



The Effect of 8-week Aquatic and Terrestrial Exercises on Functional Balance and Psychological Factors of Spastic Cerebral Palsy Girls

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Abstract

Background: Considering the stature problems and the insufficient levels of physical activity in people with cerebral palsy, balance and its influencing factors can play an important role in these patients' activities. In this study, we aimed to investigate the effect of eight weeks of aquatic and terrestrial trainings on the functional balance and psychological factors of spastic cerebral palsy girls.

Methods: This semi-experimental study was conducted based on a pretest-posttest design. We investigated 19 girls with diplegia and quadriplegia spastic cerebral palsy who aged from 8-15 years and lived in Yazd, Iran. The participants were selected based on the available population and categorized into two groups of terrestrial training (N = 10) and aquatic training (N = 9). Both groups received training for eight weeks (three times a week). In order to evaluate the participants' functional balance, Berg's functional balance test was performed for both groups before and after the intervention. In addition, Depression Anxiety and Stress Scales (DASS-21) were applied to study the psychological factors of both groups before and after the intervention. To analyze the data, the Shapiro-Wilk test, independent t-test, and dependent t-test were used.

Results: The results showed that both terrestrial and aquatic training groups improved considering functional balance, but this improvement was just significant in aquatic training group (P=0.042). However, no significant difference was observed in the psychological factors as well as depression, anxiety, and stress.

Conclusion: We suggest aquatic trainings to improve the functional balance.

Keywords: Cerebral palsy, Balance, Anxiety, Stress

Conflicts of Interest: The authors have no conflict of interest in this study.

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Introduction

Cerebral palsy is the most common disability that begins in the childhood and has a variety of effects on the daily activities of patients [1]. It has different types, including quadriplegia and spastic diplegia (85.7%), ataxic (4.3%), dyskinetic (6.5%), and hypotonic (3.7%) [2, 3]. Spastic cerebral palsy children have musculoskeletal problems, motor

disorders, and reduced pelvic movements that cause movement stiffness and lead to sedentary life style. These problems result in postural instability, imbalance, and abnormal posture [4]. Spasm of the Iliopsoas muscle, as the strongest hip flexor, leads to trunk bending in these patients and this condition is exacerbated by the abdominal muscles. Conse-

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↑What is "already known" in this topic:

Few studies have been performed for comparing the effectiveness of terrestrial exercise with aquatic exercise on the function of patients with cerebral palsy.

→What this article adds:

This study shows that aquatic exercises were more effective than terrestrial exercises in cerebral palsy children.

quently, the center of gravity of the body tends to go forward and therefore, the likelihood of falling increases in these children. Existence of internal spin and femoral flexion, as well as involvement of Sartorius, hamstring, and biceps femoris muscles along with weak knee extensors cause flexion in the knee joint. All these factors cause serious disorders in walking and balance in these patients [5]. People suffering from physical and motor disabilities also have psychological complications related to their disability. Mood and anxiety disorders were the most commonly diagnosed problems among the people who received welfare counseling services [6]. Psychological factors affect neurological patients directly by causing damage to their neural tissues and indirectly as a response to the inability and disability. Depression, chronic fatigue, hysteresis reaction, chronic pain, and cognitive changes are among the psychological barriers in the rehabilitation of neurological patients [7] and cerebral palsy, as a neurological disease is no exception in this regard.

The main goal of treatment in cerebral palsy is improvement of the ability to walk or engage in the functional activities. Therapeutic exercises are intended to improve the performance of children with cerebral palsy up to an appropriate level [8]. Exercise therapy at the lower trunk was observed to improve the muscle strength, capacity, and flexibility, which have important role in walking [9]. Terrestrial exercises are very similar to daily activities since they do not neutralize the gravity, but the aquatic environment with properties such as hydrostatic pressure induces feelings of floatation and depth and can be used as an ideal environment to do physical exercises. Many of the movements that are difficult to do on the land are easily carried out in the water and people are able to perform them with less intensity. The floating property of water is the upward push of water, which is completely in the opposite direction of pressure induced by land. Due to this property, body weight decreases by 90 percent in water. As a result, the pressure on the joints is reduced and the body is able to perform the exercises completely [10]. This method can also reduce pain, increase the flexibility of muscles and bones, reduce muscle spasms, and finally increase the strength and ability of the individual [11].

Although clinical rehabilitation interventions are recommended for these children around the world, the current situation suggests that the level of sports and recreational activities for these children is not enough. Children with cerebral palsy have insufficient physical activity due to their stature problems; whereas, these children need at least one hour of exercise a day [12].

In a study that evaluated the effects of complementary and alternative therapies on cerebral palsy, children who used these treatments were significantly (70%) better than the control group (47%) [13]. The effects of different methods such as kinesio-taping techniques [14], virtual reality and motion therapy [15], rebound therapy [16], exercise therapy [9], as well as massage and cold therapy [17], alone or in combination with other methods were also investigated. These studies indicated that such techniques improved motor function [14, 15], dynamic activities [14],

and flexibility [9, 16]. They also enhanced muscle strength and balance [16], decreased spasticity, and increased range of movements [17] in patients with cerebral palsy. Studies showed that these exercises were useful for patients with cerebral palsy [18, 19] and improved flexibility, pulmonary function [18], functional skills, endurance, and speed of walking in children with cerebral palsy [20]. Such exercises were also effective in improving the range of movements, muscle strength, pain relief [21], and the gait energy expenditure index [22].

Due to the lack of studies dealing with the effect of aquatic training interventions on the rehabilitation of these patients, the efficacy of such interventions for these patients has not been well evaluated [18] and more studies are needed in this area. Since studies conducted so far have not reported any negative effect for such exercises [23], this method can be used as an alternative treatment even for patients with high GMSCF [24]. Because high GMSCF patients not only have significant motor activity limitations [18], but also the number of terrestrial exercises appropriate for them is limited [25], these exercises can be useful for their whole life [26]. However, personal and environmental barriers such as fear, rejection, transportation, and access problems limit application of this method [27].

Considering the above ideas, we need to conduct more studies to investigate the effect of different rehabilitation methods on balance and motor skills of patients with cerebral palsy. Furthermore, we need to consider the fact that physical and motor disability of children with cerebral palsy has several psychological complications. Therefore, in this comparative study, we investigated the effects of aquatic and terrestrial trainings, as two types of rehabilitation therapies, on the functional balance ability and psychological factors of children with cerebral palsy.

Methods

Selection of volunteers

The present quasi-experimental interventional study was carried out using a pretest-posttest design. Girls with cerebral palsy who aged 8-15 years and referred to Saba Rehabilitation Center in Yazd within April to July 2017. The samples were selected according to the available community of patients with cerebral palsy. Participants included 20 girls with diplegia and quadriplegia spastic cerebral palsy and all of them had reduced muscle strength. The inclusion criteria were: diagnosis of diplegia and quadriplegia by physician, age range of 8-15 years, having no specific cardio-respiratory problem, having no hearing and vision impairments, having no apparent limitation in the lower limb passive range, having Gross Motor Function Classification System (GMFCS) level 1 or 2, having the ability to understand and execute verbal instructions, and having no history of surgery in the past year. The only exclusion criterion was the absence of more than five treatment sessions throughout the study period. After receiving the written consent forms from the participants' parents and explaining the process of intervention for children and their companions, the patients were randomly divided into two groups of aquatic training (N = 10) and terrestrial training

(N = 10), then all participants were evaluated for functional balance by Berg test and Psychological status by DASS-21 test.

Berg balance test

This test was developed in 1989 by Berg and since then it has been used for the elderly as well as patients with stroke, MS (multiple sclerosis), Parkinson's disease, and many other neurological and orthopedic disorders. In this test, the ability of a person is evaluated in 14 daily movement maneuvers [28]. The maneuvers of Berg balance scale include: 1. Sitting unsupported; 2. Standing with feet apart; 3. Standing with feet together; 4. Standing with closed eyes; 5. Standing with one foot front; 6. Standing on one foot; 7. Standing to sitting; 8. Sitting to standing; 9. Transferring from bed to chair; 10. Turning 90 degrees; 11. Turning 360 degrees; 12. Retrieving object from the floor; 13. Reaching forward with outstretched arm; 14. Placing alternate foot on stool. At each stage, the person can get a score from zero (the minimum score) to four (the maximum score). Based on the quality of performance, a score of four means complete ability and a score of zero shows inability to perform the activity. Therefore, the maximum total score that a person can achieve in this test is 56; higher scores indicate better balance ability. In this test, the scores of 0-20 represent high falling risk, scores of 21-40 mean moderate level of falling risk, and the scores of 41-56 indicate low levels of falling risk [29].

The required time for the tests is 15 to 20 minutes and a small amount of equipment is needed to perform it. The reliability and validity of this scale are very high, so that it is known as a gold standard. This test was applied in study in Iran [28]. A study showed that Berg balance scale had high reliability and validity for measuring the balance in spastic hemiplegic cerebral palsy children and could be used as a valid clinical measure for the evaluation of children with cerebral palsy [30].

DASS-21 test

the DASS-21 test, which includes 21 items and investigates the subscales of depression (questions number 3-5-10-13-16-17-21), anxiety (questions 2-4-7-9-15-19-20), and stress (questions 1-6-8-11-12-14-18), was applied to study the psychological status of the subjects. The scoring of this test is recorded in Table 1.

Method of intervention

After performing the pre-test, the patients participated in 60-minute training exercises three sessions a week, for eight weeks. This intervention was designed based on the findings of a study indicating that training two to three times a week increased muscle strength; whereas, exercises conducted once a week were not enough to increase the muscle strength [20]. The Aquatic Training group exercised for three 60-minute sessions in a pool per week, while the Terrestrial Training Group exercised for the same time in the clinic. Initially, the exercises in each session contained 25 minutes of warming and stretching the trunk and lower limb muscles. Then, 10 minutes of balance exercises

and 20 minutes of reinforcement exercises were performed. Finally, 5 minutes of cool down exercises were performed to restore the body to its original state. The reinforcement trainings were designed in the form of single-joint, two-joint, multi-joint, and combined exercises (static, semi-dynamic, and dynamic balance exercises) according to the participants. In the initial sessions, the exercises were provided with supportive forces and over a period of time, they were conducted independently.

Statistical analysis method

In order to analyze the data, SPSS was used. The Shapiro-Wilk test was also applied to calculate the data. Furthermore, to study the intra-group changes in pre- and post-test measurements, we run the paired t-test. In order to compare the results of the two groups, Independent t-test was applied at the significant level of 0.05.

Results

In this study, 20 children with a main age of 12.09 ± 2.2 were assigned into two groups of aquatic training (N=10) and terrestrial training (N=10). The mean age in aquatic training group and terrestrial training group were 11.94 ± 2.2 , 12.33 ± 2.4 ($P=0.792$) respectively. The mean height and weight in aquatic training group and terrestrial training group were 140.06 ± 12.8 , 140.18 ± 11.47 ($P=0.745$), 38.66 ± 12.43 , 36.95 ± 10.025 ($P=0.982$) respectively.

During the study, one of the children in the aquatic training group was excluded from the study due to refused to continue (Figure 1).

The Descriptive information of patients is presented in Table 2.

As shown in Table 2, there is no significant difference between the two groups in terms of participants' characteristics pre-test scores.

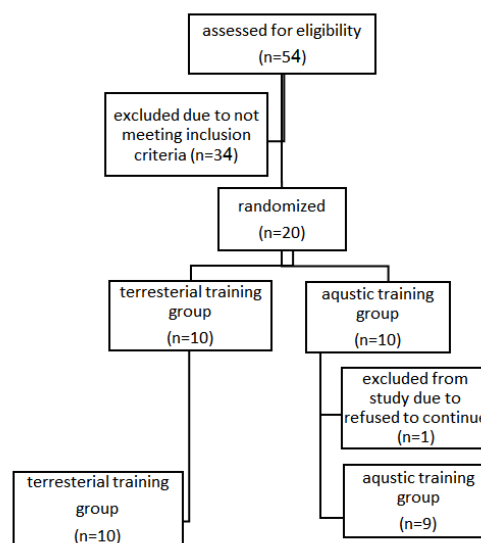


Figure 1. Study flowchart of patients' disposition

Table 2. Patients' Descriptive information at the beginning of the study

Variable	Aquatic Training Group (n = 9)	Terrestrial Training Group (n = 10)	p
Balance	32.00±11.1	29.60±11.1	0.644
Stress	11.33±3.1	9.40±5.2	0.133
Anxiety	7.56±1.5	7.00±4.5	0.220
Depression	8.44±3.7	5.60±5.6	0.298
Psychological factors	27.33±8.6	22.00±12.4	0.754

Table 3. Comparison of changes in the five studied variables before and after the intervention between two groups

Variable	Aquatic Training Group (n = 9) (mean difference between pre & post test ± standard deviation)	Terrestrial Training Group (n = 10) (mean difference between pre & post test ± standard deviation)	p
Balance changes	4.33 ±1.2	3.10 ±1.2	0.047
Stress changes	-0.33±0.7	-0.20±0.42	0.905
Anxiety changes	-0.33±0.7	0.00±0.00	0.447
Depression changes	0.44±0.7	0.30±0.6	0.661
Psychological factors changes	-1.11 ±0.9	00.5±0.9	0.156

In order to study and compare the aquatic and terrestrial training groups' performance, we investigated the changes related to the variables after the intervention. We found that both groups had a significant improvement in balance function, but these changes were only significant in the aquatic training group (P=0.042). In terrestrial training group, participants' stress and psychological factors improved after the intervention, although the difference was not significant (P=0.661, P=1, respectively). The subjects in the aquatic training group also had improvement in their stress and psychological factors, but the difference between the results of pre- and post-tests was not significant (P=0.541, and P=974, respectively). In the aquatic training group and Terrestrial Training Group the impact of trainings on the stress was positive (-0.33±0.7, -0.20±0.42 respectively), but not significant (P=0.905). However, no positive effect was observed on depression in both groups. In Table 3, the level of changes is compared in both groups.

As Table 3 shows, the only significant difference was observed in the functional balance in the aquatic training group.

Discussion

In the present study, we compared the effects of eight-week aquatic and terrestrial trainings on the functional balance and psychological factors of spastic cerebral palsy girls. The results of the study showed that the functional balance of individuals in both groups improved, but this improvement was significantly higher in the aquatic training group. As reported in the previous studies, resistance exercises improved coarse motor skills, balance, and walking speed in children with diplegic cerebral palsy. The purpose of rehearsal exercises and rehabilitation programs in these

children was reported to increase the general body capacities and enhance independent function [21]. In addition, resistance and balance exercises affected muscle strength [33, 34, 14], trunk endurance, balance [33, 14, 35], postural stability, and prevented from the secondary musculoskeletal disorders [34]. The central stability exercises [36], climbing exercises, and sitting to standing exercises [37] also improved balance.

The water environment has unique properties for children and adolescents. For example, the weight-bearing requirements, the amount of trunk control, joints load, and gravity effects are reduced in water [24] and as a result, aquatic exercises are more likely to maintain joint integrity than the land-based activities [38]. It was also reported that activity in water increased self-esteem and reduced the patient's resistance to do difficult activities [39]. Given that aquatic activities are potentially more fun and romantic for children; their motivation would be reinforced for doing these exercises in water [40]. All of these factors can increase the effectiveness of aquatic exercises in comparison with the terrestrial exercises; the result that we obtained in this study.

In literature, different results have been obtained for the effects of aquatic exercises on the psychological factors of various diseases. For instance, average efficiency was observed for aquatic exercises in the treatment of fibromyalgia [41]. In another study, aquatic training method decreased depression in patients with fibromyalgia [42], but it did not affect the anxiety of these patients in another research [43]. However, in the other study, it decreased both anxiety and depression [44]. Water therapy had a significant effect on the life quality (mood, physical capacity, and enjoyment) of patients with heart failure [45] and decreased stress in patients with intensive care needs [46]. Moreover, the aquatic endurance training had positive effect on the patients' public health (anxiety, insomnia, somatic symptoms, social functions, and depression) [47].

The water environment is very pleasant, comfortable, and fun because it reduces the pressure on the joints and provides a good environment for people to exercise [48]. Floating in the water can affect psychosocial aspects by creating a kind of mental vacuum feeling, reducing mental

Table 1. Scoring method of DASS-21

Degree	Depression	Anxiety	Stress
Normal	0-9	0-7	0-14
Mild	10-13	8-9	15-18
Moderate	14-20	10-14	19-28
Severe	21-27	15-19	26-33
Extremely severe	28 and more	20 and more	34 and more

and psychological stress, and decreasing the norepinephrine secretion [49]. In studies that reported significant progress in psychological factors, the duration of exercises was more than 20 weeks [50, 51] or the exercises were accompanied with the training of patients [52-54]. Thus, it seems that lack of significant changes in the psychological factors of our study were due to the short duration of exercises.

We suggest other researchers to conduct studies with a larger sample size and longer training time to investigate the influence of this treatment method and other types of exercises on the functional balance and psychological factors of children with cerebral palsy. Furthermore, there are few studies on the psychological factors in patients with cerebral palsy and the impact on these factors on the treatment and rehabilitation of cerebral palsy patients is still unclear.

Conclusion

Aquatic training improves functional balance in children with cerebral palsy. Therefore, we recommend that it be used in the rehabilitation of patients with cerebral palsy. But more studies are needed for the effectiveness of aquatic trainings on psychological factors.

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Conflict of Interests


The authors declare that they have no competing interests.

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تأثیر هشت هفته تمرینات آبی و خشکی بر تعادل عملکردی و عوامل روان شناختی دختران فلج مغزی اسپاستیک

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چکیده

مقدمه: با توجه به وجود مشکلات قامتی و سطح ناکافی فعالیت بدنی در افراد مبتلا به فلج مغزی، تعادل و عوامل موثر بر آن می‌تواند نقش مهمی را در عملکرد ایفا کند. این پژوهش به بررسی تأثیر هشت هفته تمرین آب و خشکی بر تعادل عملکردی دختران فلج مغزی پرداخته است.

روش‌ها: پژوهش حاضر از نوع نیمه تجربی با طرح پیش آزمون-پس آزمون است. که در آن ۱۹ دختر مبتلا به فلج مغزی اسپاستیک دیپلزی و کوادریپلزی ۵-۱۸ سال از یزد، ایران مورد مطالعه قرار گرفته اند. از جامعه در دسترس در قالب دو گروه تمرین در خشکی (۱۰ نفر) و آبدرمانی (۹ نفر) به عنوان آزمودنی شرکت داشتند. هر دو گروه تحت مداخلات تمرینی مربوطه؛ به مدت هشت هفته (سه جلسه در هر هفته) قرار گرفتند. قبل و بعد از اعمال مداخله در هر دو گروه آزمون برگ جهت ارزیابی تعادل عملکردی و پرسشنامه افسردگی، اضطراب، استرس (DASS-21) جهت ارزیابی عوامل روان‌شناختی اجرا شد. برای تجزیه و تحلیل داده‌ها از آزمون شاپیرو-ویلک و آزمون استفاده شد.

یافته‌ها: نتایج نشان داد هم تمرینات در آب و هم تمرینات در خشکی موجب بهبود در وضعیت تعادل عملکردی شد اما این نتایج تنها در گروه تمرین در آب معنی دار شد ($P=0.042$). هر چند تفاوت معنی داری در نتایج دو گروه برای فاکتورهای روان‌شناختی (افسردگی، اضطراب، استرس) دیده نشد.

نتیجه‌گیری: استفاده از تمرینات ورزشی در آب باعث بهبود تعادل عملکردی در کودکان مبتلا به فلج مغزی می‌شود.

کلید واژه‌ها: فلج مغزی، تعادل عملکردی، اضطراب، افسردگی، استرس، عوامل روان‌شناختی

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