Accepted: 13 June 2024

***Correspondence:**
Georgios Marios Kyriakatis,
E-mail: georgemarioskiriakatis2000@gmail.com

ABSTRACT

Existing literature supports various forms of exercise as appropriate for treating people with multiple sclerosis (MS) with mild or more severe symptoms. In recent years, Pilates is a form of therapeutic exercise used more and more often in rehabilitating people with MS. The purpose of this systematic review is to explore the effectiveness of the clinical Pilates method in adult people with MS. Research was performed in 4 scientific databases (PubMed/MEDLINE, ScienceDirect, PEDro and Scopus) using the following keywords: multiple sclerosis, MS, Pilates and Clinical Pilates. Inclusion criteria were studies randomized controlled, written in English, published in 2012-2022, with adult people with MS and where the intervention should have been only the Pilates method and the results had to be relevant to physiotherapy. The methodological quality of the studies included was assessed by PEDro Scale. From a total of 329 initial records, only 12 studies were included. Results show that Pilates can improve balance, gait, functionality, physical and cognitive capacity, quality of life and body composition in adult people with MS and with mild to moderate disability. Fatigue, anxiety and depression levels did not show clear improvement after the application of the Pilates exercises in comparison with other therapeutic exercises. Pilates is a safe method of exercise for adult people with MS and can improve many symptoms. It is necessary more research to be conducted so that the effectiveness of the Pilates exercises be explored further on different parameters in patients with MS, like fatigue.

Keywords: Multiple sclerosis, Pilates, Mat pilates, Exercise method, Physiotherapy

INTRODUCTION

Multiple sclerosis (MS) is an inflammatory autoimmune disease of the central nervous system manifesting various forms of progression. The most common form of MS is the relapsing-remitting form, which is characterized by periods of remissions and relapses of symptoms.[1] It is estimated that 2.5 million people worldwide suffer from MS, while 500,000 of them are European citizens.[2]

Most patients with MS experience numbness and non-physiological muscle tone and weakness, especially in the lower limbs, resulting in gait difficulties.[3] Fatigue and visual problems are also evident in 40% of patients, while smaller proportions of patients have pain, dizziness, bladder and bowel dysfunctions, depression, or varying levels of cognitive disorders.[4] All the above deficits result in gradual loss of walking and independence of the patients with MS, which in turn, result in decreased quality of life and participation of people with MS in the community.[5]

The literature supports a large number of exercise modalities as suitable for treating less or more severe

symptoms of the patients with MS, but without demonstrating any particular one as the most effective.[6] For example, there are studies that suggest that stretching and high-intensity aerobic exercise help relax spasticity and increase aerobic capacity respectively, but various studies conclude that a combination of different types of exercise might be more effective for these patients.[3,7-9]

A therapeutic exercise method that combines different types of exercises and has been increasingly used in the recent years for people with MS is Pilates method (Clinical Pilates or Therapeutic Pilates).[10,11] The Pilates method involves repetitive exercises that aim to increase strength, flexibility and endurance of the muscles. All exercises are followed by certain rules that must be strictly applied in order to achieve the maximum effect of the exercises and avoid injuries.[12] Patients with MS who were in a wheelchair seem to have noticed physical, psychological and social benefits, an improvement in their sitting position and a reduction in shoulder and back pain, while home exercise with Pilates improved symptoms of anxiety, depression and fatigue in patients with mild to moderate mobility problems.[10,11] Pilates is an exercise method that can be performed individually or in groups, combining exercises to strengthen and stretch the body's contracting structures (muscles, ligaments and fasciae), as well as exercises to mobilise and stabilise the spine and the peripheral joints.[13]

The combination of Pilates and other forms of exercise seems to be more effective on some parameters of MS based on some research. Better results in controlling fatigue is when Pilates is combined with aerobic exercise by regulating the body's neuroimmune parameters since cytokine levels are regulated and the anti-inflammatory action of serotonin is enhanced.[14] A randomized controlled trial (RCT) concluded that combined resistance, Pilates, resistance, balance and stretching exercise activates neurotrophin production and release regardless of their disability level and thus the modified exercise may have effects in people with MS and different fitness levels, while the same combination of exercises activated anti-inflammatory processes with the production of substances such as pentraxin and cytokine.[15,16]

In modern international literature, there is a scientific gap in terms of systematic reviews that include only RCTs and that exclusively evaluate the application of Pilates programs in adult patients with MS and not in combination with other interventions. The present study will attempt to address the need to draw objective conclusions about the effectiveness of Pilates therapy in people with MS on parameters of physical, mental and cognitive function.

Therefore, the purpose of this systematic review was to investigate the effect of the Clinical Pilates therapeutic exercise method on adults with MS.

METHODS

This systematic review was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[17]

Search strategy and selection process

Search of eligible reports was conducted in four databases: PubMed/MEDLINE, Science Direct, Physiotherapy Evidence Database (PEDro) and Scopus from 2012 and until May 2022. Key terms relevant to multiple sclerosis and Pilates were used. Studies that initially met the inclusion criteria for the systematic review were entered in Mendeley reference manager. After duplicates were deleted, evaluation of the references' titles and abstracts was performed according to the pre-determined inclusion and exclusion criteria and irrelevant references were deleted. After the full texts of the included in the review studies were retrieved.

Eligibility criteria

The inclusion and exclusion criteria of the review were based on the Population/Patient, Intervention, Comparison, Outcomes (PICO) structure and are presented in Table 1. Only RCTs were meant to be included in this study.

Table 1: Inclusion and exclusion criteria of the studies.

Criteria	Inclusion	Exclusion
P	Adult people with MS (>18 years old)	Pediatric population (<18 years old)
I	Exclusively Pilates exercises	Combination of Pilates exercises and other types of exercises like aerobics, resistance, endurance, PNF or aquatic exercises
C	Presence of Control group	No control group
O	Outcomes relevant to gait, posture control//balance, fatigue, sensory integration, quality of life, physical condition, cognition etc.	Outcomes such as production of substances of the immune system (cytokine, interleukin) etc.
Year of publication	2012 – 2022	Prior of 2012
Language	English	Other than English

P=population; I=intervention; C=comparison; O=outcomes, PNF=proprioceptive neuromuscular facilitation.

Data collection process and data items

Data from studies were extracted by one person and checked by a second person. The data extracted included the characteristics of the participants (age, gender, severity of condition); the type of intervention (Pilates) and its parameters (duration of session, number of sessions and total program duration); the type of intervention of the control group and the outcome measures at post-intervention and if available at follow-up.

Quality assessment of the trials

The quality of the studies was assessed independently using the PEDro scale (Physiotherapy Evidence Database scale) by both the two authors.[18] The PEDro scale is a tool for evaluating studies involving physiotherapy interventions and in particular RCTs. It includes a total of 11 criteria with the first criterion relating to the external validity of the study, the second to ninth criteria relating to the internal validity of the study, while the last two criteria assess the statistical evidence so that the results of the study can be interpreted. Each criterion is scored 0 or 1 point, except for the first criterion which is not scored and the total score of a study can range from 0 to 10. Studies with a score 0-3 are rated as of "low methodological quality", with a score 4-5 as of "moderate methodological quality", with a score of 6-8 as of "good methodological quality" and with a score 9-10 as of "excellent methodological quality".[19]

RESULTS

Study selection

The search of the 4 databases retrieved 329 records and after duplicates were deleted 258 records remained for screening. Of these, 58 records were published before 2012 and, thus, 200 records remained for further screening. After reading the titles and abstracts, 169 studies were discarded, 3 studies were discarded due to lack of access to the full text of the studies, and finally, 12 studies were included to the review according to the inclusion and exclusion criteria. The flowchart of the PRISMA 2020 for the selection process of the studies is presented in Figure 1.

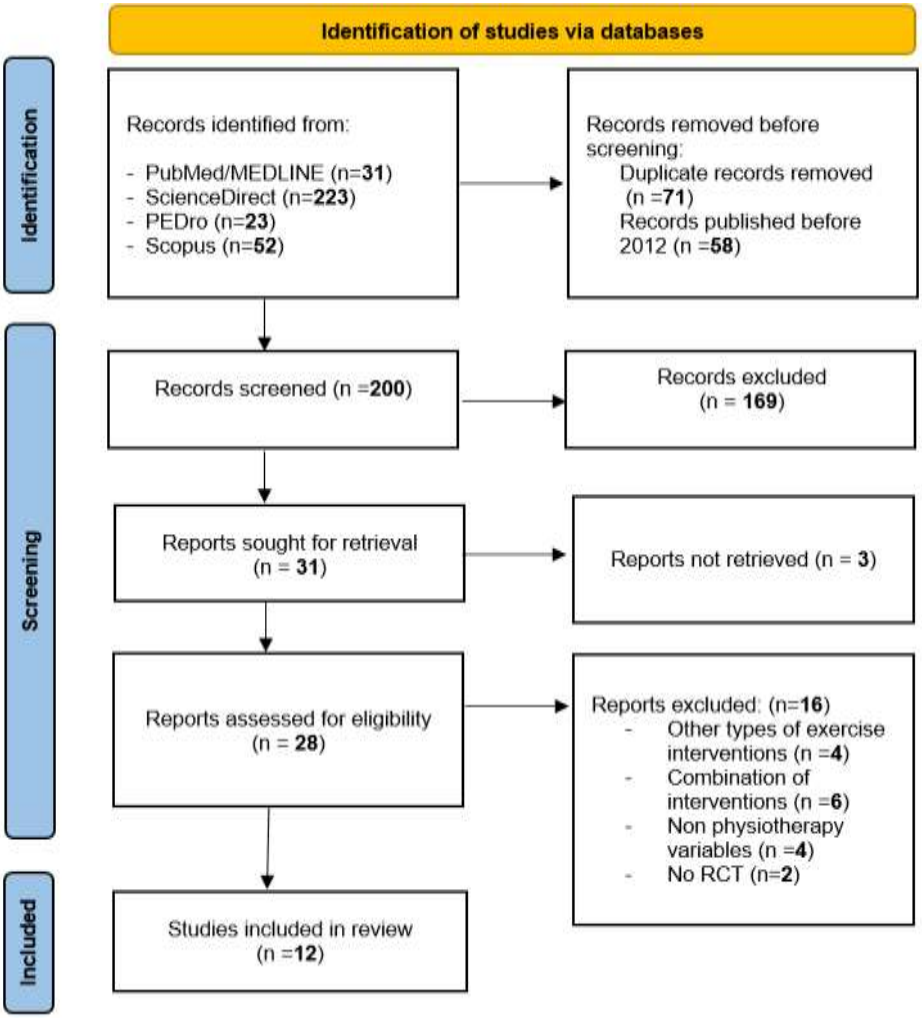

Figure 1: Flowchart of the selection of the studies process.

PEDro=Physiotherapy evidence database, RCT=randomized controlled trial.

Table 2: Characteristics of the studies.

Study	Design	Sample	Intervention group	Control group	Outcomes / measurement tools
Fleming et al[11]	Single-blind RCT	Total n=80 (69 women, 11 men) with mean age 47.1±10, Intervention group (n=39), Control group (n=41), (PDDS<3)	Twice weekly (48 hours apart) individualized Pilates sessions supported by DVD for 8 weeks at home, 60 min/session	Waiting list maintaining pre-intervention physical activity levels	Anxiety symptoms (STAI-Y2, HADS-A), depression (QIDS, HADS-D) and fatigue (MFIS)
Gheitasi et al[21]	Prospective, parallel RCT	Total n=30 men with mean age 31.35±5.7 Intervention group (n=15), Control group (n=15), (EDSS=4.55±1.1)	Individualized Pilates program in clinic for 12 weeks, 3 times a week, 60 min/session	Usual care by their medical doctor	Balance (BBS test, TUG test, FRT)
Güngör et al[29]	Single-blind, parallel, double-armed RCT	Total n=50 Age range 20-65 Intervention group (n=25), Control group (n=25), (EDSS<6)	Individualized Pilates program in clinic for 8 weeks, twice a week, 60-75 min/session	Individualized Pilates program at home for 8 weeks, 2 times a week	Isokinetic strength of quadriceps and hamstrings (dynamometer Biodex Multi-Joint System), postural sway (m-CTSIB, BESSTest, PST), core endurance and strength (Biering-Sorensen test, endurance exercises)
Abasıyanık et al[25]	RCT	Total n=33 with mean age 45.45±9.98 Intervention group (n=16), Control group (n=17), (EDSS=3.15±1.69)	Group Pilates program once a week (55-60min/session) plus a two-day home exercise program for 8 weeks	Standardized home exercises different from the Pilates exercises for 3 times per week for 8 weeks	Gait (6MWT, T25FW, TUG, MSWS-12), balance (Biodex Balance System, FES-I, ABC Scale), core stability (curl-up test), respiratory muscle strength (MIP and MEP), cognitive level (BICAMS)
Fleming et al[27]	RCT (pilot)	Total n=18 (17 women, 1 man) with mean age 49.8±8.4 Intervention group A (n=5), intervention group B (n=6), Control group (n=7), (EDSS < 3)	Supervised Pilates Mat sessions in the University of Limerick (Group A) or home-based Pilates program supported by DVD (Group B) for 8 weeks, twice a week, approximately 60 min/session	Waiting list maintaining pre-trial activity levels	Anxiety symptoms, depression, fatigue (MFIS, POMS-B, STAI-Y1, HADS, QIDS, 7d-PAR, GLTEQ)
Eftekhari et al[22]	RCT	Total n=30 women with mean age 33.00±8.08, Intervention group (n=15), Control group (n=15), (EDSS=2 - 6)	Pilates Mat training for 8 weeks, 3 days/week, 50-60 min/session	Routine life	Body weight (Seca Vogel & Halke scale), height, circumferences of waist, hip, mild arm and calf (plastic measuring tape), BMI, FM, BD and FP, skin folds (caliper MK-60, Yagami), balance (BBS), gait (10MWT, 6MWT), fatigue (MFIS)
Bulguroglu et al[30]	RCT	Total n=38 Intervention group A (n=12), intervention group B (n=13), Control group (n=13), (EDSS<4)	Individualized Mat Pilates (Group A) or Reformer Pilates (Group B) sessions with supervision for 8 weeks, twice a week, 60-90 min/session	Home program with relaxation and respiration exercises for 8 weeks, twice a week	Balance, functional mobility, core stability, fatigue severity, quality of life (Single Leg Stance, TUG, ABC, FSS, MSQOL-54)

Continued.

Study	Design	Sample	Intervention group	Control group	Outcomes / measurement tools
Kalron et al[24]	Prospective, assessor blinded, parallel RCT	Total n=45 (29 women, 16 men) with mean age 43.2±11.6 Intervention group (n=22), Control group (n=23), (EDSS=4.3±1.3)	12 half-hour individualized face to face Pilates training sessions for 12 weeks, plus an individualized 15-minute daily home exercise program	12 half-hour individualized face to face physiotherapy sessions for 12 weeks, plus an individualized 15-minute daily home exercise program	Clinical balance, gait, fatigue, physical, cognitive and psychosocial functioning (TUG, 2MWT, 6MWT, FRT, BBS, FSST, MSWS-12, MFIS)
Fox et al[23]	Multi-centre, assessor-blinded, pragmatic, tree-armed RCT	Total n=100 (74% women) with mean age 54,13±10,14 Intervention group A (n=33), intervention group B (n=35), Control group (n=32), (EDSS=4.0 - 6.5)	Individualized Pilates program (Group A) or standardized exercise program (Group B) with supervision for 12 weeks, once a week, 30 min/session, plus an individualized 15-minute daily home exercise program	Individualized 15-minute daily relaxation program at home with audio DVD facilitation for 12 weeks plus three face-to-face individualized relaxation sessions in a clinic	Gait, walking velocity, balance confidence, walking impairments (10MWT, FRT, MSWS-12, ABC, NRS)
Küçük et al[28]	RCT	Total n=20 Intervention group (n=11) with mean age 47.2±9.5 and EDSS 3.2±2.2, Control group (n=9) with mean age 49.7±8.9 and EDSS 2.8±1.4, (EDSS < 6)	Group Pilates program for 8 weeks, twice a week, 45-60 min/session	Traditional exercises (strength, balance and coordination exercises)	Cognitive impairment (MSFC), static and dynamic balance (BBS), physical performance (TUG, TIS), fatigue (MFIS), depression (BDI), quality of life (MusiQol)
Guclu-Gunduz et al[26]	Single-blinded, controlled RCT	Total n=26 Intervention group (n=18) with mean age 36 (29 – 40), EDSS 2 (0.75–3.5), Control group (n=8) with mean age 36 (27.75 – 45.25), (EDSS=1 – 3.13)	Group Pilates program for 8 weeks, twice a week, 60 min/session	8 weeks home exercise program (2 days/week) including abdominal breathing and active extremity exercises	Balance (BBS), mobility (TUG, ABC), upper and lower extremity muscle strength (dynamometer Baseline®, White Plains, New York, USA)
Hosseini Sisi et al[20]	RCT	Total n=45 men with mean age 30.3±8.3 Intervention group A (n=15), intervention group B (n=15), Control group (n=15), (EDSS=0 -4)	Rebound therapy (Group A) or Pilates program (Group B) for 8 weeks, 24 sessions, 30 min/session	Usual treatment	Static (BBS) and dynamic (TGUG) balance

RCT=Randomized Control Trial, n=number of participants, PDDS=Patient-Determined Disease Step Score, STAI=State-Trait Anxiety Inventory, HADS=Hospital Anxiety and Depression Scale, QIDS=Quick Inventory of Depressive Symptomatology, MFIS=Modified Fatigue Impact Scale, EDSS=Expanded Disability Status Scale, m-CTSIB=modified Clinical Test of Sensory Integration of Balance, BESS=Balance Error Scoring System, PST=Postural Stability Test, BBS=Berg's Balance Scale, TUG test=Time Up and Go test, FRT=Functional Reach Test, 6MWT=Six-Minute Walk Test, T25FW=The Timed 25-Foot Walk, MSWS-12=The 12-item MS Walking Scale, FES-I=Falls Efficacy Scale International, ABC=Activities-Specific Balance Confidence, MIP=Maximum Inspiratory Pressure, MEP=Maximum Expiratory Pressure, BICAMS=Brief International Cognitive Assessment for Multiple Sclerosis, POMS-B=Profile of Mood States – Brief Form, 7d-PAR=Seven-day Physical Activity Recall Scale, GLTEQ=Godin Leisure-Time Exercise Questionnaire, BMI=Body Mass Index, FM=Fat Mass, BD=Body Density, FP=Fat Percentage, 10MWT=Timed 10-Meter Walk Test, FSS=Fatigue Severity Scale, MSQOL-54=Multiple Sclerosis Quality of Life Instrument, 2MWT=Timed 2-Meter Walk Test, FSST=Four Square Step Test, MSWS-12=12-Item Multiple Sclerosis Walking Scale, NRS=Numeric Rating Scale, MSFC=Multiple Sclerosis Functional Composite, TIS=Trunk Impairment Scale, BDI=Beck Depression Inventory, MusiQol=Multiple Sclerosis International Quality of Life Questionnaire, TGUG=Timed Get-Up-and-Go.

Table 3: Assessment of the methodological quality of the studies for adherence to quality criteria and risk of bias based on the PEDro Scale.

Study	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	Total Score	Quality
Fleming et al[11]	1	1	0	1	0	0	1	1	1	1	1	7/10	Good
Gheitasi et al[21]	1	1	1	1	0	0	0	1	1	1	1	7/10	Good
Güngör et al[29]	1	1	1	1	1	0	0	0	0	1	1	6/10	Good
Abasıyanık et al[25]	1	1	0	1	0	0	0	0	0	1	1	4/10	Fair
Fleming et al[27]	1	1	1	1	0	0	0	0	0	0	1	4/10	Fair
Eftekhari et al[22]	1	1	0	1	0	0	0	0	0	1	1	4/10	Fair
Bulguroglu et al[30]	1	1	0	1	0	0	1	0	0	1	1	5/10	Fair
Kalron et al[24]	1	1	1	1	0	0	1	1	0	1	1	7/10	Good
Fox et al[23]	1	1	1	1	0	0	1	1	1	1	1	8/10	Good
Küçük et al[28]	1	1	0	1	0	0	0	1	0	1	1	5/10	Fair
Guclu-Gunduz et al[26]	1	0	0	1	0	0	1	1	1	0	1	5/10	Fair
Hosseini Sisi et al[20]	1	1	0	0	0	0	0	0	0	1	1	3/10	Low

#1=eligibility criteria, #2=random allocation, #3=concealed allocation, #4=baseline comparability, #5=participant blinding, #6=therapist blinding, #7=assessor blinding, #8=outcome data > 85%, #9=intention to treat analysis, #10=between-group difference, #11=point estimates and variability.

Table 4: Results of studies.

Study	Results
Fleming et al[11]	Pilates was statistically more effective than wait-listing on all of the above parameters (depression, anxiety, and fatigue) at 8 weeks ($p<0.001$). The results were identical in the analysis of the measurements only for the women in the sample and therefore there was no statistically significant effect of the gender variable on the results.
Gheitasi et al[21]	Balance test scores increased significantly in the Pilates group compared to the control group (usual care) after 12 weeks (pBBS=0.001, pTUG=0.003, pFRT=0.002).
Güngör et al[29]	Quadriceps and hamstring muscle strength improved statistically significantly at all angular velocities in both lower limbs in both the supervised Pilates group in a clinic and the home Pilates group ($p<0.001$) after 8 weeks compared to before the intervention. Only supervised Pilates significantly improved postural swing parameters (except with eyes closed and medial lateral swing) ($p<0.001$) after 8 weeks compared to baseline measurements. Endurance, strength and core physical capacity increased more in the group doing supervised Pilates compared to those doing an individual home program ($p<0.001$), while no statistically significant difference was observed between the two groups in fatigue ($p>0.001$).
Abasıyanık et al[25]	Balance and gait assessments had statistically significant improvement in the Clinical Pilates group after the end of the intervention ($p<0.05$) at 8 weeks. The number of improvements in respiratory muscle strength and cognitive level were significantly higher in the Clinical Pilates group than in the group doing other types of home exercises ($p<0.05$) after 8 weeks.
Fleming et al[27]	A statistically significant effect of time on total fatigue was observed in all groups (supervised Pilates, Pilates at home, Pilates on a waiting list) at 8 weeks ($p\leq0.006$) compared to before the interventions. Exercising at home statistically significantly reduced depression ($p\leq0.02$) and total fatigue ($p\leq0.02$) at 8 weeks compared to the control group. In the supervised Pilates group the anxiety symptoms were statistically higher compared to Pilates at home ($p\leq0.023$), while there was no statistically significant difference with those on a waiting list ($p\geq0.053$) after 8 weeks.

Continued.

Study	Results
Eftekhari et al[22]	There was a statistically significant reduction in weight and fat mass in both groups (Pilates and control) ($p<0.05$) after 8 weeks, but no statistically significant change in lean body mass ($p>0.05$) compared to baseline measurements. Waist, hip and arm circumference decreased significantly in both intervention groups ($p<0.05$), but there was no change in calf circumference ($p>0.05$) after 8 weeks compared to baseline. The Pilates group showed statistically significant improvements in balance ($p=0.003$), walking speed ($p=0.000$), endurance ($p=0.004$) and fatigue ($p=0.000$) after the intervention compared to the group that maintained the same lifestyle. A statistically significant difference in favor of Pilates compared to the control group was observed in BMI at 8 weeks ($p \leq 0.05$).
Bulguroglu et al[30]	The Mat Pilates and Reformer Pilates groups had statistically significant improvements in balance, functionality, core stability, fatigue and quality of life after their respective 8-week interventions compared to baseline ($p<0.05$). The control group doing home exercises appeared to improve only the quality of life parameter after 8 weeks compared to baseline ($p<0.05$). No statistically significant differences were observed in any of the parameters except core strength between the Mat Pilates and Reformer Pilates groups at the end of the interventions. More specifically, the trunk flexion test improved statistically significantly more in the Reformer Pilates group than the Mat Pilates group at 8 weeks ($p=0.044$).
Kalron et al[24]	Compared to baseline measurements, both physiotherapy and Pilates produced statistically significant improvements in balance, gait and functionality ($p<0.05$). There did not appear to be a statistically significant difference in the measurements of these parameters between the two interventions before and after 12 weeks ($p<0.05$).
Fox et al[23]	All three groups (standard exercises, Pilates, relaxation exercises) had statistically significant changes in all parameters except NRS immediately after the end of the interventions at 12 weeks compared to baseline measurements ($p<0.05$). Gait speed and movement difficulty improved statistically significantly with standard exercises compared to relaxation exercises ($p<0.05$) at both 12 and 16 weeks. Pilates compared to standard exercises showed statistically significant improvement in the same parameters only at 12 weeks ($p<0.05$) and not at 16 weeks ($p>0.05$).
Küçük et al[28]	The Clinical Pilates group had statistically significant differences in balance (BBS), fatigue (MFIS) and cognitive function (MSFC) on post-intervention measures over 8 weeks compared to before ($p<0.05$), but no statistically significant changes were observed in the parameters of physical fitness (TUG, TIS), depression (BDI) and quality of life (MusiQol) over the same time period ($p>0.05$). A statistically significant difference was also found in the control group in the measures of physical fitness (TUG, TIS) and quality of life (MusiQol) after usual treatment compared to before intervention at 8 weeks ($p<0.05$). Cognitive function (MSFC) and quality of life (MusiQol) improved statistically significantly in the Clinical Pilates group more than in the control group ($p<0.05$) , while there was no statistically significant difference in balance (BBS) at the end of the interventions ($p>0.05$).
Guclu-Gunduz et al[26]	There was a statistically significant improvement in balance (BBS), mobility (TUG, ABC) and upper and lower limb strength after the intervention with Pilates exercises at 8 weeks compared to baseline ($p<0.05$).
Hosseini Sisi et al[20]	Static (BBS) and dynamic (TGUG) balance increased statistically significantly ($p<0.01$) in both experimental groups (trampoline and Pilates), whereas no significant improvement was observed in the control group after 8 weeks compared to before the interventions ($p>0.01$). Trampoline exercise was statistically more effective than Pilates in improving dynamic balance after completing the intervention at 8 weeks ($p<0.01$). Pilates was statistically significantly more effective than trampoline exercise in improving static balance after completing the intervention at 8 weeks ($p<0.01$).

BBS=Berg's Balance Scale, TUG test=Time Up and Go test, FRT=Functional Reach Test, BMI=Body Mass Index, NRS=Numeric Rating Scale, MFIS=Modified Fatigue Impact Scale, MSFC=Multiple Sclerosis Functional Composite, TIS=Trunk Impairment Scale, BDI=Beck Depression Inventory, MusiQol=Multiple Sclerosis International Quality of Life Questionnaire, ABC=Activities-Specific Balance Confidence, TGUG=Timed Get-Up-and-Go.

Study characteristics

All of the studies used in this systematic review are RCTs and one of them is a pilot RCT. Most clinical trials used a small sample size of 18 to 50 people, and only two trials had more than 50 subjects in the sample. In all studies the sample included individuals of both genders, except for two that included only men and one that included only women.[20-22] In one study, a separate analysis of the female sample was conducted to assess the effect of gender on trial parameters.[11] All study participants were ambulatory with an Expanded Disability Status Scale (EDSS) score of less than 6.5.

All of the studies had a total duration of 8 weeks of Pilates interventions, except for three studies that had a total intervention duration of 12 weeks.[21,23,24] The majority of sessions were held twice a week. In three studies, Pilates home exercise instructions were provided alongside the intervention and in two studies DVD-assisted support was provided.[11,23-26] The duration of each session was typically 60 minutes, with a range of 45-90 minutes, with the exception of two studies where the session duration was 30 minutes.[23,24] Sessions were conducted by Pilates-certified physiotherapists, except for two studies that were conducted by certified Pilates instructors.[11,26] Three studies did not report the professional status of the instructors and whether or not they were certified.[20-22]

Pilates's sessions were mainly conducted on an individual level, except for three studies where interventions were conducted in groups.[25,27,28] Two studies did not specify whether it was an individual or group Pilates class and in three studies whether the class was Mat Pilates or Reformer Pilates.[20,22,24,27] In the remaining studies the interventions were Mat Pilates and the use of small equipment such as balls was used, rubber bands and foam rollers.[21,23,25,27,29,30]

All interventions were preceded by training in the basic principles of Pilates and training in lateral breathing and transverse abdominal activation to achieve better core activation and spinal stabilization. Also all interventions were structured in warm-up, main program and recovery and aimed at the recovery of MS symptoms. For this reason, Pilates programs were all dynamic and gradually increased the volume of exercise, either with more repetitions, or with longer session duration, or by using higher resistance, or by changing positions and reducing the support base.[11,21,22,24-30]

In addition, 4 studies did not report at all on whether or not there were any adverse events, while the remaining 8 studies did not observe any adverse events in any participant related to the types of interventions used in the clinical trials. In one study, a specific description is given only for the experimental group where there were no adverse outcomes, and in another it is reported that no adverse or harmful outcomes occurred in any of the groups.[23,24]

The characteristics of the studies used are shown in Table 2.

Quality of studies

The mean qualitative rating of the studies selected for this systematic review is 5.42. One of the studies has low methodological quality with a total score of 3/10, 6 studies have moderate methodological quality (4.5/10±0.5/10) and 5 studies were rated with good methodological quality (6/10±1/10) (Table 3).

Effectiveness of the interventions

The results of each study are presented in Table 4.

Balance

In all studies Pilates seemed to improve some of the balance parameters after the intervention compared to the initial measurements. The Pilates groups had statistically significant improvements in balance compared to usual care ($p<0.05$) and compared to those who followed the same lifestyle ($p<0.05$).[21,22] Pilates was statistically significantly more effective than trampoline exercise in improving static balance after completing the intervention at 8 weeks ($p<0.01$).[20]

Gait

Statistically significant improvement in walking speed in the Pilates group compared to the lifestyle group ($p=0.000$).[22] Other studies found no statistically significant differences between the Pilates groups and the other compared interventions.[23-25]

Fatigue

According to all studies evaluating fatigue, Pilates has a positive effect after implementation in people with MS. Pilates is more effective after 8 weeks of intervention compared to wait-listing ($p<0.001$).[11] Pilates at home statistically significantly reduced overall fatigue compared to waitlist after 8 weeks ($p\leq0.02$).[26] No statistically significant differences found between Pilates and physical therapy groups after 12 weeks ($p>0.05$).[24]

Functionality and physical ability

Functionality and physical fitness include the parameters of strength, endurance, physical and aerobic capacity. All studies had positive results on these parameters using Pilates. More specifically, endurance, strength and core physical capacity increased more in the group that did Pilates with supervision compared to those that did an individual home program ($p<0.001$).[29] Statistically significant increase in trunk flexion strength in the Reformer Pilates group compared to the Mat Pilates group at the end of the interventions ($p<0.05$).[30] Respiratory muscle strength was assessed by peak inspiratory and expiratory pressures and was found to be

significantly increased in the group doing Clinical Pilates compared to the group doing other types of home exercises ($p<0.05$).[25]

Cognitive function & quality of life

Pilates statistically significantly improved the quality of life and cognitive function of study participants compared to before the interventions. The cognitive level was significantly higher in the Clinical Pilates group compared to the group doing other types of home exercises after 8 weeks ($p<0.05$) and the cognitive function and quality of life improved statistically significantly in the Clinical Pilates group more than in the control group following a usual treatment ($p<0.05$).[25,28]

Anxiety & depression

Pilates implementation was statistically more effective on depression and anxiety than waiting list after 8 weeks ($p<0.001$), whereas there were no statistically significant differences between the compared groups in terms of anxiety symptoms after 8 weeks ($p\geq0.053$).[11,27]

Body composition

Pilates had no statistically significant difference in body composition change in women with MS after 8 weeks compared to those who maintained the same lifestyle ($p>0.05$), and only BMI decreased statistically significantly in Pilates group after the intervention ($p\leq0.05$).[22]

Comparison of different forms of Pilates

Comparing Mat Pilates with Reformer Pilates found no statistically significant differences in any of the parameters measured, except core strength, at the end of the interventions ($p>0.05$).[30] More specifically, trunk flexion test improved statistically significantly more in the Reformer Pilates group than the Mat Pilates group after 8 weeks ($p=0.044$).[30] Individual Pilates classes with and without supervision at home and found that endurance, strength and core physical capacity increased more in the group doing Pilates with supervision compared to those doing an unsupervised program ($p<0.001$), while no statistically significant difference was observed between the two groups in fatigue ($p>0.001$).[29]

DISCUSSION

The purpose of this systematic review was to investigate whether there is an effect of Pilates on the symptomatology of adults with MS. The results suggest that the question was answered and filled a gap in the literature. There are other contemporary systematic reviews in the scientific databases that address similar questions to this paper. However, authors in previous systematic reviews not only included RCTs but also other lower quality research designs, while some other authors included interventions combining Pilates with another form of exercise e.g. swimming or with physiotherapy interventions e.g. massage or medication, whereas this systematic review investigated Pilates programs exclusively.[31-34] Furthermore, the results of this review are partially consistent with the results of other contemporary systematic reviews and meta-analyses that have been conducted.

Pilates can be considered as an alternative method of training and improving balance in patients with MS, but was not found to be superior to other interventions and the authors noted that more research is needed to investigate its effectiveness.[35] More specifically, they found that Pilates had a statistically significant difference compared to controls on the BBS ($p=0.041$) and TUG ($p=0.045$) balance tests and the ABC scale ($p=0.024$), but not on the FRT ($p=0.06$). In the present systematic review only two studies give advantages of Pilates exercise over usual care after 12 weeks [BBS ($p=0.001$), TUG ($p=0.003$), FRT ($p=0.002$)] and the maintenance of the same lifestyle after 8 weeks ($p=0.003$).[21,22]

Pilates can also be considered a rehabilitation tool in a wider group of pathologies such as low back pain, ankylosing spondylitis, MS, post-menopausal osteoporosis, non-structural scoliosis, hypertension and neck pain.[36] The results were related to pain reduction and improved functionality and are consistent with the findings of the present review on the effect of Pilates on functionality and physical performance in adult subjects with MS (Table 4). The review by Byrnes et al includes only two studies related to MS, whereas the results in the present review are supported by the findings of more clinical trials.[24,25,27-30,36]

A systematic review shows that improving trunk position when measured using the TIS scale with posture-correcting interventions, such as Pilates and Ai-Chi, helps increase functional capacity in people with MS.[37] Different results were obtained in the systematic review and meta-analysis, which included 10 RCTs and 4 experimental trials.[31] This review showed that Pilates is not significantly more effective than other forms of therapy in terms of improving functional capacity [TUG ($p=0.478$), 6MWT ($p=0.378$)], fatigue [MFIS ($p=0.781$)] and quality of life [MSQOL-54 ($p=0.857$)]. The different findings may be due to the fact that the review by Raats et al was based on a very small number of studies with Pilates.[37] In contrast to that review, in the present review Pilates appears to improve endurance, strength, physical fitness and respiratory fitness probably because the present review included only RCTs and there were new studies to be included.[25,27-30]

Furthermore, a systematic review concluded that Pilates is a safe and effective method of therapeutic exercise and treatment of MS symptoms and can be considered an alternative way of recovering balance, strength, quality of life, cognitive and physical fitness and gait impairments

in people with MS.[38] Balance was shown to improve in Pilates groups compared to control groups in most studies evaluated. Although different studies were used in the review by Marques et al compared to the present review, several of the assessment tools used in the final studies were common and similar conclusions were found regarding the above MS-related parameters.[38] Quality of life was only measured through the MSQOL-54 questionnaire in the Marques et al review and showed a positive effect of Pilates on this parameter, whereas the present review additionally used the MusiQol, again showing positive results in favor of Pilates compared to the control groups after the interventions.[38]

Finally, Kyriakatis et al classify Clinical Pilates as a form of therapeutic exercise that can reduce depressive symptoms in people with MS and in some cases more than conventional physiotherapy.[39] They report that the combination of aerobic exercise and Pilates may be more effective than standard therapy, and the present systematic review showed that implementing only an individual Pilates program improved depression and anxiety levels compared to a control group.[39]

In the present study there are limitations. First of all, the studies that were finally used involved people with MS and low to moderate motor disability (EDSS<6.5). This means that the results of the present study are probably not generalizable to people with MS and greater motor disability. It is therefore considered necessary to have clinical studies that include people with greater motor disabilities, so that the results of these studies can show what happens with these groups of patients.

Another issue is that most studies do not report the clinical form of the participants' disease (benign, primary or secondary, recurrent-intermittent), in order to get a clear picture of the results in relation to the different forms of MS. Also, no accurate data are given on the compliance of participants with the intervention programs, or the drop-out rates of the programs, and there was no way of monitoring the programs performed in the patients' homes without supervision by a specialist. However, from the scoring of the eighth criterion of the PEDro scale related to the rates of completion of interventions by participants and data collection of more than 85%, it appears that a total of 6 studies did not meet this criterion.[20,22,25,26,29,30] Adherence to exercise programs is important to have reliable results. For this reason, it may be better to implement remote monitoring of individuals performing Pilates exercise at home to better control patient compliance and perhaps the results of the studies and thus lower bias rates and greater methodological integrity.

CONCLUSION

The results of the present systematic review support that the use of Pilates can really help in the management and rehabilitation of MS symptoms. The findings of the study suggest that Pilates is a safe therapeutic exercise method for adults with MS and that there is no evidence of adverse or harmful effects from its use. Pilates can surely improve various parameters to a greater or lesser extent in these patients, such as balance, gait, fatigue, functional and physical ability, cognitive function, quality of life, anxiety and depression levels, and body composition. However, further research is deemed necessary, with larger and more specific clinical studies, to investigate the effectiveness of Pilates and more specifically on various parameters of MS, such as fatigue, which is a common symptom in these patients.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

REFERENCES

1. Thompson AJ, Baranzini SE, Geurts J, Hemmer B, Ciccarelli O. Multiple sclerosis. Lancet. 2018;391(10130):1622-36.
2. World Health Organization. Atlas: Multiple Sclerosis Resources in the World 2008, 2008. Available at https://www.who.int/publications/i/item/9789241563758. Accessed on 12 December 2022.
3. Halabchi F, Alizadeh Z, Sahraian MA, Abolhasani M. Exercise prescription for patients with multiple sclerosis; potential benefits and practical recommendations. BMC Neurol. 2017;17(1):185.
4. Feinstein A, Amato MP, Brichetto G, Chataway J, Chiaravalloti N, Dalgas U, et al. Study protocol: improving cognition in people with progressive multiple sclerosis: a multi-arm, randomized, blinded, sham-controlled trial of cognitive rehabilitation and aerobic exercise (COGEx). BMC Neurol. 2020;20(1):204.
5. Ghahfarrokhi MM, Banitalebi E, Negaresh R, Motl RW. Home-Based Exercise Training in Multiple Sclerosis: A Systematic Review with Implications for Future Research. Mult Scler Relat Disord. 2021;55:103177.
6. Kyriakatis GM, Lykou PM, Dimitriadis Z, Besios T. Efficacy of remote exercise and physiotherapy programs on depressive symptoms in people with multiple sclerosis - A systematic review and meta-analysis. Mult Scler Relat Disord. 2023;79:105067.
7. Swank C, Thompson M, Medley A. Aerobic exercise in people with multiple sclerosis: its feasibility and secondary benefits. Int J MS Care. 2013;15(3):138-45.
8. Orban A, Garg B, Sammi MK, Bourdette DN, Rooney WD, Kuehl K, et al. Effect of High-Intensity Exercise on Multiple Sclerosis Function and Phosphorous Magnetic Resonance Spectroscopy Outcomes. Med Sci Sports Exerc. 2019;51(7):1380-6.
9. Tollár J, Nagy F, Tóth BE, Török K, Szita K, Csutorás B, et al. Exercise Effects on Multiple

Sclerosis Quality of Life and Clinical-Motor Symptoms. Med Sci Sports Exerc. 2020;52(5):1007-14.
10. van der Linden ML, Bulley C, Geneen LJ, Hooper JE, Cowan P, et al. Pilates for people with multiple sclerosis who use a wheelchair: feasibility, efficacy and participant experiences. Disabil Rehabil. 2014;36(11):932-9.
11. Fleming KM, Coote SB, Herring MP. Home-based Pilates for symptoms of anxiety, depression and fatigue among persons with multiple sclerosis: An 8-week randomized controlled trial. Mult Scler. 2021;27(14):2267-79.
12. Kloubec J. Pilates: how does it work and who needs it? Muscles Ligaments Tendons J. 2011;1(2):61-6.
13. Pilates JH, Miller W. Return to life through contrology. JJ Augustin, New York. 1945.
14. Alvarenga-Filho H, Sacramento PM, Ferreira TB, Hygino J, Abreu JEC, Carvalho SR, et al. Combined exercise training reduces fatigue and modulates the cytokine profile of T-cells from multiple sclerosis patients in response to neuromediators. J Neuroimmunol. 2016;293:91-9.
15. Banitalebi E, Ghahfarrokhi MM, Negaresh R, Kazemi A, Faramarzi M, Motl RW, et al. Exercise improves neurotrophins in multiple sclerosis independent of disability status. Mult Scler Relat Disord. 2020;43:102143.
16. Faramarzi M, Banitalebi E, Raisi Z, Samieyan M, Saberi Z, Mardaniyan Ghahfarrokhi M, et al. Effect of combined exercise training on pentraxins and pro- inflammatory cytokines in people with multiple sclerosis as a function of disability status. Cytokine. 2020;134:155196.
17. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:71.
18. Maher CG, Sherrington C, Herbert RD, Moseley AM, Elkins M. Reliability of the PEDro scale for rating quality of randomized controlled trials. Phys Ther. 2003;83(8):713-21.
19. Cashin AG, McAuley JH. Clinimetrics: Physiotherapy Evidence Database (PEDro) Scale. J Physiother. 2020;66(1):59.
20. Hosseini Sisi SZ, Sadeghi H, Massood Nabavi S. The effects of 8 weeks of rebound therapy and Pilates practices on static and dynamic balances in males with multiple sclerosis. Adv Environ Biol. 2014;7:4290-3.
21. Gheitasi M, Bayattork M, Andersen LL, Imani S, Daneshfar A. Effect of twelve weeks pilates training on functional balance of male patients with multiple sclerosis: Randomized controlled trial. J Bodyw Mov Ther. 2021;25:41-5.
22. Eftekhari E, Etemadifar M. Impact of Clinical Mat Pilates on Body Composition and Functional Indices in Female Patients With Multiple Sclerosis. Crescent J Med Biol Sci. 2018.
23. Fox EE, Hough AD, Creanor S, Gear M, Freeman JA. Effects of Pilates-Based Core Stability Training in Ambulant People With Multiple Sclerosis: Multicenter, Assessor-Blinded, Randomized Controlled Trial. Phys Ther. 2016;96(8):1170-8.
24. Kalron A, Rosenblum U, Frid L, Achiron A. Pilates exercise training vs. physical therapy for improving walking and balance in people with multiple sclerosis: a randomized controlled trial. Clin Rehabil. 2017;31(3):319-28.
25. Abasıyanık Z, Ertekin Ö, Kahraman T, Yigit P, Özakbaş S. The effects of Clinical Pilates training on walking, balance, fall risk, respiratory, and cognitive functions in persons with multiple sclerosis: A randomized controlled trial. Explore (NY) . 2020;16(1):12-20.
26. Guclu-Gunduz A, Citaker S, Irkec C, Nazliel B, Batur-Caglayan HZ. The effects of pilates on balance, mobility and strength in patients with multiple sclerosis. Neuro Rehabilitation. 2014;34(2):337-42.
27. Fleming KM, Coote SB, Herring MP. The feasibility of Pilates to improve symptoms of anxiety, depression, and fatigue among people with Multiple Sclerosis: An eight-week randomized controlled pilot trial. Psychol Sport Exerc. 2019;45.
28. Küçük F, Kara B, Poyraz EÇ, İdiman E. Improvements in cognition, quality of life, and physical performance with clinical Pilates in multiple sclerosis: a randomized controlled trial. J Phys Ther Sci. 2016;28(3):761-8.
29. Güngör F, Tarakci E, Özdemir-Acar Z, Soysal A. The effects of supervised versus home Pilates-based core stability training on lower extremity muscle strength and postural sway in people with multiple sclerosis. Mult Scler. 2022;28(2):269-79.
30. Bulguroglu I, Guclu-Gunduz A, Yazici G, Ozkul C, Irkec C, Nazliel B, et al. The effects of Mat Pilates and Reformer Pilates in patients with Multiple Sclerosis: A randomized controlled study. Neuro Rehabilitation. 2017;41(2):413-22.
31. Sánchez-Lastra MA, Martínez-Aldao D, Molina AJ, Ayán C. Pilates for people with multiple sclerosis: A systematic review and meta-analysis. Mult Scler Relat Disord. 2019;28:199-212.
32. Marandi SM, Nejad VS, Shanazari Z, Zolaktaf V. A comparison of 12 weeks of pilates and aquatic training on the dynamic balance of women with mulitple sclerosis. Int J Prev Med. 2013;4(Suppl 1):S110-7.
33. Duff WRD, Andrushko JW, Renshaw DW, Chilibeck PD, Farthing JP, Danielson J, et al. Impact of Pilates Exercise in Multiple Sclerosis: A Randomized Controlled Trial. Int J MS Care. 2018;20(2):92-100.
34. Natour J, Cazotti Lde A, Ribeiro LH, Baptista AS, Jones A. Pilates improves pain, function and quality of life in patients with chronic low back pain: a randomized controlled trial. Clin Rehabil. 2015;29(1):59-68.

35. Arik MI, Kiloatar H, Saracoglu I. Do Pilates exercises improve balance in patients with multiple sclerosis? A systematic review and meta-analysis. Mult Scler Relat Disord. 2022;57:103410.
36. Byrnes K, Wu PJ, Whillier S. Is Pilates an effective rehabilitation tool? A systematic review. J Bodyw Mov Ther. 2018;22(1):192-202.
37. Raats J, Lamers I, Merken I, Boeckmans J, Soler B, Normann B, et al. The content and effects of trunk rehabilitation on trunk and upper limb performance in people with multiple sclerosis: a systematic review. Eur J Phys Rehabil Med. 2022;58(1):26-32.
38. Marques KAP, Trindade CBB, Almeida MCV, Bento-Torres NVO. Pilates for rehabilitation in patients with multiple sclerosis: A systematic review of effects on cognition, health-related physical fitness, general symptoms and quality of life. J Bodyw Mov Ther. 2020;24(2):26-36.
39. Kyriakatis GM, Besios T, Lykou PM. The effect of therapeutic exercise on depressive symptoms in people with multiple sclerosis - A systematic review. Mult Scler Relat Disord. 2022;68:104407.

Cite this article as: Matsouki E, Kyriakatis GM. The effectiveness of the therapeutic exercise Clinical Pilates in adult patients with multiple sclerosis: a systematic review. Int J Clin Trials 2024;11(3):240-51.