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Original Research Article

CORRELATION BETWEEN SPASTICITY AND WEAKNESS OF THE LOWER LIMBS WITH FATIGUE IN PATIENTS WITH MULTIPLE SCLEROSIS

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ABSTRACT

Background: Individuals affected by Multiple Sclerosis (MS) present weakness in the lower limbs (LL), abnormal muscle tone and fatigue.

Aims: To correlate the spasticity and weakness of lower limbs with fatigue in Multiple Sclerosis patients.

Methods: The study is the *ex post fact* type with a correlational design, performed with patients MS. A total of 45 individuals were evaluated. The Modified Fatigue Impact Scale in MS (MFIS) was used to asses fatigue; the Modified Ashworth Scale (MAS) for lower limb (LL) spasticity and the 5-repetition sit-to-stand (5STS) test to characterize the strength of LL.

Results: The mean of MFIS was 42.76 (±19.65) points, indicating the presence of fatigue among the patients and in the 5 STS-test the average was 15.37 (±5.89) which chacacterized them with decreased muscle strength. Thirty-nine patients had some degree of spasticity in the lower limbs (86.66%). There was a positive correlation between fatigue and muscle strength of LL ($r = 0.412$ and $p < 0.05$) and between fatigue and spasticity of adductors muscles ($r = 0.295$) ($p < 0.049$).

Conclusions: Muscle strength of lower limbs is related to fatigue in MS patients demonstrating that the higher the muscle strength, the lower the presence of this symptom in multiple sclerosis patients.

KEY WORDS: Multiple Sclerosis, Muscle Spasticity, Muscular Strength, Fatigue, Physiotherapy.

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INTRODUCTION

Multiple Sclerosis (MS) symptoms depend on the region where the specific injury to the Central Nervous System (CNS) occurs. Depending on the location of the injury, there may be changes in sensitivity, muscle weakness, decreased reflexes, muscle spasms, difficulty in performing movements, lack of coordination and balance,

speech problems, fatigue, acute or chronic pain, and difficulties in bladder and intestine control [1].

According to Halabchi *et al*. [2], in addition to significant physical symptoms, such as muscle weakness, abnormal walking mechanics, balance problems, spasticity, and fatigue, multiple sclerosis may also result in mental disorders, like cognitive impairment and depression. Motor dysfunctions in patients with MS often occur due to muscle weakness, balance problems, spasticity, and fatigue [3].

Multiple sclerosis is characterized by impaired muscle strength and function, with greater impairment of the lower limbs, which decreases the patients' ability to walk [4]. The strength of the lower limbs is affected before the upper limbs [5].

Spasticity can affect approximately 80% of MS patients, and it contributes to disability these patients [6]. In MS, spasticity occurs shortly after diagnosis [7], increases disability throughout life [8], is associated with pain, and has a substantial impact on quality of life and daily activities [9]. Even low levels of spasticity can limit the function of patients with MS [10], and many patients demonstrate reduced walking speed due to increased spasticity [11].

For Rooney *et al*. [12], fatigue is a complex, multifactorial, and disabling symptom of MS. In the study by Sangelaji *et al*. [13], fatigue was a prevalent symptom, reported by 68.7% of the patients in the study.

According to Williams *et al*. [14], fatigue is one of the most common symptoms of multiple sclerosis and is generally described as a feeling of physical or mental tiredness. It impacts quality of life, work, and productivity, limiting the degree of independence of patients with MS.

Many patients have a deficit in walking capacity and demonstrate a progressive reduction in walking speed with the progression of the disease due to increased spasticity [11]. In the study by Van Asch [15], patients with MS reported that several symptoms affected mobility, including weakness in the legs (81%), fatigue (73%), difficulty in walking (69%), and lack of balance and coordination (67%).

Although the literature demonstrates that the alteration of tone and muscle strength in patients with MS interfere in these patients' functionality, there is still a lack of studies that correlate these changes to each other and to fatigue. Therefore, the objective of this study was to correlate the alteration of muscle tone and strength in the lower limbs (LL) with fatigue in patients with MS, so that upon understanding this relationship and how much it interferes in the evolution of the disease, we can establish methods of evaluation and therapeutic resources more directed to the treatment of these variables in patients.

MATERIALS AND METHODS

This is an *ex post facto* study with correlational design carried out after approval by the Research Ethics Committee of the Hospital de Clínicas de Porto Alegre (CEP HCPA), under CAAE no. 66333417.7.0000.5347. The sample size was 45 individuals and all participants signed Informed Consent Form (ICF) before data collection.

The research was carried out from a non-probability convenience sample, for which individuals who waited for a previously scheduled medical appointment in the waiting room of the Multiple Sclerosis Clinic at HCPA were selected. The patients were invited to participate in the research as volunteers, and when they accepted, they were taken to a room where the information was collected. The study included subjects who had a diagnosis of MS, were not in the period of flare-ups, if they had relapsing-remitting MS, and who were 18 years of age or older. The study excluded those who had other associated neurological diseases, injuries, or orthopedic trauma in the LL in the last year, and cardiorespiratory diseases that affected physical fitness. Data collection was performed by the same researcher, in a single visit.

The patients' personal data were obtained by filling out an anamnesis form. The Expanded Disability Status Scale (EDSS) was applied to characterize the severity and progression of MS, as it is the most widely used and recognized instrument [16].

Spasticity was assessed using the Modified Ashworth Scale (MAS) described by Bohannon;

Smith [17], which was applied to the hip adductor muscle groups, knee extensors, and ankle plantar flexors to determine the spasticity of the LL. It is graded using a score from 0 to 4. In this study, when patients were graded 0, they were classified as having no spasticity, that is, eutonia; when graded 1 or 1+, as presenting slight spasticity; when graded 2 or 3, as moderate spasticity; and when graded 4, they were classified as having severe spasticity.

The five-repetition sit-to-stand test (5STS) was used to measure the muscle strength of the patients' LL, through the time it took them to perform 5 repetitions of the sit and stand movement. According to Moller *et al*. [18], this is a valid measure to test the muscle strength of the LL in patients with MS. For this study, the cutoff point for establishing weakness in the patients'lower limbs was 7.6 seconds or more, according to the study by Bohannon *et al*. [19] with healthy adults.

The presence of fatigue was assessed by the Modified Fatigue Impact Scale for MS (MFIS), which was adapted and validated to Portuguese and consists of 21 questions with the possibility of answering from 0 to 4, totaling a score of 84 points. Values above 38 points indicate the presence of fatigue [20,21].

Data were analyzed through descriptive analysis (mean, standard deviation, relative and absolute frequency) and inferential analysis of data using the Shapiro-Wilk test. To verify the correlation of lower limb strength and spasticity with fatigue, the Spearman Correlation Test was used. The level of significance adopted was $p<0.05$.

RESULTS

Forty-five subjects were evaluated, and their clinical characteristics are described in Table 1.

Table 1: Clinical characteristics.

	n	%	Mean	SD
Gender				
Female	30	66,7	-	-
Male	15	33,3	-	-
Age (Years)	-	-	41,68	11,69
Types of MS				
RR	43	95,5	-	-
PP	1	2,25	-	-
SP	1	2,25	-	-
EDSS score (minimum-maximum)			4 / 1-6,5	-
Time since diagnosis (months)	-	-	96,5	81,46
Number attacks since diagnosis	-	-	4,8	3,87

MS: Multiple Sclerosis; RR: Relapsing remitting; PP: Primary progressive; SP: Secundary progressive; EDSS: Expanded Disability Status Scale; n: Number of patients; SD: Standart deviaton.

Table 2: Correlations of the variables: muscle strength and spasticity with fatigue.

Variables correlated with MFIS	Measures	Spearman's corretation	
		r	Sig (p)
Muscle strength	5STS	0.412	0.004917*
Spasticity of adductor (R)	MAS	0.295	0.049019*
Spasticity of adductor (L)	MAS	0.241	0.109974
Spasticity of knee extensors (R)	MAS	0.097	0.524759
Spasticity of knee extensors (L)	MAS	0.157	0.300371
Spasticity of gastrocnemius (R)	MAS	0.204	0.178065
Spasticity of gastrocnemius (L)	MAS	0.113	0.458059
Spasticity of Soleus (R)	MAS	0.163	0.201606
Spasticity of Soleus (L)	MAS	0.194	0.201606

MFIS: Modified Fatigue Impact Scale**;** MAS: Modified Ashworth Scale; D: Right; L: Left; * Significant values ($p<0,05$)

Most of the patients in this study (84.44%) presented muscle weakness in the LL, as evidenced by the 5STS. The mean performance of the studied sample was 15.37 (± 5.89) seconds.

As for muscle tone alteration, assessed by MAS, it was observed that only 6 patients (13.33%) did not present spasticity in any muscles evaluated in the LL. Of the 39 patients with tone alteration (86.66%), only 5 (11.11%) presented spasticity in all LL muscles. In addition, most spastic patients (62.22%) presented spasticity only in the flexor muscles of the ankle, that is, in the extremity of the LL.

In the data analysis, it was observed that 25 individuals (55.55%) had MFIS scores above 38 points. That is, just over half of the patients had scores that indicated the presence of fatigue. The total mean presented on this scale by the studied patients was 42.76 (± 19.65) points.

Regarding spasticity and fatigue, a significant positive correlation (r= 0.295 and p <0.049) was found between spasticity in hip adductors, assessed using MAS and MFIS values. These correlations demonstrate that the higher the values in MAS in the adductors, the higher the values found in MFIS, demonstrating that the greater the degree of spasticity of the hip adductors, the greater the impact of fatigue in MS patients. In the other muscles analyzed (knee extensors and plantarflexors), there was no significant correlation found between spasticity and fatigue (Table 2).

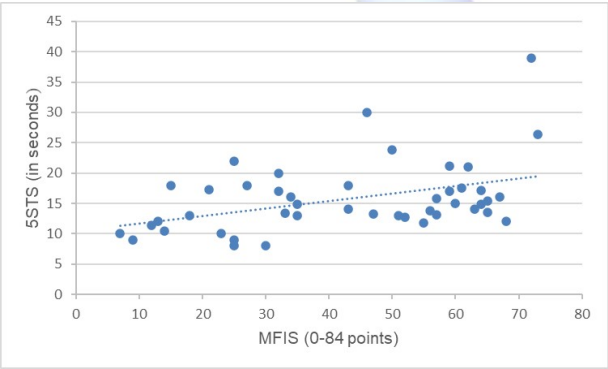

Fig 1: Correlation between 5STS and MFIS 5STS: five-repetition sit-to-stand test; MFIS: Modified Fatigue Impact Scale.
5STS: five-repetition sit-to-stand test; MFIS: Modified Fatigue Impact Scale.

A significant positive correlation (r= 0.412 and p <0.005) was observed between the results of 5STS and MFIS, demonstrating that the longer the task of sitting and standing 5x took, the greater the feeling of fatigue reported by patients with MS. This indicates that in this study the worse the muscle strength of the LL, the greater the impact of fatigue presented by individuals (Figure 1).

DISCUSSION

As found in other studies with people with MS, most patients in this study showed a decrease in the muscle strength of the LL, evidenced by the increased time to perform the 5STS test; some degree of spasticity in the LL muscles assessed; and the presence of fatigue [2,4,15,22].

According to Norbye *et al*. [10], more than 80% of people with MS are affected by spasticity, which was also found in our study (86.66%). The study by Henze *et al*. [22], which analyzed 87 patients with MS, observed that they also presented spasticity and fatigue. Differently from our study, most suffered from the secondary progressive form of the disease, and most were women, with a higher average age (50.2 years), an average EDSS that was also higher (5.7 points), with an average duration of the disease of 13.6 years. These authors reported the presence of mild spasticity and the presence of fatigue in 67% of patients.

The study by Arroyo *et al*. [23] found that most of their 404 subjects (59.2%) with MS, who were also assessed by MAS, had moderate to severe spasticity. Oreja-Guevara *et al*. [24] observed that 65.7% of their 2029 patients with MS presented spasticity, 40% of which were described as moderate to severe. These findings differ from our study, in which most subjects had only a slight alteration in muscle tone.

In the study by Norbye *et al*. [10], the participants had spasticity scores from 0 to 3 points in the MAS, with 1+ median spasticity of the plantarflexors, and most participants had a score of 0 for hip adductors and knee extensors. These results were similar to our results, in which most patients had spasticity in plantarflexor muscles.When evaluating the results of the 5STS test (15.37s), most subjects (84.44%) took longer than the expected to perform the test, characterizing muscle weakness of the LL. This result

is in line with the study by Bowser *et al*. [25], who observed that people with MS who have muscle weakness in LL take longer to perform this test than healthy people without the disease and people with MS with preserved muscle strength in the LL. In the study by Hoang *et al*. [26], 60% of the participants showed signs of weakness observed in all stages of the disease and strongly associated with the level of disability. According to Bohannon *et al*. [19], healthy adult individuals living in communities completed the test in times ranging from 6.2 to 10.6 seconds, with a mean of 7.6 ± 2.7. This work established the mean value found by Bohannon and colleagues[19] as a reference to define muscle weakness in the LL, since there are no reference values for individuals with MS. It has been observed that people with neurological diseases such as MS take longer to perform the 5STS test, thus demonstrating a decrease in muscle strength in the LL. In view of the lack of studies that determine a cutoff point for the 5STS test in patients with MS, new studies should be carried out to standardize values for the performance of this test in individuals with changes in muscle strength caused by MS.

When analyzing the symptoms described by the sample individually, fatigue was present in 55.55% of the patients in our study. This same percentage of patients with fatigue was reported in the study by Téllez *et al*. [27], who evaluated a sample of 231 individuals with MS. The mean MFIS score found was similar to the value of 44.2 (± 18.2) described by Amtmann *et al*. [28], showing that the result obtained in this study is close to the average of other studies that also evaluated this variable, such as Rooney *et al*. [12]. Other studies have also used different fatigue scales to identify the presence of this symptom, which was found to be present in 58.67 to 78.4% of patients with MS [12,29,30].

Our study found a positive correlation between spasticity and fatigue. There are few studies that correlate these symptoms; however, other associated variables have already been compared with spasticity. Sosnoff *et al*. [31]

evaluated the spasticity of 34 patients through MAS and found that individuals with MS and with spasticity in the LL had worse mobility and balance than those without spasticity. Another study that evaluated the spasticity of the plantiflexor muscles of 45 individuals with MS through MAS and a dynamometer, found a limited correlation between plantiflexor spasticity, walking speed and resistance [32]. For Karpatkin *et al*. [33], spasticity in patients with MS was not aggravated by fatigue, and fatigue did not result in increased spasticity.

Another interesting point to be discussed is that fatigue only correlated with the spasticity of the adductor muscle group and in the right lower limb. A possible explanation for this is that the spasticity in these muscles impacts the patients' walking severely, probably requiring more strength and physical conditioning and, consequently, more energy expenditure to perform it, even to walk short distances, leaving them with more symptoms of fatigue. For Bethoux [11], many patients have a deficit in walking capacity and demonstrate a progressive reduction in walking speed with the progression of the disease due to increased spasticity and other indicators of motor control deficit. Our hypothesis for this fact fact that only one side correlated, is that usually people with MS present one side of the body with greater impairment than the other.

It is interesting to note that this correlation between spasticity and fatigue in the patients in this study was established only in the muscle group of the hip adductors and in the right lower limb, and the muscle tone alteration in adductors was present in only 15.55% of the patients. This finding seems to suggest that spasticity in hip adductors in patients with MS interferes more in fatigue than spasticity in the plantiflexor muscles, since there was no significant correlation between these muscles and fatigue, even though these muscles were spastic in 28 of the sample patients.

A significant positive correlation between the strength of the LL and fatigue was observed in our study. This is because a relationship was found between the values of the 5STS and those of the MFIS, that is, the longer the time to perform the sit-and-stand test, the higher the score on the fatigue scale, indicating that the greater the muscle weakness of the LL, greater the presence of fatigue observed in patients. Our results corroborate those of Valet *et al*. [34],

who evaluated 20 individuals using the MFIS and an isometric strength test and observed an association between the decrease in muscle strength of the LL and the fatigue perceived by patients. They also found significant correlations between fatigue, mobility, walking, and aerobic capacity. For Rooney *et al*. [12], the greater severity of fatigue is associated with a greater impact of physical impairment, which may justify the relationship found between muscle strength and fatigue in this study.

The findings of our study are important to complement results found in the literature and for the formulation and guidance of the treatment of patients with MS. A study by Patejdl; Zettl [35] showed that mild spasticity in plantiflexor muscles in the early stages of the disease can evolve into spasticity with involvement of other muscles such as hip adductors and knee extensors. This shows the importance of being aware of these variables even in the initial stages and intervening on them, trying to avoid worsening muscle strength, spasticity, and consequently fatigue. It is also worth mentioning that the tests used in this study are easy to apply and provide important information to assess and monitor the presence of deficits and outline the objectives in the treatment of patients. Thus, based on the correlations found in this study, approaches that aim to strengthen the LL and control spasticity to avoid or reduce symptoms and disabilities related to fatigue in MS patients should be addressed in physical therapy treatments.

CONCLUSION

Patients demonstrated weakness and some degree of spasticity in the lower limbs and reported fatigue as one of the symptoms of MS. This study showed that there is a correlation between the muscle strength of lower limb and fatigue in individuals with MS, establishing that the lower the muscle strength the greater the impact of fatigue on these individuals.

The correlation of spasticity was established only between the increase in tone in the adductor musculature of the LL and fatigue, suggesting an influence of this musculature in this parameter. Future studies could explore better the relationship between spasticity and fatigue in these patients.

Conflicts of interest: None

REFERENCES

[1]. Mohamed K, Koriem M. Multiple sclerosis: New insights and trends. Asian Pac J Trop Biomed. 2016; 6: 429-440. https://doi.org/10.1016/j.apjtb.2016.03.009

[2]. Halabchi F, Alizadeh Z, Sahraian MA, Abolhasani M. Exercise prescription for patients with multiple sclerosis; potential benefits and practical recommendations. BMC Neurology. 2017; 17: 1-11. https://doi.org/10.1186/s12883-017-0960-9 PMid:28915856 PMCid:PMC5602953

[3]. Kamm CP, Uitdehaag BM, Polman CH. Multiple sclerosis: current knowledge and future outlook. Eur Neurol. 2014; 72: 132-41. https://doi.org/10.1159/000360528 PMid:25095894

[4]. Ng AV, Miller RG, Gelinas D, Kent-Braun JA. Functional relationships of central and peripheral muscle alterations in multiple sclerosis. Muscle Nerve. 2004; 29: 843-852. https://doi.org/10.1002/mus.20038 PMid:15170617

[5]. Kjolhede T, Vissing K, Dalgas U. Multiple sclerosis and progressive resistance training: a systematic review. Mult Scler J. 2012; 18: 1215-2. https://doi.org/10.1177/1352458512437418 PMid:22760230

[6]. Bethoux F, Marrie RA. A cross sectional study of the impact of spasticity on daily activities in multiple sclerosis. Patient. 2016; 9: 537-546. https://doi.org/10.1007/s40271-016-0173-0 PMid:27154536

[7]. Vermersch P. Mobility ImproVEment with spasticity in multiple sclerosis in Europe: The MOVE 1 EU study. Neurodegenerative Disease Management. 2014; 4: 407-415. https://doi.org/10.2217/nmt.14.44 PMid:25531685

[8]. Kister I, Bacon TE, Chamot E, Salter AR, Cutter GR, Kalina JT, Herbert J. Natural history of multiple sclerosis symptoms. International Journal of MS Care. 2013; 15: 146-158. https://doi.org/10.7224/1537-2073.2012-053 PMid:24453777 PMCid:PMC3883021

[9]. Flachenecker P, Henze T, Zettl UK. Spasticity in patients with multiple sclerosis-Clinical characteristics, treatment and quality of life. Acta Neurologica Scandinavica. 2014; 129: 154-162. https://doi.org/10.1111/ane.12202 PMid:24256407

[10]. Norbye AD, Midgard R, Thrane G. Spasticity, gait, and balance in patients with multiple sclerosis: A cross sectional study. Physiother Res Int. 2019; e1799. https://doi.org/10.1002/pri.1799 PMid:31287210

[11]. Bethoux F. Gait disorders in multiple sclerosis. Continuum. 2013; 19: 1007-1022. https://doi.org/10.1212/01.CON.0000433286.9 2596.d5 PMid:23917098

[12]. Rooney S, Wood L, Moffat F, Paul L. Prevalence of fatigue and its association with clinical features in progressive and non-progressive forms of Multiple Sclerosis. Mul Scler Relat Disord. 2019; 28: 276-282. https://doi.org/10.1016/j.msard.2019.01.011 PMid:30639830

[13]. Sangelaji B, Kordi M, Banihashemi F, Nabavi SM, Khodadadeh S, Dastoorpoor M. A combined exercise model for improving muscle strength, balance, walking distance, and motor agility in multiple sclerosis patients: A randomized clinical trial. Iran J Neurol. 2016; 15: 111-20.

[14]. Williams AE, Vietri JT, Isherwood G, Flor A. Symptoms and association with health outcomes in relapsing-remitting multiple sclerosis: results of a US patient survey. Mult Scler Int. 2014; 2014: 203183. https://doi.org/10.1155/2014/203183 PMid:25328704 PMCid:PMC4189937

[15].Van Asch P. Impact of Mobility Impairment in Multiple Sclerosis 2 - Patients Perspectives European Neurological Review. 2011; 6: 115-20. https://doi.org/10.17925/ENR.2011.06.02.115

[16]. Kurtzke JF. Rating neurologic impairment in multiple sclerosis: An expanded disability status scale (EDSS). Neurology. 1983; 33: 1444-5. https://doi.org/10.1212/WNL.33.11.1444 PMid:6685237

[17]. Bohannon RW, Smith MB. Interrater Reliability of a Modified Ashworth Scale of Muscle Spasticity. Physical Therapy. 1987; 67: 206-207. https://doi.org/10.1093/ptj/67.2.206 PMid:3809245

[18]. Moller AB, Bibby BM, Skjerbaek AG, Jensen E, Sorensen H, Stenager E, Dalgas U. Validity and variability of the 5-repetition sit-to-stand test in patients with multiple sclerosis. Disabil Rehabil. 2012; 34: 2251-8. https://doi.org/10.3109/09638288.2012.683479 PMid:22612360

[19]. Bohannon RW, Shove ME, Barreca SR, Masters LM, Sigouin CS. Five-repetition sit-to-stand test performance by community-dwelling adults: A preliminary investigation of times, determinants, and relationship with self-reported physical performance. Isokinetics and Exercise Science. 2007; 15: 77-81. https://doi.org/10.3233/IES-2007-0253

[20]. Pavan K, Schmidt K; Marangoni B; Mendes MF; Tilbery CP; Lianza S. Esclerose múltipla: adaptação transcultural e validação da escala modificada de impacto de fadiga. Arq Neuro-Psiquiatr. 2007; 65: 669-673.https://doi.org/10.1590/S0004-282X2007000400024 PMid:17876412

[21]. Filho HA, Carvalho SRS, Dias RM, Alvarenga RMP. Principais testes utilizados na avaliação de fadiga na esclerose múltipla. Revisão Sistemática. Rev Bras Neurol. 2010; 46: 37-43.

[22]. Henze T, Mackensen SV, Lehrieder G, Zetti UK, Pfiffner C, Flachenecker P. Linguistic and psychometric validation of the MSSS-88 questionnaire for patients with multiple sclerosis and spasticity in Germany. Health and Quality of Life Outcomes. 2014; 12: 327-345. https://doi.org/10.1186/s12955-014-0119-y PMid:25080934 PMCid:PMC4148533

[23]. Arroyo R, Massana M, Vila C. Correlation between spasticity and quality of life in patients with multiple sclerosis: the CANDLE study. Int J Neurosci. 2013; 123: 850-858. https://doi.org/10.3109/00207454.2013.812084 PMid:23819835.

[24]. Oreja-Guevara C, Gonzalez-Segura D, Vila C. Spasticity in multiple sclerosis: results of a patient survey. Int J Neurosci. 2013; 123: 400-408. https://doi.org/10.3109/00207454.2012.762364 PMid:23297730

[25]. Bowser B, O'Rourke S, Brown CN, White L, Simpson KJ. Sit-to-stand biomechanics of individuals with multiple sclerosis. Clin Biomech. 2015; 30: 788-794. https://doi.org/10.1016/j.clinbiomech.2015.06.012 PMid:26144661

[26]. Hoang PD, Gandevia SC, Herbert RD. Prevalence of joint contractures and muscle weakness in people with multiple sclerosis. Disabil Rehabil. 2014; 36: 1588-93. https://doi.org/10.3109/09638288.2013.854841 PMid:24236496

[27]. Téllez N, Río J, Tintoré M, Nos C, Galán I, Montalban X. Does the Modified Fatigue Impact Scale offer a more comprehensive assessment of fatigue in MS? Mult Scler. 2005; 11: 198-202. https://doi.org/10.1191/1352458505ms1148oa PMid:15794395

[28]. Amtmann D, Bamer AM, Noonan V, Lang N, Kim J, Cook KF. Comparison of the psychometric properties of two fatigue scales in multiple sclerosis. Rehabil Psychol. 2012; 52: 159-166. https://doi.org/10.1037/a0027890 PMid:22686554 PMCid:PMC3422656

[29]. Fiest KM, Fisk JD, Patten SB, Tremlett H, Wolfson C, Warren S, McKay KA, Berrigan LI, Ann Marrie R. Fatigue and Comorbidities in Multiple Sclerosis. Int J MS Care. 2016; 18: 96-104. https://doi.org/10.7224/1537-2073.2015-070 PMid:27134583 PMCid:PMC4849402

[30]. Chalah MA, Kauv P, Créange A, Hodel J, Lefaucheur JP, Ayache SS. Neurophysiological, radiological and neuropsychological evaluation of fatigue in multiple sclerosis. Multiple Sclerosis and Related Disorders. 2019; 28: 145-152. https://doi.org/10.1016/j.msard.2018.12.029 PMid:30594815

[31]. Sosnoff J, Gappmaier E, Frame A, Motl RW. Influence of Spasticity on Mobility and Balance in Persons with Multiple Sclerosis. JNPT. 2011; 35: 129-132. https://doi.org/10.1097/NPT.0b013e31822a8c40 PMid:21934374

[32]. Wagner JM, Kremer TR, Van Dillen LR, Naismith RT. Plantarflexor weakness negatively impacts walking in persons with multiple sclerosis more than plantarflexor spasticity. Arch Phys Med Rehabil. 2014; 95: 1358-65. https://doi.org/10.1016/j.apmr.2014.01.030 PMid:24582617 PMCid:PMC4152915

[33]. Karpatkin H, Babyar S, DiCarrado S, McDarby M, Narovlianski M, Perez B, Rimawi I. Increases in fatigue do not change spasticity scores in persons with multiple sclerosis. Neurodegener Dis Manag. 2018; 8: 143-150.
https://doi.org/10.2217/nmt-2017-0049
PMid:29943692

[34]. Valet M, Lejeune T, Yumiko G. et al. Fatigue and physical fitness of mildly disabled persons with multiple sclerosis: a cross-sectional study. Int J Rehabil Res. 2017; 00: 1-7.
https://doi.org/10.1097/MRR.0000000000000238
PMid:28658030

[35]. Patejdl R, Zettl UK. Spasticity in multiple sclerosis: Contribution of inflammation, autoimmune mediated neuronal damage and therapeutic interventions. Autoimmun Rev. 2017; 16: 925-936.
https://doi.org/10.1016/j.autrev.2017.07.004
PMid:28698092

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