

Original Article

The effect of an aquatic training program on walking ability and quality of life of patients with multiple sclerosis

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Abstract:

The purpose of this study was to evaluate the effect of an aquatic training program on the walking ability and quality of life of patients with multiple sclerosis. Methods: A total of 10 adults (4 male and 6 female) with MS participated in the present study. Five patients with MS (2 male and 3 female) who participated in aquatic training program and 5 sedentary patients with MS (2 male and 3 female) were assigned to intervention (MS-I) and control (MS-C) groups, respectively. Pre- and post- training exercise tests were performed to determine the walking ability, while quality of life was estimated by the Health Questionnaire (EQ-5D). According to the EuroQol Group, the EQ-5D index was calculated by the algorithm UK-TTO. The MS-I group underwent a 12-wk aquatic training program at a frequency of 2 times per week and for a duration of 40 min per session. Results: Post-training results showed that the MS-I group improved during treatment, from their baseline scores on walking ability ($p < .05$) and quality of life ($p < .05$) measurement. In contrast, MS-C group presented decreased quality of life ($p < .05$) and worst walking mobility ($p < .05$). Conclusions: Patients with MS may be able to improve their mobility and quality of life when performing a systematic and well-designed aquatic training program.

Key words: multiple sclerosis, aquatic training program, walking ability, quality of life.

Introduction

Multiple sclerosis (MS), is a demyelinating disease that affects the white matter of the Central Nervous System (Kent-Brown, Ng, Castro et al. 1997). MS is one of the most frequent neurological disease (Mostert & Kesserling, 2002) affecting a remarkable number of individuals worldwide (Kantarci & Wingerchuk, 2006) that is more prevalent in women compared to men due to genetic inclination, hereditarily determined immunological factors, hormonal effects and environmental influences (Hawkins & McDonnell, 1999; Kurtzke, 2000).

The tendency of the disability to be primary progressive has as a consequence the alteration of patient's needs with MS each year, a change that might be evident even from day to day. Since MS has an onset during early adult life (20-40 years) although it may have a minimal effect on longevity, however, it causes significant delays on the familial, professional, and social life of patients (Kalb, Holland, Giesser, & Lander, 2007; Rao, Leo, Ellington, et al. 1991).

In psychometric values, walking ability of patients with MS changes over time to a greater degree compared to the modifications that are relative to the Kurtzke Expanded Disability Status Scale (EDSS) (Schwid, 1997; Schwid, Goodman, McDermott, Bever, & Cook, 2002). In addition, walking deficiency constitutes a decisive factor for the gradual mobility deterioration of MS patients (Schwid, 1997). While walking restriction influences negatively the activities that are connected with the everyday routine of patients with MS (Romberg, 2004), improvement of walking ability resulting from their participation in physical activity programs will probably contribute in the improvement of patients' quality of life.

Research concerning quality of life of MS patients has been developed over the last few years. With commencement of illness quality of life deteriorates drastically (Rice, Oger, Duquette, et al. 1999). As for pharmaceutical treatment, interferon b seems to improve quality of patients' life (Rice et al. 1999), however, it can also cause serious neuropsychological syndromes such as depression with suicidal ideation, paranoid psychosis or hallucinations (Schaefer, Schmidt, Neumer, Scholler, & Schwarz, 2002).

As for physical exercise and its effect on MS, for many years the prevailed notion was that exercise causes fatigue due to the increase of body temperature, resulting to the avoidance of physical activity participation (Ehrman, Gordon, Visich, & Keteyian, 2009). However, this opinion has been surpassed since safe participation in intervention programs can be achieved with proper adaptations of exercise according to the functionality level and needs of MS patients without deterioration of their clinical feature (Mostert & Kesserling, 2002). The recent recognition of exercise benefits along with the combination of pharmaceutical treatment, ergo-therapy and psychological support have established physical exercise as an integral part of MS patients' treatment (Mathiowetz, Matuska, Finlayson, Luo, & Chen, 2007; Patti, Ciancio, Cacopardo, et al. 2003).

The review of literature showed that treadmill training, resistance training and other types of exercise may be beneficial for patients with MS (Broekmans, Roelants, Feys, et al. 2011; Dodd, Taylor, Shields, et al. 2011; Giesser, Beres-Jones, Budovitch, Herlihy, & Harkema, 2007; Newman, Dawes, van den Berg, et al. 2007; Ponichtera-Mulcare, Mathews, Barren, & Gupta, 1997; Sabapathy, Minahan, Turner, & Broadley, 2011; Surakka, Romberg, Ruutiainen, et al. 2004; Svensson, Gerdle, & Elert, 1994). Although aquatic exercise constitutes an increasingly popular therapy method for patients with MS (Becker, 2009), the particular conditions that result from the nature of activity such as appropriate temperature of water and difficulties related to swimming pool access, appear to constitute likely causes for the limited number of studies conducted regarding the application of water exercise programs.

The majority of studies mainly examined the effect of aquatic exercise on physical condition, spasticity and fatigue of patients with MS (Chiara, Carlos, Martin, Miller, & Nadeau, 1998; Gelsen, Grisby, & Winant, 1984; Mostert & Kesserling, 2002; Peterson, 2001; White, Wilson, Davis, & Petajan, 2000). In addition, Romberg et al. (2004) study examined the effect of an exercise program combining home activities as well as weight resistance and aquatic exercises on improving walking ability but not quality of life of patients with MS. In a recent study (Ahmadi, Nikbakh, Arastoo, & Habibi, 2010), researchers determined the effect of a training program on balance, walking ability, fatigue and quality of life in patients with MS. However, the design of this study included solely the application of a yoga exercise program as a mean to examine the effect of physical activity on relative parameters. Hence, from the above mentioned it seems that information about the influence of aquatic training on walking ability and quality of life of MS patients is limited. Thus, the purpose of the present study was to evaluate the effectiveness of an aquatic training program on walking ability and quality of life in patients with MS.

Method

Participants

The participants of the study were 10 adults patients with MS all coming from 2nd Internal Medicine Sector of AHEPA General University Hospital of Thessaloniki. The patients were assigned to 2 groups (control and intervention) according to their desire to participate, or not, in the aquatic training program. Five patients (2 male, 3 female) with MS constituted the intervention group (MS-I), whereas 5 patients (2 male, 3 female) with MS made up the control group (MS-C) of the study.

All participants until today are under strenuous medical monitoring treated with Tysarbi (Natalizumab), a humanized monoclonal antibody against alpha-4 (α4)-integrin. The patients were confirmed diagnosed with MS according to the diagnosed criteria (McDonald, Compston, Edan, et al. 2001) and they did not had any other neurological, orthopedic problem or visual disorders. The range of the EDSS (Kurtzke, 1983) score was between 1.0 and 2.5. No one of patients participated in physical activities or any other sport for six months prior to the research. All the patients were informed of the purpose of the study. The patients were informed about the testing procedures, plus written informed consent approved by an Institutional Review Board for the use of Human subjects was obtained from all the patients before investigation. Patient characteristics are presented in Table 1. All procedures followed were in agreement with the ethical guidelines of the Research Committee of Aristotle University as well as with the revised Helsinki Declaration of 2008 for research on human subjects.

Table 1. Physiological and clinical characteristics of participants.*

Groups						
Variables	MS-I (n=5)			MS-C (n=5)		
	Mean ± SD	Median	Mean Rank	Mean ± SD	Median	Mean Rank
Age (yr)	30.4 ± 3.0	30.0	3.9	35.6 ± 4.2	38.0	7.1
Height (cm)	174.8 ± 7.0	171.0	5.9	175.2 ± 10.8	169.0	5.1
Weight (kg)	74.0 ± 17.0	66.0	5.2	73.0 ± 9.7	68.0	5.8
BMI (kg·m ⁻²)	24.0 ± 4.1	22.6	4.8	23.8 ± 0.8	23.4	6.2
Years since diagnosis	5.6 ± 1.1	6.0	5.8	5.0 ± 2.6	5.0	5.2
Sex male (%)	40.0	-	-	40.0	-	-

*MS-I = Intervention group, MS-C = Control group, BMI = Body Mass Index.

Measurement/Instrument

EDSS (Kurtzke, 1983) was used to estimate walking ability of MS patients performed on a Trackmaster TM-400 (Jas MFG, Carrollton, Texas) treadmill, with assessment conducted by two specialized neurologists. Each patient was asked to walk a 500m distance on the treadmill with the speed determined at 4m/sec. Time of covering the required distance was recorded electronically by a device incorporated in the treadmill equipment. The instructions given were the same for each patient to avoid the effect of external or internal motivation. Further, no verbal communication or interference was allowed during testing, and the examiners were the same for each patient. All measurements took place the same morning hours to avoid fatigue and exhaustion of patients resulting from their everyday activities.

QoL was measured with EuroQol 5 Dimensions questionnaire (EQ-5D). It was developed by EuroQol Group (The EuroQol Group, 1990) and consists of five dimensions: mobility, self-care, usual activities, pain/discomfort and anxiety/depression. Each dimension is divided into three levels, corresponding to no problems, some problems and severe problems. Each of three levels reflects the numbers 1, 2 and 3, respectively. The level combination of each dimension results in 243 different health states from. The range of the health state is between 1111 (perfect health) and 3333 (worst health) giving values from 1.000 to -0.594, respectively, using the UK EQ-5D tariff (Dolan, 1997). EQ-5D has previously been translated and validated (Kontodimopoulos, Pappa, Niakas, et al. 2008; Yfantopoulos, 2001) for Greek population and has been used for persons with MS (Kikuchi, Mifune, Masaaki, et al. 2011; McCrone, Heslin, Knapp, Bull, & Thompson, 2008).

Procedure

The clinical examination, measurements of physical characteristics and walking ability of the patients took place at the 2nd Internal Medicine Sector of AHEPA General University Hospital of Thessaloniki. An orientation session was provided to the patients, 1 day before the actual testing sessions. During this session, verbal instructions concerning the test procedures and a demonstration of the test were provided to the patients. After the demonstration, the patients performed a number of trials to familiarize themselves with the testing procedures and equipment.

Two examiners, both familiarized with the operation of equipment and testing procedures conducted all measurements. The research protocol included 2 separate days of testing. The results showed that there was no significant difference between the 2 measurements in term of walking ability. Therefore, the purpose of the study was the estimation of the highest performance of each patient, and the better of 2 efforts was chosen for data analysis. Testing for the patients of the MS-I group included 2 measurements (initial and final), before and after the application of the intervention program, respectively. Although the patients of the MS-C group did not participate in the intervention program or in any other sport or physical activity, they underwent the same measurements as did the patients of the MS-I group.

Intervention program

The application of the intervention program took place at the indoor swimming pool of the patients' municipality. The MS-I group followed a 12-week aquatic training program (Kostidou, 2003) (Table 2) with mild intensity, at a frequency of 2 training sessions per week, for 40 minutes each session. All the patients in the MS-I group did not participate in other training programs during the research.

Table 2. Aquatic training program.

Warm up (5 min):

Deep water running
Cross country ski
Jogging
Bicycles
Open-close
Rock climb
Cuff touch

Training session (30 min):

Deep water running
Cross country ski
Jogging
Bicycles
Open-close
Rock climb
Cuff touch
Deep water double knee lift

Wall strides
Deep water bent arm pull
Deep water shoulder circles
Deep water breast stroke
Deep water elbow press
Cool Down (5 min):

Biceps Stretch

Trapezius Muscle Stretch
Stretching **cervical**

Muscles stretching **triceps**

Muscles stretching **hamstrings / quadriceps**

Each session started with a 5-minute warm-up period that included walking activities with continuous increase of range of movement and speed e.g. cross country ski, jogging, bicycle, open-close, rock climb, cuff touch. Next, the main part of the aquatic training program followed (30 min) with alteration of muscle strength and balance activities so as not to overload the same muscle groups. Activities were performed in a slow rhythm, short range of movement and distance so as not to cause breathlessness, fatigue and muscle or joint pain. Only in the event sense of cold, rhythm of exercises, range of movement and distance were increased. Between exercises, a short rest period of 15-20 seconds roughly was included along for each session. Each session concluded with a 5-minute cool-down period including gradual reduce of exercise load with flexibility exercises of all muscle groups. During each session, continuous verbal and visual feedback was provided.

During the program, no patient was absent for > 13% of the total number of sessions (3 absences out of 24 sessions). The avoidance of exposing participants in unfavorable climate conditions due to the safe and comfortable environment provided by the indoor swimming pool facilities contributed to the trouble-free conduction of the intervention program. Intensity of training was measured using Borg's 15-grade scale for Ratings of Perceived Exertion (Borg, 1982) that according MS-I group participants' responses ranged from 11 to 13 points.

Statistical Analysis

Normal distribution for all examined variables of the study was assessed by a histogram plot and Shapiro-Wilk's test. The differences in QoL, EDSS and walking ability between the groups were examined using Mann-Whitney U test. The differences between the measurements were evaluated using Wilcoxon test. The descriptive statistics are reported both as mean $\pm$ SD and as mean rank. Also the median of all data was calculated. Spearman correlation was used to examine the relationship between QoL and walking ability. The level of significance was set at $p < .05$. The statistical analysis was carried out with PASW Statistics version 18 software (SPSS Inc., an IBM Company, Chicago).

Results

Five adults in MS-I group and 5 adults in MS-C group conducted the test procedures of this study. The results showed that there were no significant differences in the physiological and clinical characteristics between the MS-I and MS-C groups (Table 1). There were no observed significant differences at initial measurements in EDSS, QoL and walking ability between groups. Post-training values in QoL and walking mobility were found to be significantly improved in MS-I group compared to MS-C group by 25.5% ($p < .05$) and 584.2% ($p < .05$), respectively (Table 3).

Table 3. Pre - post Mann-Whitney test results of the program.

Variables	□Groups	□Mean ± SD	□Median	□Mean Rank	□z	□p
<i>Pre</i>						
EDSS	MS-I	1.4 ± 0.7	1.0	4.9	-0.69	0.488
	MS-C	1.4 ± 0.2	1.5	6.1		
EQ-5D index	MS-I	0.638 ± 0.229	0.725	4.9	-0.64	0.525
	MS-C	0.736 ± 0.109	0.725	6.1		
Walking mobility (min)	MS-I	7.3 ± 1.2	7.5	4.0	-1.57	0.117
	MS-C	8.5 ± 0.8	8.3	7.0		
<i>Post</i>						
EDSS	MS-I	1.1 ± 0.9	1.0	4.0	-1.70	0.090
	MS-C	1.5 ± 0.0	1.5	7.0		
EQ-5D index	MS-I	0.910 ± 0.083	0.850	8.0	-2.64	0.008
	MS-C	0.133 ± 0.117	0.082	3.0		
Walking mobility (min)	MS-I	6.7±1.2	7.0	3.2	-2.40	0.016
	MS-C	9.0 ± 0.8	9.0	7.8		

In MS-I group, QoL was significantly increased by 68.0% ($p < .05$) and walking mobility significantly improved by 7.6% ($p < .05$). In contrast, MS-C group presented decreased QoL by 83.0% ($p < .05$) and worst walking mobility by 6.4% ($p < .05$) (Table 4).

Table 4. Pre - post Wilcoxon test results of intervention and control group.

Variables	Groups	Mean $\pm$ SD	Mean Rank	z	p
EDSS (Pre)	MS-I	1.4 $\pm$ 0.7	1.5	-1.34*	0.180
EDSS (Post)		1.1 $\pm$ 0.9			
EDSS (Pre)	MS-C	1.4 $\pm$ 0.2	1.0	-1.00 [†]	0.317
EDSS (Post)		1.5 $\pm$ 0.0			
EQ-5D index (Pre)	MS-I	0.638 $\pm$ 0.229	3.0	-2.02 [†]	0.043
EQ-5D index (Post)		0.910 $\pm$ 0.083			
EQ-5D index (Pre)	MS-C	0.736 $\pm$ 0.109	3.0	-2.03*	0.042
EQ-5D index (Post)		0.133 $\pm$ 0.117			
Walking mobility (min) (Pre)	MS-I	7.3 $\pm$ 1.2	3.0	-2.02*	0.043
Walking mobility (min) (Post)		6.7 $\pm$ 1.2			
Walking mobility (min) (Pre)	MS-C	8.5 $\pm$ 0.8	3.0	-2.02 [†]	0.043
Walking mobility (min) (Post)		9.0 $\pm$ 0.8			

* Based on positive ranks, [†] Based on negative ranks

Post-training results showed that there was no significant change in EDSS scale between or within 2 groups and no correlation was detected between QoL and walking ability in 2 groups. In the final measurement, MS-I group had significant lower values for usual activities, pain/discomfort and anxiety/depression compared to MS-C group by 50.0%, 45.5% and 60.0%, respectively ($p < .05$) (Table 5).

Table 5. Pre-post Mann-Whitney test results of EQ-5D questionnaire.

Variables	Groups	Mean $\pm$ SD	Median	Mean Rank	z	p
<i>Pre</i>						
Mobility	MS-I	1.4 $\pm$ 0.5	1.0	6.0	-0.66	0.513
	MS-C	1.2 $\pm$ 0.4	1.0	5.0		
Self care	MS-I	1.0 $\pm$ 0.0	1.0	4.5	-1.50	0.310
	MS-C	1.4 $\pm$ 0.5	1.0	6.5		
Usual activities	MS-I	1.6 $\pm$ 0.5	2.0	6.5	-1.23	0.221
	MS-C	1.2 $\pm$ 0.4	1.0	4.5		
Pain/Discomfort	MS-I	1.6 $\pm$ 0.5	2.0	6.0	-0.60	0.549
	MS-C	1.4 $\pm$ 0.5	1.0	5.0		
Anxiety/Depression	MS-I	2.2 $\pm$ 0.4	2.0	6.0	-1.00	0.317
	MS-C	2.0 $\pm$ 0.0	2.0	5.0		
<i>Post</i>						
Mobility	MS-I	1.4 $\pm$ 0.5	1.0	5.5	0.00	1.000
	MS-C	1.4 $\pm$ 0.5	1.0	5.5		
Self care	MS-I	1.0 $\pm$ 0.0	1.0	4.5	-1.50	0.134
	MS-C	1.4 $\pm$ 0.5	1.0	6.5		
Usual activities	MS-I	1.0 $\pm$ 0.0	1.0	3.0	-3.00	0.003
	MS-C	2.0 $\pm$ 0.0	2.0	8.0		
Pain/Discomfort	MS-I	1.0 $\pm$ 0.0	1.0	3.0	-2.89	0.004
	MS-C	2.2 $\pm$ 0.5	2.0	8.0		
Anxiety/Depression	MS-I	1.2 $\pm$ 0.4	1.0	3.0	-2.89	0.004
	MS-C	3.0 $\pm$ 0.0	3.0	8.0		

In addition, in MS-I group at the end of the study were noticed significant lower values in anxiety/depression compared to initial measurement by 45.5% ($p < .05$), while in MS-C group were observed higher values in usual activities, pain/discomfort and anxiety/depression by 66.7%, 57.1% and 50.0%, respectively ($p < .05$) (Table 6).

Table 6. Pre - post Wilcoxon test results of EQ-5D questionnaire.

Variables	Groups	Mean $\pm$ SD	Mean Rank	z	p
	MS-I	1.4 $\pm$ 0.5	0.0	0.00*	1.000
Mobility (Pre)					
Mobility (Post)		1.4 $\pm$ 0.5			
Mobility (Pre)	MS-C	1.2 $\pm$ 0.4	1.0	-1.00 [‡]	0.317
Mobility (Post)		1.4 $\pm$ 0.5			
Self care (Pre)	MS-I	1.0 $\pm$ 0.0	0.0	0.00*	1.000
Self care (Post)		1.0 $\pm$ 0.0			
Self care (Pre)	MS-C	1.4 $\pm$ 0.5	0.0	0.00*	1.000
Self care (Post)		1.4 $\pm$ 0.5			
Usual activities (Pre)	MS-I	1.6 $\pm$ 0.5	2.0	-1.73 [†]	0.083
Usual activities (Post)		1.0 $\pm$ 0.0			
Usual activities (Pre)	MS-C	1.2 $\pm$ 0.4	2.5	-2.00 [‡]	0.046
Usual activities (Post)		2.0 $\pm$ 0.0			
Pain/Discomfort (Pre)	MS-I	1.6 $\pm$ 0.5	2.0	-1.73 [†]	0.083
Pain/Discomfort (Post)		1.0 $\pm$ 0.0			
Pain/Discomfort (Pre)	MS-C	1.4 $\pm$ 0.5	2.5	-2.00 [‡]	0.046
Pain/Discomfort (Post)		2.2 $\pm$ 0.5			
Anxiety/Depression (Pre)	MS-I	2.2 $\pm$ 0.4	3.0	-2.24 [†]	0.025
Anxiety/Depression (Post)		1.2 $\pm$ 0.4			
Anxiety/Depression (Pre)	MS-C	2.0 $\pm$ 0.0	3.0	-2.24 [‡]	0.025
Anxiety/Depression (Post)		3.0 $\pm$ 0.0			

* The sum of negative ranks equals the sum of positive rank, [†] Based on positive ranks, [‡] Based on negative ranks

Discussion and conclusions

Reviewing the literature a lack of satisfactory amount of researches is noticed concerning the application of aquatic programs and their effect on walking ability and quality of life of MS patients. Probable causes for the limited number of studies are related with unique environmental conditions such as appropriate temperature of water and access difficulties in swimming pool premises. However, few researches related to participation of MS patients in intervention programs of different types, focus on the effect of exercise in the degree of disability, walking ability and quality of patients' life.

In the present study, improvement of walking ability noticed to individuals participating in the intervention program could be attributed to the buoyancy support in the water that reduces weight plus the higher resistance of water while executing activities. This contributed to a higher range of movement performed and to the improvement of balance as well as muscle strength with the use of assisting devices (Stopka, 2001). Walking ability represents an important factor for improving everyday routine of MS patients, since its deterioration affects negatively their possibility to participate in familial and social events as well as professional activities (Romberg, 2004). Walking constitutes a continuously modified ability throughout time to a greater degree compared to EDSS changes (Schwid et al. 1997; Schwid et al. 2002). Furthermore, walking deficits are strictly associated with overall deterioration of MS patients' moving ability (Schwid et al. 1997), thus, the same researchers support exercise as a secure mean that should be proposed to MS patients with mild to moderate level of disability.

The findings of this research are in agreement with the findings of Romberg et al. (2004) study, who applied an exercise program combining weight resistance training, aquatic exercises and home activities to patients with MS and reported an improvement of 12% and 6% for walking ability and speed control respectively.

It seems that the type of exercise is an important issue for improving walking ability as showed by findings of recent studies. In particular, researchers (Broekmans et al. 2011; DeBolt & McCubbin, 2004; Dodd et al. 2011; Hayes, Gappmaier, & LaStayo, 2011), applying weight resistance programs to patients with MS did not

notice any improvement of distance covered and walking speed. On the contrary, other researchers (Dettmers, Sulzmann, Ruchay-Plössl, Gütlér, & Vieten, 2009; Kileff & Ashburn, 2005; Rampello, 2007), who applied aerobic exercise programs reported improvement of the same parameters, probably due to the improvement of cardiovascular capacity resulting to the increased ability to produce work (Newman et al. 2007; Schultz, Gold, Witte, et al. 2004).

In the present study, the enhancement of patients' quality of life who participated in the intervention program could be attributed to the improvement of levels of the components constituting the health questionnaire, since they appear to influence positively the beliefs of patients when they were called to revalue their quality of life. Given the fact that the score of EQ-5D instrument is affected by the EDSS score (Kikuchi et al. 2011) and quality of life of MS patients gradually declines (Motl, McAuley, Snook, & Gliottoni, 2009; Putzki, Fischer, Gottwald, et al. 2009), findings of this study support the importance of participation in exercise since all patients improved their EQ-5D index score. Researchers (Kalia & O'Connor, 2005; Motl et al. 2009) reported MS patients with higher levels of physical activity and quality of life as exhibiting lower levels of disability, depression fatigue and pain and higher levels of social support.

Motl and Snook (2008) study noted that MS patients who were more active, exhibited higher autonomy for longer time period and had better control of their level of functionality whereas those parameters were connected with higher quality of life levels. Thus, exercise programs for MS patients should be more associated with quality of life enhancement in conditions that will have as a purpose the utmost improvement of the autonomous control over disability (Bandura, 1997).

Stuifbergen (1997), using SF-36 questionnaire reported an aquatic exercise program as having a positive influence on the perceptions of MS patients concerning their quality of life, suggesting that future researchers should answer in which way physical activity could be incorporated in the already demanding life of people with chronic illnesses. In addition, the same researcher supported that for many independent everyday activities the provision of minimal support could be a way of increasing physical activity levels. Therefore, instructions for using assistive movement devices for MS patients should be counterbalanced with the need to promote independent activity, reducing in this way the possibility of early fatigue and muscle weakness.

The disability level of the patients participating in the intervention program seemed to be slightly influenced by the type of exercise, as well as the intensity, frequency and duration of program, since it remained unchangeable for the majority of patients, a finding suggesting that disability level is probably not influenced by exercise type although the contribution of aquatic activity in the deceleration of illness progress could not be excluded. As for the patients who did not participate in the intervention program but only to their daily life activities adopting in a way a sedentary way of life, their walking ability and quality of life was reduced while disability level was increased in one patient and remained steady for the others. Hence, lack of physical activity and adoption of an inactive way of life seem to constitute causes of disability worsening.

These findings are particularly important since inactiveness and neurological disability represent independent risk factors for lower levels of cardiovascular functioning of MS patients. Motl and Goldman (2011) came to the same conclusion reporting patients with MS who were less active as having lower levels of physical condition, also stating that subjective means (questionnaires) and objective criteria (pedometers) of estimating physical activity should be related with VO_{2peak} even if the neurological issue is taken into account in multiple regression analysis. In addition, Motl and Goldman (2011), reported the existence of a probable biological base resulting to the independent relationship of inactivity and neurological cause with the lowered levels of cardiovascular capacity of MS patients, since inactivity is connected with the reduction of volume rate, mitochondria density and muscular oxidant ferments, that contribute in the reduction of cardiac supply and aorta oxygen difference. Thus, MS patients should be encouraged to participate in exercise programs so as to maintain their cardiovascular ability that is necessary for independent living (Durstine, Painter, Franklin, et al. 2000).

The present study showed that participation in an 12 weeks' aquatic exercise program contributed significantly to the increase of mobility and improvement of MS patients' quality of life. Future researches should focus on the application of similar programs including differ exercise protocols and larger sample of patients so as to further determine the effect of these programs on illness development. In addition, it is important to point out the necessity of co-operation between doctors, physiotherapists and specialized physical education teachers so as to provide the best possible result for MS patients, especially in those cases where mobility restriction is mostly severe.

In conclusion, walking deficits constitute a decisive factor for the overall decline of walking patients with MS since it negatively affects the activities associated with daily schedule and quality of life of patients with MS. In the past few years, the value of exercise has been widely recognized for patients with MS, as it has been proved that their participation in specialized exercise programs contributes to the improvement of physical and motor skills. Motor improvement is necessary for performing simple, however, important activities of everyday life such as walking or going up the stairs, skills that are impossible for everyone to perform without the existence of sufficient walking ability levels.

The results of this study showed that aquatic activities constitute an exceptional way of exercise for improving walking ability of patients with MS. Successful performance of basic motor skills has an overall effect on personality improvement of patients with MS, because social, emotional and occupational interaction that aquatic activities provide has a direct positive effect on their quality of life. Thus, exercise through aquatic activities should constitute an integral part of physical fitness of patients with MS.

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