Effect of pilates training on balance, muscular endurance, fatigue, and quality of life among women with multiple sclerosis

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How to Cite

Abstract

Purpose. This research aimed to investigate the effect of eight weeks of Pilates exercises on balance, muscle endurance, fatigue, and quality of life with women with MS.

Material and methods. In this research, which is of applied type and with a pre-test-post-test design with a control group, 40 women aged 25 to 50 with multiple sclerosis living in Alborz province were selected by random sampling. Sampling was done purposefully and available, and the samples were randomly divided into two experimental (20 people) and control (20 people) groups. The research exercise program was performed three days a week (one hour per session) and gradually increased from one hour to 90 minutes per session over 8 weeks. Fatigue was measured with the Fatigue Impact Scale (FIS), balance with the Berg Balance Test (BBS), general endurance with the 6-minute walk test (6MWT), the endurance of the core muscles of the body with the sit-up test, and quality of life with the Multiple Sclerosis Quality of Life (MSQOL)-54 Instrument.

Results. In relation to the variables of balance and fatigue, the results of the analysis showed that Pilates exercises had a positive effect on the fatigue of the subjects in the experimental group and caused a significant reduction in their fatigue (P=0.000). Nevertheless, the data related to muscle endurance in the core zone (P=0.723) did not show a significant effect and regarding general endurance, it showed a significant effect (P=0.010). Also, in the variable of quality of life, the data showed that Pilates exercises had a significant effect on both physical and mental dimensions of quality of life (P=0.000 and P=0.042).

Conclusion. Overall, the research findings indicate that Pilates exercises have a significant effect on the fatigue and balance of women with multiple sclerosis, but to ensure the effectiveness of these exercises on endurance and quality of life, more studies are needed.

Keywords: multiple sclerosis, quality of life, fatigue, balance, muscle endurance
Анотация

Хади Мирі, Хоссеїн Мехрабіан, Мар’ям Гафурі Пейванді, Ірина Скрипченко, Віктор Счастливець. Вплив занять пілатесом на рівновагу, м’язову витривалість, втому та якість життя жінок із розсіяним склерозом

Мета. Дослідити вплив восьми тижнів занять пілатесом на рівновагу, м’язову витривалість, втому та якість життя жінок із діагнозом розсіяний склероз.

Матеріал і методи. Дослідження, яке має прикладний характер і перед-тестові дослідження проводилось з контрольною групою із 40 жінок віком від 25 до 50 років із розсіяним склерозом, що проживають у провінції Альборз, які були відібрани шляхом випадкової вибірки. Відбір проводився цілеспрямовано та доступно, вибірки випадковим чином розподілялися на дві - дослідну (20 осіб) та контрольну (20 осіб) групи. Експериментальна програма, яка включала комплекс вправ виконувалась три дні на тиждень (одна година за сесію) протягом 8 тижнів.

Результати. Стосовно показників рівноваги та втоми результати аналізу показали, що вправи пілатесу позитивно вплинули на втому суб’єктів експериментальної групи і спричинили значне зниження їх втоми (P=0,000). Тим не менш, дані щодо м’язової витривалості в зоні кора (P=0,723) не показали суттєвого вплину, а щодо загальної витривалості показали значний вплив (P=0,010). Крім того, у перемінних якості життя дані показали, що вправи пілатесу мало значний вплив як на фізичні, так і на психічні аспекти якості життя (P=0,000 і P=0,042).

Висновок. Загалом результати дослідження показують, що вправи пілатесу мають значний вплив на рівень втоми та рівновагу жінок із розсіяним склерозом, але щоб переконатися в ефективності цих вправ на витривалість та якість життя, необхідні додаткові дослідження.

Ключові слова: розсіяний склероз, якість життя, втома, рівновага, м’язова витривалість

Аннотация

Хади Мири, Хоссеїн Мехрабиан, Марьям Гафури Пейванди, Ирина Скрипченко, Виктор Счастливец.

Воздействие занятий пилатесом на равновесие, мышечную выносливость, усталость и качество жизни женщин с рассеянным склерозом

Цель. Исследовать влияние восьми недель занятий пилатесом на равновесие, мышечную выносливость, усталость и качество жизни женщин с рассеянным склерозом.

Материал и методы. Исследования, имеющие прикладной характер и предтестовые исследования проводились с контрольной группой из 40 женщин с рассеянным склерозом в возрасте от 25 до 50 лет, проживающих в провинции Альборз, которые были отобраны путем случайной выборки. Отбор проводился целенаправленно и доступно, выборки случайным образом распределялись на две– экспериментальную (20 человек) и контрольную (20 человек) группы. Экспериментальная программа, включая комплекс упражнений, выполнялась три дня в неделю (один час за сеанс) и постепенно увеличивалась с одного часа до 90 минут за сеанс в течение 8 недель.

Результаты. Относительно показателей равновесия и усталости результаты анализа показали, что упражнения пилатеса положительно повлияли на усталость субъектов экспериментальной группы и повлекли за собой значительное снижение их усталости (Р=0,000). Тем не менее данные относительно мышечной выносливости в зоне кора (Р=0,723) не показали существенного влияния, а относительно общей выносливости показали существенное влияние (Р=0,010). Кроме того, в переменных качества жизни данные показали, что упражнения пилатеса оказали значительное влияние как на физические, так и на психические аспекты качества жизни (Р=0,000 и Р=0,042).

Вывод. В общем, результаты исследования показывают, что упражнения пилатеса оказывают значительное влияние на уровень усталости и равновесие у женщин с рассеянным склерозом, но чтобы убедиться в эффективности этих упражнений на выносливость и качество жизни, необходимы дополнительные исследования.

Ключевые слова: рассеянный склероз, качество жизни, усталость, равновесие, мышечная выносливость

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Introduction

Multiple sclerosis (MS) is a chronic disease of the nervous system with vague symptoms. Its most important symptoms are problems in concentration, impaired vision, impaired walking, sensory abnormalities, balance problems, and impaired cardiovascular autonomous control. In people with MS, muscle weakness, fatigue, mild paralysis, and spasms are common [1]. Considering that MS is an autoimmune disease and obstructs normal daily activities due to the involvement of the nervous system, it has a negative effect on the quality of life [2]. It is important to conduct research to find appropriate therapeutic exercises through which we can help the patient to return to normal life because this method can help the patient to improve their mental condition and cope with the difficulties of MS [3].

Despite the increasing number of people with MS, until now experts have not been able to make a definite recommendation about optimal intensity and volume of physical activities. This is mainly because some MS symptoms show an unsteady trend during sports activities. It has been reported that patients following intense activities experience an increase in body temperature which is in turn associated with a decrease in nerve message conduction speed in inflamed nerve tissues [4]. Since the most common age of MS disease is 20 to 40 years old, this disease can damage an important period of life and limit the ability to perform personal and social tasks. Therefore, the lack of definitive treatment for this disease causes damage to the productive forces of society [5].

The high price of medical and clinical methods is one of the main problems of people with MS. Due to the high cost and prevalence and extent of this disease, besides side effects associated with drug use, it is more convenient for patients to use non-pharmacological methods. Non-pharmacological methods seem to be a suitable option to help treat people with MS due to reducing disease problems and raising the quality level [6]. Patients can use non-pharmacological methods as a complementary treatment to slow down the progression of the disease and reduce the incidence of MS attacks, thereby delaying the onset of permanent disability [7]. Recurrence of disease symptoms even in patients who are mildly affected by this disease limits the daily activities performance. By implementing preventive measures like physical exercises, the occurrence or relapse of many symptoms can be prevented, and addressing this issue is of great importance for women with MS [8].

Exercise has been shown to affect the development of various physiological features of MS patients. It is obvious that regular exercise is effective in maintaining health and preventing disease, and despite the old beliefs, nowadays exercise for people with MS is considered a need. Although exercise significantly reduces the progress of the disease, the fatigue caused by exercise sometimes intensifies the symptoms of the disease. Pilates exercises are among the sports activities that have recently received attention in rehabilitation. Pilates is designed with simple physical movements which improve the stability of the trunk and increases strength and balance. Pilates training method can be used as a complementary treatment for people who have mobility limitations [9]. In addition, Pilates has a neurological component that is effective in improving balance, muscle endurance, flexibility, and posture. Anderson and colleagues in a study on Pilates exercises stated that based on principles of neuromuscular physiology and biomechanics, Pilates can be a functional, efficient, and long-lasting treatment method in the rehabilitation of patients.

Also, Dunleavy emphasizes the appropriateness of Pilates exercises for the mental and physical rehabilitation of patients with MS [10]. The results of Guclu-Gunduz [11] and colleagues support the effect of Pilates exercises on the motor performance of patients with MS. Based on recent research findings, physical exercises enhance the mechanisms in the brain and spinal cord that lead to an increase in the ability to call motor units. It has been shown that Pilates exercises have caused the development and sensory-motor control of body muscles, and as a result, motor performance has improved [12].

Considering the beneficial results of Pilates exercises on the improvement of various physiological and psychological factors, it can be predicted that Pilates based on core stability exercises will effectively affect the balance of patients. On the other hand, the loss of balance as the main factor in locomotion leads to immobility and causes the occurrence of other motor complications. Abnormality in balance is one of the most common complications in MS. This condition is related to risk factors such as falling and preventing daily activities. Since falls among MS patients average nine times a year, there is a need to investigate to find effective treatment methods. Also, due to the increasing number of motor and cognitive disorders as a result of disease progression, exercises that can
Methods

Forty urban-dwelling female participants aged 25 to 50 with MS were selected in a random sampling method. The participants had a disability degree (EDSS) less than 5.5 on the Kurtzke scale, could move fully without assistance up to 100 meters and were unable to perform balanced movements due to ataxia. After the initial registration in the Karaj MS Association and communication with these people for cooperation, 40 people were selected from the volunteers to participate in the research. These samples were randomly assigned to two experimental and control groups. The subjects completed the personal information form and the consent form to participate in the research. A full explanation was given about the objectives and protocol of the study. First, the basic physical information of the samples including weight and height was measured and then pre-tests of balance, muscle endurance, fatigue, and quality of life were performed.

Vital signs were monitored during the study, including breathing rate (between 20-26 breaths per minute), blood pressure (between 140-200 on 90-110 mmHg), temperature (35.5-36.5), and heart rate (70-82 beats per minute). Patients performed exercises for 30 sessions for three weeks. Exercises included Pilates therapeutic movements.

The training program started three days a week with one hour per session and gradually increased to 1.5 hours per session during 8 weeks. Each training session consisted of a 10-minute warm-up, a body workout, and a 10-minute cool-down. Pilates exercises were done in groups and the groups were divided in such a way that participants with similar physical levels were placed in the same group. All training sessions were supervised by the head of the center, a physiotherapist, and an expert in corrective movements. The sessions included basic body exercises that are performed in different positions (standing, sitting, on all fours, lying on the side, lying on the back, and lying on the stomach) and also used different exercise balls. Some of the exercise movements used in the exercise protocol were: The Hundred, Lunges, Squat, Hovering, Bridge, Leg Lift Supine, Spine Twist, and Butterfly.

Berg Test (BBS) is the tool we used to measure the balance. In this test, performance is evaluated based on 14 items that are used in everyday life. The total score of the test is 56, which indicates an excellent level. The scores for each item ranges from 0 to 4. A score of zero is the lowest level of performance and a score of 4 is the highest level of performance. The test score is calculated based on the total points in each section.

The Fatigue Impact Scale (FIS) questionnaire is used to measure patients' fatigue. The FIS is the best tool to measure the impact of fatigue on the quality of life by the American MS Association. This scale includes 40 questions that assess the limitations of people's performance in 3 cognitive, physical and social dimensions. People are asked to rate the effect of fatigue on these dimensions using a 5-point scale from 0 (no problem) to 4 (severe problem).

The sit-up test is used to measure the endurance of the core muscles in which the number of correct movements in one minute is recorded. The 6-minute walk test (6MWT) was used to measure general body endurance. In this test, the maximum distance a person can walk in 6 minutes is measured. The reason for choosing this test is that the sub-maximal 6MWT test is tolerable for patients and is widely used in clinical interventions and rehabilitation.

The Multiple Sclerosis Quality of Life-54 (MSQoL-54) was completed for the participants. This tool is specifically designed for MS patients and has been translated and validated in Iran by Ghaem et al. [13].

Statistical analysis was done using analysis of covariance test and pre-test results were considered as a covariate. Also, the effect size was reported with the eta square index (η2).

Results

Examining the research data showed that the means and standard deviation related to the duration of the disease in the research participants was 10.4 ± 3.5 and their disability index (EDSS) was 3.6±1.6. The results showed that in the experimental group, there was a significant difference in weight and body mass index from the pre-test to the post-test. But in the control group, the differences between the pre-test and post-test were not significant.

The analysis of balance, fatigue, mental quality of life, and general muscular endurance in the experimental group showed a significant difference between the pre-test and post-test results (P=0.000). But the difference was not significant in terms of core muscle endurance and physical quality of life. Also, all three investigated variables in the control group...
before and after the study did not show any significant difference. To check the difference between the two research groups in terms of the three investigated variables, first, the assumption of homogeneity of the regression slope was checked, then Levene's test showed that the assumption of homogeneity of variances was confirmed. Table 1 indicates the scores of participants in fatigue, general endurance, and quality of life. The results of covariance analysis for variables can be seen in tables 2 to 7.

Table 1

<table>
<thead>
<tr>
<th>Group</th>
<th>Time</th>
<th>Balance</th>
<th>Fatigue</th>
<th>General endurance</th>
<th>Quality of life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pilates training</td>
<td>pre</td>
<td>45.20 ± 4.94</td>
<td>40.15 ± 6.13</td>
<td>673 ± 47</td>
<td>40.60 ± 8.15</td>
</tr>
<tr>
<td></td>
<td>post</td>
<td>49.50 ± 5.95</td>
<td>34.85 ± 5.77</td>
<td>676 ± 47</td>
<td>46.05 ± 7.54</td>
</tr>
<tr>
<td>Control</td>
<td>pre</td>
<td>44.25 ± 5.90</td>
<td>38.60 ± 6.18</td>
<td>655 ± 45</td>
<td>41.55 ± 8.11</td>
</tr>
<tr>
<td></td>
<td>post</td>
<td>43.95 ± 6.09</td>
<td>38.75 ± 6.09</td>
<td>652 ± 46</td>
<td>41.40 ± 8.06</td>
</tr>
</tbody>
</table>

Table 2

<table>
<thead>
<tr>
<th>Sum of squares type III</th>
<th>d.f</th>
<th>Mean square</th>
<th>f</th>
<th>Sig</th>
<th>η²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>211.437</td>
<td>26.971</td>
<td>0.000*</td>
<td>0.422</td>
<td></td>
</tr>
<tr>
<td>error</td>
<td>290.056</td>
<td>7.839</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

As can be seen in Table 2, since the significance level of the F test is equal to 0.000 and η² = 0.422, the balance score of participants is different from pre-test to post-test and the effect size for the analysis of covariance is below the moderate level.

Table 3

<table>
<thead>
<tr>
<th>Sum of squares type III</th>
<th>d.f</th>
<th>Mean square</th>
<th>f</th>
<th>Sig</th>
<th>η²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>256.081</td>
<td>53.933</td>
<td>0.000*</td>
<td>0.593</td>
<td></td>
</tr>
<tr>
<td>error</td>
<td>113.260</td>
<td>3.061</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Since the significance level of the F test is equal to 0.000 and η² = 0.593, this indicates that the effect size for the analysis of covariance on the fatigue variable is moderate.

Table 4

<table>
<thead>
<tr>
<th>Sum of squares type III</th>
<th>d.f</th>
<th>Mean square</th>
<th>f</th>
<th>Sig</th>
<th>η²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>206.833</td>
<td>7.409</td>
<td>0.010*</td>
<td>0.167</td>
<td></td>
</tr>
<tr>
<td>error</td>
<td>1032.854</td>
<td>27.915</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

The significance level of the F test is 0.010 and the effect size is η² = 0.167. This indicates that the analysis of the covariance test has shown a significant difference, but the effect size for the analysis of covariance in the case of the general muscle endurance variable is weak.

Table 5

<table>
<thead>
<tr>
<th>Sum of squares type III</th>
<th>d.f</th>
<th>Mean square</th>
<th>f</th>
<th>Sig</th>
<th>η²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>0.122</td>
<td>0.122</td>
<td>0.723</td>
<td>0.003</td>
<td></td>
</tr>
<tr>
<td>error</td>
<td>35.446</td>
<td>0.958</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

The significance level of the F test is 0.723 and the effect size is η² = 0.003. This indicates that the analysis of variance test did not show a significant difference and the effect size for the analysis of covariance in the case of the core muscles endurance variable is weak.

Table 6

<table>
<thead>
<tr>
<th>Sum of squares type III</th>
<th>d.f</th>
<th>Mean square</th>
<th>f</th>
<th>Sig</th>
<th>η²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>46.870</td>
<td>5.980</td>
<td>0.042*</td>
<td>0.365</td>
<td></td>
</tr>
<tr>
<td>error</td>
<td>113.260</td>
<td>3.061</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>
As can be seen in Table 6, since the significance level of the F test is equal to 0.042 and the effect size is equal to $\eta^2 = 0.365$, this indicates a significant difference in the analysis of covariance test and the effect size for the covariance analysis regarding the physical quality of life variable is weak.

<table>
<thead>
<tr>
<th>Group</th>
<th>Sum of squares type III</th>
<th>d.f</th>
<th>Mean square</th>
<th>f</th>
<th>Sig</th>
<th>$\eta^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>297.667</td>
<td>1</td>
<td>297.667</td>
<td>119.298</td>
<td>0.000*</td>
<td>0.763</td>
</tr>
<tr>
<td>error</td>
<td>92.321</td>
<td>37</td>
<td>2.495</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

As can be seen in Table 7, since the significance level of the F test is equal to 0.000 and the effect size is equal to $\eta^2 = 0.763$, this indicates a significant difference in the analysis of covariance test and the effect size for the covariance analysis is high.

### Discussion

The findings of the current research indicate that people with MS were successful in adapting to Pilates exercises to improve balance, reduce fatigue and improve the quality of their mental life, but they did not benefit significantly in terms of endurance and physical quality of life. Physical performance tests used in previous studies are used as a common measurement system in physical therapy evaluations. Parameters such as gait and postural control that are assessed in physical function tests assess activities of daily living. These activities require successful coping with gravity and better use of trunk muscles. These measurements are important to determine the impairment of body muscle control. The target muscle groups of Pilates therapy are the trunk muscles. Pilates is an effective exercise to strengthen postural muscles to perform activities with less fatigue [14]. In the present research, a course of Pilates exercises was successful in achieving the goals mentioned above.

Dorado et al. studied the effects of Pilates on the volume of the rectus abdominis, oblique, and transverse muscles [15]. Their study showed the existence of asymmetry in the muscles of the abdominal wall in inactive healthy women. Doing Pilates exercises twice a week for nine months caused hypertrophy of the abdominal wall muscles, especially the rectus abdominis muscle, and eliminated the asymmetry in the oblique and transverse abdominal muscles. The effects of Pilates on limb movements have been discussed in other Pilates studies. However, we used physical performance tests that require maintaining posture (such as the 6-minute walk test) because the main muscle groups used in these tests are activities of daily living. According to the results of our study, Pilates is an effective exercise method in patients with MS to improve their ability to perform daily activities with less fatigue.

In another study by Rodriguez-Fuentes et al., MS patients received group exercises [16]. As a result of their study, it was found that group exercise has positive effects on balance, functional status, stiffness, fatigue, and quality of life. In our study, the exercise program was applied in the experimental group of the research in a group format. Therefore, the reason why our results are in line with Rodriguez-Fuentes et al.'s findings in terms of balance, fatigue, and quality of life can be due to the use of Pilates group exercises in both types of research.

Pilates therapy is an exercise program that primarily affects the trunk muscles and includes exercises in various positions with progressive features. This training method primarily affects core muscle stabilization, maintaining balance, and reducing fatigue. In previous studies, the effects of Pilates therapy on parameters such as stability, in general, have been investigated [17]. Pilates therapy focuses on the correct use of the core muscles, diaphragm, transversus abdominis, multifidus, and pelvic muscles. However, there was no significant change in muscle endurance in the patients who participated in this study. It is thought that this may be related to the training period. In previous studies on Pilates therapy, the training period was between 12 and 16 weeks.

One of the reasons for the effectiveness of Pilates exercises presented in this research in improving the mental quality of life of people with MS can be the increase in self-confidence in overcoming daily challenges, but the lack of significant improvement in the quality of physical life can be attributed to various factors: First, there is a possibility that the rate of disease progression in the subjects before the research period was so high that an eight-week period of exercises was not enough to control it, and a longer period of exercises is needed to achieve improvements. Second, it is possible that the content of Pilates exercises in the current research, due to the strong emphasis on psychological
factors such as concentration and relaxation, as well as refraining from performing high-risk movements due to the sensitivity of the research sample, could not sufficiently improve the physical capacities of people with MS.

Due to the effectiveness of Pilates exercises in improving balance, fatigue, and quality of life of women with MS, it is suggested that Pilates exercises in the form of specialized and long-lasting programs be recommended for people with MS by specialists such as the practitioners of MS Association, hospitals, and clinics. It also seems that examining the underlying factors of muscle fatigue and endurance, such as neuro-muscular coordination, hand-eye coordination, and so on can provide more information in line with the goals of this research.

The study conducted by Ozkul C., et al. concurred with the findings of this study in terms that balance and quality of life had improved by pilates training on MS patients [18]. Similarly, Abasyanuk. et al also compared yoga and Pilates groups before concluding that the latter had significantly improved in balance and quality of life [19, 20]. Further, Gheitasi M. concluded that pilates does have a significant effect on the functional balance among his study recruits [7]. Marques, et al. performed a meta-analysis on the effectiveness of Pilates in rehabilitating patients with MS and suggested that the majority of the studies showed Pilates had a positive effect on their patients [21]. Van der Linden et al. in their mixed method study on MS patients in a wheelchair also concluded that pilates helped the sitting balance of participants significantly [22].

Fleming K. M. supported the feasibility of home-based Pilates to improve the mental health of women who had minimal to mild mobility disability with MS [23]. However, Gungor et al tried to identify which of the methods namely supervised or home-based Pilates training worked better and concluded that a supervised method performed significantly better in most parameters related to core strength, posture and so on [24]. Eftekhari E. in his investigation concluded that regular Pilates training impacted the brain-derived neurotrophic factor and could be advised as parallel treatment along with drug therapy [25]. But, contended that pilates training should be based on individual needs. The results of this study were also supported by the study conducted by Mirzayev, J. A. recommended that physical training help patients with MS predominantly [26].

Many studies such as Roshandelpour, had concluded that Pilates exercises improved balance and helped overcome fatigue among his patients with MS [27]. Hence, recommended the use of Pilates training along with drug treatments. Mohamadi-Dinani, felt that Pilates training had positive effects on motor function and depression and suggested its use as a supplementary treatment for MS patients [28]. So did RezvankhahGolsefidi suggested that Pilates could be used as a complementary treatment alongside medications for MS patients as it helped them overcome fear and improved their reaction time [29].

Shahnazari also suggests Pilates as a complementary program to a medical program [30]. Duff W. R. et al. proposed that Pilates improved the functional ability of people with MS and it could help in better management of the disease [31].

However, Kalron A. in his study comparing Pilates and physical therapies did not find telling differences in balance between his two groups of participants [32].

Tomruk et.al through his study, presented that Pilates training effectively helped the patients to overcome fatigue and improve balance and also suggested that further studies were needed on the topic [33]. Kucuk F. established through their experiment that clinical Pilates has a positive effect on balance, performance, fatigue, quality of life, and helps overcome cognitive challenges and therefore can be used as an effective treatment method for patients with MS [34].

Arik the meta-analysis summarized the effectiveness of Pilates in improving balance as compared to other physical modes [35]. Though faults were identified in the methods of many studies, it concluded that pilates could be an optional method to improve balance in patients with MS.

Dennett. et.al in her study made interesting observations on the data on attendance and drop-outs of MS patients [36]. In her meta-analysis, she found that many studies did not present data on regular attendance and adherence to the training program and details of dropouts. She cites that such information can be very critical in the analysis of any intervention program for MS patients.

Carmen V. et.al. felt that though there was not much difference in the effectiveness of pilates when compared with other physical therapies, pilates did have a positive impact on both the physical and mental condition of the participants [37]. Pilates did contribute towards improving the quality of life of MS patients. On the contrary, Uzun A. proposed that the reformer type of exercise was more effective than pilates but their effects varied physically corresponding to different regions in the body [38].
analysis to test if Pilates was a feasible therapy for people with MS to improve physical function and reduce self-perceived fatigue [12]. They concluded that though they are beneficial, the benefits are not significantly greater than physical therapies. Rodriguez-Fuentes et al. in his investigation put forth that Pilates improved balance, gait, physical functions, core stability, and cognitive functions [16]. However, he did not see a clear improvement in fatigue, quality of life, and psychological function. He reported good adherence to his intervention and suggested that pilates could be used as a rehabilitation tool for patients with MS. He also suggested the need for developing clinical protocols for such programs.

**Conclusion**

Therefore, it could be said that several studies have shown that Pilates has benefited MS patients in more than one way. Though some studies have suggested a need to improve the methodology, none have suggested any harmful effect of pilates on the practitioners. Some recent studies have suggested it can be used as a complementary or supplementary therapy along with medical treatments.

Therefore, to conclude pilates training can be a very useful method for the effective management of patients with MS but with further studies on the subject and framing a rehabilitation protocol based on empirical evidence. Yet, it needs to be mentioned that it is by no means harmful and MS patients can benefit by practicing it but under proper supervision.

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