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Effect of Sensory Integration Therapy on Quality of Life in Patients with Multiple Sclerosis: A Randomized Controlled Trial

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ABSTRACT: Background: Multiple sclerosis (MS) can be attributed to a low health-related quality of life (QOL). MS patients commonly claim that role limitations and emotional issues have a significant negative impact on their QOL, comparable to physical symptoms or disability status.

Objectives: This study aimed to detect the impact of sensory integration therapy on the QOL in patients suffering from MS by the 36-item short-form QOL scale (SF-36).

Methods: Thirty-eight male and female patients diagnosed with relapsing–remitting MS were enrolled in this study. The patients were divided into two groups at random: the study group (SG) and the control group (CG). A conventional physical-therapy program was given for the CG, such as aerobic exercise, muscle stretching for both lower extremities and strengthening exercise for both lower extremities. Besides conventional physical-therapy programs, sensory integration therapy was performed by the patients in the SG. Each group had a 70-minute session, which took place twice a week for eight weeks.

The Outcome Measures: To evaluate the QOL items on the SF-36, an Arabic version of the validated short form dimension scale (SF-36) was utilized, which was divided into 8 domains. The SF-36 scale was used to assess each group before, and after 8 weeks of intervention, as well as after three-month follow-up.

Results: After treatment and throughout follow-up, the study and control groups did not differ statistically. However, when comparing the study group before and after treatment, a significant improvement was observed in all outcome measures ($P < 0.001$). From pre-treatment to follow-up, all domains except emotional well-being showed significant improvement ($P < 0.01$), whereas emotional well-being did not differ significant ($P = 0.13$). From post-treatment to follow-up, there was a significant decline in all domains ($P < 0.01$), though scores remained above pre-treatment levels. Within control group, there was a significant difference post-treatment in all domains compared with baseline ($P < 0.001$). From pre-treatment to follow-up, all domains showed significant improvement ($P < 0.05$), whereas energy/fatigue, emotional well-being, social functioning, and pain did not differ significantly ($P > 0.05$). From post-treatment to follow-up, there was a significant decline in all domains ($P < 0.01$).

Conclusion: Both rehabilitation programs were associated with significant improvements in SF-36 scores; however, adding sensory integration therapy did not produce a statistically significant improvement in QOL compared with conventional physiotherapy alone.

INTRODUCTION

Multiple sclerosis (MS) is a central nervous system disease that is immune-mediated, inflammatory, demyelinating, as well as neurodegenerative [1]. Multiple sclerosis (MS) is a leading cause of neurological impairment in young adults globally [2]. The number of cases has been rising continuously [3]. Individuals with multiple sclerosis (MS) encounter a variety of intricate motor and non-motor symptoms, which frequently exert a hidden adverse effect on ambulation, cognitive abilities, and engagement in activities.

An individual's subjective assessment of their own health situation is known as quality of life (QOL). A person's health at any given time includes not only their mental and emotional well-being, but also their social and functional capacities [5]. QOL is measured using standardized instruments and procedures, that provides a quantitative way to monitor a person's health state as a result of changes in intervention over time [6]. A patient's self-reported QOL also serves as a predictor of the development and severity of disability that may result from their condition [7].

As a result of better survival rates, the global prevalence of multiple sclerosis has increased from 2.3 million in 2013 to 2.8 million in 2020 [8]. Finding treatments that can enhance QOL for people affected by MS is essential as the prevalence of the disease rises [7].

Sensory integration therapy (SIT) was initially designed for children with sensory processing disorders and was proposed in the 1970s by Jean Ayres, who introduced the theory of SIT [9]. SIT is being increasingly investigated as a rehabilitative approach in MS. Enhancing the brain's capacity to integrate and analyze data from multiple senses is the ultimate objective of SIT. This will help with motor control, reduce fatigue, and promote functional independence [10].

SIT involves providing sensory stimulation through various tools to improve sensory experiences [11]. SIT may lead to clinically meaningful enhancement in fatigue, balance, and QOL in PwMS, but there is limited evidence on long-term outcomes. Reducing fatigue is important because it can affect every day functioning and overall well-being [12] [13].

Previous research has shown improvements in physical and mental aspects of QOL following SIT, vibration-based interventions, along with web-based wellness programs that incorporate sensory features [14]. However, few studies have focused on the role of SIT in improving QOL in people with MS, despite a significant rise in interest in this area in recent years. The purpose of this study is to collect all the evidence on the effects of SIT on QOL, so that clinical practice can be informed and QOL can be improved in PwMs.

MATERIALS AND METHODS:

Subject selection:

The study was conducted on thirty-eight male and female relapsing and remitting multiple sclerosis patients. The patients were assessed for eligibility using McDonald's criteria [20]. A neurological sheet is used to carefully take a patient's history and perform a neurological examination. The neurologist-administered Expanded Disability Status Scale (EDSS) score (2–4.5). The diagnosis was confirmed by MRI. The patients were selected from the outpatient clinic of Cairo University's Faculty of Physical Therapy as well as the Kasr Al Ainy Multiple Sclerosis Clinic (KAMSC). The patients were assigned randomly using computer-generated random numbers into two groups: the (SG) and the (CG).

The patients were chosen under the following criteria:

Subjects were both males and females who had a relapsing-remitting MS diagnosis at least one year prior to the start of the study. Patients' ages varied from eighteen to forty-five. Before the study, the patient must have maintained a stable MS disease and not experienced any episodes of relapse within the previous three months. Medical records using the EDSS (2-4.5) indicate that individuals experience issues with their visual, cerebellar, pyramidal brainstem, and sensory systems. The ability to walk for six minutes using 6-minute walk test [16].

The present study removes patients with the following conditions:

Orthopedic conditions, such as contracture abnormalities, can have an adverse effect on gait. Some diseases, like diabetes mellitus, have an impact on gait and QOL. Additional disorders affecting the visual or vestibular systems (e.g., vestibular neuritis). The modified Ashworth scale [17] showed that both lower limbs had marked spasticity grades II, III, and IV. pregnancy. Each patient was given a thorough verbal explanation of the study's rationale and key findings.

Study design:

This study was a randomized controlled trial (RCT) with a pretest-post-test design including a three-month follow-up. The effects of treatment have been evaluated by assessing subjects at baseline, after eight weeks then after three months of interventions. To guaranty equal distribution of participants, subjects were randomized into one of two groups utilizing computed generalized random numbers using permuted blocks. Each participant was told not to talk about their intervention with anybody else in the group, including the SG and the CG. Pre, post and follow up assessment were done for each of the SG and the CG.

The procedures of the current study were divided into two main categories:

Measurement procedures: Initial evaluation procedures (initial phase)

All of the previously mentioned abnormal medical conditions were ruled out by medical testing conducted on each subject. The neurological sheet that was utilized for recording each patient's medical history had details such as the patient's name, age, body mass index (BMI), and any clinical features that were noted. The goal of the assessment process was explained in steps for each patient in each group. The stages of technical measurements: At baseline, eight weeks, and three months into the study, participants had assessments with the following instruments:

Quality of Life assessment scale:

The Arabic version of the 36- item short form dimension scale (SF-36) was employed to evaluate MS patients' QOL. There was a strong correlation between the SF-36's physical summary sub-scores and EDSS, and the questionnaire had already been validated in an MS patient [18].

Items of the measure:

The components of the SF-36 were categorized into eight distinct domains. Prior to, during, and after the intervention, as well as at the three-month follow-up, both groups were assessed using the SF36 Quality of Life Questionnaire. Physical Functioning (PF), General Health Perceptions (GH), Body Pain (BP), Social Functioning (SF), Perceived Emotional Limitations (RE), General Mental Health (MH), as well as Energy/fatigue are all aspects of functioning that are related to physical health. Prior to beginning the recording process, each patient was given the opportunity to become familiar with the scale. Patients were instructed to sit in a relaxed position and answer questions concerning their activities over the last four weeks to start the evaluation. The overall score for each subscale or dimension was calculated by adding all of the items on the subscale. The responses were scored in a standardized fashion and were scaled from 0 to 100, where (0= represents the poorest health. and 100= represent the best health) in each category.

Therapeutic Procedures:

All study groups began the therapeutic intervention at the same time, and each group's sessions lasted 70 minutes (16 therapy sessions, twice a week) for 8 consecutive weeks. The groups were divided as follows. Every patient received customized treatment plans that built on their abilities, with the difficulty of tasks being progressively raised as they made progress. Patients were given sufficient time to relax in between activities to avoid fatigue [19].

Control group (CG):

In this group, patients were given a five-minute warming-up consisting of basic stretching exercises for all muscle groups; a sixty-minute traditional physical program twice weekly for 8 weeks (a total of sixteen sessions); and, finally, a five-minute cooling-down consisting of basic stretching exercises for all muscle groups [22].

Interventions for conventional physical training were:

Aerobic exercise, muscle stretching for both lower extremities, and strengthening exercise for both lower extremities.

Aerobic exercise

Aerobic exercise gradually increased in frequency, duration, along with intensity on an individual basis. Reduce the likelihood of injury, fatigue, and muscular soreness [23]. Aerobic exercise included: marching in place [24] and over ground walking.

Muscle stretching for both lower extremities:

Hip flexors, hamstrings, hip adductors, in addition to plantar flexors [25]. muscles were stretched slowly, gently, and for a long time. Holding the position for 20 to 60 seconds, the stretch reached the limit of the comfort range.

Strengthening exercise for both lower extremities:

Common muscles included the hip flexors, knee flexors, and ankle dorsiflexors. It was repeated according to the ability of each patient [26].

Study group (SG):

The exercises used in these studies were developed specifically to stimulate a postural balance response while simultaneously integrating various sensory inputs. The patients in this group were given a five-minute warm-up consisting of basic stretching exercises for all muscle groups [22], followed by thirty minutes of the same traditional physiotherapy program [27], and finally, forty minutes of the SIT program. Sessions frequently lasted for 70 minutes twice weekly for 8 consecutive weeks, with a total of sixteen sessions administered [28]. Patients were instructed to take a short rest and then cool down by stretching all of their muscles for five minutes [22].

Interventions for sensory integration therapy were:

External perturbation exercises aimed at destabilizing the body's center of pressure (CoP): The patient stood on a firm and comfortable surface, with their eyes open. The patient was told to actively keep their balance while standing on the floor as the physiotherapist performed controlled pelvic adjustments to both the coronal and sagittal planes. Then the patient repeated the above procedures while the eyes were closed.

Exercises involved self-destabilization of the center of pressure (CoP): The patient stood on a stable, comfortable surface with their eyes open and made voluntary movements in both static as well as dynamic situations.

Then the patient repeated the above procedures while the eyes were closed. Under both static and dynamic conditions tasks required the participant to stand on the floor and simulate a single step, as well as transfer their weight from one foot to the other in the coronal plane.

Exercises combined external destabilization and self-destabilization (of the center of pressure (CoP): With eyes opened, the patient stood on compliant surfaces such as foam or a sensory mat. The task progressed by increasing weight shifting and reducing the base of support. This was carried out on foam supports with different levels of firmness (a 60 cm × 60 cm) foam mat (three cm, five cm, and eight cm thick). Then the patient repeated the above procedures while the eyes were closed.

Gait training (forward and backward) with bare feet on different types of mats according to the patient's abilities; eyes open, then eyes closed. Exercises were repeated several times (two–five times) within a five-minute period.

Data analysis and statistical design:

A Windows version of SPSS, version 27, was used for the statistical analysis. The unpaired t-test was used to assess continuous baseline features between groups, whereas the chi-square test was employed for categorical variables. The data was checked for normality utilizing the Shapiro-Wilk test, and the homogeneity of variances was determined using Levene's test. The impact of treatment, time, as well as the treatment × time interaction on the SF-36 domains were investigated using a two-way mixed multivariate analysis of variance (mixed MANOVA). After identifying statistically significant effects, we used Bonferroni to account for multiple comparisons in post hoc pairwise comparisons. $P < 0.05$ was chosen as the criterion of significance.

RESULTS:

Subject characteristics:

Both the study and control groups' subject characteristics are presented in Table 1. The groups did not differ significantly with respect to age, weight, height, body mass index, illness duration, EDSS score, or gender distribution ($p > 0.05$) (Table 1).

Table 1: Subjects' characteristics.

	Study group	Control group	MD	t-value	P-value
	Mean $\pm$ SD	Mean $\pm$ SD			
Age (years)	32.16 $\pm$ 6.32	32.89 $\pm$ 7.32	-0.73	-0.33	0.74
Weight (kg)	68.37 $\pm$ 10.96	69.16 $\pm$ 13.85	-0.79	-0.19	0.85
Height (cm)	165.68 $\pm$ 8.14	168.32 $\pm$ 6.05	-2.64	-1.13	0.27
BMI (kg/m ²)	24.87 $\pm$ 3.91	24.24 $\pm$ 4.00	0.63	0.49	0.63
Duration of illness (years)	4.26 $\pm$ 2.94	4.79 $\pm$ 2.49	-0.53	-0.59	0.55
EDSS	2.84 $\pm$ 0.78	2.74 $\pm$ 0.71	0.10	0.43	0.67
Sex distribution, N (%)					
Female	12 (63%)	11 (58%)	$\chi^2 = 0.11$		0.74
Male	7 (37%)	8 (42%)			

SD, standard deviation; MD, mean difference; χ^2 , Chi-squared value; P value, probability value

Effect of treatment on SF-36:

No significant interaction between treatment and time was seen in the mixed MANOVA ($F = 0.59$, $P = 0.85$, $\eta^2 = 0.31$). $F = 56.40$, $P < 0.001$, $\eta^2 = 0.98$ indicates that time had a significant main effect. The main effect of group was not statistically significant ($F = 0.59$, $P = 0.77$, $\eta^2 = 0.14$).

Between group comparison:

Table 2 shows that there were no statistically significant differences among the study as well as control groups at post-treatment in terms of physical functioning ($d = 0.53$), role limitations due to physical health ($d = 0.32$), energy/fatigue ($d = 0.02$), emotional well-being ($d = 0.41$), social functioning ($d = 0.44$), pain ($d = 0.14$), in addition to general health ($d = 0.16$).

There were no statistically significant differences among the study and control groups at follow-up in terms of physical functioning ($d = 0.47$), role limitations due to physical health ($d = 0.52$), role limitations due to emotional problems ($d = 0.10$), energy/fatigue ($d = 0.47$), emotional well-being ($d = 0.44$), social functioning ($d = 0.40$), pain ($d = 0.32$), in addition to general health ($d = 0.34$) ($P > 0.05$) (Table 2).

Within group comparison:

The study group's SF-36 domain scores were compared within the group at baseline, post-treatment, and at follow-up (Table 3). post treatment, there was a significant improvement in all outcome measures, such as physical functioning, role limitations due to physical health and problems, energy/fatigue, emotional well-being, social functioning, pain, along with general health ($P < 0.001$). From pre-treatment to follow-up, all domains except emotional well-being showed significant improvement ($P < 0.01$), whereas emotional well-being did not differ significantly ($P = 0.13$). From post-treatment to follow-up, there was a significant decline in all domains ($P < 0.01$), though scores remained above pre-treatment levels.

Table 4 shows the within-group comparison of SF-36 domain scores in the control group across the three time points. The results showed significant improvement in all outcome measures between the pre- and post-treatment periods ($P < 0.001$). No significant difference was found between pre- and post-treatment in terms of energy/fatigue, emotional well-being, social functioning, or pain, but there was a significant enhancement in physical functioning, role limitations due to physical health, role limitations due to emotional problems, as well as general health ($P < 0.05$). There was significant reduction in all outcome measures between the post-treatment and follow-up periods ($P < 0.01$).

Table 2: Comparison of SF-36 between groups.

Outcomes		Study group	Control group	MD	95% CI	P-value	d
		Mean $\pm$ SD	Mean $\pm$ SD				
Physical functioning	Pre-treatment	66.58 $\pm$ 15.99	63.95 $\pm$ 16.38	2.63	-8.02, 13.28	0.62	0.16
	Post-treatment	92.37 $\pm$ 8.06	87.89 $\pm$ 8.71	4.48	-1.05, 9.99	0.11	0.53
	Follow-up	83.42 $\pm$ 14.91	76.84 $\pm$ 12.82	6.58	-2.57, 15.73	0.15	0.47
Role limitations due to physical health	Pre-treatment	32.89 $\pm$ 11.94	34.21 $\pm$ 17.10	-1.32	-11.02, 8.39	0.78	0.09
	Post-treatment	76.32 $\pm$ 30.59	67.11 $\pm$ 26.42	9.21	-9.60, 28.02	0.33	0.32
	Follow-up	59.21 $\pm$ 22.38	48.68 $\pm$ 17.63	10.53	-2.73, 23.78	0.12	0.52
Role limitations due to emotional health	Pre-treatment	38.59 $\pm$ 12.49	36.83 $\pm$ 10.53	1.76	-5.83, 9.36	0.64	0.15
	Post-treatment	82.46 $\pm$ 17.09	77.21 $\pm$ 19.41	5.25	-6.79, 17.28	0.38	0.29
	Follow-up	50.88 $\pm$ 17.10	49.12 $\pm$ 17.13	1.76	-9.51, 13.02	0.75	0.10
Energy/fatigue	Pre-treatment	37.89 $\pm$ 17.82	36.05 $\pm$ 18.15	1.84	-9.99, 13.68	0.75	0.10
	Post-treatment	71.32 $\pm$ 10.12	71.58 $\pm$ 14.34	-0.26	-8.43, 7.90	0.95	0.02
	Follow-up	50.26 $\pm$ 14.38	42.63 $\pm$ 17.67	7.63	-2.97, 18.23	0.15	0.47
Emotional well-being	Pre-treatment	50.32 $\pm$ 21.84	44.63 $\pm$ 23.37	5.69	-9.20, 20.57	0.44	0.25
	Post-treatment	76.21 $\pm$ 13.43	70.32 $\pm$ 15.22	5.89	-3.55, 15.34	0.21	0.41
	Follow-up	57.89 $\pm$ 15.96	50.11 $\pm$ 19.34	7.78	-3.88, 19.46	0.18	0.44
Social functioning	Pre-treatment	50.00 $\pm$ 19.09	48.03 $\pm$ 21.35	1.97	-11.35, 15.30	0.77	0.10
	Post-treatment	85.53 $\pm$ 17.31	77.63 $\pm$ 18.90	7.9	-4.03, 19.82	0.19	0.44
	Follow-up	64.47 $\pm$ 20.94	55.92 $\pm$ 21.80	8.55	-5.51, 22.62	0.22	0.40
Pain	Pre-treatment	50.00 $\pm$ 16.20	49.74 $\pm$ 23.45	0.26	-13.00, 13.53	0.97	0.01
	Post-treatment	80.92 $\pm$ 19.17	78.03 $\pm$ 20.98	2.89	-10.33, 16.12	0.66	0.14
	Follow-up	62.89 $\pm$ 19.19	56.05 $\pm$ 23.26	6.84	-7.19, 20.87	0.33	0.32
General health	Pre-treatment	45.79 $\pm$ 17.58	44.74 $\pm$ 19.75	1.05	-11.25, 13.36	0.06	0.86
	Post-treatment	67.11 $\pm$ 14.07	66.05 $\pm$ 15.05	1.06	-8.54, 10.64	0.07	0.83
	Follow-up	58.16 $\pm$ 15.20	52.37 $\pm$ 15.67	5.79	-4.37, 15.95	0.37	0.26

SD, standard deviation; MD, mean difference; CI, confidence interval; p-value, probability value; P value, probability value; d, Cohen effect size.

Table 3: Comparison of SF-36 between pre- and post-treatment and follow-up in study group.

Outcome	Pre-treatment vs Post-treatment			Pre-treatment vs Follow-up			Post-treatment vs Follow-up		
	MD	95% CI	P-value	MD	95% CI	P-value	MD	95% CI	P-value
Physical functioning	-25.79	-32.94, -18.64	0.001	-16.84	-24.72, -8.97	0.001	8.95	3.10, 14.79	0.001
Role limitations due to physical health	-43.43	-61.35, -25.49	0.001	-26.32	-38.46, -14.18	0.001	17.11	4.45, 29.76	0.005
Role limitations due to emotional problems	-43.87	-53.60, -34.12	0.001	-22.9	-21.81, -2.75	0.008	31.58	25.61, 37.55	0.001
Energy/fatigue	-33.43	-40.76, -26.08	0.001	-12	-19.88, -4.86	0.001	21	13.89, 28.21	0.001

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Emotional well-being	- 25.89	-34.07, - 17.72	0.001	- 7 . 5 7	-16.69, - 1.53	0.13	1 8 . 3 2	12.01, 24.62	0.001
Social functioning	- 35.53	-41.76, - 29.30	0.001	- 1 4 . 4 7	-24.00, - 4.95	0.002	2 1 . 0 6	10.60, 31.50	0.001
Pain	- 30.92	-42.84, - 19.01	0.001	- 1 2 . 8 9	-23.60, - 2.19	0.01	1 8 . 0 3	6.86, 29.19	0.001
General health	-21.32	-28.43, - 14.21	0.001	- 12 37	-19.64, - 5.10	0.001	8 . 9 5	3.21, 14.68	0.001

MD, mean difference; CI, confidence interval; p-value, probability value; P value, probability value

Table 4: Comparison of SF-36 between pre- and post-treatment and follow-up in control group.

Outcome	Pre-treatment vs Post-treatment			Pre-treatment vs Follow-up			Post-treatment vs Follow-up		
	MD	95% CI	P-value	MD	95% CI	P-value	MD	95% CI	P-value
Physical functioning	- 23.94	-31.10, - 16.80	0.001	- 12.89	-20.77, - 5.02	0.001	11.05	5.21, 16.90	0.001
Role limitations due to physical health	- 32.90	-50.82, - 14.97	0.001	- 14.47	-26.61, - 2.33	0.01	18.43	5.77, 31.07	0.002
Role limitations due to emotional problems	- 40.38	-50.12, - 30.64	0.001	- 12.29	-21.82, - 2.76	0.008	28.09	22.12, 34.06	0.001
Energy/fatigue	- 35.53	-42.87, - 28.18	0.001	-6.58	-14.09, 0.93	0.10	28.95	21.79, 36.11	0.001
Emotional well-being	- 25.69	-33.86, - 17.51	0.001	-5.48	-14.58, 3.63	0.42	20.21	13.90, 26.52	0.001
Social functioning	-29.6	-35.84, - 23.38	0.001	-7.89	-17.42, 1.63	0.13	21.71	11.26, 32.16	0.001
Pain	- 28.29	-40.21, - 16.37	0.001	-6.31	-17.02, 4.39	0.44	21.98	10.81, 33.14	0.001
General health	-21.31	-28.43, - 14.21	0.001	-7.63	-14.90, - 0.36	0.03	13.68	7.95, 19.42	0.001

MD, mean difference; CI, confidence interval; p-value, probability value; P value, probability value

DISCUSSION:

Studies examining the effectiveness of various treatments to reduce the effects of MS and its symptoms, such as muscle fatigue, and to improve the QOL for PwMS have been conducted in recent years. Balance, gait, and upper limb recovery have all been studied in relation to SIT in PwMS in several published studies [29, 30]. Additionally, the impact of SIT intervention on QOL was evaluated in a few trials.

Consequently, the aim of this current research was to see how SIT impacts QOL in PwMS. This research included thirty-eight male and female multiple sclerotic patients who had definite diagnosis of RRMS. The patients were randomized into two groups: one research group: the study group (SG) & one control group (CG). In the CG patients were given the selected traditional physiotherapy-program. Besides selected traditional physiotherapy-program, patients were given sensory integration therapy in the SG. The session time for each group was seventy minutes (sixteen treatment sessions twice weekly) for eight successive weeks for all groups then followed-up after three months.

There were no statistically significant differences between the two groups at treatment or three months following the SF-36 administration in the SG group compared to the CG group. However, in all outcome measures, the SG showed a significant improvement across baseline, after treatment, and during the follow-up period. While there was no statistically significant difference in emotional well-being between the pre- and post-treatment periods, all outcome measures demonstrated significant improvement. There was significant reduction in all outcome measures from post-treatment to follow-up, even though scores were higher than they had been pre-treatment.

Also, compared within CG at each of the three time points (before, during, and after treatment) across all outcome measures. From baseline to follow-up, our study demonstrated statistically significant improvements across all outcome measures. There was no significant difference in energy/fatigue, emotional well-being, social functioning, or pain between pre- and post-treatment, but there was significant enhancement in physical functioning, role limitation owing to physical health and emotional difficulties, and overall health. The reduction was statistically significant in all outcome measures from post-treatment to follow-up.

The theoretical rationale for linking SIT to QOL is based on how the nervous system integrates sensory input into action. Although it promises that SIT encourages neuroplasticity and functional recovery in adults with MS. Recent research by Patagia et al. utilized functional neuroimaging and standardized clinical measures to demonstrate significant brain remodeling along with measurable improvements in sensory processing, functional independence, and QOL. Based on these findings, SIT can be considered a neuro-rehabilitation method that successfully combines elements of occupational therapy along with neuroscience [31]

Calabr'o & Galperin et al. corroborated this study's results by detecting that the SG and CG place a strong emphasis on cognitive-motor skills, which explains why there were no appreciable differences in QOL ratings between them. The cognitive aspects of the balance control system are given priority in each intervention, though in different ways. This common focus on cognitive-motor integration is probably what accounts for the comparable improvements in QOL scores between the two groups [28] [32].

Similar to that, the task-oriented nature of both treatments may explain why Khalil & Callesen et al. discovered no statistically significant increases in QOL scores between the two groups. Tasks and activities in both exercise programs were designed to improve certain areas of physical health. For example, walking and balance exercises were involved. Participants in the two programs reported comparable gains in physical health following their participation, which is likely attributable to their shared aims and methods [33] [34].

Additionally, our results are in line with those of Yang et al. using the 2025 network meta-analysis of 31 RCTs, which indicated that exercise therapies were superior to conventional treatment for fatigue, but there was no overall QOL improvement across cohorts. In a subgroup analysis, Yang et al. found that resistance training significantly decreased fatigue in female patients with relapsing-remitting MS as well as in individuals without this condition. Resistance training along with hippotherapy, which lasted longer than eight weeks, had greater effects. There was no overall increase in QOL; however, female patients improved significantly after resistance training [35].

Moreover, our findings are recommended by Bromley et al., who provided that traditional physiotherapy improves QOL in PwMS, and his data suggests benefits are frequently stronger for physical function and fatigue than for overall QOL scores [36]. Also, moderate evidence in a study by Nakau et al. indicated that traditional physiotherapy alone improved fatigue and balance but did not significantly improve QOL while using MS QOL-54 (MSQOL-54) physical or mental scores, underperforming compared to Pilates [37].

Gandolfi et al. found that sensory integration therapy improves balance, fatigue, and functional mobility in PwMS, although direct benefits on QOL outcomes were not significantly different between groups. Improvements in balance control as well as

gait performance was observed in his study after SIT training, which he attributes mostly to an incorporation of cognitive-motor along with motor-motor dual tasks. These modifications led to functional gains [19]. These practical benefits should carry over into the psychological area, where they are expected to have a positive impact on anxiety, depression, stress, as well as overall life satisfaction determined by the questionnaire [38]. Consequently, these enhancements contribute to better mental health and QOL satisfaction.

Asghari et al. in contrast, provide in his recent trial after comparing SIT to virtual reality and control groups in 36 MS patients that SIT training over eight weeks significantly improved overall, physical, and mental well-being when used MSQOL-54 components compared to controls in 36 MS patients [39].

Moreover, Raji et al. and Madroño-Miguel et al. demonstrated that broader rehabilitation approaches, including therapeutic education programs that develop sensorimotor skills, have shown positive QOL effects in 72% of studies incorporating such components, suggesting that sensory integration principles may be most effective when embedded within comprehensive rehabilitation frameworks [40] [41].

A cross-sectional analysis by Goubar et al. Conducted on individuals with sensory integration impairment, it demonstrated significant differences in all eight SF-36 domains compared to healthy controls. Significant group differences were found in the areas of mental health and fatigue. Pain and social interaction are both linked to evidence that the demands of the environment don't match up with people's sensory patterns. This can lead to emotional distress and a reduced ability to cope [42].

According to previous research, SIT may be more effective in improving balance disorders (BDs) in individuals with RRMS than traditional training or SG training conducted in different sensory conflict contexts. At least a month following treatment, you may still feel the benefits of your training. Improved central integration of sensory input processes, less fatigue, and a decrease in falls may all be outcomes of targeted balancing training. Reported confidence during activities of daily living (ADL) or QOL did not show any significant "group $\times$ time" relationships [19].

Furthermore, Basalic et al., in a scoping review, emphasized that multimodal rehabilitation integrating lifestyle components may enhance QOL outcomes beyond conventional physical approaches alone. The network meta-analysis revealed that balance-focused exercise regimens and cognitive-behavioral treatment were the most effective, with minimal evidence backing aerobic and resistance training. Integrated therapies seemed encouraging although they were inadequately represented in the research [43].

Incorporating psychomotor training with lifestyle-related techniques, such as managing fatigue, optimizing sleep, controlling stress, and providing cognitive or behavioral support, is likely to improve QOL, according to the clinical consequences of this study's analysis. Physical exercise is still an important component of rehabilitation. Multiple types of therapies that are supported by technology may be especially helpful for treating symptoms that are hard to understand and making it easier for people to get to rehabilitation services. On the other hand, the study does note a few limitations. We cannot confidently rule out clinically significant effects due to the small sample size, but it does cast doubt on the data's generalizability to the larger MS community. Evaluating SIT's effectiveness on MS progression requires future interventional and longitudinal investigations. Nonetheless, the findings might be useful for future studies aiming to improve QOL in PwMS.

CONCLUSIONS:

The present study demonstrated that both rehabilitation programs were associated with significant improvements in SF-36 scores; however, adding sensory integration therapy did not produce a statistically significant improvement in quality of life compared with conventional physiotherapy alone.

AUTHOR CONTRIBUTIONS:

H.M.A.; Formal analysis, A.A.E.; Investigation, M.M.G.; Methodology-writing-original draft, N.M.S and A.A.E. Validation-writing-review& editing, All authors have read and agreed to the published version of the manuscript.

INSTITUTIONAL REVIEW BOARD STATEMENT:

This study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Faculty of Physical Therapy Ethical Committee, Cairo University, Egypt (P.T.REC/012/005138).

INFORMED CONSENT STATEMENT:

Informed consent was obtained from all subjects involved in the study.

DATA AVAILABILITY STATEMENT:

The data presented in this study are available on request from the corresponding author.

DISCLOSURE STATEMENT:

No author has any financial interest or received any financial benefit from this research.

CONFLICT OF INTEREST:

The authors state no conflict of interest.

REFERENCES

- [1] Amin, M., & Hersh, C. M. (2023). Updates and advances in multiple sclerosis neurotherapeutics. *Neurodegenerative Disease Management*, 13(1), 47-70.
- [2] Jakimovski, D., Zivadinov, R., Weinstock, Z., Burnham, A., Wicks, T. R., Suchan, C., ... & Benedict, R. H. (2024). Cognitive function in severe progressive multiple sclerosis. *Brain Communications*, 6(4), fcae226.
- [3] Portaccio, E., Magyari, M., Havrdova, E. K., Ruet, A., Brochet, B., Scalfari, A., & Amato, M. P. (2024). Multiple sclerosis: emerging epidemiological trends and redefining the clinical course. *Lancet Reg Health–Europe* 44: 100977.
- [4] Barin, L., Salmen, A., Disanto, G., Babačić, H., Calabrese, P., Chan, A., ... & von Wyl, V. (2018). The disease burden of multiple sclerosis from the individual and population perspective: which symptoms matter most?. *Multiple sclerosis and related disorders*, 25, 112-121.
- [5] Post, M. (2014). Definitions of quality of life: what has happened and how to move on. *Topics in spinal cord injury rehabilitation*, 20(3), 167-180.
- [6] Gil-González, I., Martín-Rodríguez, A., Conrad, R., & Pérez-San-Gregorio, M. Á. (2020). Quality of life in adults with multiple sclerosis: a systematic review. *BMJ open*, 10(11), e041249.
- [7] Walton, C., King, R., Rechtman, L., Kaye, W., Leray, E., Marrie, R. A., ... & Baneke, P. (2020). Rising prevalence of multiple sclerosis worldwide: Insights from the Atlas of MS. *Multiple Sclerosis Journal*, 26(14), 1816-1821.
- [8] FEDERATION 3rd, M. I. (2020). *Atlas of MS, 3rd edition, Part 1: Mapping Multiple Sclerosis Around the World*.
- [9] Ayres, A. J. (1972). *Sensory Integrative Processes: Implications For the Institution Southwestern Region Deaf-Blind Center, Sacramento, Calif.*
- [10] Mross, K., Jankowska, M., Meller, A., Machowska-Sempruch, K., Nowacki, P., Masztalewicz, M., & Pawlukowska, W. (2022). Sensory integration disorders in patients with multiple sclerosis. *Journal of Clinical Medicine*, 11(17), 5183.
- [11] Afza, F., Manzoor, S., & Afzal, A. (2017). How the Development of Tone and Posture Occurred in Newborns.
- [12] David Ruban, S., Christina Hilt, C., & Petersen, T. (2021). Quality of life in multiple sclerosis: The differential impact of motor and cognitive fatigue. *Multiple Sclerosis Journal–Experimental, Translational and Clinical*, 7(1), 2055217321996040.
- [13] Piñar Morales, R., Guirado-Ruiz, P. A., & Barrero Hernández, F. J. (2025). Impact of fatigue on quality of life in adults with multiple sclerosis.
- [14] Titcomb, T. J., Sherwood, M., Ehlinger, M., Saxby, S. M., Shemirani, F., Ten Eyck, P., ... & Snetselaar, L. G. (2023). Evaluation of a web-based program for the adoption of wellness behaviors to self-manage fatigue and improve quality of life among people with multiple sclerosis: A randomized waitlist-control trial. *Multiple sclerosis and related disorders*, 77, 104858.
- [15] Thompson AJ, Banwell BL, Barkhof F, et al. Diagnosis of multiple sclerosis: (2017) revisions of the McDonald criteria. *Lancet Neurol* 2018; 17: 162–173.
- [16] Müller, R., Hamacher, D., Keune, P. M., & Oschmann, P. (2023). Stability of sensor-based gait parameters reassessed after a period of one year in people with multiple sclerosis. *BMC neurology*, 23(1), 120.
- [17] Bohannon RW, Smith MB. (1987). Interrater reliability of a modified Ashworth scale of muscle spasticity. *Phys Ther*;67(2):206–7.

- [18] Faraclas, E., Lynn, J., Lau, J. D., & Merlo, A. (2022). Health-related quality of life in people with multiple sclerosis: how does this population compare to population-based norms in different health domains?. *Journal of Patient-Reported Outcomes*, 6(1), 1-11.
- [19] Gandolfi, M., Munari, D., Geroïn, C., Gajofatto, A., Benedetti, M. D., Midiri, A., ... & Smania, N. (2015). Sensory integration balance training in patients with multiple sclerosis: a randomized, controlled trial. *Multiple Sclerosis Journal*, 21(11), 1453-1462.
- [20] Molhemi, F., Monjezi, S., Mehravar, M., Shaterzadeh-Yazdi, M. J., Salehi, R., Hesam, S., & Mohammadianinejad, E. (2021). Effects of virtual reality vs conventional balance training on balance and falls in people with multiple sclerosis: a randomized controlled trial. *Archives of physical medicine and rehabilitation*, 102(2), 290-299.
- [21] Amiri, B., Sahebozamani, M., Sedighi, B., 2019. The effects of 10-week core stability training on balance in women with multiple sclerosis according to expanded disability status scale: a single-blinded randomized controlled trial. *Eur. J. Phys. Rehabil. Med.* 55 (2), 199–208.
- [22] Straudi, S., Manfredini, F., Lamberti, N., Zamboni, P., Bernardi, F., Marchetti, G., ... & Basaglia, N. (2017). The Effectiveness of Robot-Assisted Gait Training versus conventional therapy on mobility in severely disabled progressive Multiple sclerosis patients (RAGTIME): study protocol for a randomized controlled trial. *Trials*, 18, 1-12.
- [23] MacKay-Lyons, M., Billinger, S. A., Eng, J. J., Dromerick, A., Giacomantonio, N., Hafer-Macko, C., & Tang, A. (2020). Aerobic exercise recommendations to optimize best practices in care after stroke: Aerobics 2019 update. *Physical Therapy*, 100(1), 149-156.
- [24] Eng, J. J. (2010). Fitness and Mobility Exercise (FAME) program for stroke. *Topics in geriatric rehabilitation*, 26(4), 310.
- [25] Pau, M., Coghe, G., Corona, F., Marrosu, M. G., & Cocco, E. (2015). Effect of spasticity on kinematics of gait and muscular activation in people with multiple sclerosis. *Journal of the Neurological Sciences*, 358(1-2), 339-344.
- [26] Nguyen, P. T., Chou, L. W., & Hsieh, Y. L. (2022). Proprioceptive neuromuscular facilitation-based physical therapy on the improvement of balance and gait in patients with chronic stroke: A systematic review and meta-analysis. *Life*, 12(6), 882.
- [27] Raipure, A., Kovala, R. K., Haripal, P., & Kovala Sr, R. K. (2023). Effectiveness of Neurodevelopmental Treatment and Sensory Integration Therapy on Gross Motor Function, Balance and Gait Parameters in Children with Spastic Diplegia. *Cureus*, 15(8).
- [28] Calabr`o, R.S., Russo, M., Naro, A., et al., 2017. Robotic gait training in multiple sclerosis rehabilitation: can virtual reality make the difference? Findings from a randomized controlled trial. *J. Neurol. Sci.* 377, 25–30.
- [29] Moreno-Verdu, M., Ferreira-Sanchez, M. R., Cano-de-la-Cuerda, R., & Jimenez-Antona, C. (2019). Efficacy of virtual reality on balance and gait in multiple sclerosis. *Systematic review of randomized controlled trials. Revista de Neurologia*, 68(9), 357-368.
- [30] Webster, A., Poyade, M., Rooney, S., & Paul, L. (2021). Upper limb rehabilitation interventions using virtual reality for people with multiple sclerosis: A systematic review. *Multiple sclerosis and related disorders*, 47, 102610.
- [31] Patagia Bakaraki, M. (2025). The Effect of Sensory Integration on Neuroplasticity and Functional Recovery in Neurological Patients. Preprints.
- [32] Galperin, I., Mirelman, A., Schmitz-Hübsch, T., Hsieh, K. L., Regev, K., Karni, A., ... & Hausdorff, J. M. (2023). Treadmill training with virtual reality to enhance gait and cognitive function among people with multiple sclerosis: a randomized controlled trial. *Journal of Neurology*, 270(3), 1388-1401.
- [33] Khalil, H., Al-Sharman, A., El-Salem, K., Alghwiri, A. A., Al-Shorafat, D., Khazaaleh, S., & Abu Foul, L. (2019). The development and pilot evaluation of virtual reality balance scenarios in people with multiple sclerosis (MS): a feasibility study. *NeuroRehabilitation*, 43(4), 473-482.
- [34] Callesen, J., Cattaneo, D., Brincks, J., & Dalgas, U. (2018). How does strength training and balance training affect gait and fatigue in patients with Multiple Sclerosis? A study protocol of a randomized controlled trial. *NeuroRehabilitation*, 42(2), 131-142.
- [35] Yang, J., Li, H., Zhang, Y., Hu, S., & Yu, Z. (2025). Effects of exercise on fatigue and quality of life in multiple sclerosis: A network meta-analysis and systematic review. *Journal of Neurology*, 272(9), 621.
- [36] Bromley, L. E., & Weinstock-Guttman, B. (2024). Effects of physical therapy and dalfampridine on function and quality of life in nonambulatory individuals with multiple sclerosis: a randomized controlled trial. *International Journal of MS Care*, 26(3), 98.

- [37] Nakau, E. T., de Souza Castro, I., Talles, J. A. R., Dias, A. E., & Labronici, R. H. D. D. (2023). Physiotherapy and pilates in the functionality and quality of life of people with multiple sclerosis. *Fisioterapia Brasil*, 24(5), 555-563.
- [38] Hebert, J. R., Corboy, J. R., Vollmer, T., Forster, J. E., & Schenkman, M. (2018). Efficacy of balance and eye-movement exercises for persons with multiple sclerosis (BEEMS). *Neurology*, 90(9), e797-e807.
- [39] Asghari, S. H., Ilbeigi, S., Ahmadi, M. M., Yousefi, M., & Mousavi-Mirzaei, M. (2025). Comparative effects of sensory motor and virtual reality interventions to improve gait, balance and quality of life MS patients. *Scientific Reports*, 15(1), 20310.
- [40] Raji, I., El Harch, I., Ragala, M. E. A., Berraho, M., Nejjar, F., & Belahsen, M. F. (2024). A systematic review of the impact of therapeutic education programs on the quality of life of people with Multiple Sclerosis. *Health Promotion Perspectives*, 14(2), 97.
- [41] Madronero-Miguel, B., & Cuesta-García, C. (2021). Effects of rehabilitation on fatigue, disability and quality of life in people with multiple sclerosis: a systematic review. *Rehabilitation*, 55 (1), 38-48.
- [42] Goubar, P., & Velnar, T. (2025). Assessing Health-Related Quality of Life Outcomes Through Sensory Modulation Profiles in Adults with Atypical Sensory Processing: A Cross-Sectional Study. *Journal of Health and Rehabilitation Sciences*, 4(1), 62-68.
- [43] Basalic, E. B., Roman, N. A., Minzatanu, D., Manaila, A. I., Baseanu, I. C. C., & Miclaus, R. S. (2026). Reconsidering Rehabilitation and Lifestyle Approaches to Improve Quality of Life in People with Multiple Sclerosis: A Scoping Review. *Medicina*, 62(1), 215.