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Effect of 8-Week Aquatic, Land- based and Combined (Aquatic-Land) Training Programs On Walking Capacity in Women with Multiple Sclerosis (MS): A Burdenko Approach

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ABSTRACT: Multiple sclerosis (MS) is a chronic disease affecting all aspects of life in patients with this disease and causes a wide range of functional problems, including reduced walking capacity. The aim of this study was to compare the effects of 8 weeks aquatic, land-based and combined (aquatic-land) exercise programs according to Burdenko method on the walking capacity measured by 6-Minute Walk Test (6MWT). This was a pre- post design study. Thirty one women diagnosed with MS, age range 30-50 years, EDSS<4.5, and living in Amol, Iran participated in this study. The paired t-test results demonstrated a significant improvement in the walking ability of individuals after aquatic exercises ($t = -2.23$, $\alpha = 0.048$), land-based exercises ($t = -5.31$, $\alpha = 0.001$) and combined exercises ($t = -4.00$, $\alpha = 0.001$) compared to the pretest. The results of covariance test indicated that aquatic, land-based and combined exercise programs had different effects on the walking ability (power = 0.80, P = 0.001, and $F_{30, 2} = 8.98$). Results of LSD post hoc analysis further indicated that the mean 6MWT in the land-based exercise group and combined exercise group was significantly higher than the aquatic exercise group ($p<0.05$), but no significant difference was found in the mean of 6MWT between land-based exercise group and combined exercise group ($p>0.05$). According to the results of this study, the combined and land-based exercises can be suggested for people with MS in order to improve their walking capacity. These methods can be suggested as appropriate non-pharmacologic complementary therapies in the rehabilitation centers.

KEY WORDS: Multiple Sclerosis, Burdenko Method, walking Ability, Aquatic exercise, Land-based exercise, 6 Minute Walk Test.

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INTRODUCTION

Multiple Sclerosis (MS), a chronic progressive disorder of the central nervous system, [1, 2] is an autoimmune disease, whose pivotal mechanism is damage to the body by immune system or impairment of myelin-producing cells [3]. Although the cause of the disease is unclear, its occurrence is highly influenced by genetic and environmental factors, such as infection [4], and is usually diagnosed based on symptoms and medical examination results [5]. Similar to many autoimmune disorders, the disease is more prevalent in women and the global rate of the disease in women is twice as high as in men [6, 7]. The number of MS patients in the world is 2.1 million in 2008 and 2.3 million in 2013, about 30 per 100 000 [8, 9 and 10]. Studies show that the number of people with this disease is on the rise [11, 12]. In Iran, the incidence of the disease has increased in the last three decades. By 1976, only 26 patients had been diagnosed with MS in the country, but now with 70,000 MS patients, Iran has the first rank in the Middle East [12, 13].

The MS disease can impair the ability of some parts of the nervous system and cause many symptoms, including functional problems and reduced daily activity due to fatigue, imbalance, and heat sensation and decreased walking ability [14, 15]. The MS patients complain of difficulty in walking and decrease in daily function. The loss of walking ability due to imbalances, tremor, walking instability, dizziness, body imbalance and weakness is one of the most common problems in these patients. Most people with this disease lose their walking ability prior to death. About 90% of MS patients can walk independently in the first 10 years of the disease, but this statistics is reduced to 75% in the first 15 years of the disease [16, 17]. The MS patients also show less willingness to attend in the community due to walking disability to avoid attracting the attention of others. Due to the young age of MS patients and their presence in the age of social activity, appropriate therapeutic exercises are effective in improving walking ability and increasing their physical capability. Inactivity and failure to participate in physical activity are also a serious risk as it reduces their physical fitness [18, 19].

There is no definitive and well-known treatment for MS. The purpose of using therapies is to manage symptoms, such as restoring body function after a relapse, preventing new attacks, and preventing disability. The pharmacological management of this disease is associated with side effects including false symptoms intensification, mood disorder, flu-like symptoms, and rapid systemic reactions, [20, 21]. The use of non-pharmacological treatments, called complementary therapies, can decelerate the course of MS, reduce the number of attacks and delay the onset of permanent disability [21, 22].

Studies show that aquatic therapy is effective for MS patients and is superior in some factors such as fatigue and quality of life in comparison with land-based exercises [19, 23 and 24]. Meanwhile, several studies have reported significant effects of land-based exercises on patients with the involvement of the central nervous system, including MS [25, 26].

However, the evidence on the priority of aquatic exercise to land-based, especially in mobility, is unclear. The variation in the research design and the measured variables makes it difficult to reach the unanimous outcome in these patients, while the effect of combined aquatic-land exercise on MS patients remains unclear [27].

The key question is whether combined aquatic-land exercise, compared to aquatic or land-based exercises alone, has a greater effect on the improvement of walking function in MS patients. The answer to this question could compare the effects of different exercise environments on patients and suggest the most effective training method.

The Burdenko method (comprehensive land - aquatic therapeutic exercises) has been designed based on the principles of physical fitness and the six essential parameters of everyday life and sport including balance, coordination, flexibility, endurance, speed and strength [28].

The Burdenko method exercises cover the whole body, including the mind and improve the daily function of individuals. This individual based method, includes-three aspects: rehabilitation, conditioning and training. The movements are performed bilaterally in the organs at multiple directions (creating harmony and balance) and at multiple speeds (leading to body adaptation and increase of concentration) [29]. In this way, the aquatic exercise utilizes the mechanical properties of water and uses a vertical position to fit most of the daily activities. In contrast, the land-based exercise takes advantage of the effects of gravity center and increased core stabilization; and the combined method benefits from the positive features of both land-based and aquatic environments, which somehow challenge the center of gravity and the center of buoyancy [30]. This study examined the effects of 8-week aquatic, land-based and combined aquatic-land exercise programs on the walking ability of women with MS. The results of this study can be helpful in understanding, describing and managing the symptoms of patients with MS.

METHODS

Subjects

The statistical population of the current study consisted of women with MS, aged 30-50 years old and registered at the MS Society of Amol in Mazandaran province. The inclusion criteria were EDSS<4.5, MS diagnosis by a neurologist and a medical record in the MS Society of Amol, no attendance in regular physical activities at least 6 months before and during the present research, no history of orthopedic, metabolic, epilepsy, cardiovascular and psychiatric illnesses, no history of relapses at least 4 weeks prior to the study, and complete motor ability without the help of others or auxiliary devices such as cane and the ability to attend training sessions. Of the 90 female patients introduced by the MS Society of Amol, 45 cases were selected based on the scope of the

research and the inclusion and exclusion criteria. 15 subjects were randomly assigned into each of the three groups of Study.

Procedure

The patients were informed firstly through the MS Society of Amol and then were selected based on the inclusion and exclusion criteria of the study. Before participating in the study and during a meeting, the subjects were requested to complete the consent form as well as declare their readiness to participate in the research. At this meeting, the patients received the necessary information about the research objectives, the conditions for participation in the exercises and the implementation of exercises. In addition, they completed the study forms under the supervision of the researcher. The training program of this study was conducted in swimming pool and gym at Shomal university of Amol. The subjects were acquainted with the training environment one week prior to the beginning of intervention, and passed the pretest at the baseline.

Outcomes

The participants were evaluated within the pretest and posttest design using 6 Minute Walk Test (ICC = 0.96) to assess the walking ability [31]. This test records the farthest distance that a person can walk with normal steps in 6 minutes.

Intervention

After the pretest, the subjects performed land-based, aquatic and combined exercise programs based on the defined protocol (Table 1). Intervention was performed for 8 weeks, 3 days a week, and 45-90 minutes per session. First and last 10 minutes of each session were allocated to warm up and cool down. The first- and second-level of exercise protocols included rehabilitation and conditioning in order to make ready the participants.

The warming up in water was accomplished as walking in water at multiple speeds and directions, rotation while walking, and the warming up in land-based as walking at multiple speeds and directions, stretching and soft exercises in the upper and lower extremities. During warm-up, cool down, fatigue and spasms during exercise, body shaking was performed for 15-20 seconds as well as deep breathing. The FITT (Frequency, Intensity, Time, and Type) principle was applied throughout the exercise sessions, considering the patient's capacity as combined movements, increasing the frequencies and changing the speed. The exercise intensity was determined using the Borg scale, Rating of Perceived Exertion that was used to measure the intensity level of exercise a person experiences during workout. In the current study, authors asked patients to stop their exercise if the level of their PER reached to more than 14, as it is accepted that PRE between 10 to 14 on the Borg Scale indicates a moderate level of exercise intensity.

The aquatic exercise was done vertically with buoyancy tools and training tools tailored to the practice objectives. The land-based exercise was firstly started horizontally (without weight bearing), then slowly moved towards the exercises in the supine position and finally in the standing position (full weight bearing), static and dynamic. In this environment, the training tools were used in accordance with the objectives of the exercise. The practice was progressed from simple to complex exercises. If the subjects felt pain during a movement, that exercise was abandoned, or was done later and at the right time.

Table 1. The exercises protocol in exercise groups [29]

Weeks	Program	Movement series	Frequency	Speed*	Duration (minutes)	RPE**
1	Rehabilitation	1	10	Medium	45-60	10-14
2	Rehabilitation	1	10	Slow (3), Medium (3), Fast (3), Slow (1)	45-60	10-14
3	Rehabilitation	2	10	Slow (3), Medium (3), Fast (3), Slow (1)	45-60	10-14
4	Rehabilitation	2	10	Slow (3), Medium (3), Fast (3), Slow (1)	45-60	10-14
5	Rehabilitation	3	10	Slow (3), Medium (3), Fast (3), Slow (1)	45-60	10-14
6	Conditioning	1	21	Slow (7), Medium (7), Fast (7)	45-90	10-14
7	Conditioning	2	21	Slow (7), Medium (7), Fast (7)	45-90	10-14
8	Conditioning	2	21	Slow (7), Medium (7), Fast (7)	45-90	10-14

* Exercises was performed at the rehabilitation and conditioning levels. First 5 weeks, including 10 repetitions in multiple speeds except first week. The last 3 weeks including 21 repetitions at multiple speeds.

**RPE: Rating of Perceived Exertion

Descriptive statistics were used to describe the data from the pre-test and post-test. In the inferential statistics, the data normality was controlled by Shapiro-Wilk test, and homogeneity of variances was evaluated by Levene's test. The paired sample t-test was applied to examine intra-group differences. One-way ANOVA was used to compare the groups at baseline. The analysis of covariance (ANCOVA) tested the differences between three exercise groups by eliminating the effect of pre-test data. The LSD post hoc test was employed to check the differences between the paired groups in the post-test. Data were analyzed using SPSS, version 20. The significance level was defined as 0.05.

STATISTICAL RESULTS

Because of physical and psychological problems as well as personal issues, 14 cases dropped out of the study, and 31 of them completed the programs [land-based (N=9), aquatic (N=12) and combined exercises (N=10)]. The demographic characteristics of the subjects are presented in Table 2. Based on the results of one-way ANOVA, there were no significant differences in age, height and weight between the three groups (p <0.05). In the inferential section, after verifying the assumption of normal distribution and homogeneity of the variance, the effect of the exercises in the three exercise programs on walking capacity was investigated.

The descriptions (mean, standard deviation and confidence interval) of walking ability in the pretest and posttest as well as the results of the paired t-test for intragroup comparison of the exercise groups have been reported in Table 3. The results showed a significant difference between the pretest and the posttest scores in the walking ability, among all study groups (p <0.05). The results of ANCOVA test in Table 4 show a significant difference between the three exercise groups in terms of the level of walking ability (p=0.001). Using the LSD post hoc analysis (Table 5), it was observed that the difference between land-based exercise group with aquatic exercise as well as aquatic exercise with combined exercise was significant (p <0.05), but there was no significant difference between Land-based exercise group with combined exercise group (p> 0.05).

Table 2. Demographic characteristics of subjects in study groups

Training groups	Number	Age (year)	Height (cm)	Weight (kg)	EDSS (0-10)
Land-based	9	35.67 ±1.51	161.78 ± 1.92	63.00 ± 3.23	2.28 ±0.22
Aquatic	12	40.50 ± 2.39	159.83 ± 1.85	69.50 ± 1.81	2.71 ± 0.38
Combined aquatic-land training	10	38.40 ± 2.05	162.20 ± 2.09	63.10 ± 1.96	2.20 ± 0.37
Total	31	38.42±1.23	161.16±1.11	65.55±1.40	2.42±0.20

Table 3. Results of within group comparisons for 6MWT

exercise groups	Pre-test		Post-test		Confidence interval		p-value
	Mean	Standard deviation	Mean	Standard deviation	Lower	Upper	
Land-based training group	648.91	36.15	784.56	48.61	-194.57	-76.72	0.00
Aquatic training group	667.92	36.52	686.50	33.59	-36.95	-0.22	0.04
Combined group	634.60	53.37	737.60	55.14	-161.23	-44.77	0.00

Table 4. Analysis of covariance to compare the effectiveness of land-based, aquatic and combined exercise programs on the walking ability

Variable	Groups	Sum of squares	Degrees of freedom	Mean squares	F	Significance level	Observed power
Walking ability	pre test	477951.20	1	477951.20	112.55	0.000	
	post test	76261.45	2	38130.73	8.98	0.001	0.80

Table 5. The results of LSD post hoc analysis to determine the differences among groups in 6MWT

Variable	Group (I)	Group (J)	Mean difference (I-J)	Standard error	Significance level
Walking ability	Land-based training	Aquatic training	116.17	28.79	0.00
	Land-based training	aquatic training-land-based	33.320	29.97	0.30
	Aquatic training	aquatic training - land-based	-82.85	28.06	0.01

DISCUSSION

In the patients with MS, due to myelin degradation in the central nervous system and impairment in balance as well as muscle weakness, walking is challenging. An appropriate therapeutic exercise can improve the walking and the balance of the patients. The rehabilitation aims to prevent functional disorders, increasing ability and improving the quality of life [32]. Due to the expansion of the MS population and their need to appropriate services, it is necessary to study and identify the ways that may help reduce the alongside problems of this disease. This study was conducted to compare the effect of 8-week land-based, aquatic and combined exercise programs using Burdenko method on the walking ability of MS women. The results of this study suggested that eight weeks of Burdenko method exercises in women with MS led to a significant improvement in the walking ability in all groups. Comparing these three groups, land-based exercise and combined aquatic-land exercise indicated a significant difference in the walking variable compared to the aquatic exercise.

The results of the effect of Land-based exercises on improving walking ability were in line with most of the studies on the land-based exercises in MS population, including Wier et al. (2011), Sabapathy et al. (2010), Pilutti et al. (2011), Cakit et al. (2010), Golzari et al. and Geddes et al.

(2009) [24, 33, 34, 35 and 36]. In justifying the results, it can be stated that land-based exercises benefit from the effect of the center of gravity and the core stabilization; thus, the land-based exercises with systematic and regular program can improve walking ability in these patients [30].

Concerning the impact of aquatic exercises on improving the walking ability of individuals with MS, the results of this study were consistent with the findings of Kalron et al. (2015), Salem et al. (2011), Broach et al. and Karegarfard et al. (2011) [37, 38, 39, 40 and 41]. In justifying this conclusion, we can point out that the aquatic exercise can help a person produce full range of motion and so increase muscle strength, even in weak extremities that are unable to move naturally, [41]. The aquatic exercise with suitable temperature creates a safe environment for individuals with MS and reduces muscle stiffness, allowing for easier movement. The lower bodyweight while immersed in water compared to land-based exercise, reduces the amount of workload on muscles and bones ultimately reduces the energy expenditure [27, 30]. Water transmits heat approximately 25 times faster than air [27, 42], thus the temperature rises less as a result of aerobic activity inside water, so the patients show less sensitivity to heat and deal better with physical activities.

Several studies have pointed out to the effects of land-based and aquatic exercises alone or Compared to each other on different variables

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in a variety of chronic conditions such as MS, but they did not mention the effects of combined aquatic-land exercise such as the Burdenko method.

Research limitations and future suggestions

This study suffered several limitations such as small sample size and lack of having a control group. As the benefits of exercise have been definitely confirmed for the people with MS, and considering the small number of people with MS who live in Amol, we preferred to not having a control group and so have more people in our exercise groups. Future studies may test the effects of the protocols used in the present study on the patients with a higher EDSS, and other MS-related symptoms and consequences. Determination of the effects of study intervention for the longer time after stopping the training programs is suggested as well.

CONCLUSION

According to the findings of this study, it can be concluded that eight weeks of land-based, aquatic and combined aquatic-land exercise programs have positive effects on the walking ability of MS patients However, land-based and combined aquatic-land exercise showed significantly better effects on study outcome than the aquatic group alone. Meanwhile, this study showed that the combination of land-based and aquatic exercises could have the positive effects of either aquatic or land-based training alone. Thus, the combined aquatic-land training program is recommended as a more appropriate exercise method that could fit into the interests and conditions of people with MS. The findings can be exploited as appropriate non-pharmacologic complementary therapies by medical, therapeutic, physiotherapy and rehabilitation centers

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