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RESEARCH ARTICLE

Correlation of Lower Limb Muscle Strength with Functional Mobility and Quality of Life in Patients with Multiple Sclerosis

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There are no conflicts of interest for this study.

ABSTRACT

Introduction: Multiple sclerosis (MS) generates physical deficits such as muscle weakness of the lower limbs and reduced functional mobility, thus presenting a decline in the patients' quality of life.

Objective: Correlate the muscle strength of lower limbs with functional mobility and quality of life in patients with multiple sclerosis.

Methodology: Correlational, ex post facto retrospective study. Data from 49 patients with multiple sclerosis were used, chosen from an existing database of the Neurofunctional Physiotherapy Outpatient Clinic of the Hospital de Clínicas de Porto Alegre. The tests analyzed for the study were: The 5-repetition sit-to-stand (STS) test (5STS - lower limb muscle strength) and Timed up And Go (TUG - functional mobility), in addition to the Multiple Sclerosis Impact Scale (MSIS-29 - quality of life) in individuals with MS.

Results: The average time that patients performed the 5STS was 15.39 (± 8.65) seconds. In the TUG, the average was 11.50 (± 8.40) seconds. Regarding the MSIS-29 scale, the percentage in the physical domain was 37.83% (± 25.10%) and in the psychological domain 45.18% (± 28.92%). A positive correlation was found between the time to perform the 5STS test and the time to perform the TUG (r=,566 p<,000). A positive correlation was also found between 5STS and the physical domain of MSIS-29 (r=,351 p<,0014).

Conclusion: The greater the muscular strength of the lower limbs, the greater the functional mobility and the quality of life in the physical environment of these patients.

Keywords: Multiple Sclerosis, Lower Extremity, Muscle Strength, Mobility Limitation, Quality of Life, Physical Therapy Specialty.

Introduction

Multiple sclerosis (MS) is an autoimmune, inflammatory, chronic, and progressive disease that affects the central nervous system by destroying myelin and axons to varying degrees[1, 2]. It is the most common chronic non-traumatic neurological disease in young adults[3]. Results in motor, cognitive, and neuropsychiatric symptoms that can occur independently of each other[4].

The main deficits found in these patients are muscle weakness, sensory disturbance, monocular visual loss (optic neuritis), double vision (diplopia), gait instability, and ataxia[5]. In addition to physical symptoms, MS patients also have mental and emotional disabilities such as depression and distress[6].

In multiple sclerosis, lower limb muscle weakness causes loss of mobility and function of the limbs, alters posture, and generates abnormal stress on many of the structures essential for ambulation[7]. The 5-repetition sit-to-stand (5STS) test is a method to assess lower limb muscle strength[8]. According to Moller et al. (2012)[9], this is a valid measure to test lower limb muscle strength in MS patients.

Because they present a reduction in physical activity, patients with multiple sclerosis have an impairment in functional mobility, especially walking, thus influencing the independence of these patients[10, 11]. The alteration in functional mobility can be defined as an impairment in deambulation. Changes in functional mobility are one of the most common and disabling consequences of MS[12]. To assess functional mobility, the clinical test used is the Timed Up and Go (TUG)[13]. Sebastião et al. (2016)[14], cite the TUG test as a valid measure of functional mobility in clinical and research practice in people with MS. In a study of 436 people with MS it was shown that 45% of those with MS reported mobility difficulties within one month of diagnosis and 93% after 10 years[15].

In patients with MS, functional mobility alterations can interfere with participation, activities of daily living, employment, and quality of life[16, 17]. According to Sailer and colleagues (2019)[18], these aspects collaborate to MS being considered the most common cause of disability in young adults.

According to Astudilla and collaborators (2011)[19], multiple sclerosis patients have difficulties in performing their activities of daily living, thus causing a negative impact on their quality of life. Because they present these difficulties, the social support offered to patients is much lower. As a result, they end up feeling useless, resigned, helpless, and with low self-esteem, potentiating the worsening of their quality of life[20].

The World Health Organization (WHO, 1995), cite that to quality of life can be understood as an individual's perception of his or her place in life, in the context of the culture and value systems in which he or she lives, and in relation to his or her goals, expectations, standards, and concerns. It involves spiritual, physical, mental, psychological, and emotional well-being, as well as social relationships, such as family and friends, and also health, education, housing, sanitation, and other life circumstances[21].

The Multiple Sclerosis Impact Scale-29 (MSIS-29), already translated and validated into Portuguese, is used to assess the quality of life in MS patients[22]. Research on quality of life in MS is important because it has the potential to identify and contribute to the main factors that can improve or worsen the quality of life in these patients[20].

One of the main deficits of patients with multiple sclerosis is muscle weakness, which causes impairment in functional mobility, limiting the ability to walk and leading to a poorer quality of life. The objective of this study was to characterize the patients' lower limb muscle strength through the 5STS, functional mobility through the TUG, and quality of life through the MSIS-29, and to identify if there was a correlation between lower limb muscle strength with functional mobility and quality of life in patients with multiple sclerosis, in order to identify how much lower limb muscle weakness is able to influence functional mobility and quality of life of these patients. From these data, rehabilitation professionals will be able to identify the main deficits in muscle strength, functional mobility, and quality of life presented by these patients and establish the appropriate treatment.

Methods

This is a correlational, retrospective ex post facto study. It was approved by the Ethics Committee of the Institute of Cardiology/University Foundation of Cardiology (CEP IC/IFUC) under number CAAE 31426920.8.0000.5333.

The study was conducted from a database of patients diagnosed with Multiple Sclerosis. Patients evaluated and followed-up at the Neurofunctional Physiotherapy in Multiple Sclerosis Outpatient Clinic of the Hospital de Clínicas de Porto Alegre (HCPA), which is linked to the Neuroimmunology Outpatient Clinic of HCPA. The database is under the responsibility of the coordinating professor of the Outpatient Clinic, who signed the Term of Agreement for Data Use, thus authorizing the use of the information necessary to complete the study.

Patients who were evaluated from August 2015 to August 2019 and had complete assessment

of muscle strength, functional mobility, and quality of life tests and had a rating of 6.5 or less on the Expanded Disability Status Scale (EDSS) were included.

Patient information such as the type of MS and time of diagnosis were obtained through anamnesis. Patients were evaluated using the 5-repetition sit-to-stand (5STS) test to measure lower limb muscle strength[8]. The Timed Up and Go (TUG) was also used to assess functional mobility[13]. The quality of life of patients was assessed by the Multiple Sclerosis Impact Scale-29 (MSIS-29). It is a self-report measure with a physical scale and a psychological scale [22].

The normality value of the 5STS test, according to Bohannon et al. (2007)[23], was 7.6s, i.e., if the time to perform the 5STS test was equal to or longer than 7.6 seconds, the result would indicate that the patient had lower limb weakness. For the TUG, the normality data were based on Podsiadlo; Richardson (1991)[13], which indicated that results between 11s and 20s are considered normal for people with disabilities; between 20s and 29s there is impairment of balance, gait speed and functional capacity; and results above 30s are predictive of falls. For the MSIS-29, the answers are divided between the physical and the psychological domains. After that, a conversion was made in percentage for each domain, and the closer to 100%, the more negative influence MS has on the quality of life of these patients[22].

The data was analyzed through descriptive analysis (mean and standard deviation) and inferential analysis of the data by the Kolmogorov-Smirnov and Shapiro-Wilk normality tests. To verify the correlation of muscle strength with functional mobility and quality of life, Pearson's Correlation Test was used. The significance level adopted was $p < 0.05$.

Results

The data of 49 subjects of both sexes were analyzed, 30 females (61.2%) and 19 males (38.8%). The mean age of the patients was 42.6 (±12.6) years. Most of the patients had relapsing-remitting type multiple sclerosis (95.9%) and 7.1 (±5.7) years in mean time of diagnosis.

As for disease progression, patients had a mean EDSS of 3.3 (± 1.9), which characterized them as having moderate disability but walking fully. In relation to the degree of functional independence the patients were classified as independent through the Barthel index with a mean of 97.2 (± 4.4) (Table 1).

The average time that the patients performed the 5STS was 15.39 (±8.65) seconds. This result shows that, on average, the patients had muscle strength deficit in the lower limbs. As for the TUG, the average was 11.50 (±8.40) seconds, which indicates a preserved functional mobility.

Table 1. Descriptive characterization of the sample

Variables	n / Mean	Standart Deviation
Gender (Female %/Male %)	30 (61,2%) / 19 (38,8%)	
Age (years)	42,6	± 12,6
Type of MS (RR %/PP %)	47 (95,9%) / 2 (4,1%)	
Time of diagnosis (years)	7,1	± 5,7
EDSS (mean/mode)	3,3/2,0	± 1,9
Barthel Index (points)	97,2	± 4,4

Legend: RR- Relapsing-remitting; PP: primarily progressive.

The time patients performed the 5STS showed moderate positive correlation (r=.566 p<.000) with the time they performed the TUG. This finding shows that lower limb strength correlates positively with functional mobility. The greater the lower limbs muscle strength, the greater the functional mobility of the MS patient (Table 2, Figure 1).

Table 2. Correlations between strength, functional mobility and quality of life

		Functional Mobility	Quality of Life (physical domain)	Quality of Life (psychological domain)
Lower Limb Muscle Strength	r	,566	,351	0,072
	p	,000	,0014	0,0623

Legend: Pearson's Correlation Test. The significance level adopted was $p < 0.05$.

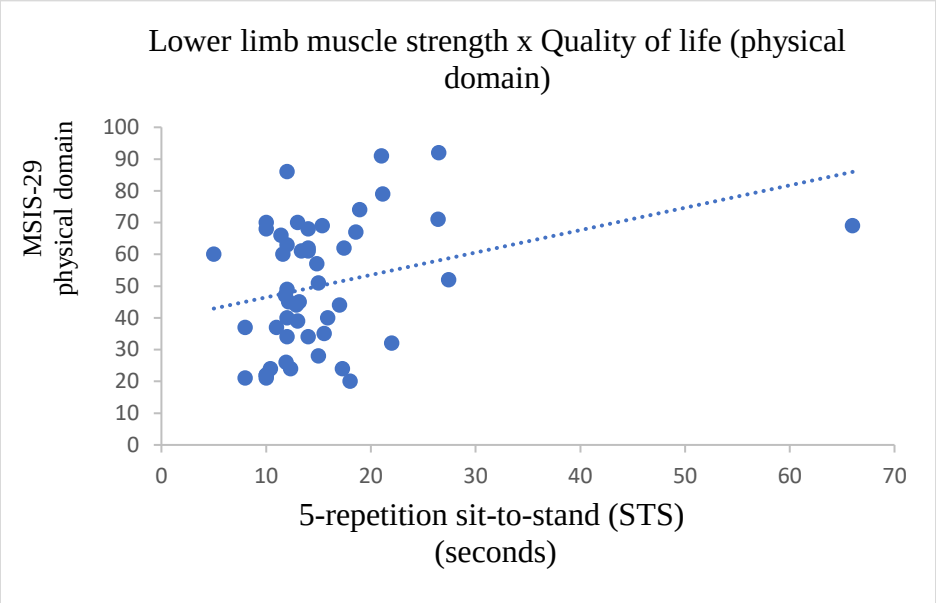

Figure 1. Correlation between lower limb muscle strength and functional mobility

Regarding the MSIS-29 scale, the percentage of the mean in the physical domain was 37.83% (±25.10%) and in the psychological domain was 45.18% (±28.92%), showing that for these patients MS is affecting the psychological and physical domains in a similar way, with greater influence of the psychological domain on the quality of life of patients with MS.

Lower limb muscle strength correlated positively with the physical domain of quality of life in the MSIS-29 (r=.351 p<.0014) (Table 2, Figure 2). It is possible to say that the greater the lower limb strength in these patients, the better the perception of their quality of life regarding the aspects involving the physical domain, characterizing that the physical aspects interfere in the quality of life of MS patients. Lower limb muscle strength did not correlate with the psychological domain of quality of life in the MSIS-29.

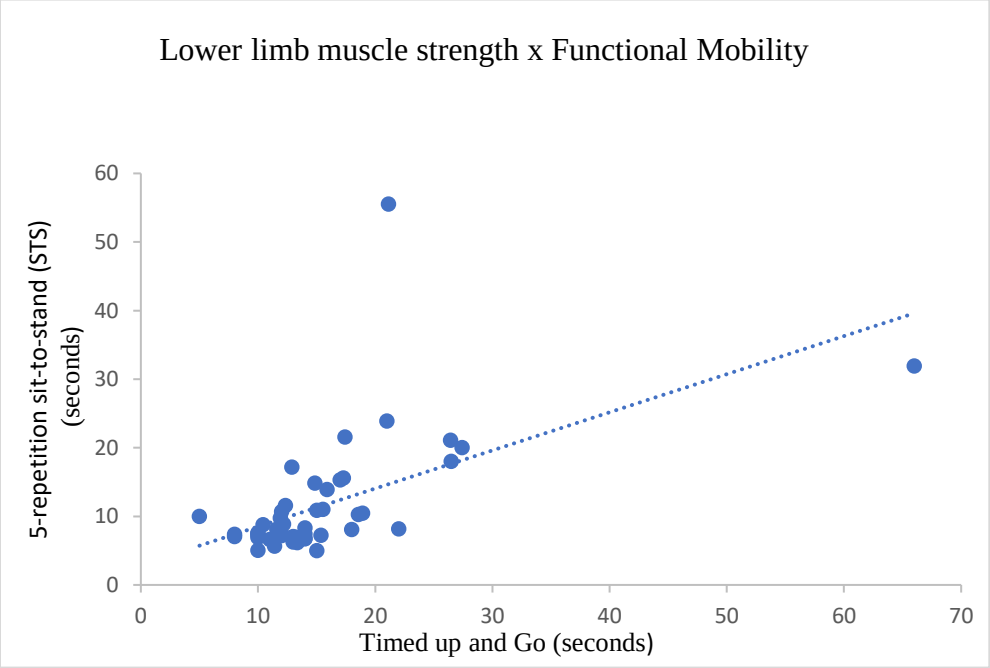

Figure 2. Correlation between lower limb muscle strength and the physical domain of quality of life.

Discussion

Multiple sclerosis (MS) is an inflammatory and neurodegenerative disease whose etiology is still not fully understood. In MS the female gender is clearly predominant, with a sex ratio of 2 to 3 compared to males[24]. In our sample, the majority of participants were female (female-to-male ratio of 1.63:1) and classified with relapsing-remitting MS. These data are in line with the study by Negreiros and collaborators (2015)[25], who found that there is a higher proportion among females compared to males and the most common form of the disease was also the relapsing-remitting Brazilian patients. The reason for this proportion is not clear, despite the observation that women are generally more susceptible to autoimmune diseases, and that this predisposition may therefore be related to hormones[26].

Most of the patients studied were young adult women with minimal disability caused by the disease. The time of diagnosis for the discovery of MS was close to 35 years of age. These results are very similar to the study by Kaufmann and colleagues (2018)[27], who in a sample of 996 people with MS found that the mean age for the time of diagnosis was 38 years. Also in that study, it was found that 75% of cases had a time to diagnosis of less than 5 years. A much higher percentage compared to our study, which showed only 42.85% in the sample with diagnosis time less than 5 years.

In our study, patients with Multiple Sclerosis were found to have lower limb weakness. Bohannon et al. (2007)[23] conducted a study in which he indicated that scores above 7.6s on the 5STS predict lower limb weakness. In many studies, the 5STS is the clinical instrument of choice to assess lower limb strength and has been used because it provides a good insight into the functional strength of patients[28]. Its application has been tested and has good applicability in individuals with neurological diseases, including those with multiple sclerosis[9, 29].

The average time to perform the 5STS by the patients studied was 15.39s (±8.65), demonstrating, therefore, altered muscle strength in the lower limbs. This result is similar to the study by Kjolhede and collaborators (2015)[30] who found that patients with MS also have weakness in the lower limbs and presented an average of 9.48 seconds (±2.70) to perform the 5STS. The average age of the patients in the cited study was 43.3 (±8.2), which is similar to the average age of the participants in our study.

In MS patients, the main muscle strength deficits are found in the lower limbs[31]. This characteristic is very important, because the alteration in lower limb strength in these patients negatively influences the performance of walking, balance and the ability to go up and down stairs[30]. Because of this, patients reduce their level of physical activity and thus potentially increase the risk of mortality from causes related to cardiovascular diseases, metabolic syndromes and osteoporosis[32].

Through a systematic review by Jorgensen et al. (2017)[31] it was found that MS patients had impaired muscle strength, power, and rate of strength development when compared to the control group of the studies in this review. These characteristics generate a negative impact on the independence of these patients. According to Hansen et al. (2014)[33], there is an inverse relationship between lower limb muscle strength and level of disability, i.e., the lower the strength, the higher the level of disability of the patients.

Mãnago and colleagues (2018)[34] investigated the association that the lower limbs and trunk have on gait in patients who had mild and moderate MS. They found that the main predictors of gait were the plantar flexors, knee flexors, hip abductors, and trunk flexors, showing that a weakness in these muscle groups can hinder ambulation. In a systematic review by Ramari and collaborators (2020)[35], it was found that the weaker lower limb has the power to influence 20% to 30% of the performance in functional capacity tests (gait, dynamic balance, sitting and standing up), thus showing that MS patients may present performance alterations due to an asymmetry of strength between the limbs.

Guner; Inanici (2015)[36] identified that MS patients present weakness in the lower limbs. In addition, these authors found a positive correlation between lower limb muscle strength with gait speed, step length, and knee joint amplitude. For these authors, the greater the lower limb muscle strength, the greater the gait speed.

Altered mobility is one of the most common and impactful consequences in MS patients. People with MS report difficulties in walking and mobility12. In the study by LaRocca (2011)[37], it was observed that 41% of patients reported this difficulty, and of these, 70% said that walking was the most challenging aspect for them. Heesen et al. (2008)[38], report that walking was the most important and impactful evaluated body function in these patients. People with MS report difficulties in their ambulation and mobility. This mobility alteration has a very negative impact on the lives of these patients, as it directly affects their activity, participation, and quality of life[39].

The patients evaluated for this study presented preserved functional mobility, with average values considered within normality in people with disability, according to the parameters of Podsiadlo; Richardson (1991)[13]. For Wamser and collaborators (2015)[40], this result indicates that the patients presented a good musculoskeletal performance and a positive functional capacity to exercise.

In our sample, the EDSS of the patients was 3.3 with mode 2. The EDSS is an assessment scale administered to evaluate the functional systems of the central nervous system and describe the progression of the disease in patients with MS[41]. According to Kurtzke (1983)[42], creator of the EDSS, for patients to present impaired ambulation and require the use of a walking device, the EDSS classification would need to be at least 6 points. In this study, the patients presented minimal disability and improved walking ability, thus justifying the possible result found in relation to functional mobility.

Another hypothesis that may explain the result in the functional mobility of these individuals is the average presented by them in the Barthel Index (BI). The BI is a questionnaire that evaluates the functional independence in relation to personal care, mobility, locomotion, besides excretion (feces and urine). In the original version, each item is scored on the patient's ability to perform these activities independently. The overall score can range from 0 to 100. The higher the score, the greater the independence of these patients[43]. In our sample, the patients' mean score on the BI was 97.2 (± 4.4), showing independence on the part of the patients.

People with MS usually have physical and cognitive impairment. These symptoms progress over time and can be the main determinants of the quality of life of these people[44]. In the study conducted by Algahtani and collaborators (2017)[45], 292 MS patients were evaluated, and mobility, usual activities, self-care, pain/discomfort, anxiety/depression were correlated with the quality of life of these patients. Important results were found, in which 72.9% of the patients reported some degree of mobility restriction; 68.2% showed problems in usual activities of daily living; 60.3% presented obstacles in self-care; 71.9% reported pain and discomfort and 73.6% of the patients presented anxiety and depression disorders.

In this study, from the results of the MSIS-29 questionnaire, which is a scale of physical and psychological impact perceived in MS, the patients demonstrated that MS affects the psychological domain more than the physical domain. This result is similar to the study conducted by Sander; Kugler; Elsner (2020)[46] who found that the main symptoms that interfere with the quality of life of MS patients are the so-called "hidden symptoms," such as depression, pain, and cognitive deficit, in addition to the change in mobility that also appears as an influencing symptom.

In MS, mood disorders and especially depression are symptoms that appear in more than half of the patients. This symptom is more frequent than in a population of the same age with other types of disease[47]. Its etiology is probably due to multifactorial factors, which include biological, psychological, and social determinants[48]. Another unfavorable aspect that can aggravate psychopathological symptoms in MS is that the disease begins in early adulthood, an important time, when affective, professional, and family life are beginning. This situation ends up leading to an emotional imbalance, generating loss of self-esteem associated with the fear that occupies this person as a member of the family and society[49].

Lower limb muscle strength correlated with the physical domain of quality of life, demonstrating that increased muscle strength improves physical issues related to quality of life. In the study by Zaenker et al. (2018)[50], lower limb resistance training (quadriceps and hamstrings) was found to significantly improve the physical domain of quality of life in these patients. Whereas, the study by Kierkegaard et al. (2016)[51] found that lower limb resistance training has the power to significantly improve only the psychological domain of the MSIS-29. There are still different results in the literature, for this reason more study is needed in addressing this issue.

When analyzing the results found in this study, it can be said that work to maintain or gain lower limb muscle strength in MS is important. The alteration in lower limb strength in these patients interferes with functional mobility, and can directly influence the performance of activities related to changing the body's position or place, when walking or running. The ability to perform these activities allows the individual to be independent in his activities of daily living. Thus, this influence of altered lower limb muscle strength on functional mobility impacts the quality of life of these patients. Therefore, it is fundamental that in a physiotherapy treatment protocol for MS patients the muscular strengthening of the lower limbs be one of the objectives. Strength training through resistance exercises and associated with the training of activities that involve the mobility of these patients such as walking, sitting and standing up, and

climbing up and down stairs are fundamental as conducts to be performed.

There used to be a belief that physical exertion aggravated symptoms of MS, and physical therapists and people with MS were encouraged to limit physical activity and exertion. It is now suggested that physical activity, including resistance exercises for strength training, is safe for people with MS and that some of the disability that occurs after the disease is due to lack of activity and deconditioning secondary to MS[52].

For a long time, physical therapy in MS patients was limited to stretching and active exercises without resistance, because there was an understanding among health professionals that strength exercises with load could overload these patients, bringing more disability. Thus, it is fundamental for the physical therapist to understand that patients with MS can perform resistance exercises associated with mobility activity training to avoid deconditioning due to the sedentary style of these patients and thus maintain their quality of life. More studies that address the importance of muscle strengthening work in MS are necessary to enable the understanding that an exercise program that involves muscle strengthening improves functional mobility and quality of life in people with MS.

Conclusion

This study identified that MS patients had lower limb weakness, preserved functional mobility, and that MS influenced psychological rather than physical quality of life issues. Lower limb strength correlated with functional mobility. Patients who have greater lower limb muscle strength have greater functional mobility and better quality of life in the aspects that involve the physical domain.

The data obtained in this study shows the importance of knowing how these variables correlate to better support the physiotherapeutic practice in patients with Multiple Sclerosis.

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