Physiotherapy in multiple sclerosis

Fizjoterapia w stwardnieniu rozsianym

Anna Łuszczyńska[1], Włodzisław Kuliński[1,2]

[1]Department of Physical Medicine, Institute of Physiotherapy, Faculty of Medicine and Health Science, Jan Kochanowski University, Kielce, Poland
Head of the Department: Prof. JKU Włodzisław Kuliński MD, PhD
[2]Department of Rehabilitation, Military Medical Institute, Warsaw, Poland
Head of the Department: Prof. JKU Włodzisław Kuliński MD, PhD

Medical Studies/Studia Medyczne 2015; 31 (3): 168–177
DOI: 10.5114/ms.2015.54755

Key words: multiple sclerosis, treatment, physiotherapy.

Słowa kluczowe: stwardnienie rozsiane, leczenie, fizjoterapia.

Abstract

Introduction: Multiple sclerosis (MS) is a chronic, progressive, demyelinating disease of the central nervous system. 2.5 million people are affected by MS worldwide; in Poland, the number of patients is approximately 40,000. Patients with multiple sclerosis suffer from a number of symptoms associated with this disease.
Aim of the research: To assess the effectiveness of physiotherapy in MS.
Material and methods: The study enrolled 25 MS patients aged 27–72 years (including 16 females and 9 males), undergoing 6-week rehabilitation. They were examined twice: before and after rehabilitation. The study used two questionnaires created by the author. Evaluation of the clinical status and disease severity was based on the Kurtzke Expanded Disability Status Scales (EDSS), the Lawton Instrumental Activities of Daily Living (IADL) Scale, and the Multiple Sclerosis Impact Scale (MSIS-29). The results were analysed with Student's *t*-test and the chi-square (χ^2) test.
Results: Statistical analysis showed significant (the level of significance was 0.05) progress in the functional status of the patients after physiotherapy, as evidenced by improved results with respect to the motor efficiency in the Kurtzke Expanded Disability Status Scale (EDSS), the functional assessment in the Lawton Instrumental Activities of Daily Living (IADL) Scale, and the influence of MS on patients' daily life in the Multiple Sclerosis Impact Scale (MSIS-29) seen in the majority of the patients, which confirms a positive impact of the therapy.
Conclusions: In the study group, comprehensive rehabilitation had a beneficial influence on the improvement of functional status and the level of motor ability. Physiotherapy turned out to be an extremely effective form of symptomatic treatment of MS patients.

Streszczenie

Wprowadzenie: Stwardnienie rozsiane (SM) jest przewlekłą, postępującą, demielinizacyjną chorobą ośrodkowego układu nerwowego. Na SM choruje ok. 2,5 mln osób na świecie, w Polsce ta liczba wynosi ok. 40 tysięcy.
Cel pracy: Ocena skuteczności fizjoterapii u pacjentów chorujących na SM.
Materiał i metody: Badaniu poddano 25 osób chorych na SM w wieku 27–72 lat przebywających na 6-tygodniowym turnusie rehabilitacyjnym. Badanie przeprowadzono 2-krotnie, tj. przed rozpoczęciem usprawniania rehabilitacyjnego i po jego zakończeniu. W badaniach posłużono się dwiema autorskimi ankietami. Do oceny stanu klinicznego i zaawansowania choroby użyto ponadto Rozszerzonej skali niewydolności ruchowej Kurtzkego (EDSS), Skali oceny złożonych czynności życia codziennego – IADL (skala Lawtona) oraz *Multiple Sclerosis Impact Scale* (MSIS-29). Wyniki poddano analizie statystycznej, posłużono się przy tym testem *t*-Studenta dla dwóch prób zależnych oraz testem χ^2.
Wyniki: Analiza statystyczna wykazała znaczącą (na poziomie istotności 0,05) poprawę stanu funkcjonalnego pacjentów po zastosowaniu fizjoterapii. Może o tym świadczyć poprawa u większości badanych w zakresie: wydolności ruchowej w skali Kurtzkego, stanu funkcjonalnego ocenianego za pomocą skali IADL oraz wpływu SM na życie codzienne (wg *Multiple Sclerosis Scale*).
Wnioski: W badanej grupie kompleksowa rehabilitacja wpłynęła skutecznie na poprawę stanu funkcjonalnego oraz ocenę poziomu sprawności fizycznej badanych. Fizjoterapia okazała się niezwykle pomocną formą leczenia objawowego chorych na SM.

Introduction

Multiple sclerosis (MS) is the most common inflammatory demyelinating organic disease of the central nervous system, found most often in young people [1, 2]. According to the data of the National Health Fund, MS affects approximately 40,000 people in Poland, with 2.5 million MS patients worldwide.

The disease is characterised by the presence of focal neurological deficits and usually involves periods of relapses (exacerbation) and remissions. Multiple sclerosis is a chronic progressive disease. Within the central nervous system (CNS), it results mainly in the disintegration of the myelin sheaths and damage to the axons. Disseminated lesions, called plaques or sclerae, 1 mm to several centimetres in size, are usually located in the white matter or the white-grey matter junction of the brain and spinal cord [3–6].

Figure 1 presents myelin sheath lesions in the course of MS.

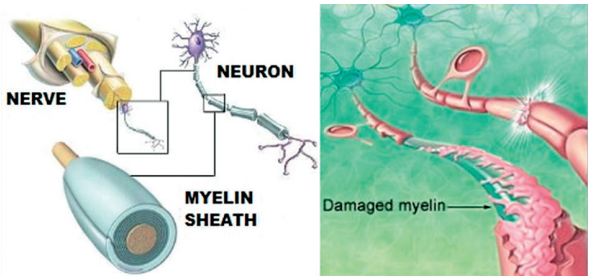

Figure 1. Myelin sheath lesions in the course of MS (according to [7])

Aetiopathogenesis

The cause of multiple sclerosis has not yet been established. External (environmental) factors, genetic factors, and the resulting autoimmune responses are believed to play an important role.

Clinical presentation of multiple sclerosis

Early symptoms of MS and its further course vary, depending on the location of the foci of demyelination [4, 5, 7, 8].

Typical symptoms of multiple sclerosis:

1. Repeating relapses followed by a complete recovery and increasing motor function impairment.
2. Ocular symptoms: retrobulbar neuritis, usually unilateral, present in approx. 30% of MS patients as one of the early signs of the disease.
3. Oculomotor problems, causing intermittent diplopia.
4. Fatigue, found in 75–95% of MS patients.
5. Brain stem symptoms: trigeminal neuralgia found in 1.5% of patients.
6. Cerebellar symptoms, found in 75% of patients, including ataxia (ataxic gait), intention tremor, dysdiadochokinesia, dysmetria, and speech disorders.
7. Pyramidal symptoms found in 80% of patients, e.g. spastic paresis of one or both lower limbs and increased muscle tone (spasticity).
8. Sensory symptoms present in 50% of MS patients, including decreased superficial sensation, disturbed sensation of vibration within the lower limbs, paraesthesia.
9. Urinary bladder and bowel symptoms, found in 20% of patients, including impaired micturition (overactive bladder with involuntary urination, incomplete bladder emptying with urinary retention) and impaired bowel function (constipation or faecal incontinence).
10. Sexual disorders, cognitive and psychological problems, impaired memory, attention, and the ability to form new memories, language disorders in the form of aphasia or dysphasia, unjustified euphoria, depression.

Clinical course of multiple sclerosis

Taking into consideration the deficit symptoms associated with the disease, the following forms of MS have been distinguished:

a) Cerebro-spinal (disseminated) MS involves cranial nerves (oculomotor nerves and optic nerve), spinal cord (results in spastic paresis of the lower limbs and impaired sphincter function), and the cerebellum.
b) Spinal (paraparetic) MS in which spastic lower limb paresis is the main symptom.
c) Cerebellar MS characterised by cerebellar deficits.
d) Hemiparetic MS characterised by hemiparesis.

Diagnosis of multiple sclerosis

The diagnostic work-up in MS is based on clinical observation of the patient as well as thorough history-taking from the patients and the people close to them.

The diagnosis of multiple sclerosis is confirmed with imaging studies (magnetic resonance), event-related potentials (visual, sensory, auditory, and motor), and the examination of the cerebrospinal fluid.

Magnetic resoanace imaging (MRI) allows for the assessment of the stage of the disease as well as treatment outcomes. It is performed using T1- and T2-weighted images.

A particularly important part of MS diagnostic work-up is FLAIR MRI. This method is more sensitive than classic MRI and serves to determine the exact size and severity of the lesions (Figure 2).

Clinimetrics in multiple sclerosis

The clinical status of an MS patient is assessed on the basis of functional tests and clinimetric scales.

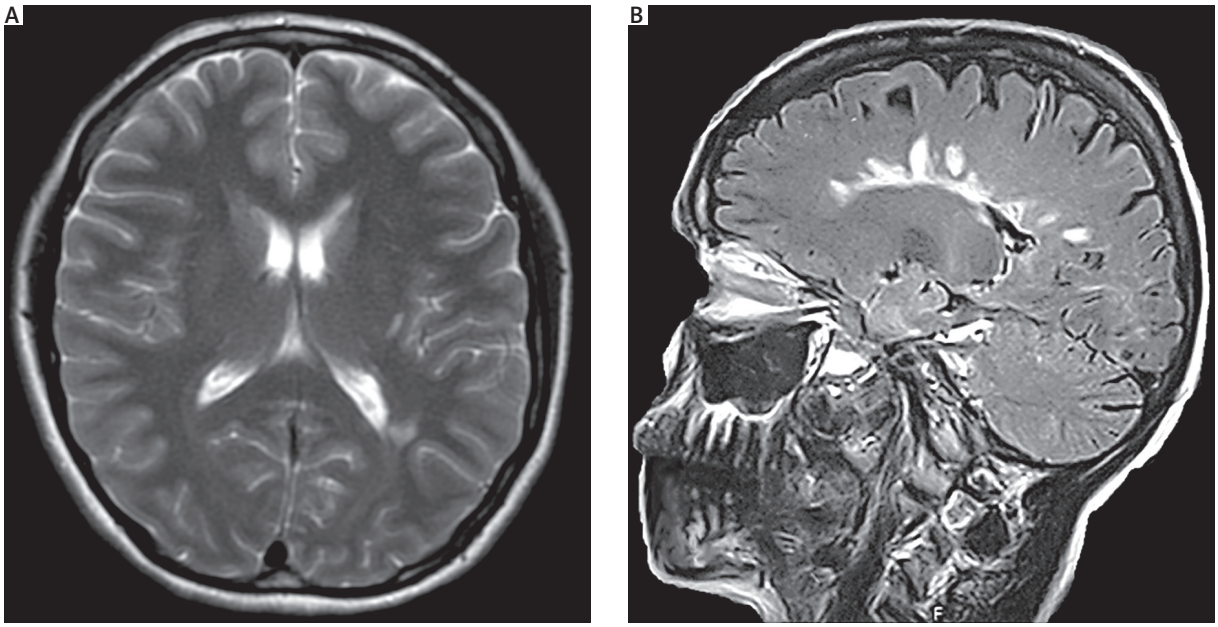

Figure 2 A, B. FLAIR MR images of an MS patient (according to [9])

They are used in order to assess the patient's disability, disease progression, and treatment outcomes as well as the quality of life [10].

Nowadays, the most popular scale is the numerical EDSS (Expanded Disability Status Scale). It was developed in 1983 by American neurologist John Kurtzke. It is a 10-point scale (with half points) describing the degree of patient's ability, where 0 means no disability (no symptoms of the disease) and 10 means the death of a patient due to MS.

MS Impact Scale (MSIS) is another tool for the assessment of disability in MS patients. The patient receives a questionnaire consisting of 29 questions. The questions concern motor function of the limbs, eyes, sensation, coordination, and balance as well as gait, sphincter, and sexual disturbances. The score ranges from 1 to 5, where 1 means no function disturbances and 5 means maximum impairment of a given function.

The quality of life in MS patients is assessed with the following scales: Beck scale, Sickness Impact Profile (SIP), Medical Outcomes Study 36-Item Short Form Health Survey, EuroQoL EQ-5D Index, Multiple Sclerosis Quality of Life-54 (MSQOL54), ADL, and IADL. Moreover, functional assessment of the patients incorporates such general scales as the Barthel Index, FIM, and "Repty" Functional Index.

The ADL (Katz index) assesses basic activities of daily living. It determines the range of physiotherapeutic management at the patient's home.

The Lawton IADL scale assesses instrumental activities of daily living.

The "Repty" Functional Index reflects the degree of disability. The scale encompasses five basic areas: self-care, sphincter control, mobility, locomotion, and communication.

Fatigue in MS patients is assessed with the Fatigue Severity Scale (FSS), Modified Fatigue Impact Scale (MFIS), and Fatigue Severity Scale specific for MS.

In the case of multiple sclerosis, the assessment of spasticity is extremely important. The examination is based on scales, particularly the Ashworth scale.

Numerous studies have shown that pharmacological treatment should be strictly connected with physical therapy, which needs to be introduced as early as possible and adjusted to the type and severity of the disease [11–16]. Its main goal is to improve the functional status and delay the development of disability, since maintaining independence as long as possible is very important for MS patients. Apart from standard physical treatment including physiotherapy and kinesiotherapy, the following modern methods of rehabilitation are used: hippotherapy, music therapy, art therapy, bibliotherapy, hydrotherapy, occupational therapy, and relaxation techniques. Physical therapy should be supplemented by educating the patients and their families, removing architectural and social barriers and broadly defined social assistance [15, 17, 18].

Physiotherapy in multiple sclerosis

Treating spasticity, decreased muscle strength, impaired sphincter function, coordination disturbances, and ataxia as well as pain and paraesthesia [17–20].

Rehabilitation should be aimed at:
- Preventing a decrease in the physical fitness and mental ability as well as the development of disability.
- Compensating for the loss of function in the damaged organs.
- Adapting the patient to changed environmental conditions.
- Creating appropriate conditions for maintaining independence.

Physiotherapy during relapses: During a relapse, physiotherapy is mainly aimed at preventing the sequelae of immobilisation and the lack of physical activity. It is necessary to often change the patient's position in order to avoid pressure ulcers; their prophylaxis uses also physical procedures (polarised light). In addition, patients should perform breathing and cough exercises.

Prior to the rehabilitation, the patient should be taught how to breathe correctly.

A significant role is played by passive exercises of the paretic limbs and appropriate positional exercises (preventing contractures). Due to the progressive character of multiple sclerosis, physiotherapy should be comprehensive and ongoing.

The rehabilitation program in patients whose degree of disability according to the Kurtzke Expanded Disability Status Scale (EDSS) is below 6 should include the following: breathing exercises, aerobic exercises, active non-weight bearing exercises, active free exercises, balance exercises, coordination exercises, neurophysiological methods and neuromuscular re-education. Patients with an EDSS score > 6 should undergo breathing exercises, active non-weight bearing exercises, passive exercises and balance exercises. They are often mobilised and undergo gait education. Neurophysiological methods and biofeedback are also used.

Active non-weight bearing exercises are introduced in patients whose muscle strength is between –2 and +2 according to the Lovett scale. The exercises are non-weight bearing due to the use of a block and weight system, the therapist's hands or a water environment.

Active free exercises are introduced in patients whose muscle strength is 3 according to the Lovett scale.

Balance and coordination exercises. To achieve coordination, the patient's movements have to be smooth, precise, and efficient.

Neurophysiological methods used in MS patients include proprioceptive neuromuscular facilitation (PNF), NDT-Bobath therapy, biofeedback, mobilisation, and gait education.

Aerobic training. Multiple sclerosis patients may have spastic muscle paresis. It is a motor dysfunction caused by upper motor neuron damage and characterised by muscle hypertonia, increased tendon reflexes, the presence of pathological symptoms, and increased tonic stretch reflex. Spasticity contributes to contractures, joint deformation, pressure ulcers, vein thrombosis, and infections and is usually accompanied by pain [11, 16, 20].

Hufschmidt's method in treating spasticity is a physiotherapy procedure consisting of the stimulation of spastic muscles and their antagonists with so-called double rectangular electrical pulses. Hufschmidt's method involves the stimulation of a spastic muscle with a short pulse (causing its contraction), followed by short-term relaxation. In the case of MS, the flexors and extensors of the following joints are stimulated: hip, knee, ankle, wrist, elbow, and shoulder. Hufschmidt's electrical stimulation is conducted with appropriate parameters:
- rectangular pulse shape with the duration of 0.2–0.5 ms, time between pulses is 1 s for the upper limb and 1.5 s for the lower limb;
- pulses are released with a delay of 100–300 ms;
- interval between the cycles is 0.5–1.5 s;
- session duration is 15–20 min, sessions take place every day or every other day;
- current intensity has to be high enough to result in an intensive muscle contraction, with the contraction of the antagonists stronger than the contraction of the spastic muscles [10, 11].

Tonolysis. It is a modified Hufschmidt's method consisting mainly of the stimulation of a spastic muscle with a short triangular or rectangular pulse; however, when the muscle relaxes, the antagonist muscle is stimulated with a series (train) of trapezoidal, sinusoidal, or triangular pulses.

Orthopaedic aids. Multiple sclerosis is a chronic disease. As it progresses, the risk of impaired locomotion increases and the use of orthopaedic aids becomes necessary. Multiple sclerosis patients may use the following mobility aids: canes, tripod canes, quad canes, crutches, walking frames, and wheelchairs. It is also important to eliminate any barriers preventing the patients from active participation in social life.

Other physiotherapeutic and balneotherapeutic methods used in MS patients include: low- and medium-frequency currents, ultrasound therapy, electrical stimulation, four-cell baths, underwater massage, carbonic acid baths, variable low-frequency magnetic fields, laser therapy, and cryotherapy [11–14, 16 17, 19].

Low-frequency magnetic fields. Magnetic field therapy consists of physical procedures using the influence of a slowly changing magnetic field on the human body. In MS patients, low-frequency fields are used to treat the increased muscle tone, muscle tremor, dizziness, and pain. It is also important to facilitate the process of regeneration of the damaged nerves. Its biological effects include improved metabolism in the nervous tissue, increased synaptic

reorganisation, and treating pain. The sessions in MS patients use low-frequency sinusoidal magnetic fields with field induction of 10 mT, frequency of 5–10 Hz, and session duration of approximately 12 min. The first 5–10 sessions in a cycle should be conducted every day and then the procedures should take place twice a week.

Magnetic field stimulation procedures use variable low-induction magnetic fields (field induction does not exceed 100 μT/0.1 mT). Magnetic fields used in MS patients have a pulse frequency between 180 and 195 Hz. In these patients, magnetic field stimulation is aimed at alleviating the signs and symptoms, especially depression, fatigue, and cognitive impairment.

Cryotherapy. The main indication for local cryotherapy in MS patients is treating increased muscle tone and preparation for kinesiotherapy (cryokinetics). Whole-body cryotherapy is very beneficial to the patients as it improves their well-being and eliminates fatigue. A cryotherapy session is followed by kinesiotherapy lasting at least 20 min.

Laser therapy. The biological effect of low-energy laser light in MS patients includes its positive influence on the stimulation of Schwann cell proliferation and, consequently, nerve regeneration. Laser biostimulation activates the transmission and absorption in the tissues. The therapeutic outcomes may also include improved balance, coordination, lower muscle tone and better muscle endurance, analgesic, regenerative and anti-inflammatory effects, and increased tissue perfusion and microcirculation.

Table 1. Age distribution

Age [years]	Female		Male		Total	
	n	%	*n*	%	*n*	%
< 20	0	0	0	0	0	0
20–30	2	12.5	2	22.2	4	16
31–40	4	25	0	0	4	16
41–50	7	43.8	3	33.3	10	40
> 50	3	18.7	4	44.5	7	28

Table 2. Onset of disease

Age [years]	Female		Male		Total	
	n	%	*n*	%	*n*	%
< 20	5	31.3	1	11.1	6	24
20–30	6	37.5	4	44.4	10	40
31–40	5	31.3	2	22.2	7	28
> 40	0	0	2	22.2	2	8

Aim of the research

The aim of the study was to assess the effectiveness of physiotherapy in patients with multiple sclerosis. We assumed a positive influence of physiotherapy on self-care, locomotion, mobility, and communication in MS patients.

Material and methods

The study enrolled a group of MS patients treated at the Department of Rehabilitation of the St. Lukas Specialist Hospital in Końskie between 1 September 2014 and 27 March 2015. Patients gave their written consent to participate in the study. The group included 16 women and 9 men (mean age was 45 years).

The study was conducted in two stages. The first stage involved the use of an original questionnaire and the IADL scale (the Lawton scale modified for MS patients). The second part included a questionnaire subjectively assessing the effectiveness of the rehabilitation, the IADL scale evaluating instrumental activities of daily living, and the Multiple Sclerosis Impact Scale (MSIS-29) showing the influence of MS on the patient's everyday life.

Moreover, the clinical status of all study participants was assessed with the Kurtzke Expanded Disability Status Scale (EDSS). The first stage of the study was conducted on the first day after admission to the Department of Rehabilitation while the second stage took place on the last day of the 6-week stay.

The first stage involved the use of a questionnaire consisting of 17 questions concerning personal data and basic information about the disease. In the second stage, the questionnaire used included questions concerning the procedures the patients had undergone as well as their assessment and the influence of physiotherapy on the functional status.

The data of the study participants are presented in Table 1.

In the study group, the highest number of patients (over 65%), both in men and women, were married. Forty percentage of the patients had vocational secondary education, 32% had secondary education, and 12% had a university degree. Nearly a third of the participants worked in full-time jobs, and 25% were pensioners or were drawing disability pensions.

The largest group of MS patients were individuals who had been ill for 11 to 15 years (approx. 33% of all patients) while the smallest group consisted of those in whom the duration of the disease was less than 10 years (Table 2). 2/3 of the study group had relapsing-remitting MS (64%); the lowest number (only 3 patients, 12%) had primary-progressive MS (Table 3).

Thirty-three percentage of MS patients had relapses less frequently than once a year. In 4% of the patients, spasticity was found only in the upper limbs.

The study results show that the most common form of kinesiotherapy during the inpatient rehabilitation program was exercise with the use of kinesiotherapeutic methods (e.g. PNF, NDT-Bobath), which was reported by 88% of the study participants. The second most popular form of rehabilitation was self-assisted exercises (76%), while 64% of the patients had undergone gait education. The most common form of physiotherapy was cryotherapy (88%); magnetic field therapy or magnetic field stimulation were less popular (75%).

Statistical analysis

The resulting data was statistically analysed with Student's *t*-test and the chi-square (χ^2) test. Moreover, descriptive statistics were used, i.e. mean, standard deviation, median, minimum, and maximum. Student's *t*-test for dependent samples was used to analyse the results from the IADL, EDSS, and MSIS-29 scales. The χ^2 test allowed for establishing the relationship between:

- the degree of spasticity and disease duration,
- the patient's functional status and the form of the disease,
- the level of physical fitness in everyday life and disease duration,
- the level of patient's physical fitness, the number of relapses, and the functional status of the patient.

Results

The study participants underwent physical examination twice: before and after the therapy, with the IADL (Lawton) scale, Expanded Disability Status Scale (EDSS), and Multiple Sclerosis Impact Scale (MSIS-29).

According to the IADL, physical therapy resulted in improved health status both in women and men, as compared with the baseline results. In women, the mean IADL score increased from 16.88 to 17.69, the median (middle value) increased from 17 to 18.5 points, and the maximum value did not change. The minimum value was lower by 1 point. In men, the mean value increased by 0.76 points and the median increased from 17 to 18 points. Similarly to women, the maximum value in men remained the same. Student's *t*-test for dependent samples confirmed a statistically significant improvement in the health status of the patients studied (Table 4).

Table 3. Type of disease

Disease	Female		Male		Total	
	n	%	*n*	%	*n*	%
Relapsing-remitting	10	62.4	6	66.7	16	64
Secondary-progressive	3	18.8	3	33.3	6	24
Primary-progressive	3	18.8	0	0.0	3	12
Progressive-relapsing	0	0	0	0.0	0	0

According to the Kurtzke Expanded Disability Status Scale, the clinical status of the patients improved. In women, the mean value decreased from 6.03 to 5.7 points; a similar decrease was found in men (from 5.39 to 5.1 points). Student's *t*-test for dependent samples confirmed a statistically significant improvement in the health status of the patients (Table 5).

An analysis with the Multiple Sclerosis Impact Scale (MSIS-29) revealed an improvement with respect to the influence of the treatment on the everyday life of the patients. The mean value was lower both in women (from 99.38 to 94.44 points) and men (from 94.16 to 87.88). Student's *t*-test for dependent samples confirmed a statistically significant improvement in the health status of the patients studied (Table 6).

The results allow us to establish a relationship between the assessment of the degree of spasticity and the duration of MS (Table 7). The result shows a statistically significant correlation between the degree of

Table 4. IADL scale – statistical data

Parameter	Female		Male		Total	
	Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment
Mean value	16.88	17.69	16.67	17.33	16.8	17.56
Standard error	0.93	1.05	1.31	1.44	0.74	0.83
Standard deviation	3.72	4.21	3.94	4.33	3.72	4.16
Difference in mean values	0.81		0.66		0.76	
Pearson's correlation	0.98		0.99		0.98	
Median	17	18.5	17	18	17	18
Minimum	9	8	11	11	9	8
Maximum	24	24	23	23	24	24
Value of *p* in Student's *t*-test	0.0047		0.0050		< 0.001	

Table 5. EDSS – statistical data

Parameter	Female		Male		Total	
	Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment
Mean value	6.03	5.7	5.39	5.1	5.86	5.48
Standard error	0.5	0.55	0.65	0.67	0.40	0.42
Standard deviation	2.06	2.20	1.94	2.04	2.0	2.12
Difference in mean values	0.33		0.29		0.38	
Pearson's correlation	0.99		0.99		0.98	
Median	6.5	6.5	6.5	6	6.5	6.5
Minimum	1	0	2.5	1.5	1	0
Maximum	8.5	8.5	7	7	8.5	8.5
Value of *p* in Student's *t*-test	0.0013		0.02		0.00025	

Table 6. MSIS-29 – statistical data

Parameter	Female		Male		Total	
	Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment
Mean value	99.38	94.44	84.89	76.22	94.16	87.88
Standard error	7.3	8	8.12	8.21	5.59	6.06
Standard deviation	29.19	31.89	24.36	24.61	27.94	30.29
Difference in mean values	4.94		8.67		6.28	
Pearson's correlation	0.99		0.99		0.99	
Median	102.5	95	86	77	100	90
Minimum	39	32	33	29	33	29
Maximum	139	139	115	108	139	139
Value of *p* in Student's *t*-test	0.0009		0.00019		< 0.001	

Table 7. Relationship between assessment of degree of spasticity and MS duration

Disease duration [years]	Degree of spasticity				Total
	Spasticity only in upper limbs	Spasticity only in lower limbs	Spasticity of the whole body	No increased muscle tone	
1–5	0	2	0	1	3
6–10	0	2	0	1	3
11–15	0	6	3	0	9
16–20	0	1	3	0	4
> 20	1	0	5	0	6
Σ	1	11	11	2	25

$\chi^2 = 31.09$, df = 12, C = 0.68, p = 0.0019 < 0.05.

Table 8. Relationship between patient's physical fitness and age of onset of multiple sclerosis

Age of disease diagnosis	Decrease in EDSS score after rehabilitation			Total
	0	0.5	1	
< 20	1	4	1	6
20–30	6	3	1	10
31–40	3	2	2	7
> 40	0	1	1	2
Total	10	10	5	25

$\chi^2 = 5.92$, df = 6, C = 0.77, p = 0.43 > 0.05.

Table 9. Dependence of functional status on type of disease

Type of disease	Increase in IADL score after rehabilitation				Total
	< 0	0	1	2	
Relapsing-remitting	0	4	6	5	15
Secondary-progressive	1	4	1	0	6
Primary-progressive	0	3	0	0	3
Progressive-relapsing	0	1	0	0	1
Total	1	12	8	7	25

$\chi^2 = 13.33$, df = 6, C = 0.76, p = 0.038 < 0.05.

spasticity and disease duration. Pearson's coefficient *C* is 0.74, indicating a very strong correlation between these variables. The longer the duration of the disease, the higher the degree of spasticity.

The results allow us to determine the relationship between the patient's physical fitness and the age of onset of multiple sclerosis (Table 8). The results show that this relationship is not statistically significant; the age of MS diagnosis does not influence the level of physical fitness in the patient.

Statistical analysis allowed for determining whether the functional status of the patient depends on the type of the disease (Table 9). The results show a statistically significant correlation between the functional status of patients after rehabilitation and the type of disease. The contingency coefficient is 0.76, indicating a very strong correlation between these variables. As far as the functional status is concerned, the participants with relapsing-remitting MS achieved the best results.

The results were also analysed with respect to a correlation between the functional status (measured with the change in the MSIS-29 score after rehabilitation as compared with baseline results) and the duration of the disease (Table 10). Analysis of the results allows us to conclude that the correlation between the functional status and disease duration is statistically significant. A high Pearson's coefficient *C* indicates a strong correlation between the variables. Rehabilitation results in better outcomes in those recently diagnosed with MS as compared with patients whose disease duration is longer.

The results may also be used in the assessment of the correlation between the level of physical fitness (EDSS score after rehabilitation) and the number of exacerbations (relapses); primary-progressive MS was an exclusion criterion because there are no relapses in this form of the disease (Table 11). The data shows that the correlation between the level of physical fitness and the number of relapses is statistically significant. Pearson's coefficient *C* is 0.57, indicating a strong correlation between the variables. The higher the number of relapses, the lower the level of physical fitness in the patients.

Discussion

Multiple sclerosis is an important problem for 21st-century medicine. As the disease progresses, the patients suffer from new symptoms and the existing ones intensify, decreasing the functional status. Due

Table 10. Correlation between functional status and disease duration

Disease duration [years]	Decrease in MSIS-29 score after rehabilitation				Total
	< 0	0–5	5–10	> 10	
1–5	0	0	0	3	3
6–10	0	2	1	0	3
11–15	0	4	4	1	9
16–20	1	0	2	1	4
> 20	0	2	4	0	6
Total	1	8	11	5	25

$\chi^2 = 22.91$, df = 12, C = 0.76, p = 0.028 < 0.05.

Table 11. Correlation between level of physical fitness and number of relapses

Number of relapses	Decrease in EDSS score after rehabilitation					Total
	0–2.5	3–4.5	5–6.5	7–7.5	8–10	
1–4	4	2	2	0	0	8
5–9	0	3	2	2	0	7
10–20	0	0	3	1	1	5
> 20	0	0	0	1	1	2
Total	4	5	7	4	2	22

$\chi^2 = 27.27$, df = 12, C = 0.57, p = 0.007 < 0.05.

to the chronic character of the disease, the clinical status of the patient must be regularly controlled and the physiotherapy program requires modifications adjusting it to the current level of physical fitness.

The disease concerns mainly young people (particularly between the age of 20 and 40). The range of the therapy depends on numerous factors, such as age, dynamics of the disease, patient's physical fitness, and the presence and severity of defects. It should include management during relapses and remissions, placing considerable importance on treating spasticity.

The present paper assesses the influence of physiotherapy on the functional status of MS patients. Our results show that physical therapy significantly influences the level of fitness and clinical status of the patients. Moreover, the degree of spasticity depends on disease duration. Spasticity was very severe in patients in whom disease duration exceeded 20 years, while those who had suffered from multiple sclerosis for less than 5 years did not have increased muscle tone at all or showed slight spasticity only in the lower limbs.

The assessment of the functional status was also influenced by the type of the disease.

According to the patients, the most effective physiotherapeutic procedure is cryotherapy. Many specialists have attempted to assess the influence of magnetic field therapy and magnetic field stimulation on the rehabilitation of MS patients. Fibiger *et al.* studied the effect of magnetic field stimulation on the quality of life and clinical status of patients with advanced MS [13]. The study enrolled 87 individuals who scored between 6 and 9 points on the EDSS. The authors assessed the patients' status before and after rehabilitation with the Cendrowski numerical scale and Kurtzke EDSS. The use of magnetic fields resulted in a statistically significant improvement in the clinical status of the patients. Magnetic field stimulation led to a considerable improvement with respect to everyday activities, muscle strength, sphincter control, and lowering the increased muscle tone. Moreover, studies have shown that variable magnetic fields contribute to decreasing fatigue. Sieroń *et al.* used low-frequency magnetic fields and achieved decreased pain and muscle tremor as well as better control of micturition [19]. Woldańska-Okońska *et al.* attempted to assess the influence of laser light and magnetic field stimulation on the functional status and muscle tone in MS patients. The assessment took place before and after rehabilitation and was based on the EDSS and Ashworth scale. The use of magnetic field therapy and laser therapy resulted in a statistically significant improvement in the functional status and muscle tone of the patients.

The dependence of the clinical status on the number of relapses was evaluated by Mirowska-Guzel and Członkowska [5]. The study showed that the frequency of relapses does not have a significant influence on the development of disability and disease progression.

Multiple sclerosis is a difficult diagnostic and therapeutic problem. The present study results show a statistically significant correlation between the degree of spasticity and the duration of MS. Spasticity is more severe in patients whose disease duration is longer as compared with those recently diagnosed with MS.

The dependence of the functional status on the type of disease also proved to be important. The best outcomes were achieved in patients with relapsing-remitting MS, while those with secondary- and primary-progressing disease showed worse results.

The fact that the assessment of the functional status depends on disease duration also turned out to be important. Patients with long disease duration showed worse rehabilitation results than those with shorter duration of MS. The correlation between the level of physical fitness and the number of relapses in patients with relapsing-remitting MS is also statistically significant. The level of fitness in patients with a large number of MS relapses is lower than in those with a smaller number of exacerbations.

According to the patients, exercises using kinesiotherapeutic and neurophysiological methods and cryotherapy were the most effective parts of the rehabilitation.

Conclusions

The degree of spasticity depends on disease duration. The longer the duration of the disease, the higher the degree of spasticity. Physiotherapy had better outcomes in patients with relapsing-remitting multiple sclerosis. Physiotherapy was most successful in patients with shorter disease duration. The assessment of the patient's physical fitness does not depend on the age of onset of multiple sclerosis. The level of patient's physical fitness depends on the number of relapses. The higher the number of relapses, the lower the level of fitness. The patients listed exercises using kinesiotherapeutic methods (PNF, Bobath) and cryotherapy as the most effective part of the rehabilitation.

Conflict of interest

The authors declare no conflict of interest.

References

1. Hollenbach JA, Oksenberg JR. The immunogenetics of multiple sclerosis: a comprehensive review. J Autoimmun 2015; 2: 30001-9.
2. Dell'Avvento S, Sotgiu MA, Manca S, et al. Epidemiology of multiple sclerosis in the pediatric population of Sardinia, Italy. Eur J Pediatr 2015; 07: 10-4.
3. Broadley SA, Barnett MH, Boggild M. A new era in the treatment of multiple sclerosis. Med J Aust 2015; 203: 139-41.
4. Lindsay K, Bone I. Neurologia i neurochirurgia. Wydawnictwo Elsevier Urban & Partner, Wrocław 2013.

5. Mirowska-Guzel D, Członkowska A. Stwardnienie rozsiane – nie zawsze ciężka choroba. Terapia 2007; 2: 46-9.
6. Stasiołek M, Mycko M, Selmaj K. Patogeneza stwardnienia rozsianego. Pol Przegl Neurol 2005; 1: 92-8.
7. Mirowska-Guzel D, Członkowska A. Zaburzenia funkcji poznawczych w stwardnieniu rozsianym. Terapia 2007; 2: 50-3.
8. Romero K, Shammi P, Feinstein A. Neurologists accuracy in predicting cognitive impairment in multiple sclerosis. Mult Scler Relat Disord 2015; 4: 291-5.
9. Siger M. Diagnostyka stwardnienia rozsianego metodą rezonansu magnetycznego. Pol Przegl Neurol 2006; 2: 48-56.
10. Opara J. Klinimetria w neurorehabilitacji. PZWL, Warsaw 2012.
11. Brus H, Kapko W, Janota J, et al. Elektrostymulacja metodą Hufschmidta w leczeniu spastyczności. Rehabilitacja w Praktyce 2013; 2: 39-40.
12. Długosz M, Stasiak-Pietrzak A, Krekora K, Czernicki J. Pola magnetyczne w diagnostyce, terapii i rehabilitacji chorych na stwardnienie rozsiane. Balneol Pol 2009; 53; 182-8.
13. Fibiger W, Starowicz A, Wilk M. Wpływ magnetostymulacji na jakość życia chorych z SM. Fizjoter Pol 2010; 10: 202-9.
14. Kubsik A, Klimkiewicz P, Woldańska-Okońska M. Zastosowanie promieniowania laserowego w fizjoterapii chorych na stwardnienie rozsiane. Wiad Lek 2012; 65: 55-61.
15. Lennon S, Stokes M. Fizjoterapia w rehabilitacji neurologicznej. Wydawnictwo Elsevier Urban & Partner, Wrocław 2009.
16. Opara J, Brus H, Kapko W, et al. Zastosowanie pola magnetycznego w stwardnieniu rozsianym. Rehabilitacja w Praktyce 2013; 2: 42-4.
17. Kuliński W. Metody stosowane w fizjoterapii. In: Fizjoterapia w pediatrii. Kuliński W, Zeman K (eds). PZWL, Warsaw 2012.
18. Kuliński W. Fizykoterapia. W: Rehabilitacja medyczna. Elsevier & Partner, Wroclaw 2012; 351-411.
19. Sieroń A. Próba wykorzystania zmiennego pola magnetycznego w objawowym leczeniu stwardnienia rozsianego. Pol Tyg Lek 1996; 51: 113-5.
20. Olchowik B, Sobaniec W, Sołowiej E, Sobaniec P. Aspekty kliniczne zwalczania spastyczności. Neurol Dziec 2009; 18: 47-57.

Address for correspondence:

Włodzisław Kuliński
Department of Physical Medicine
Institute of Physiotherapy
Faculty of Medicine and Health Science
Jan Kochanowski University
al. IX Wieków Kielc 19, 25-317 Kielce, Poland
E-mail: wkulinski@hotmail.com