DOI: 10.4274/jmsr.galenos.2024.2024-7-1

Journal of Multiple Sclerosis Research 2024;4(2):28-37

REVIEW

Effects of Motor Imagery Training on Health-related Quality of Life in Persons with Multiple Sclerosis: A Narrative Review

Turhan Kahraman

Izmir Katip Celebi University Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Izmir, Turkey

Abstract

Multiple sclerosis (MS) is a chronic autoimmune disorder that impacts the central nervous system. It typically develops during young adulthood, substantially impacting the health-related quality of life (HRQoL) through physical, cognitive, and psychosocial dysfunction. Recent breakthroughs in medical and rehabilitative approaches stress the need to enhance HRQoL for MS patients. Motor imagery (MI) training, involving the mental rehearsal of physical movements without actual execution, has emerged as a promising rehabilitation technique. This method activates neural circuits analogous to those during physical movement and improves motor function and psychological well-being in diverse neurological conditions, including MS. This narrative review synthesizes existing research on the effects of MI training on HRQoL in MS patients. Studies consistently report enhancements in motor function, including improved walking and reduced symptoms of fatigue and depression following MI interventions. Despite differing protocols and methodologies, the findings collectively suggest that MI training can enhance HRQoL in MS patients. Implementing MI training presents difficulties, including standardizing protocols, ensuring patient adherence, and addressing cognitive impairments influencing training effectiveness. In conclusion, MI training exhibits potential to enhance HRQoL in MS patients by addressing both physical and psychological aspects of the disease, thereby boosting overall well-being and functional independence.

Keywords: Multiple sclerosis, motor imagery, quality of life, rehabilitation, walking

Introduction

Multiple sclerosis (MS) is a chronic autoimmune neurological disorder characterized by inflammatory demyelination and axonal damage (1). It is typically diagnosed between the ages of 20 and 30, when individuals are at their most active in their social and professional lives (1). An approximated 2.9 million individuals worldwide are believed to be living with MS, as indicated by recent epidemiological studies (2).

Since MS can affect various regions of the central nervous system, it causes several symptoms and signs, including motor, sensory, visual, and autonomic disorders, impairing physical and cognitive function and adversely influencing employment (1,3,4). These negative consequences in MS patients result in activity limitations, participation restrictions, and disability. Additionally, MS is a chronic disease that frequently features relapses and unpredictable progression. It substantially impairs the psychological, social, and economic status of individuals due to its extensive array of impairments and limitations. These factors raise concerns regarding the right to a healthy life, which is considered one of the most fundamental human rights. The primary objective of treatment and management in MS, as with all diseases, should be to enhance the quality of life for individuals.

Previous research on the impact of MS was mainly focused on impairment and disability (5). However, in 1992, Rudick et al. (6) conducted a pioneering study that investigated the health-related quality of life (HRQoL) in MS patients. This study contrasted patients with MS, inflammatory bowel disease, and rheumatoid arthritis and discovered that MS patients exhibited the lowest HRQoL. Similarly, in 1996, Petajan et al. (7) conducted an innovative randomized controlled trial that studied the effects of exercise in MS patients. This study indicated that aerobic exercise training had a beneficial effect on physical fitness and quality of life. Over the past 30 years, there have been numerous positive advancements in the medical and

Address for Correspondence: Turhan Kahraman, Izmir Katip Celebi University Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Izmir, Turkey
E-mail: turhan.kahraman@yahoo.com **ORCID-ID:** orcid.org/0000-0002-8776-0664
Received: 10.07.2024 **Accepted:** 22.08.2024

rehabilitation fields related to MS. As the importance of HRQoL has increased, its assessment and use as an outcome measure have become more significant in clinical research, practice, and health policy decision-making.

Overview of Motor Imagery Training

Motor imagery (MI) training entails the mental rehearsal of physical movements without performing actual movements (8). This technique engages neural circuits similar to those that are activated during the physical execution of movements. MI training has been employed in diverse neurological rehabilitation settings to enhance various functions, primarily physical function, with promising results (9-11). MI training is a low-risk, non-invasive intervention that can be incorporated into rehabilitation programs to address the physical and psycho-socioeconomic challenges faced by MS patients (11-13).

The effectiveness of MI training is based on its ability to trigger neural plasticity. Neuroplasticity describes the brain's ability to reorganize by establishing new neural connections and modifying cortical organization (14). This is essential in MS, where demyelination and axonal damage impair normal neural communication (15). MI training stimulates brain regions involved in both motor processes, thereby facilitating neural adaptation and compensatory mechanisms. Studies using neuroimaging techniques, including functional magnetic resonance imaging and positron emission tomography, as well as transcranial magnetic stimulation studies, have demonstrated heightened activity in the motor and premotor regions of the brain during MI (16-19). This heightened activity is comparable to that observed during actual movement, indicating that MI training can enhance motor planning and execution pathways.

Motor function enhancement is one of the primary objectives of MI training in MS patients. Mobility and overall independence are significantly influenced by motor impairments associated with MS, including muscle weakness, spasticity, and coordination difficulties. Several studies have demonstrated that MI training can lead to notable improvements in physical function, particularly in walking ability in MS patients (20-23). These studies documented increased walking endurance, walking speed, and resolution of self-reported walking difficulties. Additionally, Kahraman et al. (21) reported that MI training is also effective in improving dynamic and static balance, as well as balance confidence.

Research has demonstrated that symptoms such as depression, fatigue, cognitive disorders, and sleep disturbances are prevalent and can exert detrimental effects on daily life as well as social and professional activities (24,25). Psychosocial well-being can also be improved through MI training. Numerous studies have demonstrated that MI training substantially improves cognitive functions, depression, anxiety, and fatigue symptoms (20-23).

Walking speed and fatigue were the most improved outcome measures, as reported by four studies (20-23), followed by walking endurance (20,22,23) and self-reported walking difficulties (20-22) as reported by three studies (Figure 1).

Outcome Measures to Assess Health-related Quality of Life in the Reviewed Studies

Several questionnaires, including the Multiple Sclerosis International Quality of Life Questionnaire (MusiQoL), the Multiple Sclerosis Impact Scale-29 (MSIS-29), the Short Form Health Survey-36 (SF-36), and the EuroQol 5-Dimension (EQ-5D) questionnaire, have been employed across the reviewed studies when evaluating HRQoL in MS patients. It is crucial to consider the strengths and limitations of each of these instruments when interpreting the results and selecting suitable measures for future research.

MusiQoL is explicitly designed for MS patients, capturing the distinctive challenges and experiences associated with the disease (26). This specificity increases its relevance and sensitivity to alterations in HRQoL in MS patients. It offers a comprehensive evaluation of HRQoL, encompassing a wide variety of life domains, such as psychological well-being, relationships, and daily activities. The detailed nature of MusiQoL can be tedious for certain patients, particularly those with cognitive impairments or severe disabilities, which may impact response rates and data accuracy. It may not be appropriate for comparisons with the general population norms or individuals with other chronic conditions due to its MS-specificity.

Like MusiQoL, MSIS-29 is designed for MS patients; however, it is more concise and uncomplicated, which facilitates completion by the participants (27). It specifically assesses the physical and psychological impact of MS, which are essential components of HRQoL in this demographic. MSIS-29 may not adequately address other aspects of HRQoL, such as social relationships or economic factors, despite its success in capturing physical and psychological effects. Additionally, a study indicated that MSIS-29 may be restricted in its ability to evaluate alterations associated with disease-modifying therapies in patients with minimal disability (28).

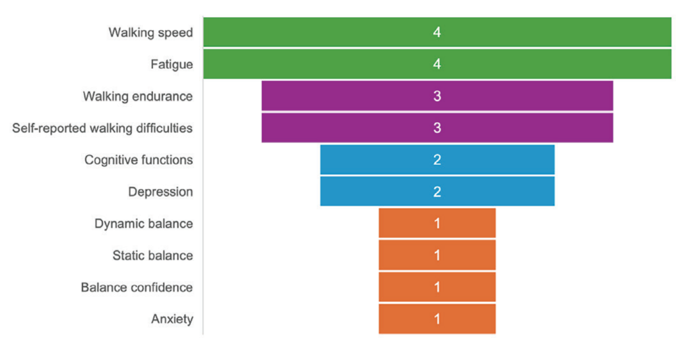


Figure 1. Number of studies reporting substantial improvement in different study outcome measures following motor imagery training

Table 1. Details of studies exploring the effects of motor imagery training on HRQoL in MS patients

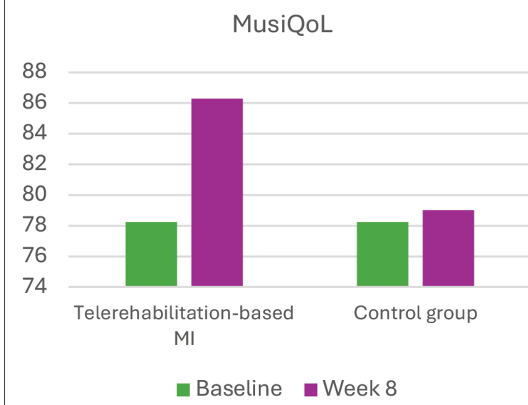
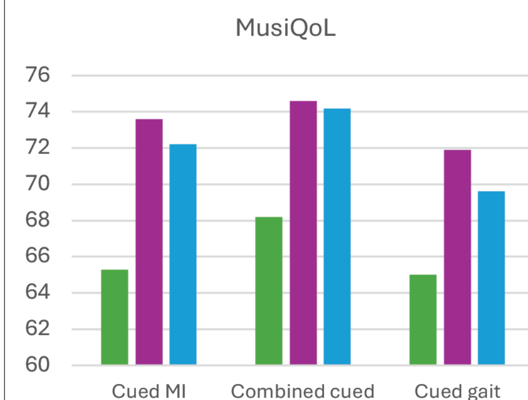
Study	Groups (number of participants) and EDSS score	Interventions	Outcome measure for HRQoL	Key findings on HRQoL	Visual representation of key findings
Kahraman et al. (21)	Telerehabilitation-based MI (n=20): EDSS, median (IQR) = 1 (0-1.75) Control group (n=15): EDSS, median (IQR) = 2 (0-2.5) Healthy controls (n=20)	Telerehabilitation-based MI: 2 times/week 20-30 minutes 8 weeks 16 sessions in total Control group: No intervention	MusiQoL	Baseline (pre-intervention): Telerehabilitation-based MI = 78.22 (70.36, 84.07) Control group = 78.22 (72.58, 84.67) After 8 weeks (post-intervention): Telerehabilitation-based MI = 86.29 (82.25, 94.35), change from baseline = 8.87 (0, 20.16); p=0.002* Control group = 79.03 (66.73, 90.92), change from baseline = -1.21 (-7.66, 7.46); p=0.802	
Seebacher et al. (23)	Cued MI (n=44): EDSS, median (IQR) = 2.5 (2.0-4.0) Combined cued MI and cued gait training (n=44): EDSS, median (IQR) = 3.0 (2.5-4.0) Cued gait training (n=44): EDSS, median (IQR) = 3.0 (2.0-4.0)	For all groups: 4 times/week 30 minutes, 4 weeks 16 sessions in total	MusiQoL	Baseline (pre-intervention): Cued MI = 65.3 (59.4-81.4) Combined cued MI and cued gait training = 68.2 (61.5-73.3) Cued gait training = 65.0 (57.2-69.6) Week 4 (post-intervention): Cued MI = 73.6 (67.0-99.6), change from baseline = 9.1 (0.8-18.2); p<0.001* Combined cued MI and cued gait training = 74.6 (67.7-82.1), change from baseline = 6.7 (-1.4 to 15.4); p=0.003* Cued gait training = 71.9 (65.2-77.9), change from baseline = 8.3 (2.3-4.9); p<0.001* Week 13 (follow-up): Cued MI = 72.2 (58.6-96.6), change from baseline = 5.9 (-4.0-15.5); p=0.027* Combined cued MI and cued gait training = 74.2 (64.0-79.0), change from baseline = 6.4 (-1.5 to 13.2); p=0.036* Cued gait training = 69.6 (62.5-78.2), change from baseline = 4.5 (1.8.0 to 12.4); p=0.001*	

Table 1. Continued

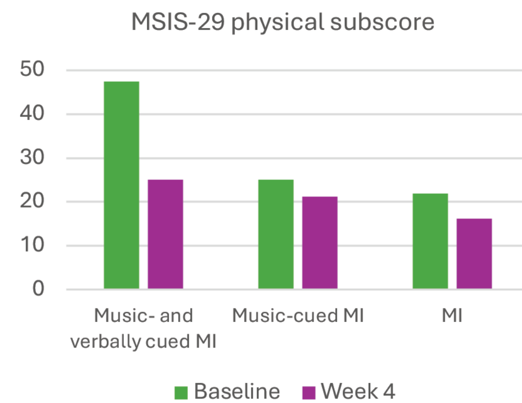
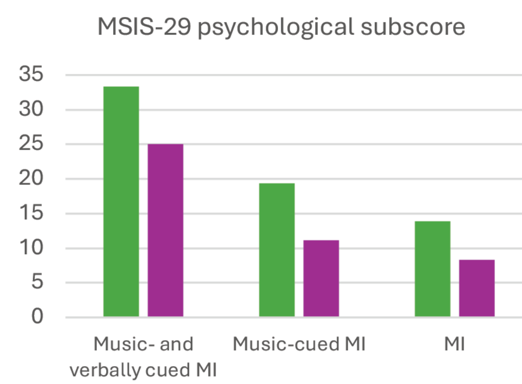
Study	Groups (number of participants) and EDSS score	Interventions	Outcome measure for HRQoL	Key findings on HRQoL	Visual representation of key findings
Seebacher et al. (20)	Music- and verbally cued MI (n=19): EDSS, median (range) = 3.0 (1.5-4.5) Music-cued MI (n=20): EDSS, median (range) = 2.5 (1.5-4.5) MI (n=20): EDSS, median (range) = 2.5 (1.5-4.5)	For all groups: 6 times/week 17 minutes, 4 weeks 24 sessions in total	MSIS-29 (physical and psychological subscore)	Baseline (pre-intervention) for MSIS-29 physical subscore: Music- and verbally cued MI = 47.5 (12.5, 76.2) Music-cued MI = 25 (6.2, 56.2) MI = 21.9 (3.7, 63.7) Week 4 (post-intervention) for MSIS-29 physical subscore: Music- and verbally cued MI = 25.0 (5.0, 61.2), change from baseline = -15.0 (-38.7, -1.2)*, clinically significant improvement: n=15 (78.9%)* Music-cued MI = 21.2 (2.5, 37.5), change from baseline = -7.5 (-28.7, 8.7), clinically significant improvement: n=10 (50%) MI = 16.2 (2.5, 51.2), change from baseline = -3.1 (-41.2, 8.7), clinically significant improvement: n=7 (35%) Baseline (pre-intervention) for MSIS-29 psychological subscore: Music- and verbally cued MI = 33.3 (2.8, 66.7) Music-cued MI = 19.4 (0.0, 47.2) MI = 13.9 (0.0, 66.7) Week 4 (post-intervention) for MSIS-29 psychological subscore: Music- and verbally cued MI = 25.0 (2.8, 50.0), change from baseline = -11.1 (-50.0, 16.7), clinically significant improvement: n=12 (63.2%) Music-cued MI = 11.1 (0.0, 36.1), change from baseline = -2.3 (-19.4, 13.9), clinically significant improvement: n=9 (45%) MI = 8.3 (0.0, 52.8), change from baseline = -1.4 (-38.9, 19.4), clinically significant improvement: n=8 (40%)	 

Table 1. Continued

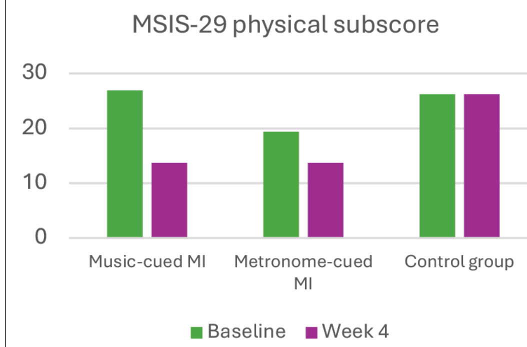
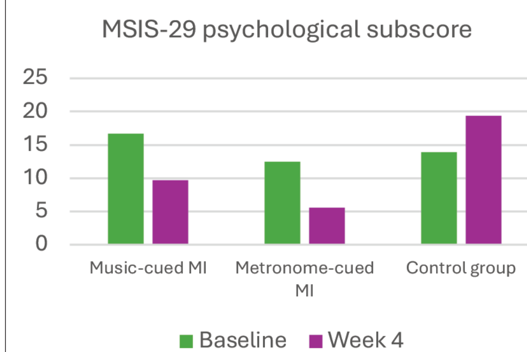
Study	Groups (number of participants) and EDSS score	Interventions	Outcome measure for HRQoL	Key findings on HRQoL	Visual representation of key findings
Seebacher et al. (22)	Music-cued MI (n=34): EDSS, median (range) = 2.0 (1.5-4.5) Metronome-cued MI (n=34): EDSS, median (range) = 2.0 (1.5-4.5) Control group (n=33): EDSS, median (range) = 2.0 (1.5-4.5)	For intervention groups: 6 times/week 17 minutes, 4 weeks 24 sessions in total Control group: No intervention	MSIS-29 (physical and psychological subscore) SF-36 (physical and mental subscore) EQ-5D-3L (index value and VAS)	Baseline (pre-intervention) for MSIS-29 physical subscore: Music-cued MI = 26.9 (2.5-53.8) Metronome-cued MI = 19.4 (1.2-81.2) Control group = 26.2 (2.5-52.5) Week 4 (post-intervention) for MSIS-29 physical subscore: Music-cued MI = 13.7 (0-51.2), change from baseline = -6.9 (-36.2-7.5)*, clinically significant improvement: n=17 (50%) Metronome-cued MI = 13.7 (0-63.7), change from baseline = -5 (-42.5-6.2)*, clinically significant improvement: n=14 (41.2%) Control group = 26.2 (1.2-75), change from baseline = 1.2 (-22.5-48.7), clinically significant improvement: n=7 (21.2%)	
				Baseline (pre-intervention) for MSIS-29 psychological subscore: Music-cued MI = 16.7 (0-55.6) Metronome-cued MI = 12.5 (0-58.3) Control group = 13.9 (0-61.1) Week 4 (post-intervention) MSIS-29 psychological subscore: Music-cued MI = 9.7 (0-41.7), change from baseline = -6.9 (-41.7 to 8.3)*, clinically significant improvement: n=19 (55.9%)* Metronome-cued MI = 5.6 (0-63.9), change from baseline = -2.8 (-27.8 to 5.6)*, clinically significant improvement: n=10 (29.4%) Control group = 19.4 (0-63.9), change from baseline = 2.8 (-13.9 to 38.9), clinically significant improvement: n=4 (12.1%)	

Table 1. Continued

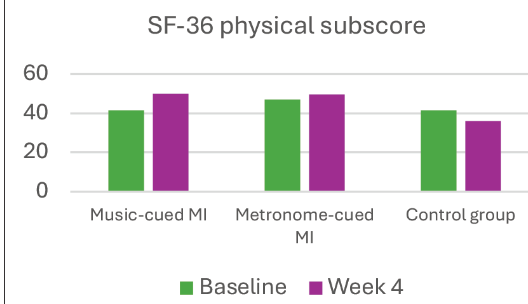
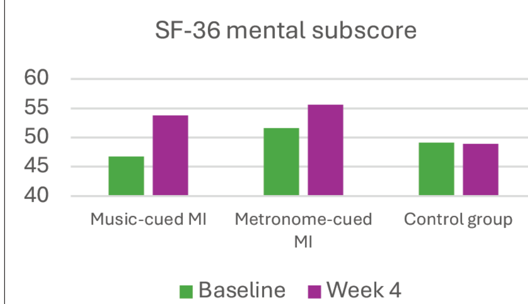
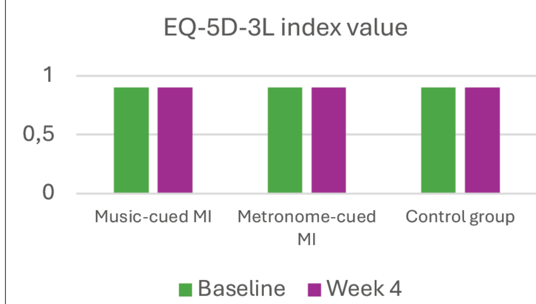
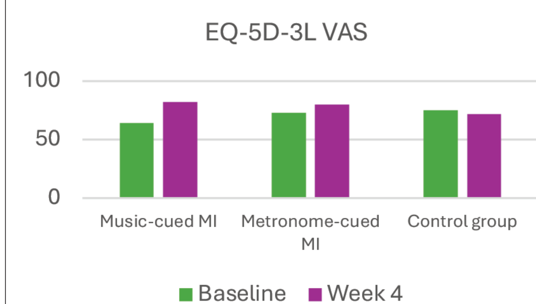
Study	Groups (number of participants) and EDSS score	Interventions	Outcome measure for HRQoL	Key findings on HRQoL	Visual representation of key findings
Seebacher et al. (22)	Music-cued MI (n=34): EDSS, median (range) = 2.0 (1.5-4.5) Metronome-cued MI (n=34): EDSS, median (range) = 2.0 (1.5-4.5) Control group (n=33): EDSS, median (range) = 2.0 (1.5-4.5)	For intervention groups: 6 times/week 17 minutes, 4 weeks 24 sessions in total Control group: No intervention	MSIS-29 (physical and psychological subscore) SF-36 (physical and mental subscore) EQ-5D-3L (index value and VAS)	Baseline (pre-intervention) for SF-36 physical subscore: Music-cued MI = 41.4 (19.1-62.7) Metronome-cued MI = 47.1 (18.5-66) Control group = 41.6 (24.5-59.6) Week 4 (post-intervention) for SF-36 physical subscore: Music-cued MI = 50 (27.7-63.1), change from baseline = 2.7 (-4.8 to 22.8)*, clinically significant improvement: n=15 (44.1%)* Metronome-cued MI = 49.7 (16.6-61.8), change from baseline = 2.3 (-12 to 16.6)*, clinically significant improvement: n=12 (31.3%)* Control group = 35.9 (24.8-58.1), change from baseline = -2.5 (-24.5 to 6.4), clinically significant improvement: 2/33 (6.1%)	
				Baseline (pre-intervention) for SF-36 mental subscore: Music-cued MI = 46.8 (21.5-62.4) Metronome-cued MI = 51.6 (12.2-65.5) Control group = 49.1 (21.8-63.9) Week 4 (post-intervention) for SF-36 mental subscore: Music-cued MI = 53.8 (25.2-64.3), change from baseline = 2.4 (-15.1 to 22.9)*, clinically significant improvement: n=13 (38.3%) Metronome-cued MI = 55.6 (25.2-65.6), change from baseline = 2 (-14 to 28.1)*, clinically significant improvement: 11/34 (32.4%) Control group = 48.9 (23.4-62.7), change from baseline = -0.3 (-14.9 to 14.2), clinically significant improvement: n=4 (12.1%)	

Table 1. Continued

Study	Groups (number of participants) and EDSS score	Interventions	Outcome measure for HRQoL	Key findings on HRQoL	Visual representation of key findings
Seebacher et al. (22)	Music-cued MI (n=34): EDSS, median (range) = 2.0 (1.5-4.5) Metronome-cued MI (n=34): EDSS, median (range) = 2.0 (1.5-4.5) Control group (n=33): EDSS, median (range) = 2.0 (1.5-4.5)	For intervention groups: 6 times/week 17 minutes, 4 weeks 24 sessions in total Control group: No intervention	MSIS-29 (physical and psychological subscore) SF-36 (physical and mental subscore) EQ-5D-3L (index value and VAS)	Baseline (pre-intervention) for EQ-5D-3L index value: Music-cued MI = 0.9 (0.6-1.0) Metronome-cued MI = 0.9 (0.1-1.0) Control group = 0.9 (0.3-1.0) Week 4 (post-intervention) for EQ-5D-3L index value: Music-cued MI = 0.9 (0.7-1), change from baseline = 0 (-0.1 to 0.4) Metronome-cued MI = 0.9 (0.2-1), change from baseline 0 (0.1 to 0.2) Control group = 0.9 (0.3-1), change from baseline = 0 (-0.6 to 0.5) Baseline (pre-intervention) for EQ-5D-3L VAS: Music-cued MI = 64 (30-100) Metronome-cued MI = 73 (24-100) Control group = 75 (30-95) Week 4 (post-intervention) for EQ-5D-3L VAS: Music-cued MI = 82 (40-100), change from baseline = 9 (-10 to 33)*, clinically significant improvement: n=19 (55.9%)* Metronome-cued MI = 80 (35-100), change from baseline = 5 (-8 to 51)*, clinically significant improvement: 11/34 (32.4%) Control group = 72 (30-97), change from baseline = 0 (-15 to 35), clinically significant improvement: n=6 (18.2%)	 

*p<0.05, EDSS: Expanded disability status scale, IQR: Interquartile range, HRQoL: Health-related quality of life, MS: Multiple sclerosis, MI: Motor imagery, MusiQoL: Multiple sclerosis international quality of life, MSIS-29: Multiple sclerosis impact scale-29, SF-36: Short Form-36, EQ-5D-3L: EuroQol-5D-3L Questionnaire, VAS: Visual analog scale

SF-36 is a HRQoL instrument that is extensively used across different populations and conditions, including MS (29,30). Its comprehensive validation facilitates reliable comparisons with the general population data and other disease groups. It assesses multiple dimensions of health, including physical functioning, pain, general health perceptions, and mental health, providing a comprehensive assessment of HRQoL. SF-36 may conceivably underestimate the impact of MS on certain aspects of life by overlooking some MS-specific issues as a generic measure. While its broad applicability and exhaustive nature render it valuable, the SF-36 scoring process can be complex. The calculation of its eight subscales and two summary measures (physical and mental health) is particularly complex, necessitating meticulous interpretation to prevent errors or inconsistencies (31).

EQ-5D is a simple instrument that can be rapidly administered, making it suitable for use in large studies or clinical settings where time is limited (32). It offers a single utility score that can be employed in cost-effectiveness analyses, which is valuable for health economics and policy decision-making. The simplicity of EQ-5D comes at the expense of depth. It covers only five dimensions (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression), which may result in the neglect of other critical components of HRQoL in MS patients (33).

Each of these HRQoL questionnaires has its own unique set of strengths and limitations, rendering them appropriate for different research or clinical contexts. The selection of the instrument, the characteristics of the MS population being evaluated, and the HRQoL aspects that are most pertinent to the intervention or outcome under investigation should be determined by the specific objectives of the study. To achieve a thorough understanding of the influence of MI training on the HRQoL in MS patients, it would be beneficial to integrate disease-specific instruments with generic measures. This method strikes a balance between the comprehensive insights offered by specialized instruments and the more general, analogous data from general assessments.

Health-related Quality of Life Improvements After Motor Imagery Training

Quality of life is a multifaceted concept that encompasses physical health, psychological state, social relationships, and environmental factors (34). Enhanced physical and cognitive functions, along with improved psychosocial well-being, contribute to a more holistic sense of health and fulfillment. MI training has been shown to significantly improve HRQoL in individuals with MS, despite the fact that HRQoL has not been the primary outcome measure in previous studies (20-23).

Kahraman et al. (21) employed the MusiQoL scale to evaluate HRQoL following an 8-week telerehabilitation-based MI program for MS patients. Their study demonstrated that this intervention significantly improved HRQoL, with a large effect size ($p=0.002$, Cohen's $d=1.916$). Similarly, Seebacher et al. (23) used the MusiQoL as a secondary outcome measure and reported that cued MI training significantly enhanced MusiQoL scores at the fourth week ($p<0.001$) and follow-up (week 13) ($p=0.027$) compared to the baseline. Additionally, they demonstrated that combining cued MI with cued gait training also improved MusiQoL scores at the fourth week ($p=0.003$) and week 13 ($p=0.036$) compared to the baseline.

In a 2019 study, Seebacher et al. (20) used the MSIS-29 to evaluate HRQoL while investigating the effects of a four-week program that involved music and verbally cued MI, music-cued MI, or MI alone in MS patients. They discovered that 78.9% of participants in the music and verbally cued MI group exhibited clinically significant improvements in the MSIS-29 physical subscore ($p<0.05$), despite not demonstrating improvement in the total or psychological subscores. No significant improvements were noted in the other groups in HRQoL.

In a separate 2017 study, Seebacher et al. (22) examined the impact of 4-week music-cued MI and metronome-cued MI on HRQoL in persons with MS, using diverse tools including the MSIS-29, SF-36, and EQ-5D-3L. They revealed that both music-cued and metronome-cued MI significantly enhanced MSIS-29 physical and psychological subscores, SF-36 physical and mental subscores, and EQ-5D-3L visual analog scores ($p<0.05$).

MI training methods and treatments differ across studies. The therapy sessions are scheduled to last between 17 and 30 minutes, with a frequency of 2 to 6 week. The total treatment duration is 4 to 8 weeks, resulting in 16 to 24 sessions overall. Table 1 contains the specifics of the studies that investigated the impact of MI training on MS patients' HRQoL.

Clinical Implications

These results underscore the potential of MI training as a non-invasive, cost-effective intervention that can improve HRQoL in MS patients (11). MI training can contribute to a more comprehensive approach to MS management by improving physical and cognitive functions, as well as social and emotional well-being (Figure 1). Clinicians should contemplate incorporating MI training into rehabilitation programs to aid MS patients in achieving better overall outcomes.

Possible Challenges

Despite its benefits, the implementation of MI training in clinical practice faces numerous challenges. The necessity of standardized protocols for ensuring consistent and replicable results is underscored by the variation in outcome measures, duration, and delivery modalities of MI across studies. Additionally, patient adherence and engagement in MI training programs can vary, potentially impacting the efficacy of the intervention.

Ensuring access to technology and the provision of adequate training for both patients and healthcare providers are critical factors in the successful incorporation of MI training into routine care. Moreover, cognitive impairments, disability, and cognitive fatigue are known to negatively influence MI ability in MS patients (13). The effectiveness of MI training may also be influenced by other factors, including the phenotype of MS, anxiety, and depression (13). It is essential to resolve these issues by implementing appropriate precautions and support mechanisms to increase patient participation and maximize the benefits of the intervention.

Future Directions

To further substantiate the efficacy of MI training in enhancing the HRQoL of individuals with MS, future research should prioritize large-scale, randomized controlled trials. Investigating the long-term consequences and identifying optimal training protocols will be essential for optimizing the benefits of this intervention on HRQoL.

Developing standardized guidelines and protocols for MI training in MS is essential. These guidelines should specify training frequency, duration, and intensity to ensure consistency and effectiveness across various clinical settings, ultimately enhancing HRQoL. Furthermore, integrating technological advancements such as virtual reality, biofeedback, and telerehabilitation may enhance the delivery and engagement of MI training. These innovations can increase the accessibility and efficacy of the training, thereby potentially yielding more substantial enhancements in HRQoL for MS patients.

It is imperative to recognize that most participants exhibited minimal levels of disability in the context of the reviewed studies. This characteristic may restrict the generalizability of the results to the broader population of MS patients, particularly those with higher disability levels. Future research should endeavor to involve a more diverse range of participants, particularly those with moderate to severe disability. Expanding the participant pool to encompass individuals with differing degrees of disability would also enable a more detailed exploration of the potential need for MI training to be customized to address the specific needs of those with higher disability levels. Additionally, the effectiveness of MI training in improving HRQoL for those with more severe disabilities is a field that remains largely unexplored. Addressing this gap could result in more inclusive and comprehensive guidelines that accommodate the complete spectrum of disability in MS patients, thereby improving the overall outcomes for this population.

Conclusion

MI training is a promising intervention for enhancing the HRQoL in MS patients. This method addresses multiple aspects of MS by improving physical, cognitive, and psychosocial functions. Further research and clinical implementation of MI training are necessary, as the significance of HRQoL in MS management continues to increase. Integrating MI training into rehabilitation programs may provide significant benefits, allowing MS patients to live more active, meaningful lives.

Ethics

Conflict of Interest: The author declare no conflict of interest.

Financial Disclosure: The author declared that this study received no financial support.

References

1. McGinley MP, Goldschmidt CH, Rae-Grant AD. Diagnosis and Treatment of Multiple Sclerosis: A Review. JAMA. 2021;325:765-779.
2. The Multiple Sclerosis International Federation, Atlas of MS, 3rd Edition. 2020.
3. Murray TJ. Diagnosis and treatment of multiple sclerosis. BMJ. 2006;332:525-527.
4. Kahraman T, Temiz H, Abasiyanik Z, Baba C, Ozakbas S. Dual-task difficulties as a risk factor for unemployment in people with multiple sclerosis. Brain Behav. 2023;13:e3299.
5. Benito-León J, Morales JM, Rivera-Navarro J, Mitchell A. A review about the impact of multiple sclerosis on health-related quality of life. Disabil Rehabil. 2003;25:1291-303.
6. Rudick RA, Miller D, Clough JD, Gragg LA, Farmer RG. Quality of life in multiple sclerosis. Comparison with inflammatory bowel disease and rheumatoid arthritis. Arch Neurol. 1992;49:1237-1242.
7. Petajan JH, Gappmaier E, White AT, Spencer MK, Mino L, Hicks RW. Impact of aerobic training on fitness and quality of life in multiple sclerosis. Ann Neurol. 1996;39:432-441.
8. Mulder T. Motor imagery and action observation: cognitive tools for rehabilitation. J Neural Transm (Vienna). 2007;114:1265-1278.
9. Singer T, Fahey P, Liu KPY. Effectiveness of Motor Imagery in the Rehabilitation of People With Parkinson's Disease: A Systematic Review and Meta-Analysis. Neurorehabil Neural Repair. 2024;38:460-475.
10. Zhao LJ, Jiang LH, Zhang H, Li Y, Sun P, Liu Y, Qi R. Effects of Motor Imagery Training for Lower Limb Dysfunction in Patients With Stroke: A Systematic Review and Meta-analysis of Randomized Controlled Trials. Am J Phys Med Rehabil. 2023;102:409-418.
11. Gil-Bermejo-Bernardez-Zerpa A, Moral-Munoz JA, Lucena-Anton D, Luque-Moreno C. Effectiveness of Motor Imagery on Motor Recovery in Patients with Multiple Sclerosis: Systematic Review. Int J Environ Res Public Health. 2021;18:498.
12. Agostini F, Pezzi L, Paoloni M, Insabella R, Attanasi C, Bernetti A, Saggini R, Mangone M, Paolucci T. Motor Imagery: A Resource in the Fatigue Rehabilitation for Return-to-Work in Multiple Sclerosis Patients-A Mini Systematic Review. Front Neurol. 2021;12:696276.
13. Seebacher B, Reindl M, Kahraman T. Factors and strategies affecting motor imagery ability in people with multiple sclerosis: a systematic review. Physiotherapy. 2023;118:64-78.
14. Ruffino C, Papaxanthis C, Lebon F. Neural plasticity during motor learning with motor imagery practice: Review and perspectives. Neuroscience. 2017;341:61-78.
15. Lubetzki C, Stankoff B. Demyelination in multiple sclerosis. Handb Clin Neurol. 2014;122:89-99.
16. Hétu S, Grégoire M, Saimpont A, Coll MP, Eugène F, Michon PE, Jackson PL. The neural network of motor imagery: an ALE meta-analysis. Neurosci Biobehav Rev. 2013;37:930-949.

17. Tacchino A, Pedullà L, Podda J, Monti Bragadin M, Battaglia MA, Bisio A, Bove M, Brichetto G. Motor imagery has a priming effect on motor execution in people with multiple sclerosis. Front Hum Neurosci. 2023;17:1179789.

18. Loporto M, McAllister C, Williams J, Hardwick R, Holmes P. Investigating central mechanisms underlying the effects of action observation and imagery through transcranial magnetic stimulation. J Mot Behav. 2011;43:361-373.

19. Munzert J, Lorey B, Zentgraf K. Cognitive motor processes: the role of motor imagery in the study of motor representations. Brain Res Rev. 2009;60:306-326.

20. Seebacher B, Kuisma R, Glynn A, Berger T. Effects and mechanisms of differently cued and non-cued motor imagery in people with multiple sclerosis: A randomised controlled trial. Mult Scler. 2019;25:1593-1604.

21. Kahraman T, Savci S, Ozdogar AT, Gedik Z, Idiman E. Physical, cognitive and psychosocial effects of telerehabilitation-based motor imagery training in people with multiple sclerosis: A randomized controlled pilot trial. J Telemed Telecare. 2020;26:251-260.

22. Seebacher B, Kuisma R, Glynn A, Berger T. The effect of rhythmic-cued motor imagery on walking, fatigue and quality of life in people with multiple sclerosis: A randomised controlled trial. Mult Scler. 2017;23:286-296.

23. Seebacher B, Helmlinger B, Pinter D, Heschl B, Ehling R, Hechenberger S, Reindl M, Khalil M, Enzinger C, Deisenhammer F, Brenneis Md C. Actual and Imagined Music-Cued Gait Training in People with Multiple Sclerosis: A Double-Blind Randomized Parallel Multicenter Trial. Neurorehabil Neural Repair. 2024;38:555-569.

24. Hanna M, Strober LB. Anxiety and depression in Multiple Sclerosis (MS): Antecedents, consequences, and differential impact on well-being and quality of life. Mult Scler Relat Disord. 2020;44:102261.

25. Pourhaji F, Peyman N, Taraghdar MM, Jamali J, Tehrani H. Explaining the burden of psychosocial factors on the worsening symptoms of MS: a qualitative study of patients' experiences. BMC Neurol. 2023;23:98.

26. Simeoni M, Auquier P, Fernandez O, Flachenecker P, Stecchi S, Constantinescu C, Idiman E, Boyko A, Beiske A, Vollmer T, Triantafyllou N, O'Connor P, Barak Y, Biermann L, Cristiano E, Atweh S, Patrick D, Robitail S, Ammoury N, Beresniak A, Pelletier J; MusiQol study group. Validation of the Multiple Sclerosis International Quality of Life questionnaire. Mult Scler. 2008;14:219-230.

27. Hobart J, Lamping D, Fitzpatrick R, Riazi A, Thompson A. The Multiple Sclerosis Impact Scale (MSIS-29): a new patient-based outcome measure. Brain. 2001;124:962-973.

28. Regnault A, Loubert A, Brennan R, Meunier J, Naujoks C, Cano S, Adlard N. Does the Multiple Sclerosis Impact Scale-29 (MSIS-29) have the range to capture the experience of fully ambulatory multiple sclerosis patients? Learnings from the ASCLEPIOS studies. Mult Scler J Exp Transl Clin. 2023;9:20552173231201422.

29. Ware JE, Gandek B. The SF-36 Health Survey: Development and use in mental health research and the IQOLA Project. Int J Ment Health. 1994;23:49-73.

30. Nortvedt MW, Riise T, Myhr KM, Nyland HI. Performance of the SF-36, SF-12, and RAND-36 summary scales in a multiple sclerosis population. Med Care. 2000;38:1022-1028.

31. Lins L, Carvalho FM. SF-36 total score as a single measure of health-related quality of life: Scoping review. SAGE Open Med. 2016;4:2050312116671725.

32. Brooks R. The EuroQol group after 25 years: Springer Science & Business Media, 2012.

33. Campbell JA, Ahmad H, Chen G, van der Mei I, Taylor BV, Claflin S, Henson GJ, Simpson-Yap S, Laslett LL, Hawkes K, Hurst C, Waugh H, Palmer AJ. Validation of the EQ-5D-5L and psychosocial bolt-ons in a large cohort of people living with multiple sclerosis in Australia. Qual Life Res. 2023;32:553-568.

34. Kahraman T. Health-Related Quality of Life in Multiple Sclerosis. In: Çetişli-Korkmaz N, Bilek F (Eds). Neurorehabilitation in Multiple Sclerosis. Ankara, Hipokrat Yayıncılık, 2023, pp 277-290.