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Research paper

The Effect of Resistance and Cognitive-Motor Training on Motor Function and Fatigue in Women with Multiple Sclerosis[1]

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Abstract

In multiple sclerosis, common problems such as early fatigue, poor performance, balance and postural control reduce the chance of success in daily activities. Therefore, the present study intends to compare and evaluate the effects of two methods of resistance and cognitive-motor training on motor function and fatigue in women with multiple sclerosis. Thirty-three women with multiple sclerosis with disability index 0 to 4 were divided into three groups of resistance training, cognitive-motor, and control (11 people in per group). The exercises consisted of 16-sessions that lasted 45 to 60 minutes each session. Fatigue severity scale was used to measure fatigue, and 25-foot (8 m) walking test kinematically was used to measure motor function. One-way analysis of variance, paired t-test and multivariate analysis of covariance were applied to analyze the data. The results showed that in the resistance training group, the research intervention caused significant changes in the improvement of fatigue (Sig. = 0.005, Effect size = 0.79), but no significant improvement was observed in walking performance. In addition, in the cognitive motor training group, significant changes were observed in both variables of walking performance and fatigue index. Therefore, it

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seems that cognitive-motor training has a greater effect on walking performance and fatigue in women with multiple sclerosis.

Keywords: Cognitive-Motor Training, Multiple Sclerosis, Postural Control, Walking, Fatigue

Introduction

Multiple sclerosis (MS) is a central nervous system neurodegenerative disease characterized by multifocal inflammation, demyelination, oligodendrocyte loss, and axonal degeneration (Seyman, Jones, Guenette, Vosoughi, Selchen & Amezcua, 2020). Nerve damage caused by this disease leads to several motor and cognitive deficits and results in progressive disability. Therefore, it has a negative effect on the quality of life of people with MS (Matveeva, Bogie, Hendriks, Linker, Haghikia & Kleinewietfeld, 2018). In this regard, approximately 80% of patients with inflammatory bowel disease experience some degree of movement disorder that reduces their ability to provide financial and physical support (Dalgas, Langeskov-Christensen, Stenager & Riemenschneider, 2019). Treatment of MS requires some significant socio-economic considerations that results from direct and indirect factors (Maggio, Russo, Cuzzola, Destro, La Rosa & Molonia, 2019). Among the symptoms of this disease, core balance and stability disorders (Storm, Nair, Clarke, Van der Meulen & Mazzà, 2018), muscle weakness mainly in the lower extremities (van den Akker, Beckerman, Collette, Twisk, Bleijenberg & Dekke, 2017) and fatigue are very important because they seem to play a prominent role in patients' loss of function (Tarakci, Yeldan, Huseyinsinoglu, Zenginler & Eraksoy, 2013). According to this notion, treatment programs should aim to improve the deficiencies that have the greatest impact on the progression of patients' disabilities.

Sadeghzadeh et al. (2019) conducted a research titled comparing six weeks of walking training in different water and water-land environments on improving fatigue, balance and walking speed in women with MS in Kerman city. The result showed that walking exercises have caused significant changes in improving fatigue and balance of patients in the groups of water exercise and water-dry exercise, but no significant changes have been observed in walking speed. The findings of Qitasi et al. (2019) revealed that 6 weeks of water massage had a significant effect on walking speed, posture control (static and dynamic balance), pain intensity, fatigue and quality of life of women with multiple sclerosis. Qanbarzadeh and Balavi (2020) in a study entitled the effect of resistance exercises with different intensities on airway resistance indicators and muscle fatigue and endurance in women with multiple sclerosis concluded that resistance training improved balance, fatigue, and muscle endurance in the research groups. Cruz et al. (2020) in a study titled the effect of a combined strength and cognitive-motor program in multiple sclerosis patients showed that people with MS who participated in the combined training program for 24 weeks improved their balance variables, speed of force growth, and static muscle strength compared to the control group, and the training of the combined program can improve the performance of MS people in daily activities such as walking, standing or sitting.

Understanding how to reduce physical discomfort and fatigue during the disease process, is an essential factor (Kalron, Menascu, Dolev & Givon, 2017). The progression of disability in MS is usually marked by an increase in the Extensive Disability Status Scale (EDSS), and little is known about the extent to which any particular disability develops over the course of the disease. Therefore, as a first step, analyzing how all these parameters differ among different groups of patients can provide useful information for optimizing rehabilitation programs according to the stage of each patient's disease (Seyman et al, 2020). Another element to improve our understanding of which disabilities should be prioritized in a rehabilitation program is to analyze their relative contribution to specific parameters related to the degree of disability. For example, MS patients reported walking (Henning, Edwards, Ansara & Fritz, 2021) and movement disorders (Barbarulo, Lus, Signoriello, Trojano, Grossi & Esposito, 2018) as two of the most debilitating symptoms of the disease; because it limits their ability to perform daily living activities (such as walking, getting up from the chair, restricting rotational movements, climbing stairs, etc (Callesen, Cattaneo, Brincks, Kjeldgaard & Dalgas, 2020). Several studies have shown that reduction in lower limb strength, balance (Tarakci et al, 2013) and core stability (Mehta, Young, Lai, Wang, Kim & Thirumalai,2019) is strongly associated with worsening gait speed and functional mobility in MS patients. In MS, the worsening of any physical factor caused by the disease is usually associated with other factors (Tintore ,Vidal-Jordana & Sastre, 2019).

Recently, a new training method called cognitive-motor training has been recommended to improve the performance of MS patients. When a cognitive task is combined with a physical rehabilitation exercise, it is called cognitive-motor interventions (Pagliari, Di Tella, Jonsdottir, Mendozzi, Rovaris & De Icco, 2021). For example, balance training and strength training combined with cognitive training or performing dual task exercises can be recommended. The effect mechanism of these exercises is that the brain will able to make new neural connections and based on a process called neural molding. When two tasks are performed simultaneously, independent actions should not be considered (Pagliari et al., 2021). On the other hand, resistance training is a strong stimulant to increase muscle protein synthesis as well as increase muscle size. Improving nerve conduction, increasing the motor units' recall, endorsing the synchronicity of motor units, and increasing hypertrophy are the basics for improving motor readiness after resistance training (Balavi & Ghanbarzade, 2020).

What causes dysfunction and walking speed is balance disturbance. The ability of the neuromuscular system with the right amount of force to correctly use the muscles to perform functional tasks with the minimum amount of energy and pressure on the human motor system is called performance. In order to improve sensory organization and posture control, reduce fatigue, and improve walking speed performance of people with MS, resistance and cognitive motor exercises can be used because resistance exercises improve nerve conduction and increase the recall of motor units and increase the synchrony of motor units. In addition, cognitive movement exercises are a dual task whose function is based on neural modeling and the brain creates new neuronal connections during cognitive movement exercises.

The high prevalence of falling, tiredness, lack of balance and inability to maintain postural control and decrease the speed of performing daily functions are important motivational factors that lead to the recognition of the factors affecting the occurrence of this injury. The most common complication of MS is fatigue as this sign is one of the most important and major reasons for reducing the quality of life and unemployment in these patients. Since medical diagnosis and treatment conditions nowadays are done with high costs, it prompted the researcher to carry out a series of exercise protocols to investigate preventive measures at a lower cost to improve the performance of MS sufferers. Considering the studies done on MS patients, the researchers were taken into consideration the necessity of conducting this study in which the effect of resistance and motor cognitive exercises on walking performance and fatigue index of women with MS was examined. Therefore, it is necessary to pay attention to resistance and cognitive movement exercises and its role in the coordination of different senses in movement performance and the level of fatigue. Therefore, this study investigated and compared the effect of two methods of resistance and cognitive-motor training on motor function and fatigue in women with multiple sclerosis.

Methodology

The aim of this study was to investigate the effect of an 8-week period of resistance and cognitive-motor training on walking performance and fatigue index among women with multiple sclerosis (MS). Thirty-three patients with MS participated in the study in three groups of resistance training, cognitive-motor training, and control, whose mean height was 160.7, 162.2 and 161.5, respectively. Moreover, their mean weights were 64.1, 63.8 and 64.7, respectively. The range of scores of the subjects on the EDSS scale, which was completed by the Kurtzke Disability Questionnaire by a specialist physician, ranged from 0 to 4.

The present study is a quasi-experimental research using pre-test and post-test.The statistical population of the present study consisted of women with multiple sclerosis in Alborz province and Karaj city. The researcher first referred to the Alborz Province MS Association and announced a research invitation. The samples were selected voluntarily and through the convenience sampling method. They were randomly divided into control and experimental groups. The volunteers were examined by a neurologist. Due to the Covid-19 pandemic, patients were limited to clients of MS association.

In this study, walking performance variables were evaluated by 25-feet walking test and fatigue index by FSS fatigue severity questionnaire. The diagrams related to pre-test and post-test of these variables are shown in the resistance training, cognitive-motor and control groups in figures 1 and 2.

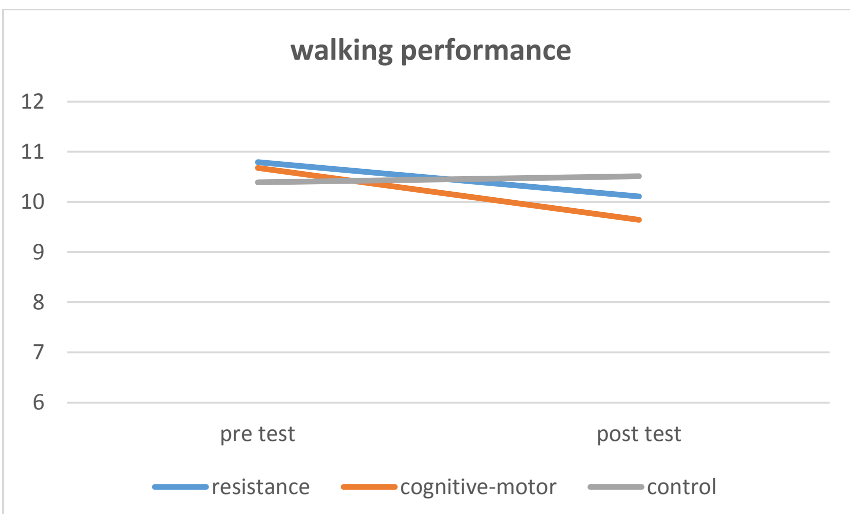

Figure 1 - Comparison of walking performance before and after the research protocol in three groups

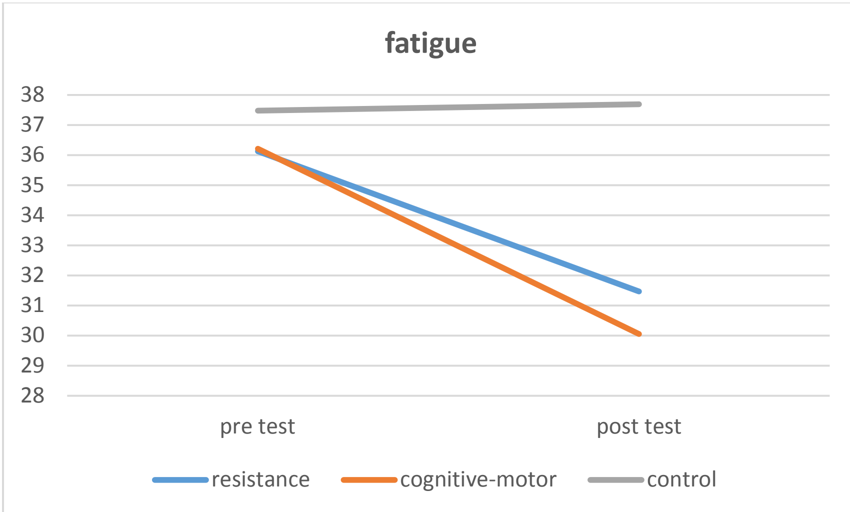

Figure 2 - Comparison of fatigue before and after the research protocol in three groups

The resistance experimental group performed resistance exercises for 8 weeks and 2 non-consecutive sessions every week for 45 minutes. The exercise program in this study was divided into three parts: The first stage was to prepare the body for the main exercise by walking and doing simple stretches for 10 minutes; the second stage of the main program consisted of 25 minutes, which was carried out according to the training protocol such as shoulder abduction, chest press, rowing movement, Swedish swimming, sit-up and stand-up, hip abduction, standing half-squat movement and moving jump movement; and, in the the third stage, they cooled the body for 10 minutes with gentle stretching and relaxing movements. In order to maintain the dynamic intensity during the exercises, the number of repetitions and the cognitive load increased in proportion to the progress of the subjects, and the exercises were planned in three levels. The first level had the least load and repetition, and the second level slightly increased the load and repetition, and the third level was allocated to the most load. The subjects entered the next stage through success in each stage.

Cognitive- motor exercises were performed simultaneously in the cognitive motor group during 8 weeks and 2 non-consecutive sessions each week for a duration of 45 to 60 minutes. This protocol consisted of 10 Functional Gait Assessment (FGA) exercises such as walking on a safe level, stepping on obstacles, walking backwards, walking on stairs, walking and turning 180 degrees. In addition, cognitive task exercises including counting backwards, multiplying and dividing numbers, counting the months of the year, and counting coins simultaneously with facial movement exercises.

To maintain the health of the participants in all stages of the research, the subjects used masks and kept social distance. They used mats, napkins and personal items as well as hand washing before and after exercises. As mentioned earlier, the participants voluntarily participated in this study and all of them were in the age range of 30 to 60 years, and their degree of disability was equal to or less than 4 on the Kurtzke scale. None of the subjects had diseases other than MS such as heart, respiratory and infectious problems. The subjects' mental states, including excitement and anxiety, could not be controlled before and during the exercises, but the researcher tried to minimize the disturbing factors by providing equal conditions for all in a calm environment with positive and inspiring sentences. Paired t-test and one-way analysis of variance (one-way ANOVA) were used to clear the difference between groups. Tukey post hoc test was used in case a significant difference was seen between the groups. All statistical calculations with a significance coefficient of $P < 0.05$ was done by SPSS software version 25.

Results

The results showed that in all variables, the regression slope was respected (motor function = 0.81 and fatigue = 0.10). Furthermore, the results of Leven's test showed that the variances were equal in all variables and no error was made in assuming the equality of variances in the desired variables (motor function = 0.62 and fatigue = 0.22). Based on the box test, considering the significance level greater than 0.001, it can be stated that the assumption of homogeneity of variance-covariance matrix was met. In the resistance training group, there was no significant difference between the walking performance before and after the intervention (p= 0.056), but the fatigue index before and after the intervention was significantly changed (p= 0.005). However, in the cognitive-motor training group, a significant difference was observed between walking performance (p= 0.012) and fatigue(p= 0.001) before and after the research period. Therefore, eight weeks of cognitive-motor training has been effective in improving all of research factors in women with MS. The result is showen in table 1.

Table 1 - Results of t-test for walking performance and fatigue index in resistance and cognitive-motor training groups

Group	Variable	t test	Mean difference	df	sig	Effect size (cohens D)
Resistance training	Walking performance	1.046	0.68	10	0.056	0.45
	Fatigue	2.135	0.34	10	0.005	0.79
Cognitive motor training	Walking performance	2.718	1.04	10	0.002	0.67
	Fatigue	3.628	6.16	10	0.001	0.89

Then, multivariate analysis of covariance (considering the pretest result as a covariate variable) was used to extract the covariance effect of the pretest result on the comparison results of walking performance and fatigue of women with MS (Table 2 & 3).

Table 2 - Results of analysis of covariance to examine the walking performance variable

Variable	Source of difference	Sum of squares	df	Mean of squares	F	P value	Eta squared (η^2)
Walking performance	Pre test	49.75	1	49.75	112.62	0.00*	0.59
	group	10.146	3	5.278	7.79	0.01*	0.41
	error	12.98	23	0.792	-	-	-

Table 3 - Results of analysis of covariance to examine the fatigue index variable

Variable	Source of difference	Sum of squares	df	Mean of squares	F	P value	Eta squared (η^2)
fatigue	Pre test	32.86	1	32.86	69.78	0.00*	0.61
	group	8.953	3	3.824	6.34	0.02*	0.45
	error	13.24	23	0.648	-	-	-

According to the results of analysis of covariance, there was a significant difference between the mean of post-tests in walking performance and fatigue index between the three groups (resistance training, cognitive motor and control) (p=0.00), Therefore, Tukey's post hoc test was used to determine the difference between 3 groups. The results of Tukey post hoc test showed that the cognitive group experienced more effects on motor function and fatigue than the resistance and control groups.

Discussion

The results of the present study showed that resistance training had no significant effect on walking performance. Tintore et al. (2019) reported that TRX training affects intensity and gait speed in women with multiple sclerosis in the age group of 20 to 40 years. TRX exercises are among balance-strength training methods that are performed with straps mounted on the ceiling and wall (Tintore et al., 2019). Balavi and Ghanbarzadeh (2020) showed that high resistance trainings, improve balance and muscle endurance and has similar effects to moderate-intensity exercises on pulmonary function indices in women with MS (Balavi et al., 2020). The results of Costa et al. (2018) showed that classical progressive resistance training resulted in better transfer of strength adaptations to functional tests that were closer to daily activities (Costa et al., 2018). These findings are not consistent with the results of the present study on walking index; because in present study, resistance training could not significantly improve walking performance. The reason for this inconsistency can be due to the difference in the training protocol, the age group of the subjects, the statistical population and the number of training days.
Moreover, the study's findings revealed that resistance training had significant effect on fatigue index. These findings are consistent with those of Tintore et al. (2019), Balavi and Ghanbarzadeh (2020) and Pagliari et al. (2021), showing that resistance training improves the fatigue index. Based on the findings of the present study, resistance exercises are among the methods that can have an effect on reducing fatigue. One of the possible reasons for this effect is the mobilization of motor units and the call for more movement, which is obtained as a result of resistance training. As the motion call increases, the pressure during daily or occupational activities is divided among more movement units as the person feels less tired.
Based on the findings of the present study, resistance training is one of the methods that can reduce fatigue. One of the possible reasons for this effect is the uniting of motor units and higher motor recall, which is the result of resistance training. In fact, the more the motor call increases, the more pressure is distributed among the number of motor units during daily activities or work so that the person feels less tired. The present study is inconsistent with the results of Kakavand (2017). The results of this study indicate that resistance training has increased Claudin11 levels, which is an important factor in the formation of

the myelin sheath of the nerve fiber. BDNF levels have played an important role in the development, maintenance and repair of the nervous system. Increasing the level of mobility and physical activity, along with reducing fatigue, is directly related to improving functional factors. In this study, it was proved that moderate-intensity resistance training, such as high-intensity resistance training, has been effective. The reason for this discrepancy can be in the amount of differences in training sessions that have been applied to the protocol people for a longer period of time and the difference in samples with a different age range from the present study. Furthermore, the type of protocol applied was different from the present study.

Statistical analysis showed that the cognitive-motor training could significantly improve indicators of motor function and fatigue. The results of the present study is consistent with the results of Barbarulo et al. (2018). That study showed that yoga exercises had a greater effect on the performance of MS subjects than resistance exercises. Dalgas et al. (2020) in a study have shown that modulation of function in brain regions plays an important role in visual function that occurs in the rehabilitation pathway in MS and is associated with clinical improvement. Therefore, according to the alignment of the results of this study with the findings of the present study, brain function can be improved through cognitive exercises and its effect on improving visual function. Therefore, it is predicted that this process is an underlying factor related to improving balance and motor function after cognitive motor exercises. Since there is a direct relationship between improving brain activity and developing the level of balance and neuromuscular coordination, the findings of the present study can be justified based on improving walking performance and reducing fatigue after cognitive-motor exercises. Thus, it seems that the neural basis of these improvements is related to the improvement of nervous system functions after performing cognitive-motor exercises. Based on the study's findings, the cognitive aspect of cognitive-motor exercises was able to help improve balance and, as a result, improve performance in walking test. Moreover, these exercises improved fatigue in women with MS, which is most likely the result of reducing cognitive fatigue or increasing the resistance of these subjects against fatigue.

Conclusion

Sports training reduces the ability dependent on the central nervous system and shows the progress of indicators of postural control and walking performance. Decreasing physical activity causes a decrease in muscle mass and a decrease in a person's performance. Since resistance exercises can help to increase the blood flow to the muscles, it helps to strengthen the muscles. Furthermore, cognitive-motor exercises by involving the cognitive dimension related to motor improve the coordination of the nerve and muscle. According to the results of the present study, it seems that cognitive- motor and resistance exercises can increase the functions of women with MS, which can be seen in the results of walking performance and fatigue tests.It seems that women with MS in the present study, benefited more from resistance exercises to reduce fatigue compared to walking.

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