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The Role of Physical Activity and Rehabilitation in the Management of Multiple Sclerosis: A Review

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Abstract

Background: Multiple sclerosis (MS) is a chronic autoimmune disease that leads to a wide range of disabling symptoms such as muscle weakness, fatigue, balance problems and reduced quality of life. The main treatment approach is pharmacological, however it does not fully address the physical symptoms, what brings out the need of complementary strategies.

Aim of the study: This review summarizes current evidence on the role of physical activity and rehabilitation in MS.

Material and Methods: A narrative literature review based on the literature on PubMed.

Conclusions: Resistance training, aerobic exercise, balance and gait training, and aquatic therapy were all found to improve physical function, fatigue, cognition, and quality of life in people with MS. Balance training was the most effective way in reducing fatigue. Despite this evidence, exercise participation among MS patients remains low. Physical activity should be considered as a part of comprehensive MS care, and further high-quality research is needed to establish standardised exercise guidelines.

Key words: "multiple sclerosis," "physical activity," „exercise," „rehabilitation," "resistance training," "aerobic exercise," "balance," "gait," "fatigue," and "aquatic therapy."

1. Introduction:

Multiple sclerosis (MS) is a chronic autoimmune disease of the central nervous system (CNS) leading to demyelination and neurodegeneration. It is one of the leading causes of neurological disability in young adults as

it affects mostly people aged 20-30 (Shi and Liu 2024). Estimated 2.3 million people around the world are diagnosed (Haki et al. 2024), particularly in high-income countries (Shi and Liu 2024). The disease touches mostly women with ratio 3:1 (Shi and Liu 2024). The etiology remains unclear, however current evidence points to genetic predisposition and environmental factors, including a strong association with Epstein-Barr virus infection (Klotz et al. 2025), lack of vitamin D, smoking and even birth season (Haki et al. 2024). The destruction of the myelin in the central nervous system is mainly caused by the autoreactive CD4+ T helper cells (Th1 cells). These cells are usually activated outside the CNS, often after a viral infection and produce cytokines that attack the myelin (Haki et al. 2024).

Clinical manifestations of MS are very heterogeneous and include muscle weakness, spasticity, ataxia, sensory disturbances and fatigue as well as double vision and bladder dysfunction (Haki et al. 2024). In addition, MS patients often suffer from depression, pain and have trouble with walking (Sortino et al. 2023). As a result, patients face a higher risk of falling and often experience reduced independence and mobility (Andreu-Caravaca et al. 2022). These symptoms may affect the daily living and have a strong impact on quality of life (QoL) even in the early stages of the disease (Gómez-Melero et al. 2024).

MS diagnosis is based on magnetic resonance imaging (MRI), which can reveal lesions and CNS atrophy (Haki et al. 2024). The McDonald criteria state that MS can be diagnosed if a patient's brain MRI shows demyelinating lesions that are both disseminated in space and disseminated in time. This means the lesions must be found in different areas of the central nervous system, and new lesions must appear on a follow-up MRI scan (Haki et al. 2024). The diagnostic criteria for MS have changed recently. Evidence shows that MS can begin long before any symptoms appear, sometimes visible only as an incidental finding on brain scans, a stage now known as radiologically isolated syndrome. Even earlier, some patients may experience non-specific symptoms such as fatigue, depression, or sleep problems years before an official diagnosis is made. The updated 2024 McDonald criteria are meant to make diagnosis more accurate by using advanced MRI markers (Klotz et al. 2025).

There are three clinical types of MS (Lublin et al. 2014). The most common (85%) is the Relapsing/remitting MS (RRMS) which is characterized by clearly defined disease relapses, followed by periods of partial or

complete remission. During remission, symptoms improve and may disappear completely. After 10-15 years of RRMS 50% of untreated patients can develop the Secondary progressive MS (SPMS) which always is a consequence of RRMS (Correale et al. 2017). Each year, about 2% of people with RRMS transition to SPMS, which means that over time, most people with RRMS eventually develop this more advanced form of the disease (Haki et al. 2024). With time passing, the symptoms are constantly developing and worsening without attacks. The transition from RRMS to SPMS is usually diagnosed retrospectively due to no clear clinical imaging or biological markers to identify the change (Lublin et al. 2014). Lastly the Primary progressive MS (PPMS) (15%) is characterized by constant progression with a lower frequency of relapses (Haki et al. 2024).

MS treatment relies on three paths: management of acute relapses, disease-modifying therapies and symptomatic treatment. Physiotherapy and pharmacotherapy are the treatment of choice for managing spasticity (Haki et al. 2024). However, no current treatment allows remyelination or CNS repair. Pharmacological treatment alone is not enough to help with symptoms such as fatigue, spasticity or impaired mobility (Haki et al. 2024). This creates a cycle, in which physical impairment restricts daily activity and worsens quality of life (Sortino et al. 2023), highlighting the need for complementary, non-pharmacological approaches. Similar approaches have proven valuable in other chronic conditions, where adjusted exercise programmes also improve quality of life and functional outcomes (Stasiak et al. 2025). Due to the symptoms of MS, patients often reduce their level of physical activity or completely give up exercise. In a survey of 741 people with MS, more than 75% did not exercise (Correale et al. 2022). Despite these barriers, there is strong evidence that structured, goal directed exercise can benefit people with MS, improving walking capacity, aerobic fitness, and muscle strength (Correale et al. 2022).

2. Aim of the study: In this review we aim to summarize current evidence on the role of physical activity and rehabilitation including aerobic exercise, resistance training, balance and gait training, and aquatic therapy in the management of multiple sclerosis, focusing on their effect on mobility, fatigue and quality of life.

3. Materials and methods: A comprehensive literature review was conducted using the PubMed database, with a combination of the keywords "multiple sclerosis," "physical activity," "exercise," and "rehabilitation," along

with more specific terms such as "resistance training," "aerobic exercise," "balance," "gait," "fatigue," and "aquatic therapy."

For many years neurologists discouraged MS patients from exercise due to concerns that it could cause relapses or even worsen fatigue. However, evidence shows that structured exercise programmes are both safe and beneficial in managing MS symptoms (Proschinger et al. 2022). Rehabilitation can help control symptoms, regain muscle function, and increase daily movement, leading to improved quality of life (Sortino et al. 2023). This includes aerobic exercise, such as walking, resistance training (Sortino et al. 2023), balance training, and hydrotherapy. Physical activity may also affect disease activity and progression, although the specific mechanisms are not yet known (Proschinger et al. 2022). The following sections review the evidence for each of these approaches individually.

4. Training

4.1 Resistance training

Resistance training is a form of exercise where muscles contract against an external resistance, such as weights, resistance machines, bands or a person's own body weight. This increases muscle strength and, with progressive overload, can lead to muscle hypertrophy (Westcott, 2012). It is one of the most extensively studied forms of exercise in people with multiple sclerosis (MS). In the general population, resistance training is associated with numerous health benefits, including improved physical performance, better movement control, and greater functional independence (Westcott, 2012).

Several randomized controlled trials have demonstrated the effectiveness of resistance training in people with MS. A 12-week resistance training programme involved 25 women with relapsing-remitting MS (aged 18–45, EDSS ≤4), divided into an exercise group (n=12) and a non-exercise MS group (n=13), with 15 healthy women serving as controls. Resistance exercise was performed three times per week at 60-80% of one-repetition maximum (1RM). Resistance training led to improvements in muscle strength, functional capacity, and quality

of life compared with the non-exercising group. However, no significant changes were observed on the oxidative stress biomarkers such as malondialdehyde (MDA), superoxide dismutase (SOD), and glutathione peroxidase (GPx) (Nezhad et al. 2024).

Similarly a 12 week Progressive resistance training (PRT) programme targeting the lower limbs significantly improved muscle strength and functional capacity in 38 MS patients. Importantly, these results lasted for another 12 weeks after ending the training (Dalgas et al. 2009).

Long-term resistance training was associated with improvements in dynamic balance, as reflected by a significant increase in Functional Reach Test performance, although no significant improvements were observed in other measures of functional mobility (Broekmans et al. 2011).

High-intensity resistance training (HIRT) has been shown to significantly reduce self-reported fatigue and improve psychological well-being in people with multiple sclerosis, regardless of whether participants trained once or twice a week, suggesting that even a single supervised session per week may be beneficial. Moreover, reductions in fatigue were associated with changes in plasma inflammatory biomarkers, suggesting that resistance exercise may have immunomodulatory effects (Englund et al. 2022).

A related pilot study tested a 6-week exercise program combining virtual reality treadmill training with resistance training in frail people with MS. The program was found to be safe and feasible, supporting the need for larger studies in the future (Zanotto et al. 2026).

Based on current evidence and international exercise guidelines, resistance training is recommended two times per week for people with MS, targeting the major muscle groups with progressive increases in training intensity as tolerated (Kalb et al. 2020).

4.2 Balance and gait training

Balance impairment and gait dysfunction are among the most significant causes of disability in multiple sclerosis, significantly increasing the risk of falls and limiting mobility. As a result, balance and gait training have become

a key focus of rehabilitation research in this population. MS patients who struggle with balance disorders may benefit from core stability exercises.

A systematic review and meta-analysis of seven RCTs (379 participants with EDSS<6) has shown that six to ten weeks of core stability exercises, performed two to three times per week can significantly improve balance, measured by the Berg Balance Scale (Choobsaz et al. 2024).

A recent review synthesising 21 studies on gait rehabilitation in MS found a wide range of different training protocols, with programme lengths from 4 to 24 weeks, including resistance training, aerobic exercise, balance training, and multimodal programmes. Twelve weeks of Pilates has improved step length and speed of walking, although these gains were comparable to those achieved by conventional physical therapy. Whole-body vibration training led to improvements in most gait parameters, including walking speed and step length. Similarly, a seven-week balance exercise programme produced significant improvements in walking ability with large effect sizes (Sepehrifar and Sahebozamani 2025).

Another study provided strong (level 1) evidence that balance-focused interventions improve mobility in people with MS, with high-intensity, task specific training associated with the best outcomes (Corrini et al. 2023).

4.3 Aerobic exercise

Aerobic exercise is based on rhythmic activity that increases heart rate and cardiovascular oxygen demand. It is another strategy studied for people with MS with particular interest in the effect on cognitive function, as the problem can affect up to 70% of patients with PMS. It can have a huge impact on daily life, employment and relationships with other people (Feinstein et al. 2020).

A meta-analysis about exercise affecting cognition in people with multiple sclerosis based on 26 studies with 708 participants found that aerobic exercises improved at least one cognitive domain in 10 out of 12 studies. Resistance training also showed benefits, although it was evaluated in far fewer studies, while a single study on yoga found no cognitive improvement. The authors concluded that aerobic and combined exercise are the most

studied and most effective ways to improve cognition in people with MS, but more research is still needed on resistance, balance, and stretching exercises (Elkhooly et al. 2024).

Combining aerobic exercise with cognitive tasks, such as reciting motivational phrases while moving, seems to work even better. In a study of 30 people with relapsing-remitting MS, this combined approach increased brain-derived neurotrophic factor (BDNF) levels and improved dual task performance and mood more than aerobic training alone (Farajnia et al. 2025).

Similarly, a study of 43 people with MS compared aerobic and strength exercise and found that both improved levels of nerve growth factors (NGF and NT-3), as well as cognition, fatigue, sleep quality, and quality of life. Balance improved only in the aerobic group. The authors suggested this might mean exercise helps support neural regeneration, though this idea still needs more research to confirm (Açık et al. 2023). This aligns with other research showing that regular exercise supports brain plasticity through factors like BDNF (Dołęga et al. 2024).

However, unlike the long-term training programmes described above, one study tested whether a single 20-minute aerobic exercise session could improve brain blood flow and thinking skills in 16 people with MS. Blood flow changed briefly after exercise but returned to normal within 30 minutes. Thinking speed improved after both exercise and rest, with no clear difference between them. This suggests that any short-term boost in cognitive performance after exercise is not simply caused by changes in brain blood flow (Lefferts et al. 2021).

4.4 Aquatic therapy

Aquatic therapy is exercise performed in warm water. The water supports the body's weight, which reduces stress on the joints and makes movement easier and less painful. This makes it a good option for MS patients who have trouble moving because of muscle stiffness.

A systematic review and meta-analysis including 11 RCTs found that most of the analyzed outcomes significantly improved with hydrotherapy compared to control groups. The authors recommended integrating

aquatic therapy with conventional physical therapy, while noting the need for larger studies with longer follow-up periods (Amedoro et al. 2020).

A different randomized controlled trial tested a 20-week Ai-Chi programme (gentle, flowing exercises in the pool) in 73 people with MS and compared it with standard breathing and relaxation exercises on land. The Ai-Chi group showed a significant reduction in pain with scores dropping about 50% right after the treatment. Also, the results lasted up to 10 weeks. Improvements were also seen in muscle spasms, fatigue, disability, autonomy and depression (Castro-Sánchez et al. 2012).

A separate randomized controlled trial involving 32 women with MS found that 8 weeks of aquatic exercise significantly improved walking distance, balance, and fatigue compared to a control group, with all three outcomes showing meaningful improvement after the training period (Kargarfard et al. 2018).

4.5 Fatigue

Fatigue is a common symptom of multiple sclerosis and many patients say it affects their daily life even more than physical disability. That is why reducing fatigue has become an important goal in rehabilitation.
The previously mentioned aquatic therapy has also shown benefits for fatigue and quality of life. In a trial involving 21 women with relapsing-remitting MS, the ones who completed 8 weeks of supervised aquatic exercise showed significant improvements in fatigue and several aspects of quality of life compared to the control group, with benefits already showing after just 4 weeks (Kargarfard et al. 2012).

A network meta-analysis including 27 studies and 1470 participants has shown that aquatic therapy was the most effective form of exercise for MS patients struggling with fatigue, among ten different types of exercise compared. Other forms of exercise, such as aerobic training, also reduced fatigue levels, although less effectively. Interestingly, one form of exercise (climbing) actually performed worse than doing no exercise at all, showing that not all types of physical activity are equally beneficial for managing fatigue (Chen et al. 2021).

Another large network meta-analysis involving 113 trials and almost 7000 participants found that balance training had the biggest impact on fatigue reduction. Cognitive behavioral therapy (CBT) also showed a big effect and was the only method that outperformed balance exercise. However, the evidence for balance training was only moderate, while the evidence for cognitive behavioral therapy was strong, so these results should be interpreted carefully (Harrison et al. 2021).

High-intensity interval training (HIIT) has also improved exercise capacity and reduced fatigue in MS patients (Martín-Núñez et al. 2025).

Tele-exercise which is a form of exercise that could be done from home via video calls, offers a solution for patients who face accessibility barriers of traditional, supervised rehabilitation. A meta-analysis of 13 trials found that tele-exercise significantly improved fatigue, depression, physical and mental health, and quality of life in people with MS, with mind-body exercises showing larger effects than combined training approaches (Najafi et al. 2025).

An important thing to consider when exercising with MS is heat sensitivity. About 60 to 80% of patients have disease symptoms when their body temperature rises due to hot weather or sun exposure (Kaltsatou and Flouris 2019). Physical activity also raises body temperature, which can temporarily make MS symptoms worse in some patients. This may discourage some patients from exercising. However, these symptoms are temporary and reversible. The solution to this problem may be exercising in cooler temperatures (Šilarová et al. 2024).

5. Discussion

Overall, the information reviewed here suggests that physical activity and rehabilitation bring meaningful benefits for people with MS in multiple areas such as muscle strength, balance, cognitive function, fatigue and quality of life. Resistance training, aerobic exercise and aquatic therapy all showed improvements in physical function and wellbeing. Balance training stood out to be one of the most effective approaches for reducing

fatigue. This matches the well-known general health benefits of regular exercise (Matusiak and Grabowska 2026).

However not all findings had a positive outcome. Some studies found no significant effect of exercise on specific parameters such as static balance or mobility, suggesting that exercise may help with some outcomes more than others. Also, while exercise improves physical function and subjective symptoms, its effect on the disease activity and progression measured by EDSS or MRI remains unclear. Notably, the aquatic therapy studies used quite different protocols, from structured Ai-Chi programmes to general aquatic exercise, making it difficult to determine which particular approach is the most effective. These inconsistencies may be partly explained by weaknesses in the studies themselves. Many trials had small sample sizes and lasted only a short time, which makes it harder to draw strong conclusions. Despite these limitations, the evidence supports the statement that physical activity and rehabilitation should be a part of care for MS patients, especially knowing that the pharmacological treatment alone is not enough to relieve symptoms like fatigue and spasticity. However, exercise participation rates among MS patients remain low, revealing a gap between what research shows and what actually happens in everyday clinical practice.

A systematic review comparing aerobic and resistance training in 22 trials with 966 participants found both to be equally effective in improving lower limb function and fatigue reduction in MS patients. This suggests that doctors can suggest either form of activity or exercise based on patients' preference rather than one being superior to the other (Taul-Madsen et al. 2021).

Future research should prioritize larger, longer term randomized controlled trials with standardized outcome measures, in order to establish clearer, more generalizable guidelines. Future studies should also look more closely at how exercise affects disease activity and find better ways to help patients stick with exercise programmes long term.

6. Conclusions

This review shows that physical activity and rehabilitation have real benefits for people with multiple sclerosis like improving muscle strength, balance, cognitive function, fatigue, and quality of life. Resistance training, aerobic exercise, aquatic therapy, and balance training all seem especially promising, although the strength of evidence varies. Since medication alone often cannot fully manage MS symptoms, physical activity should be seen as an important part of overall care. More high-quality research is still needed to create clear, standardized exercise guidelines and help patients stick with them long term. Overall, encouraging patients to stay physically active, in whatever form suits them best, appears to be a simple yet valuable step in supporting their long-term health and independence.

Disclosure:

Author's Contribution

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