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ABEF

Influence of water activities on the functional balance of children and adolescents with cerebral palsy

Influência das atividades aquáticas no equilíbrio funcional de crianças e adolescentes com paralisia cerebral

Influencia de las actividades acuáticas en el equilibrio funcional de niños y adolescentes con parálisis cerebral

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Resumo

Objetivo: investigar se um programa de atividades aquáticas interfere no equilíbrio de crianças com paralisia cerebral. **Método:** a investigação foi realizada por meio da Escala de Equilíbrio Pediátrica (EEP), onde foi mensurado o grau de equilíbrio estático e dinâmico de 20 escolares de ambos os generos com paralisia cerebral, classificados como I e II quanto aos níveis do Sistema de Classificação da Função Motora Grossa Expandida e Revisada (GMFCS-E & R), praticantes de atividades aquáticas, com idade média de 13.2 ± 3.92 (média ± desvio padrão) anos. O teste foi realizado em 2 momentos (início e após 2 meses de prática). **Resultados:** os participantes melhoraram seu equilíbrio em 26,7% na EEP ($p<0.005$, $r = 0,037$). O coeficiente de correlação de Pearson foi usado para a correlação entre a média da idade e a média da pontuação obtida na escala no incício e após a intervenção. Houve correlação de 0,79 e 0,29 entre o escore obtido na EEPe a idade no início e no final respectivamente. **Conclusão:** desta forma, crianças com paralisia cerebral consideradas ativas e praticantes de atividades aquáticas parecem apresentar menor déficit de equilíbrio ao longo do tempo, o que pode contribuir para a prevenção de quedas, melhorar a postura, concentração e socialização.
Palavras-chave: Paralisia cerebral. Equilíbrio. Atividades aquáticas.

Abstract

Objective: to investigate whether an aquatic activity program interferes with the balance of children with cerebral palsy. **Method:** the investigation was carried out using the Pediatric Balance Scale (PBS), which measured the degree of static and dynamic balance of 20 students of both genders with cerebral palsy, classified as I and II regarding the levels of the Classification System of the Expanded and Revised Gross Motor Function (GMFCS-E & R), practitioners of aquatic activities, with an average age of 13.2 ± 3.92 (mean ± standard deviation) years. The test was performed in 2 moments (beginning and after 2 months of practice). **Results:** the participants improved their balance by 26.7% in the PBS ($p <0.005$, $r = 0.037$). Pearson's correlation coefficient was used for the correlation between the mean age and the mean score obtained on the scale at the beginning and after the intervention. There was a correlation of 0.79 and 0.29 between the PBS score and age at the beginning and at the end, respectively. **Conclusion:** in this way, children with cerebral palsy considered active and practicing water activities seem to have less balance deficit over time, which can contribute to the prevention of falls, improve posture, concentration, and socialization.
Keywords: Cerebral palsy. Balance. Water activities.

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Resumen

Objetivo: investigar si un programa de actividades acuáticas interfiere con el equilibrio de los niños con parálisis cerebral. **Método:** la investigación se realizó mediante la Escala de Equilibrio Pediátrico (EEP), la cual midió el grado de equilibrio estático y dinámico de 20 estudiantes de ambos sexos con parálisis cerebral, clasificados como I y II en cuanto a los niveles del Sistema de Clasificación del Ampliado. y Función Motora Gruesa Revisada (GMFCS-E & R), practicantes de actividades acuáticas, con una edad promedio de 13,2 ± 3,92 (media ± desviación estándar) años. La prueba se realizó en 2 momentos (inicio y 2 meses de práctica). **Resultados:** los participantes mejoraron su equilibrio en un 26,7% en el EEP (p <0,005, r = 0,037). Se utilizó el coeficiente de correlación de Pearson para la correlación entre la edad media y la puntuación media obtenida en la escala al inicio y después de la intervención. Hubo una correlación de 0,79 y 0,29 entre la puntuación EEP y la edad al inicio y al final, respectivamente. **Conclusión:** de esta forma, los niños con parálisis cerebral considerados activos y que practican actividades acuáticas parecen tener menor déficit de equilibrio con el tiempo, lo que puede contribuir a la prevención de caídas, mejorar la postura, la concentración y la socialización.

Palabras-clave: Parálisis cerebral. Equilibrio. Actividades acuáticas.

Introduction

Cerebral Palsy (CP) or "chronic non-progressive encephalopathy" is an injury in one or more parts of the brain, often caused by the lack of oxygenation of brain cells, refers to a group of postural and movement disorders that occur during the development of a brain formation, which causes limitations in daily life[1-3]. Although the brain injury that causes CP is not progressive, it mainly affects mobility throughout life[4], it is persistent but variable, and can also be described as a static encephalopathy, in which the clinical picture can vary over time due to growth, development and maturation of the central nervous system[5].

Studies point to spasticity, joint deformities, shortening and muscle imbalance as the main changes in the musculoskeletal system capable of interfering in the postural control of children with CP, as well as in the sensory changes observed, such as visual and auditory and vestibular deficits[6-8]. Motor restrictions resulting from the cerebral palsy subtype (spastic, dyskinetic, ataxic, hypotonic, or mixed) are often (3/4 of cases) accompanied by other limitations and pathologies (for example, epilepsy and / or secondary skeletal muscle pathology)[5].

Due to the same gestural act performed, children with CP, present greater energy expenditure than another child of the same age group without pathology during the execution of the movements. Thus, children and adolescents with cerebral palsy have lower energy needs and levels of physical activity than their healthy peers; therefore, they are more subject to the adverse effects of inactivity[9,10], like the

lack of balance, constant falls, deficient coordination, and inadequate and unstable posture can lead to fear, insecurity and inattention.

Knowing that balance is the ability to maintain the body's position on its support base, whether stationary or mobile[11], its analysis and training are necessary to minimize the effects and consequences to which people with CP are subject.

To maintain balance in any posture, the human body needs to receive information about its position in space and in the environment. This information is received by the body through the neural system, which integrates sensory information to access the position and movement of the body in space and the musculoskeletal system that generates forces to control the position of the body, known as the postural control system[12,13]. Postural control has two behavioral objectives: orientation and postural balance. Postural orientation is related to the positioning and alignment of body segments in relation to each other and in relation to the environment. Postural balance is the state in which all the forces acting on the body are balanced to keep it in the desired position and orientation[14]. For these two behavioral goals, orientation, and postural balance, to be achieved by the postural control system, perception (integration of sensory information to analyze the position and movement of the body in space) and action (ability to produce forces for control body positioning systems). Thus, postural control requires continuous interaction between the musculoskeletal and neural systems[13,15]. All this behavior tends to become more inaccurate and demand more from the human body, when it is in an environment that requires constant adaptations, such as the aquatic environment. For the individual with CP during movement in the water, it is necessary to control the center of gravity of the body when moving on its support base, and adequate levels of strength of the lower limbs to maintain static and dynamic balance and stabilize the ankle joint11. Thus, physical activity is a fundamental support in the development of new motor and adaptive skills to help improve the functionality of the body in these conditions.

The role of physical exercise in the rehabilitation of children with CP has gained importance as studies have been published denying adverse effects on muscle tone (spasticity), joint range, movement pattern and functionality; and since self-will and physical fitness were recognized as key elements for the

success of rehabilitation programs whose objective is to improve motor skills and levels of participation[16,17].

It is believed that through aquatic programs exercises related to static and dynamic balance for children with cerebral palsy are essential, as they contribute to disorders related to movement, coordination, balance, and posture, and improves motor function, which is mainly impaired by disability.

The characteristics of the aquatic environment are particularly advantageous for the rehabilitation of children and adolescents with CP: the reduction of the perverse effects of imbalance, deficit in postural control, excessive joint load, and gravity, allows a more accessible motor performance for young people, providing confidence and incentive to adhere to the execution of tasks with increasing degree of difficulty[9,16].

Thus, this study aims to investigate whether a program of aquatic activities interferes with the static and dynamic balance of children with CP.

Method

Quasi-experimental quantitative study of pre-intervention and post-intervention in the comparison of a single group. The study has the approval of the Research Ethics Committee of Paulista University through the Brazil Platform number: 4,204,891.

Participants

In this study, 35 individuals of both genders, aged between 5 and 19 years old, with clinical diagnosis of mild to moderate CP, classified as I and II as to the levels of the Classification System of the Expanded and Revised Gross Motor Function (GMFCS-E & R)[18], practitioners of aquatic activities who participated in educational activities at the Rainha da Paz Community of Love - Sta Parnaíba - SP, were invited to participate in this project. of research, however only 20 volunteers met the inclusion criteria and accepted to perform the study procedures, another 4 were excluded for not presenting a clinical certificate for aquatic activities, 5 presented cognitive, visual or auditory deficits that prevented the fulfillment of verbal instructions and / or visual impairments, 6 presented contraindications to frequent a heated pool, such as fever (n = 2), urinary or fecal incontinence (n = 2), alteration in blood pressure (n = 1), and a high possibility of changes in the prescription of medications during the research period (n = 1).

Among the inclusion criteria are having a degree of mild to moderate spasticity (from level I to III of the

GMFCS-E & R), clinical certificate authorizing the patient to attend a heated pool and perform only aquatic physical activity so that other physical activities do not interfere in the study and have the informed consent form signed by the person responsible.

Exclusion criteria were presenting another associated disease that may interfere with physical assessments such as cognitive, visual, or auditory deficits that make it impossible to follow verbal and / or visual instructions, or contraindications to frequent a heated pool, such as fever, urinary or fecal incontinence, alteration blood pressure, open wound, or change in medication prescription during the research period.

Procedures

The Brazilian version of Pediatric Balance Scale (PBS)[18] was used, as it is widely used in clinical practice and in research for child and youth with CP, in addition to being a low-cost research, it is a safe administration route to measure static balance and patients' dynamics. It also meets several proposals, such as monitoring the progress of patients, assessing the effectiveness of interventions in clinical practice and research and quantitative description of the ability to balance function, compared to other instruments, have greater reliability and validity when used in scientific research.

It is characterized as a validated instrument, of functional assessment of balance composed of 14 tasks with five items each and a score of 0-4 for each task, where 0 means not performing the task and 4 performing the task independently. The maximum score obtained is 56 points, with lower scores indicating greater deficiencies in balance. The total score ranges from 0-56 points, and we have a score for the risk of falls, a score below 45 points. The lower the score added at the end, the greater the risk for falls; the higher, the better the individual's performance.

The materials used were a stopwatch, measuring tape, two 30 cm plastic chairs with and without a support arm, a 25 cm high bench and a stairway to and from the pool. To perform the data analysis, the activities were divided into groups with similar functional tasks: transfers with tests 1.4 and 5, stationary tests with tests 2,3,6 and 7, functional range with test 8, components rotational with tests 9,10 and 11 and decreased support base with tests 12,13 and 14.

Qualitative assessment of static and dynamic balance

The evaluations took place at the beginning and after three months of the water activities, which were based on

relaxation and flexibility movements lasting 35 min. twice a week and was carried out by a physical education teacher who volunteered for our project.

1st day: the assessment test started, in the shallow part of the pool, with water approximately on the student's hips, the transfer test was applied, using the plastic chair as material, test objective 1: the patient sitting, asking to stay in trying not to use your hands as a support. In test 4: the patient standing and trying to sit with minimal use of the hands. In Test 5: transfer from a chair with an armrest to another without an armrest.

- 2nd day: Static tests were applied using the bench for test 2: standing for 2 minutes without support, test 3: remaining seated without support on the back, but with feet supported on the plastic chair, sitting without support the back with arms crossed for 2 minutes. Test 6: Standing without support with eyes closed, remaining for 10 seconds. Test 7: standing unsupported with your feet together, keeping your feet together, standing upright without holding on.
- 3rd day: Functional reach test was applied, using the measuring tape on the edge of the pool in test 8: keep your arms extended at 90 degrees, extending your fingers, and trying to reach the greatest possible distance. The recorded measurement is the distance the fingers can reach while the subject is at the maximum forward tilt possible. The patient was asked to perform the task with both arms to prevent rotation of the trunk.
- 4th day: Rotational component test was developed, in test 9, the proposed objective was to pick up an object from the floor (on the pool ladder) from the standing position, pick up a shoe / slipper located in front of your feet. In test 10, standing, turn around and look back over your right and left shoulders. Turn and look back over your left shoulder, then repeat to your right. The teacher can take an object to look at and place it behind the subject to encourage him to perform the rotation. In test 11, turn 360 degrees, turn completely making a full circle, pause, do the same in the other direction.
- 5th day: It was developed as the last tests of diminished support base, test 12: to place alternate feet on the step of the pool ladder, remaining standing and without support. Place each foot alternately on the step, continue until each foot has touched the step four times. Test 13: to remain standing without support with another foot forward placing one foot directly in

front of the other. If the patient realizes that he cannot put his foot directly in front, try to take a step long enough that the heel remains in front of the toe of your other foot. (To obtain 3 points, the stride length may exceed the length of the other foot and the width of the support base may approach the subject's normal stride position). Test 14: stand on one leg, stand on one leg if you can without support.

The same test was applied individually, each student had his / her result, identification card and score obtained for the sum. The classes in this period were applied and focused on the development of specific motor skills including static and dynamic balance applied by the physical education teacher of the "Rainha da Paz" association and accompanied by the person in charge of the study, where the classes were observed, and each important point was reported. related to balance and that could contribute or interfere with the test result. After applying PBS, we concluded with the post-test to collect the results for analysis.

Statistical analysis

All statistical analysis was performed using the Microsoft Excel program, in the preparation of graphs and tables. The collected data were initially analyzed for normality of the sample with the Shapiro-Wilk test, indicating parametric data ($p > 0.05$) for PBS. From that, we opted for the paired T-Student Test for dependent samples, with comparative pre-intervention and post-intervention. It was used as a significance index of $p \leq 0.05$ (5%). Pearson's correlation coefficient was used for the correlation between the mean age and the mean score obtained on the scale at the start and after the intervention.

Results

Most participants were male (70%) with an average age of 13.2 ± 3.92 (mean ± standard deviation) years and in light rating level for cerebral palsy, as Table1. According to the PBS score, there was an improvement in all patients, with the results varying from 10 to 15 points from the pre-test to the post-test, the students showed improvement in the aspect of both static balances as dynamic and better postural adjustment.

The sample data identified that through aquatic activities, a significant improvement in the global balance of people with cerebral palsy is acquired (Graphic 1), which was not statistically proven in dynamic balance (Graphic 2), as in static balance (Graphic 3). The descriptive analysis identified that children with cerebral palsy who practice

water activities seem to show improvement in balance. In general, participants improved their balance by 26.7% on the PBS ($p < 0.005$, $r = 0.037$). Pearson's correlation coefficient was used for the correlation between the mean age and the mean score obtained on the scale at the start and after the intervention. There was a correlation of 0.79 and 0.29 between the score obtained on the PBS and age at the beginning and at the end, respectively.

Table 1. Sample characterization (n=20).

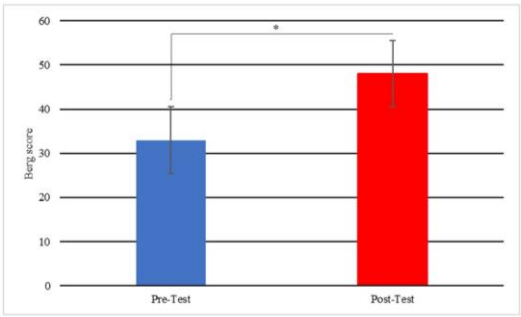
Variables	Descriptive Statistics		
Gender	Male	n=14	70%
	Female	n=6	30%
Diagnostic Classification of CP (GMFCS-E & R)	Level I	n=16	80%
	Level II	n=4	20%
	Mean ± standard deviation		
Age (years)	13.2 ± 3.92		
Weight (Kg)	56.55 ± 7.91		
Height (m)	1.63 ± 0.069		

Discussion

The results presented prove the main hypothesis of the study, emphasizing that aquatic activities can improve the postural control of individuals with CP, as demonstrated by the mean values of the balance analysis according to the PBS test score.

Although standardized scales are available in the literature with well-established psychometric properties, few studies have used specific instruments to assess postural control (i.e., PBS). This test, in addition to having good validity and reliability, is easy to handle, not too long (that is, the administration lasts a maximum of 15 min), includes materials available in clinical settings and assesses the performance of the functional tasks that are part of the children and the daily activities of adolescents, but we need to be attentive, as the results suggest that the mechanisms of postural control in school-age children (7 to 13 years) with CP are modifiable[19].

Figure 1. Demonstration of the participants' assessment of the pre- and post-intervention balance.



* $p < 0.005$.

Our results also corroborate with studies that demonstrated the efficiency of the application of different motor activities in gaining balance[20,21]. The balance activities can facilitate the control of the tone allowing the proper posture for the functional movement, thus promoting motor learning. A well-executed activity requires basic elements such as cognition, vision, vestibular responses, muscle contraction and good range of motion. ease and performance

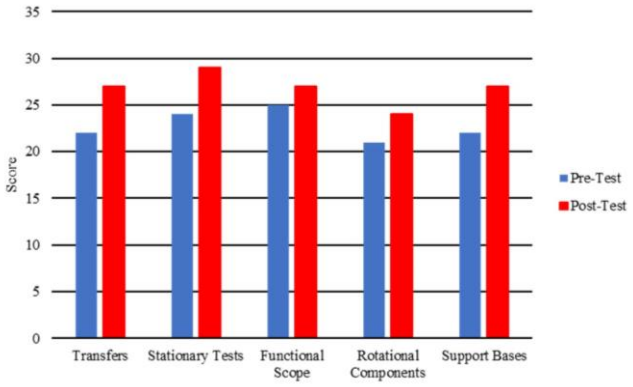
during activities is the ability to maintain balance[22].

As an analysis of secondary objectives, we can observe and identify with the literature, showing that exercises can also bring benefits in terms of pain relief and quality of life for people with cerebral palsy[23]. Some adults report the use of exercise as a treatment for pain and consider it moderately effective[23,24], which can have a positive impact on quality of life. In addition, a positive association between physical activity and physical, behavioral, emotional, and social quality of life has been reported in children with CP[25,26]. As physical exercise is a structured physical activity, the implementation of an exercise program can result in improvements in the quality of life of people with CP. However, there is still a lack of consensus on the theoretical approach and implementation of postural control[27].

With the improvement of the balance, we can assume its action in the prevention of falls, providing to the individual experiences of encounter, cooperation and overcoming, valuing the practice of aquatic activities in children with cerebral palsy with an emphasis on health.

Thus, based on the results of this study, it can be suggested that the specificity of balance activities, through the experience of static and dynamic balance on different surfaces, with different sensory and environmental strategies, thus promotes better postural adjustment and considerable balance.

Figure 2. Demonstration of the participants' evaluation regarding their Dynamic Balance before and after the intervention of the Berg Balance test ($p > 0.005$).



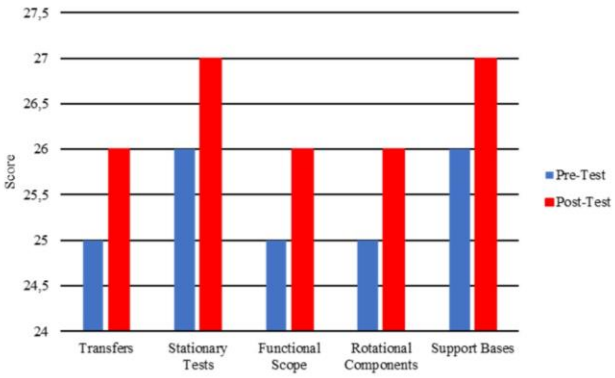
Thus, based on the results of this study, it can be suggested that the specificity of balance activities, through the experience of static and dynamic balance on different surfaces, with different sensory and environmental strategies, thus promotes better postural adjustment and considerable balance.

Postural stability, like many biological measures, has an intrinsic variation influenced by physical, biomechanical, metabolic, and pisco-social factors[28]. Many factors affect the evolution of postural results, such as motivation, concentration, fatigue, emotional state, test time and relationship with the evaluator[29].

Bibliographic findings observed in practical studies reveal that the flexibility of the environmental and temporal conditions of the environment causes it to occur, as well as the flexibility in motor and postural performance[20]. Exercises that promote changes in body mass, greater speed, and greater complexity (different activities) will increase confidence, efficiency and safety during an activity that requires efficient postural control[30,31]. Therefore, in this study, the environmental factors that correspond to the different surfaces and stimulation of aquatic activities may be responsible for the development of balance in general, which influenced the improvement of the subjects' postural adjustment.

However, it is important to note that, in children, the variability of static and dynamic balance measures may be due to changes in postural contro[30]. Children with CP need the opportunity to practice postural adjustment in a variety of relevant situations, causing skill development to occur[32,33]. There is an improvement in posture, the teaching method brings, among other physical, psychological, and social benefits, through static and dynamic balance activities in the water. Postural and balance activities should be an integral part of these children regardless of the modality, as the imbalance can cause several difficulties in activities of daily living[20].

Figure 3. Demonstration of the evaluation of the participants in relation to their Static Balance before and after the intervention of the Berg Balance test (p> 0.005).



In relation to aquatic activity, there is a consensus on the benefits in the treatment of individuals with brain disorders, but there are some differences between the authors[29,30]. Some indicate the practice of exercises in water to treat problems associated with brain injuries, but do not recommend training in functional activity, as they consider that the aquatic environment does not provide adequate stability, leading to the facilitation of associated reactions, which interfere with the desired movement[34,35]. Others, however, believe that the aquatic environment and all its resources, if well used, can provide stability for the patient's active participation in improving functional capacity[36].

A well-executed activity requires basic elements such as cognition, vision, vestibular responses, muscle contraction and good range of motion. In addition, one of the main elements for movement to occur to facilitate performance during the performance of activities is the ability to maintain balance[37]. The study revealed that balance offers and controls the input of sensory stimuli, that the child spontaneously forms the adaptive responses that integrate all sensations, these sensory stimuli in all the joints, skin, and muscles of the child, will generate motor and sensory responses for the restoring balance. With that, children with cerebral palsy gradually master these sensations and responses, their brain learns to modulate sensory activity and forms a more accurate body perception[37]. Therefore, a lesson plan aimed at a treatment of balance through aquatic activities using different surfaces and materials that stimulate sensory information will promote improvement in the response of the individual with cerebral palsy and may improve balance and postural adjustment, bringing more autonomy to this audience.

Study limitations

We observed that in this study compared to other similar methodologies, the number of subjects is not very different although it can be considered a limiting criterion to the results. Another important point would be the use of a control group for more reliable comparative observations. Determinants of monitoring aquatic activities, such as frequency, intensity, and duration of exercises, could be better measured.

Study Potentials

- To show the importance of motor activities in the postural control and balance of people with CP.
- Water activities can also be significant in improving balance performance.
- To promove discussions for new studies that may contribute to the quality of life of people with CP.

Conclusion

Well-planned and developed water activity with specificity in static and dynamic balance contributes positively to postural adjustment, improving physical aspects such as strength, and toning, as well as in the functional activities of these patients, stimulating sensory information of children with cerebral palsy and providing benefits to the individual's integral health, with safety and autonomy factors in the execution of tasks, establishing conditions for a more active life and less dependence. Further studies are suggested to highlight the need for aquatic activities for people with CP.

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