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THE EFFECT OF AQUATIC THERAPY AT DIFFERENT LEVELS OF WATER DEPTH ON FUNCTIONAL BALANCE AND WALKING CAPACITY IN CHILDREN WITH CEREBRAL PALSY

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ABSTRACT

The purpose of this study was to evaluate the effects of aquatic therapy program on functional balance and walking capacity in children with cerebral palsy. The sample consisted of six children (4 boys and 2 girls) with cerebral palsy. The average age of the participants was 7 year 4 months ± 1y 2mo (Mean ±SD). All the children were able to walk independently with or without assistive devices. Gross Motor Function Classification System levels of the participants were I to III. This scale divides walking ability into 5 levels. The aquatic program lasted for 8 weeks and twice per week. Each session lasted for 50 minutes, comprising 10 minutes of warm-up and stretching and 40 minutes of walking in the pool at different levels of water depth. Each child started walking at nipple height water every five minutes the depth of water was decreased by 1 inch. Functional balance (pediatric balance scale) and walking capacity (1minute walk test) were evaluated before and after intervention. Changes in functional balance were statistically significant between initial and final testing, at p= 0.026. There was statistically significant change in the walking capacity, between initial and final testing, at p= 0.041.Functional balance and walking capacity were improved in children with cerebral palsy following aquatic therapy in the pool at different levels of water depth.

KEYWORDS: *Aquatic therapy, cerebral palsy, functional balance, walking ability, water walking*

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INTRODUCTION

Cerebral palsy(CP), the most common childhood physical disability, describes a group of non-progressive disorders of the premature developing brain that adversely affect movement and posture, causing limitations in activities and participation.[1] Impairments such as weakness, spasticity, and incoordination, lead to difficulty in activities such as propelling their wheelchairs, walking independently, negotiating steps, and running or navigating safely over uneven terrain.[2] Improving one's ability to walk or to perform other functional activities are often the primary therapeutic goals for people with CP.[3] Aquatic interventions are some forms of alternative therapy used for children with cerebral palsy and similar Neuromotor damages.[4] Aquatic exercise is optimal for this population because it decreases weight-bearing requirements and the effects of gravity, requires less trunk control to support the body, and provides decreased joint loading. Success in activities in the water may lead to increased enjoyment and greater participation.[5] Aquatic therapy has physiological effects that can be classified into thermal and mechanical effects. Mechanical effects include both hydrostatic and hydrodynamic effects. The mechanical effects of aquatic therapy include buoyancy, hydrostatic pressure, and hydrodynamic force. Buoyancy decreases the effect of gravity and enables children with cerebral palsy to perform activities they cannot perform on land.[6]These characteristics may allow children with CP to exercise in water with more freedom than on land. The resistive forces of buoyancy and viscous drag permit a variety of aerobic and strengthening activities that can be easily modified to accommodate the wide range of motor abilities of children with CP.[7] The aim of this research was to determine the aquatic exercise effects which included water walking in different water depth on functional balance and walking speed in children with cerebral palsy.

MATERIALS AND METHODS

Participants

The sample consisted of six children (4 boys and 2 girls) with cerebral palsy. All children were selected from the Terita neuro rehabilitation center in the city of Karaj. Descriptive characteristics of study participants are presented in Table 1.

Inclusion criteria were as follows

Diagnosis of cerebral palsy, aged 6 to 10 years, able to walk independently with or without an assistive device, able to follow simple verbal instructions, Gross Motor Function Classification System levels of I to III, written consent from their parents. The average age of the participants was 7 year 4 months ± 1y 2mo (Mean ±SD). One child had level I, Three children had level II, and two children had level III of the Gross Motor Function Classification System (GMFCS).

Exclusion criteria were as follows

Receiving botulinum toxin injection or surgery no earlier than 6 months before project start, uncontrolled epilepsy; skin problems such as open wounds, or active infection.

Table 1
Descriptive characteristic of the participants.

The number of participants	**7**		
Age (year and month)	Mean		SD
	7.4		1.2
Gender	Male		Female
	4		2
GMFCS Levels	I	II	III
	1	3	2

Measurements

Gross Motor Function Classification System (GMFCS)

GMFCS is a 5 level classification system that describes the gross motor function of children with cerebral palsy on the basis of their self-initiated movement with particular emphasis on sitting, walking, and wheeled mobility. Distinctions between levels are based on functional abilities and on how meaningful they are in daily life, the need for assistive technology and to a much lesser extent, movement quality .[8] Level I - means walking without restriction, the limitations are in the more advanced gross motor skills. Level II - means walking without assistive devices, walking limitations outdoors and in the community. Level

III - means walking with assistive mobility devices, walking limitations outdoor and in the community .[8]

The Pediatric Balance Scale (PBS)

PBS, a modification of Berg's Balance Scale, was developed as a reliable measure of functional balance measure for school-age children with mild to moderate motor impairments. The PBS has been demonstrated to have good test-retest and inter rater reliability when used with school-age children with mild to moderate motor impairments. PBS can be used clinically to screen for functional balance deficits, identify a need for physical therapy intervention, and to monitor progress within a therapeutic program. It is quick to administer and is easily scored. Total test administration and scoring time is 15 minutes. The PBS does not require the use of specialized equipment. It provides clinicians with a standardized format for measurement of functional balance tasks which are routine components of physical therapy examination for the school-age child with mild to moderate motor impairments .[9] The Berg Balance Scale has undergone extensive reliability and validity testing within the geriatric patient population .[10]

Minute walk test (1MWT)

Walking capacity was evaluated with the 1-Minute walk test (1MWT) on a flat circular walking track.[11]Each meter is marked with adhesive tape to make it easy to calculate the completed distance. The child will be instructed to walk for one minute as fast as possible, without running. After one minute the meter nearest to the child's position will be recorded and the total distance completed will be used for the analysis.[12] 1- Minute walk test is a valid measure for assessing functional ability in children with cerebral palsy. Its cost-effectiveness and user friendliness make it a potentially useful tool in the clinical setting .[11]

Design and Procedure

The aquatic program lasted for 8 weeks with training sessions twice per week. Each session lasted 50 minutes, comprising 10 minutes of warm up and stretching and 40 minutes of walking in the pool at different water depth. Each child started water walking at nipple height which allows the body to be mostly supported by water buoyancy and provides water resistance for the body to work against. Every five minutes the depth of water was decreased by 1 inch. In the last five minutes of session, the level of water was at anterior superior iliac spine (ASIS) level. Temperature of pool water was between 33°c and 36°c.The program was conducted in a 4*4 meter pool which was located in the Terita Nuro rehabilitation Center in the city of Karaj. The floor of the pool was adjustable and movable to different height by four hydraulic jacks which allows different water depth from 0 cm to 150 cm. Functional balance and walking capacity were evaluated before and after intervention by an occupational therapist.

STATISTICAL ANALYSIS

In this research we had 6 children so the Wilcoxon test for nonparametric statistics was used in order to detect the differences between the initial and final measuring of the PBS and 1MWT.

RESULTS

Descriptive statistics for pre-and post-training measurements of functional balance, and walking capacity are presented in Table 2. The obtained results show a statistically significant difference between the initial and final measuring of the PBS and 1MWT.

Table 2
Pre-test and post-test values of PBS and 1MWT

Variable	Pre-test		Post-test		P-value
	Mean	SD	Mean	SD	
PBS	24.50	7.71	27.83	7.08	= 0.026
1MWT	19.16	8.51	20.66	8.16	= 0.041

PBS (p value <0.05) and 1MWT (*p value <0.05*)

Regarding PBS result, which refers to functional balance, statistically significant changes were noted at the post-test measuring compared to the pre-test, at the p= 0.026 significance level. The means of PBS at initial and final measuring were respectively, 24.50 and 27.83. For 1MWT result, which refers to walking capacity, statistically significant changes were found between initial and final testing, at the p= 0.041 significant level. The means of 1MWT at initial and final measuring were respectively, 19.16 and 20.66.Fig. 1 and Fig. 2 depict pre-test and post-test values of PBS and

1MWT for each participant, respectively. Compared to pre-training data, all 6 participants exhibited improvements in functional balance, and five participants displayed an increase in walking capacity following our intervention

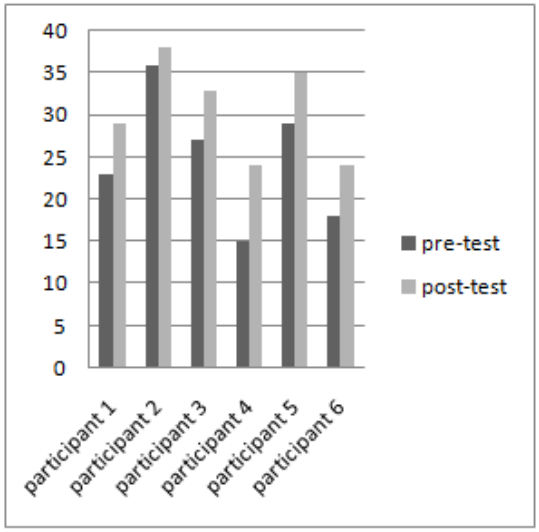

Figure 1
Values of PBS for each participant

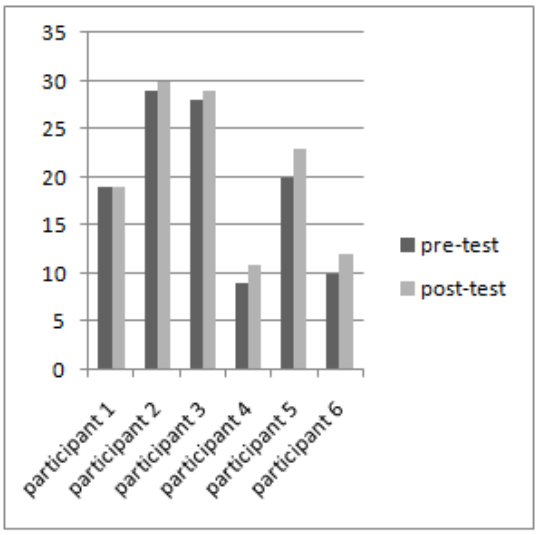

Figure 2
values of 1MWT for each participant

DISCUSSION

Motor dysfunctions in children with cerebral palsy result in limited activities in daily life.[13,14] Many studies have pointed to the potential of pediatric aquatic therapy programs to significantly benefit children with cerebral palsy.[5,15] Aquatic exercise is a great form of exercise for children with CP because of the unique properties of water that may reduce risks associated with joint loading, and may allow a child to engage more easily in intensified strength and/or aerobic activity than land-based exercise.[15] In this research the great potentials of aquatic exercises for cerebral palsy children with different levels of gross motor function (GMFCS I, II and III) were explored. The most progress in functional balance and walking capacity in this study occurred in participants with GMFCS III and after that II. Our result is similar to the study of, Lai *et al.* They investigated the pediatric aquatic therapy on motor function and enjoyment in children diagnosed with cerebral palsy of various motor severities. They indicated that pediatric aquatic therapy generates greater gains in gross motor function and physical activity enjoyment, especially for children with Gross Motor Function Classification System level II and the spastic diplegic subtype.[13] Children with CP have weaker muscles than healthy children.[16,17] Muscle strength correlates with gait and motor function.[18,19,20]. The resistive forces of buoyancy and viscous drag permit a variety of aerobic and strengthening activities on lower extremities that can be easily modified to accommodate the wide range of motor abilities of children with CP.[7]The present study made use of these potentials of aquatic therapy to increase the muscle strength in lower extremity of children with cerebral palsy along with gradual decrease of water depth every five minutes. In the procedure adopted the water depth was decreased in order to reduce the support provided by the water to the children when they water walked. When a child with CP walks in water, negative influences of poor balance and poor postural control can be compensated by water [15] so it was essential that the level of water was gradually decreased to minimize water support.

CONCLUSION

The results of this research suggest that the applied aquatic program which included water walking in different levels of water depth led to improvement in functional balance and walking capacity in children with cerebral palsy. This was just a pilot study. In order to use these results as a practical method of aquatic therapy, it is necessary to do this research with a bigger sample size and it is better to have a control group.

AUTHORS CONTRIBUTION STATEMENT

Fatorehchy S. and Hosseini S.A. conceived and designed the study and collected the data.

Fatorehchy S. performed the experiments and wrote the paper.Rassafiani M. performed the analysis.

CONFLICT OF INTEREST

Conflict of interest declared none

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