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Influence of a Complex Rehabilitation Process on Quality of Life in Patients With Multiple Sclerosis

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Abstract: *Patients with multiple sclerosis (MS) have a lower quality of life (QoL) than the general population. Rehabilitation is an essential part of the comprehensive treatment of MS patients. The aim was to determine the influence of complex physical therapy on the QoL of MS patients and the association of functional status with certain domains of health-related QoL. We followed 58 MS patients. The complex kinesitherapy used the Bobath concept and occupational therapy with the use of robot-assisted rehabilitation for the upper extremities. Before the start of rehabilitation and at the end, functional status was assessed by the Expanded Disability Status Scale (EDSS) and Berg Balance Scale (BBS). QoL was assessed through the standardized SF36 test and summarized into two scores: physical health component score and mental health component score. The average age of patients was 49.38 years. There was a significant improvement in all patients after the therapy, both in functional status and in QoL. There were no significant correlations between the EDSS and BBS with QoL parameters (individual SF36 categories and two summary scores). Duration of the disease correlated with the EDSS and BBS, but not with QoL. The age of patients did not correlate with functional status or with QoL. Physical therapy improves both functional status and QoL, but improvements do not correlate. There is a need to incorporate QoL assessment into assessments of disease severity, progression, and treatment success to obtain the most relevant results in creating the right treatment strategy.*

Keywords: *Functional status, Neurodegenerative Diseases, Occupational Therapy, Physical therapy*

INTRODUCTION

Multiple sclerosis (MS) is a chronic, incurable inflammatory disease of the central nervous system (CNS). It affects young adults at a time of maximum personal, professional, and social development. It is characterized by fully or partially reversible episodes of neurological deficit lasting several days to weeks (Reich et al., 2018). It has a variable clinical picture that depends on the affected structures of the brain or spinal cord. The most common symptoms are motor weakness, sensory disorders, gait and coordination disorders, and optic neuritis (Saguil et al., 2022). Accompanying disorders are sphincter disorders, sexual dysfunction, pain, speech and swallowing disorders, cognitive dysfunction, and psychological disorders that significantly limit the patient's functioning in everyday life and social activities (Barin et al., 2018). These processes lead to a decrease in physical activity and mobility, which causes a vicious circle and secondary complications that endanger other organ systems. Psychological reactions arise from learning about the presence of the disease.

Research suggests that early initiation of an active lifestyle and exercise in MS patients can promote neuroprotection, neuroregeneration, and neuroplasticity (White et al., 2008). Patients tolerate programmed exercise well, and it is a safe and effective way to improve their quality of life (QoL) by optimizing daily functioning and increasing their participation in various areas of life (Padgett et al., 2013; Dalgas et al., 2009). Rehabilitation is increasingly recognized as an essential part of the comprehensive treatment of patients with MS and it reduces inflammatory cytokines in the immune system, protects the CNS, slows down neurodegeneration, induces neuroplasticity, and slows the disease progression (Centonze et al., 2020; Isaković et al., 2019; Simpson et al., 2015). Various types of physical activity have been proposed for patients with MS, such as aerobic exercises, progressive resistance exercises and interval training, combined endurance and strength training (Ilett et al, 2016). An important place in the treatment of patients belongs to the proprioceptive neuromuscular facilitation and Bobath neurodevelopmental treatment (Kubsik-Gidlewska et al., 2017).

MS patients have a lower QoL than the general population. QoL is influenced by several disease-related factors, such as the degree of disability or type of MS, and factors such as social support, education, age, or employment

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(Wilski et al., 2019). There is an increased prevalence of psychiatric comorbidities, depression and anxiety in patients with MS compared to the general population, which often represents a reactive state (McKay et al., 2018). These conditions change the patient's objective perception of health already after the diagnosis, which further significantly reduces the QoL of these patients. QoL is also affected by general well-being and social functions that are not directly related to the neurological disease, but which patients consider to be even more important determinants of health condition than impaired physical function (Rothwell et al., 1997).

The aim of this research was to determine the influence of complex physical therapy on the functional status and QoL of patients with MS and the association of functional status with certain domains of health-related QoL.

MATERIAL AND METHODS

The research was conducted at the Institute for Physical Medicine, Rehabilitation and Orthopedic Surgery "Dr. Miroslav Zotović", Banjaluka, Bosnia and Herzegovina from March 2022 to November 2023 in accordance with the provisions of good clinical practice with the approval of the Ethics Committee of the mentioned institution *(number of the decision 116-01-3106-2/22)*. During this period, 74 MS patients, both genders, were treated at the Neurorehabilitation Department. The inclusion criteria were: a confirmed diagnosis of MS, persons older than 18 and younger than 70 years of age, and cognitive function according to the Mini Mental Test $\geq$ 24. Exclusion criteria were: worsening of the MS during the study, relapse of the disease in the last month, confirmed psychiatric diagnosis, newly confirmed neurological, rheumatological or orthopedic disease, worsening of cardiovascular and respiratory system function, and development of an inflammatory disease with febrility.

After the examination by a specialist in physical medicine and rehabilitation and before the start of rehabilitation, patients' functional status was assessed by graduate physiotherapists using the Expanded Disability Status Scale (EDSS) and Berg Balance Scale (BBS), which monitored functional progress during rehabilitation. The EDSS is suitable for detecting the effectiveness of clinical interventions and monitoring the progression of MS (Meyer-Moock et al., 2014). The BBS is a valid and reliable, most commonly used tool for assessing balance and fall risk in patients with MS, assessing static sitting balance, postural changes, transfers, and standing balance (Caselli et al., 2023; Cattaneo et al., 2007).

The evaluation of patients' QoL was done by the standardized SF36 test with eight domains, which can be summarized in two scores, the physical component summary (PCS) score and the mental component summary (MCS) score (Gitman et al., 2023; *Gil-González et al., 2020*).

For all patients, rehabilitation lasted five weeks, five days a week. Physical therapy has been adapted to the individual needs of the patient. The first segment was kinesitherapy, which included a program lasting 45 to 60 minutes, according to the patient's ability. The Bobath concept was a central part of the treatment, with a proven positive impact on balance, postural control and indirectly adaptive neuroplasticity index (*Castelli et al., 2022*). It emphasizes the critical role of postural stability (essential for selective movements and balance) and represents a part of the comprehensive treatment of MS patients (Ilett et al., 2016; *Raine, 2007;* Abreu-Corrales et al., 2023). Walking, balance and coordination exercises were conducted, and also exercises to improve muscle strength, improve or maintain range of motion, breathing exercises, and walking exercises at the loom. Exercises to strengthen the muscles of the pelvic floor were part of the program, depending on the type of damage to the sphincter functions (is it the result of CNS damage or bladder detrusor insufficiency). Before kinesitherapy, in patients with spasticity, the Novafon® device for a mild vibration massage was used to cause relaxation, which enables the implementation of the program.

The occupational therapy was also used, two times a day, lasting 30 to 45 minutes. It enables optimal functional independence in various areas of life, self-care, work professional abilities, and socialization. Robot-assisted training was also conducted on the Hocoma Armeo®Senso medical device for upper limbs, which uses three sensors and a handheld module to track movements and provide real-time feedback on improved performance. All patients were able to perform this training. At the end of the rehabilitation, the EDSS, BBS and SF36 testing was repeated.

The obtained results were statistically processed with SPSS version 29 software (IBM corporation, New York, USA), using methods of descriptive statistics, correlation analysis and t-test. A p-value of <0.05 was considered statistically significant.

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RESULTS

The inclusion criteria were fulfilled by 58 patients. The average age of patients was 49.38 years (range 31 to 68 years). 74.1 % of patients were female, and 25.9 % were male. In all patients, there was a significant improvement, both in functional status and in QoL (table 1).

Table 1. EDSS and parameters of quality of life before and after therapy (mean ±SD)

	EDSS	BBS	SF36	PCS	MCS
Before therapy	5.3±1.8	24.31±11.2	43.9±17.0	39.4±16.2	48.4±18.4
After therapy	4.6±1.7	32.33±12.2	53.7±18.5	48.2±17.8	57.7±19.8
Δ	-0.7±0.6 *	8.02±7.94*	9.7±13.5 *	8.8±12.4 *	9.2±14.3 *

*EDSS - Expanded Disability Status Scale, BBS- Berg Balance Scale, PCS- physical component summary score, MCS- mental component summary score. *$p<0.001$ testing withing groups using paired samples t test*

When compared individually, in all categories of SF36 there was a significant improvement after the therapy (table 2).

Table 2. Comparisons of individual 36 categories before and after therapy

	N	ρ	p
Physical functioning	58	.824	.000
Role limitations due to physical health	58	.682	.000
Role limitations due to emotional problems	58	.541	.000
Energy/fatigue	58	.596	.000
Emotional well-being	58	.747	.000
Social functioning	58	.766	.000
Pain	58	.579	.000
General health	58	.767	.000
Health change	58	.748	.000

Correlations of EDSS and SF36 categories showed weak and statistically nonsignificant correlations (table 3).

Table 3. Correlation of EDSS and SF36 categories before and after therapy

	EDSS before therapy		EDSS after therapy	
	r	p	r	p
Physical functioning	-.134	.324	-.155	.255
Role limitations due to physical health	-.213	.114	-.255	.057
Role limitations due to emotional problems	-.089	.515	-.164	.228
Energy/fatigue	.138	.309	-.019	.892
Emotional well-being	.126	.356	.081	.554
Social functioning	-.179	.186	-.116	.396
Pain	-.018	.893	-.055	.688
General health	-.081	.554	-.162	.233
Health change	-.149	.275	-.134	.324

EDSS - Expanded Disability Status Scale.

Also, there were no statistically significant correlations between EDSS, PCS and MCS (table 4).

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Table 4. Correlations between EDSS with PCS and MCS

Therapy	EDSS		BBS	
	Before r (p)	After r (p)	Before r (p)	After r (p)
PCS	-.119 (.375)	-.211 (.112)	-.126 (.345)	.021 (.877)
MCS	-.049 (.712)	-.116 (.386)	-.184 (.092)	-.034 (.799)

EDSS - Expanded Disability Status Scale, PCS- physical component summary score, MCS- mental component summary score.

Duration of the disease showed significant correlations with EDSS and BBS, but not with values of QoL (table 5).

Table 5. Correlation of the disease duration with examined parameters before and after therapy

	Duration of the disease (months)	
	ρ	p
EDSS before therapy	.534	.000*
EDSS after therapy	.55	.009*
BBS before therapy	-.508	.000*
BBS after therapy	-.338	.009*
PCS before therapy	.166	.214
PCS after therapy	.112	.401
MCS before therapy	.223	.092
MCS after therapy	.128	.339
SF36 before therapy	.186	.163
SF36 after therapy	.122	.361

EDSS - Expanded Disability Status Scale, BBS- Berg Balance Scale, PCS- physical component summary score, MCS- mental component summary score.

The age of patients also did not show statistically significant correlations with EDSS, BBS, PCS, and MCS (table 6).

Table 6. Correlation of age of patients with functional parameters and quality of life before and after therapy

	EDSS before therapy	EDSS after therapy	BBS before therapy	BBS after therapy	PCS before therapy	PCS after therapy	MCS before therapy	MCS after therapy
r	.228	.203	-.215	.006	-.172	-.171	-.220	-.190
p	.085	.127	.105	.964	.198	.198	.097	.152

EDSS - Expanded Disability Status Scale, BBS- Berg Balance Scale, PCS- physical component summary score, MCS- mental component summary score.

DISCUSSION

Organized rehabilitation from the very beginning of MS gives a real result because of individualized assessment, monitoring and adjustment of interventions (*Centonze* et al, 2020). Physical therapy improves the mobility of patients and prevents muscular atrophy, increases muscle strength, affects spasticity, improves tone, balance and coordination, and maintains or improve range of motion. In our research, an individual approach was applied to all patients with adaptation to the clinical condition, taking care to schedule the program over twelve hours to prevent patient exhaustion. Fatigue, overheating and signs of increased spasticity have to be monitored carefully (*Kwolek et al., 2010; Kubsik-Gidlewska et al., 2017*).

In our research, the basis of the treatment was the application of the Bobath concept. It assumes that the essence of motor deficits, as a consequence of MS, is a dysfunction of postural reflexes required for coordination in space. Correct muscle tone and active movements can be achieved by inhibiting pathological postural patterns (*Woszczak,*

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2005; Lada, 2010). The advantage of the concept is the possibility of positioning the patient in all positions, which enables work with patients with severe motor deficits. Impaired postural control and balance (during sitting, standing, and walking) are regularly seen in MS patients, so exercises were also carried out to restore these functions. Also, means of kinesitherapy and occupational therapy were added.

The success of rehabilitation was estimated with the EDSS instrument, the gold standard in everyday practice for patients with MS (Cohen et al., 2021). It ranges from 0, defined as a "neurologically normal finding" to 10, which represents a fatal outcome of MS. A study reported that impaired balance and coordination of the upper extremities was also found in patients with an EDSS score of 0 compared to healthy controls (Krieger et al., 2022). In our sample at the end of rehabilitation there was a statistically significant decrease in the EDSS score. Several patients had an EDSS of seven to 8.5 before the treatment, and by the end values decreased to 4.5 to 6.5. It means that, from the need for a wheelchair, they came to a state of mobility with aids or limited independent mobility. In contrast, a smaller number, with relatively low EDSS values, did not show significant progress. So there is a multifactorial influence on success in rehabilitation, and the patient's passivity and lack of interest in rehabilitation, or the existence of psychological imbalances are often reasons for inadequate progress in treatment, regardless of physical activation. For patients with significant progress, their knowledge of the importance of rehabilitation, insight into the improvement of other patients or the final availability of such a complex rehabilitation program helped. Compared to years of life, there was no statistically significant correlation with EDSS values before and after rehabilitation. Comparing the EDSS values and the duration of the disease before and after rehabilitation, there was a significant statistical correlation, with the increase in disease duration the values of the EDSS score also increased, which is expected for a progressive neurological disease.

People with MS are at greater risk of falling than the general population and older subjects, with a reported prevalence of falls of 48% to 63% (Nilsagard et al., 2009). It was found that 63.5% to 82.6% of patients report a fear of falling, which reduces their activities (Finlayson et al., 2006). The risk of falling, circumstances, consequences and causes are different in patients with MS than in a healthy person of the same age and gender. These patients fall more with a higher likelihood of injury, often indoors, even in younger individuals with less disability (Mazumder et al., 2014). BBS is a sensitive and specific measure for identifying the risk of falling (Ayvat et al., 2024). As a result of a complex rehabilitation, the BBS value improved statistically significantly in our patients. Clinical studies confirm this, giving significant results on the effectiveness of physiotherapy (Caselli et al., 2023). The minimum clinically important difference in the BBS is 3 points for patients with MS to perceive as a clinical change in balance performance (Gervasoni et al., 2017). In individual samples of our patients, only four patients did not achieve more than 2 points by the end of rehabilitation. These were middle-aged patients with an average duration of the disease of about four years, with an EDSS value of 2 to 4, a person without the need for assistance in everyday life and a BBS value of 39 to 41. Improvement in the functional state assessed by the EDSS was not a measure of improvement obtained by BBS. Data indicated that there was no linear relationship between fall status and mobility function, although at a certain threshold, further decline in mobility function was associated with fewer falls, probably due to reduced exposure to fall risk (Matsuda et al., 2012). We did not find statistically significant correlations of BBS with age of patients. The rate of decline is lower in women than in men and decreases with increasing age (Nilsagård et al., 2015). In our patients, BBS correlated statistically significantly with the duration of the disease, as expected due to the damage of the systems responsible for the balance with the progression of the disease.

The results obtained from our patients confirm the importance of organized rehabilitation in patients with MS, which is also confirmed by basic brain research (Lozinski et al., 2022). MRI in patients after kinesitherapy improves connectivity between brain regions even after eight weeks. Activity in patients with mild sensorimotor deficits of the upper extremities restores brain activity that coincides with a reduction in compensatory activity in other brain areas and reduces overall brain damage.

QoL in patients with MS is not systematically assessed in routine clinical practice. Health-related QoL is a concept used to represent a patient's perception of their health status (*Post, 2014; Ysrraelit et al., 2017*). A patient's perception of QoL can even predict disease progression and disability (*Walton et al., 2020; Visschedijk et al., 2004*). QoL is mainly based on the subjective measurement of a patient's health status, offering a quantitative method for monitoring health status (*Gitman et al., 2023*). The values of all SF36 domains and two summary scores of QoL, PCS and MCS, significantly improved after rehabilitation. The best results were obtained in the domain of physical

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functioning, while the lowest results were in the domain of limitations due to emotional difficulties. At the beginning of treatment, our patients had an interview with a psychologist and a social worker. The importance of social support for better QoL is already emphasized (*Gil-González et al., 2020*). Our results showed no significant correlation between age and PCS and MCS. It would be expected that with aging and MS progression there will be a worse QoL. This was found in a research where old age was related to poorer outcomes in domains of SF36 except mental health (*Ysrraelit et al., 2017*). Older patients, neurological damage and disability were identified as risk factors for QoL (*Calandri et al, 2017*).

MS is most often diagnosed at a younger age, and the non-existence of this difference with age and its association with QoL in our work can be linked to the fact that patients who are diagnosed with MS, with no possibility of cure, need time to come to terms with this emotional shock and to cope with future challenges (*Gil-González et al., 2020*). Also they need to adapt to a life with the disease and to provide themselves with as much QoL as possible. The results of our work did not find a statistically significant correlation between the duration of the disease and the PCS and MCS. Literature data shows the existence of a correlation between the duration of the disease and employment in patients with MS and the total SF36 score in univariate analysis, however, this correlation was not significant in multivariate analysis (*Contentti et al, 2017*). Also, a study did not show the existence of a correlation between the duration of MS and QoL (*Morales et al., 2007*). This means that the experience of the disease, its acceptance, living with it and achieving QoL is equally demanding both at the beginning and in the advanced stages of the disease, regardless of the degree of dysfunctionality.

In our sample, EDSS, PCS and MCS scores improved after rehabilitation, but the EDSS did not correlate with PCS and MCS. Also, the eight domains of the SF36 had no significant correlations with the EDSS. A previous study showed that patients and doctors disagreed about which health domains are most important in MS (*Kremenchutzky et al., 2013*). The combination of relapse, progression of physical disability, and disease activity assessed by NMR reflect only part of the impact of MS on the patient's daily life. Measurements of health-related QoL have been considered as relevant assessments of disease progression, response to treatment, and the level of assistance patients need (*Lysandropoulos et al., 2015*). Therefore, researchers recommend that assessment of disease-related QoL should be included along with other parameters (clinical and biological) when assessing response to disease treatment. The inclusion of the individual perspective of the patient is a key element in improving healthcare outcomes (*Giovannoni et al., 2015*).

The main limitation of our study is that patients did not have organized psychological treatments, which we believe would have given significantly better MCS values.

CONCLUSION

In patients with MS, functional state and QoL significantly improve after organized physical therapy, but there is no correlation between them. Duration of the disease has a significant correlation with functional state, but not with quality of life. Age of patients does not correlate with functional status or with quality of life. Health professionals need to incorporate QoL assessment into assessments of disease severity, progression and treatment success to obtain the most relevant results in creating the right treatment strategy.

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