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Original Article

Sport adapted hippotherapy for disabled people affected by multiple sclerosis

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Abstract:
Purpose: There are not many sports serving as therapy for people suffered from multiple sclerosis. Consequently, there is a lack of protocols to develop wellness in terms of improvements in skills and abilities in these subjects. This study aimed to demonstrate the effectiveness of a hippotherapy-based training protocol to improve skills and abilities, including quality of movement, balance, and core strength, that could be useful for fit-well-ness of these subjects. *Methods:* The study involved 12 subjects (35.6 ± 6.2 years old) with multiple sclerosis. The 12-week program consisted of 1 weekly 60-minute hippotherapy session divided into ground warm-up, middle phase and cool-down on both horseback and ground. MdR scale, Stork Balance test and sit-up test were administered pre-post 12 weeks. After checking the normality of the data with Shapiro-Wilk test, a dependent-samples t-test was performed to check the differences pre-post 12 weeks. Data were processed using SPSS statistical software with an alpha level set at 0.05. *Results:* A statistically significant improvement was found in all parameters tested ($p<0.05$). Specifically, there was an improvement in MdR score (+29.4%), balance (+31.1%) and abdominal muscle strength (+42.3%). *Conclusions:* The results demonstrated the effectiveness of the 12-week hippotherapy program for people suffered from multiple sclerosis to improve quality of movement, static balance, and core strength. These evidences can provide a basis from which technicians and practitioners can be inspired to develop protocols designed to ensure the development and maintenance of an adequate level of well-fit-ness in all people through fun, safe, and dynamic activity.
Key Words*: physical activity, core stability, balance control, therapy, efficiency, wellness*

Introduction

Multiple sclerosis (MS) is the most common nontraumatic disabling disease affecting young adults (Kobelt et al., 2017). It represents a condition that can affect the brain and spinal cord, causing a wide range of potential symptoms, including problems with vision, arm or leg movement, sensation, or balance, the underlying cause of which remains uncertain (Dobson & Giovannoni, 2019). The onset of this disease usually occurs in young adulthood, between the ages of 20 and 40; women are two to three times more affected than men, and this difference appears to be increasing in some areas of the world (Amato et al., 2018). Globally there are an estimated 2-3 million people living with MS, with a prevalence of 50-300 per 100,000 individuals. However, the disease is not equally prevalent worldwide as its distribution seems to be related to latitude: in fact, generally, the number of cases increases with increasing distance from the equator. In Europe, the prevalence of the disease is 12/100,000 in the Mediterranean basin regions, while it is 45/100,000 in central Europe and Scandinavian regions. In Switzerland, there are about 15,000 people with MS, or about one case for every 560 inhabitants. MS predominantly affects young adults, with 54 an age range of 20 to 40 years (80% of cases), but it can also be diagnosed in pediatric age (3-10% of cases) or more rarely in advanced adulthood. Women are more affected than men, with a ratio of more than 2:1. Symptoms widely found in MS are fatigue, difficulty maintaining balance, and reduced strength (Rommer et al., 2019), in addition to numerous other symptoms that limit the people's individual's quality of life. Meta-analyses and systematic reviews of randomized trials have shown positive correlations between exercise and general well-being for people with MS, which has important repercussions on quality of life (Motl et al., 2017).

Physical activity, in addition to providing adequate symptomatic treatment (tertiary prevention), is effective in modifying the lifestyle of the affected person (secondary prevention) and in promoting an adequate level of health useful to avoid the onset of most diseases (primary prevention) (Kinnett-Hopkins et al., 2017) and generally, motor control and learning play an important role on every aspect of development of human being (Raiola, 2017, 2014).

Studies indicate that interventions such as physical therapy and therapeutic physical exercises can improve many of the deficiencies observed in MS. However, the effectiveness of such interventions is not always confirmed in relation to functional aspects. Recently Canning & Hicks (2020), described an overview of rehabilitation strategies designed for autoimmune conditions, identifying as the main components of MS rehabilitation: increased physical capacity, muscle strength, aerobic resistance and functional skills. MS involves a wide range of symptoms, the rehabilitation of these patients requires a multidisciplinary approach, and more

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satisfactory results are observed with techniques that make use of sensory strategies. There are many activities that could contribute to the promotion of healthy lifestyles, well-being, and health of people individuals (Morano et al., 2019) and, one of them, it is hippotherapy. It can be regarded as a useful systemic activity for people individuals with neuromuscular disorders including MS (Heine, 1997). Since the 1960s, the term hippotherapy began to be introduced into the medical literature in Germany, Austria, and Sweden as its protocols began to be introduced in addition to traditional physical educational/therapies. It was standardized by a group of Canadian and American therapists who in the late 1980s. In the past decades, the effectiveness of hippotherapy as a therapeutic method has been described in a series of neurologic conditions that compromise postural control and mobility.

Hippotherapy is a physical and occupational therapy that uses the natural gait and movement of a horse to provide motor and sensory input. It is based on improving neurological function and sensory processes and is used for people individuals with physical and mental disorders (Koca & Ataseven, 2016). Hippotherapy has important psychological, social, and educational effects and promotes stimulation of many organ systems including the sensory, musculoskeletal, limbic, vestibular, and ocular systems (Silkwood-Sherer et al., 2012; Champagne & Dugas, 2010).

Another advantage of hippotherapy is that it stimulates problem-solving discovery through a productive learning style, as the subject develops functionally appropriate behaviors, reacting to the horse's movement. This method requires postural reactions combined with the dissociation of the pelvic and scapular waist, and constant tonic adjustments, besides varying the visual information in quantity and magnitude, and also increasing the demand for sensory information sent to the vestibular system. The trainer can assist this process by manipulating the environment, thus randomizing the anticipatory and reactive adjustments needed for different responses (Silkwood-Sherer & Warmbier, 2007).

Therefore, the simultaneous improvement of multiple body systems such as musculoskeletal, vestibular, and ocular, by hippotherapy may promote alterations and reorganization of the central nervous system and increase the possibility to transfer this learning in other movement patterns used in everyday life activities. The uniqueness of hippotherapy as a means of rehabilitation lies in the direct impact of the rhythmically ordered motor and sensory loading on the sick person when making close contact with the horse, due to which a consistently pronounced wellness effect is realized (Gridneva, 2011).

The variety of different biomechanical influences and the highest emotional effect in hippotherapy, expresses the opinion that it is impossible to obtain such effect when using other means of adaptive physical culture. Specifically, adapted physical activities also allow full participation to achieve better wellness levels (D'Isanto et al., 2022cd, Aliberti, Raiola, 2021, Raiola, 2015ab). In the same way the high fit level of performance could have effect on person of special needs in terms of health and, overall, of education of it (D'Elia, 2021, Imparato et al. 2021). Participation in exercise programs is a key strategy for improving motor performance and could significantly improve daily activities and quality of life.

However, although there is countless evidence on the beneficial effects of hippotherapy and physical activity in general in people individuals with MS, one of the critical issues found is the lack of expertise on the part of physical activity practitioners with respect to this type of situation (Learmonth & Motl, 2016). Therefore, training methods should be centered on the ecological-dynamic approach instead of the cognitive approach because of the methods of the first one approach consider the person for their aptitude and motor competences (D'Isanto et al., 2022ab, Raiola et al., 2022, Di Domenico et al., 2022).

Too often, it statues generally the benefit effects of hippotherapy without the scientific based evidences because the hippotherapy has not investigated by using sport protocol. So, this study aimed to demonstrate the effectiveness of a hippotherapy-based training protocol to improve motor and sport skills, including quality of movement, balance, and core strength, that could be useful for the general well-being and functionality of subjects with MS. In this case, the null hypothesis (H_0) stated that the proposed training protocol provides no improvement, while our alternative hypothesis (H_1) stated the 12 weeks of training protocol was beneficial in terms of movement quality, balance, and core strength.

Material & methods

Design and participants

An experimental one-group pretest-posttest design with convenience sampling was used. The study involved 12 subjects (age, Mean ± standard deviation [SD] = 35.6 ± 6.2 years old) with MS. Before starting the experimental study, informed consent was obtained from the subjects involved after informing them about the timing, procedure, and risks and benefits of the protocol study. The study was conducted according to the guidelines of the Declaration of Helsinki. Data were treated anonymously.

Assessment

A battery of physical tests was administered pre-post 12 weeks: the MdR scale, a neuromotor rating scale for equestrian rehabilitation, to assess quality and finalized movements, the Stork Balance Stand Test, to assess static balance, and the Sit Up Test, to assess core stability and strength.

MdR scale

The MdR scale (Cerino & Frascarelli, 2011) developed by Manfredi & Del Rosso, involved observing a series of exercises performed on horseback both in motion and stationary. All moving exercises must be performed exclusively at a walking pace, on a straight course with a minimum length of 15 meters, and assessments must be made after 5 minutes of walking or 3 laps. The MdR scale includes 90 items, 47 of which are performed with the horse stationary and 43 with the horse in motion. Only the moving-horse items were chosen for the present study. For each item, a score, from 0 to 3, is assigned according to the level of execution: 0 = does not start, 1 = starts but partially executes (<10%), executes (between 10 and 99%), 3 executes perfectly.

Stork test

The Stork test was used to measure balance ability in a static position. The average time the subject maintained a balanced position on each foot was recorded: the subject in a standing position, with hands at his or her sides and without shoes, lifted one leg and rested his or her toes against the knee of the contralateral leg, then lifted the heel of the foot resting on the floor, trying to maintain the position as long as possible.

Sit-up test

Finally, the Sit-up test, aimed to assess the strength of the abdominal muscles was performed. The subject, lying supine, with legs flexed and feet supported, was asked to lift the torso off the floor. The maximum number of repetitions in one minute was recorded.

Training protocol

The experimental protocol lasted for 3 months and 1 weekly session lasting 60 minutes. Each session was characterized by exercises in postural alignment, trunk control, upper and lower limb strengthening, balance and coordination, muscle strengthening, consolidation of psychomotor aspects, and spatiotemporal organization through lateralization exercises. A typical session was shown in Table 1.

Table 1. Training protocol example.

Phase	**Time**	**Position**	**Exercises**
Warm-up	10 minutes	ground	The subject tried to relax through rhythmic and oscillatory movements of the horse.
Middle phase	40 minutes	horseback and ground	There was an increase of difficulty by performing motor tasks and actions, such as introducing figures, changing direction to test the ability to dynamically adapt trunk position, adapting to acceleration or decrease in gait and thus the frequency of pelvic perturbations, and also more specific exercises such as changing position in the saddle. This was followed by ground exercises to improve balance, coordination, and muscle strength.
Cool-down	10 minutes	horseback and ground	contact and manipulation, grooming from basic needs to hair care, play activities

In addition, the intervention was characterized by changes in speed and direction (avoiding cones, making circles), changes in gait and respective perturbations (from stride to trot, vice versa, from stride to halt, etc.), and changes in terrain that add challenges for the one in the saddle with the purpose of further stressing balance and stability. The activities offered were generally simple and thus covered the correct approach to the animal, contact and handling, grooming from basic needs to coat care, playful activities, conduct and basic performance activities.

Statistical analysis

Descriptive statistics were used to summarize the data into M ± SD and percent frequency. After checking the normality of the data ($p > 0.05$) with the Shapiro Wilk test, the dependent samples t-test was used to test for differences between the tested parameters before and after the application of the 12-week protocol. Data analysis was performed with Statistical Package for Social Science software (IBM SPSS Statistics for Windows, version 26.0. Armonk, NY). The significance level was set at 0.05.

Results

Improvements were shown in all three parameters tested. Specifically, the MdR scale showed an average score improvement of 29.4%, the balance test showed an average improvement of 31.1 %, and finally there was an improvement in abdominal muscle strength of 42.3% highlighted with the Sit up test. A detailed description is shown in Table 2.

Table 2. Input and output test results with percentage of improvement.

Subject	Age	MdR Scale			Stork test			Sit up Test		
		pre	post	%	pre	post	%	pre	post	%
1	24	14	30	29	20	35	34	30	50	49
2	34	13	32	31	25	38	37	29	48	47
3	28	12	33	32	23	30	29	28	43	42
4	45	15	34	33	22	30	29	25	40	39
5	34	16	33	32	20	28	27	32	43	42
6	29	17	35	34	26	40	39	33	44	43
7	40	15	37	36	24	28	27	27	45	44
8	42	14	31	30	15	30	29	26	38	37
9	37	13	20	19	16	33	32	24	42	41
10	35	16	27	26	18	32	31	23	38	37
11	40	18	27	26	17	30	29	25	39	38
12	39	19	26	25	19	31	30	31	50	49
Average	35.6	15.2	30.4	29.4	20.4	32.1	31.1	27.8	43.3	42.3
SD	6.2	2.1	4.7	4.7	3.6	3.8	3.8	3.3	4.3	4.3

Statistically significant differences ($p<0.05$) were found pre-post 12 weeks of hippotherapy in the MdR, $t(11)=-9.88$, $p=0.001$; stork test, $t(11)=-10.2$, $p=0.001$; sit up test, $t(11)=-16.84$, $p=0.001$. A detailed description is shown in Table 3.

Table 3. T-test for paired dependent samples pre-post 12 weeks of hippotherapy.

		Paired Differences					t	df	p
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	MdR pre - post	-15,25	5,34492	1,54295	-18,646	-11,854	-9,884	11	<.001
Pair 2	Stork test pre - post	-11,6667	3,96194	1,14371	-14,184	-9,14937	-10,201	11	<.001
Pair 3	Sit up test pre - Sit up test post	-15,5833	3,20393	0,92489	-17,619	-13,5477	-16,849	11	<.001

Dicussion

The results of the present study showed that 12 weeks of hippotherapy improved quality of movement, static balance, and abdominal muscle strength in subjects with MS. Specifically, the greatest improvement occurred in abdominal endurance, as the average percentage of improvement was 42.3%. The muscles of the abdomen are part of an anatomical structure that serves as a force transmission loop in the human body. This area is referred to as the core. An adequate level of strength in this district ensures stability in both static and dynamic conditions. In line with our findings, the study by Freeman et al. (2010), demonstrated the effectiveness of an 8-week intervention focusing on core stability in improving balance and mobility in people with MS. Following abdominal resistance, we find static balance improved on average by 31.1%. Before administration of the protocol, the average time in the stork position was about 20 seconds (poor level). After 12 weeks of hippotherapy, this time was about 32 seconds (average level). Improved balance control, both static and dynamic, has positive effects on reducing falls and thus reduces the risk of injuries caused by them. Cattaneo et al. (2007) demonstrated the positive relationship between maintaining good balance and reduced fall rates in subjects with MS. Exercises in different sensory contexts, which may include hippotherapy protocols, can have an impact in improving dynamic balance. Finally, we find the quality of movement experienced an average improvement of 29.4%. This parameter is very important as skills transferable to other contexts are tested as they are structured in variable contexts. Exercises carried out on horseback in movement stimulate the acquisition and development of transversal skills useful for increasing the levels of general well-being and health of the individual (Russo et al., 2019). Indeed, there are trunk and limb mobility exercises in all planes of space. Overall, the hippotherapy protocol provided significant benefits in terms of general well-being to people with MS. The limitation of the study is definitely the sample size. Future studies could replicate the study by enlarging the sample, perhaps by submitting a questionnaire in order to investigate clients' perceptions in terms of satisfaction with the activity performed and their needs (D'Elia et al., 2022) in order to get a more complete picture of the instructor's work in structuring personalized and effective training programs.

Our results were aligned with previous studies, including the findings of Vermöhlen et al. (2017) who demonstrated an improvement in balance following 12-weeks of hippotherapy. A systematic review, which collected studies on this topic, also showed that hippotherapy had a positive effect on balance in people with MS and improved quality of life (Bronson et al., 2010). Balance work in these people is critical as its decline negatively affects mobility, autonomy, and quality of life. The aim of physical exercise is precisely to enable the subject to perform activities of daily living independently, acting on those parameters considered fundamental

including mobility, strength, balance, etc.... Moraes et al. (2021) stated that hippotherapy can improve balance, mobility, perceived fatigue, and quality of life for people with MS. The various movements performed by the horse and additional exercises provide the subject with different sensory signals, a system lacking in people with MS. In addition, the subject must engage the core muscles to sit upright on the horse and making adjustments to accommodate the horse's movements, thereby also improving core stability and strength (Long et al., 2013), another parameter improved as a result of the 12-week protocol. Finally, as for the MdR scale, to our knowledge it has never been used in the literature, however, it could be a useful tool to assess the qualitative aspect of movement in order to complement the quantitative assessment. The limitation of the study is the sample size and the absence of the control group, emphasizing the need to repeat the study on a larger sample in order to divide it into several groups and compare them. The strength is a hippotherapy protocol that can improve strength and stability of the abdomen and balance in subjects with MS in terms of quantitative parameters, and quality of movement, thanks to the use of the MdR scale, which is the novelty in terms of qualitative assessment.

Conclusions

From the results of the study, it was possible to state that hippotherapy is a valuable tool for promoting physical activity for people with MS, as it goes a long way toward stimulating numerous variables, including strength, balance, and quality of movement. In addition, it is a safe and fun activity carried out in the natural environment that stimulates the development of physical, cognitive and relational skills through a continuous relationship with the environment and the animal. The study also intends to expand the use of hippotherapy for people with other conditions, such as cerebral palsy or autism. These evidence can provide a basis from which technicians and practitioners can be inspired to develop protocols designed to ensure the development and maintenance of an adequate level of well-being and health in all people through fun, safe, and dynamic activity.

Conflicts of interest - The author declares no conflicts of interest.

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