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

Elahe Akbar \(^1\), Hamideh Abutorabi Zarchi \(^2\), Nasim Namiranian M.D\(^3\), Marzie Abutorabi Zarchi M.D\(^{4*}\)

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-
quenty, 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 partosomes, hamstring, and bi- 
ciceps femoris muscles along with weak knee extendors 
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 di- 
gnosed problems among the people who received welfare 
counseling services [6]. Psychological factors affect neuro-
logical patients directly by causing damage to their neural 
tissues and indirectly as a response to the inability and dis-
ability. Depression, chronic fatigue, hysteresis reaction, 
chronic pain, and cognitive changes are among the psycho-
logical barriers in the rehabilitation of neurological patients 
[7] and cerebral palsy, as a neurological disease is no ex-
ception in this regard.

The main goal of treatment in cerebral palsy is improvement of the ability to walk or engage in the functional activ-
tivities. Therapeutic exercises are intended to improve the performance of children with cerebral palsy up to an appro-
priate level [8]. Exercise therapy at the lower trunk was ob-
served to improve the muscle strength, capacity, and flexi-
bility, 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 environ-
ment 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 inten-
sity. The floating property of water is the upward push of 
water, which is completely in the opposite direction of pres-
sure induced by land. Due to this property, body weight de-
creases 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 recom-
manded for these children around the world, the current sit-
uation suggests that the level of sports and recreational ac-
tivities for these children is not enough. Children with cer-
ebral 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 meth-
ods 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 investigat-
ed. 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 
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 ex-
penditure 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 pa-
tients 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 cere-
bral 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 rehabilita-
tion therapies, on the functional balance ability and psycho-
logical factors of children with cerebral palsy.

**Methods**

**Selection of volunteers**

The present quasi-experimental intervention study was 
carried out using a pretest-posttest design. Girls with cere-
bral palsy who aged 8-15 years and referred to Saba Reha-
bitilation Center in Yazd within April to July 2017. The 
samples were selected according to the available commu-
nity 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 in-
clusion criteria were: diagnosis of diplegia and quadriple-
gia by physician, age range of 8-15 years, having no spe-
cific cardio-respiratory problem, having no hearing and vi-
sion 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 ex-
clusion criterion was the absence of more than five treat-
sment 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 com-

**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-dy-

**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**

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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 ($P=0.905$). 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 ($0.33\pm0.7$, $-0.20\pm0.42$ 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. Patients’ Descriptive Information at the Beginning of the Study

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

### Table 2. Comparison of Changes in the Five Studied Variables Before and After the Intervention Between Two Groups

<table>
<thead>
<tr>
<th>Variable</th>
<th>Aquatic Training Group</th>
<th>Terrestrial Training Group</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(mean difference between pre &amp; post test ≠ standard deviation)</td>
<td>(mean difference between pre &amp; post test ≠ standard deviation)</td>
<td></td>
</tr>
<tr>
<td>Balance changes</td>
<td>4.33±1.2</td>
<td>3.10±1.2</td>
<td>0.047</td>
</tr>
<tr>
<td>Stress changes</td>
<td>-0.33±0.7</td>
<td>-0.20±0.42</td>
<td>0.905</td>
</tr>
<tr>
<td>Anxiety changes</td>
<td>-0.33±0.7</td>
<td>0.00±0.00</td>
<td>0.447</td>
</tr>
<tr>
<td>Depression changes</td>
<td>0.44±0.7</td>
<td>0.30±0.6</td>
<td>0.661</td>
</tr>
<tr>
<td>Psychological factors changes</td>
<td>-1.11±0.9</td>
<td>0.50±0.9</td>
<td>0.156</td>
</tr>
</tbody>
</table>

### Table 1. Scoring Method of DASS-21

<table>
<thead>
<tr>
<th>Degree</th>
<th>Depression</th>
<th>Anxiety</th>
<th>Stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>0-9</td>
<td>0-7</td>
<td>0-14</td>
</tr>
<tr>
<td>Mild</td>
<td>10-13</td>
<td>8-9</td>
<td>15-18</td>
</tr>
<tr>
<td>Moderate</td>
<td>14-20</td>
<td>10-14</td>
<td>19-28</td>
</tr>
<tr>
<td>Severe</td>
<td>21-27</td>
<td>15-19</td>
<td>26-33</td>
</tr>
<tr>
<td>Extremely Sev</td>
<td>28 and more</td>
<td>20 and more</td>
<td>34 and more</td>
</tr>
</tbody>
</table>
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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The effect of Aquatic and Terrestrial Exercises on Spastic Cerebral Palsy


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

الله اکبر ۱، حمیده ابوترابی زارچی ۲، نسیم نمیرانیان ۳، مرضیه ابوترابی زارچی ۴

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 آبی 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 دختربچه فلج مغزی اسپاستیک دیپلژی و کوادریپلژی ۱۸-۵ سال از یزد، ایران مورد مطالعه قرار گرفته اند. از جامعه دردسترس در قالب دو گروه درمانی شرکت داشتند. گروه اول به منظور تمرین شنا در آب و گروه دوم به منظور تمرین بر دو پا در صحنه عملیاتی لازم بود. برای ارزیابی تعادل عملکردی به کار نظریه DASS-21 (افسردگی، استرس، اضطراب) از آزمونهای اسپیچس انجام شد.

یافته‌ها: نتایج نشان داد که هشت هفته تمرین در آب و هشت هفته تمرین در صحنه عملیاتی باعث بهبود تعادل عملکردی در دختران مبتلا به فلج مغزی می‌شود. این تفاوت معنی‌دار بود که P=0.042.

نتیجه‌گیری: استفاده از تمرینات ورزشی در آب و صحنه عملیاتی باعث بهبود تعادل عملکردی دردکسان مبتلا به فلج مغزی می‌شود.

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

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2. حمیده ابوترابی زارچی، باشگاه پژوهشگران جوان و نخبگان، واحد یزد، دانشگاه آزاد اسلامی، یزد، ایران
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4. مرضیه ابوترابی زارچی، استادیار روانپزشکی اجتماعی مرکز تحقیقاتی دانشگاه علوم پزشکی و خدمات بهداشتی درمانی شهید صدوقی، یزد

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