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ORIGINAL ARTICLE

Assessment of functional balance in children with sensory impairments undergoing hippotherapy

Avaliação do equilíbrio funcional de crianças com comprometimentos sensoriais submetidos a hipoterapia

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KEYWORDS

Cerebral palsy
Down syndrome
Equine-assisted therapy
Intellectual disability
Postural balance

ABSTRACT

Objective: To evaluate the functional balance of children with sensory impairments submitted to hippotherapy.
Methods: 24 children of both genres equally participated in three groups: cerebral palsy (CP), Down syndrome (DS), and intellectual disability (ID) with the respective age groups (10.71 ± 2.69 years), (12.83 ± 2.64 years), and (11 ± 1.69 years). There were 15 attendances in hippotherapy with riding materials specific to each group. The Pediatric Balance Scale (EEP) was used before the 1st and after the 15th hippotherapy session (pre and post moments) to assess functional balance. The data were analyzed using the Shapiro-Wilk tests (normality), Bartlett test (homogeneity), and, between the pre- and post-care times, the paired t-test (intra-groups) and ANOVA with Bonferroni's multiple comparison tests (between groups), with statistical significance for $p < 0.05$.
Results: in the post-attendance, there was an increase in the EEP score for the three groups (intra groups) with significance for children with ID ($p = 0.003$) and DS ($p = 0.033$); the CP group had a lower score (inter groups) in both times, pre ($p = 0.003$) and post ($p = 0.002$) attendance.
Conclusion: hippotherapy contributed to the functional balance of children with distinct sensory impairments, according to the clinical diagnosis and riding material specific to the group, thus being able to be considered a therapeutic method with relevant benefits regarding the sensory aspects of the population.

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PALAVRAS-CHAVE

Deficiência intelectual
Equilíbrio postural
Paralisia cerebral
Síndrome de down
Terapia assistida por cavalos

RESUMO

Objetivo: avaliar o equilíbrio funcional de crianças com comprometimentos sensoriais submetidos a hipoterapia.
Métodos: participaram 24 crianças, de ambos os sexos, alocadas igualmente em três grupos: paralisia cerebral (PC), síndrome de Down (SD) e deficiência intelectual (DI) com as respectivas faixas etárias (10,71 ± 2,69 anos), (12,83 ± 2,64 anos) e (11 ± 1,69 anos). Foram realizados 15 atendimentos na hipoterapia com os materiais de montaria específicos para cada grupo. Para avaliação do equilíbrio funcional foi utilizada a Escala de Equilíbrio Pediátrica (EEP), antes do 1° e após 15° atendimento (momentos pré e pós) na hipoterapia. Os dados foram analisados por meio dos testes *Shapiro-Wilk* (normalidade), teste *Bartlett* (homogeneidade) e, entre os momentos pré e pós-atendimentos, o teste t-pareado (intra grupos) e ANOVA com testes de múltiplas comparações de *Bonferroni* (inter grupos), com significância estatística para $p < 0,05$.
Resultados: no pós-atendimento houve aumento na pontuação da EEP para os três grupos (intra grupos) com significância para crianças com DI ($p = 0,003$) e SD ($p = 0,033$); o grupo PC apresentou menor pontuação (inter grupos) em ambos os momentos, pré ($p = 0,003$) e pós ($p = 0,002$) atendimentos.
Conclusão: a hipoterapia contribuiu para o equilíbrio funcional de crianças com comprometimentos sensoriais distintos, de acordo com o diagnóstico clínico e o material de montaria específicos para grupo, podendo assim, ser considerado um método terapêutico com benefícios relevantes quanto aos aspectos sensoriais das populações envolvida.

INTRODUCTION

Balance is a complex sensory skill that integrates different systems, such as visual, somatosensory, and vestibular[1,2], critical for postural control and contributing to the infant neurosensory development[3]. In childhood, the appropriately developed and improved postural control can promote motor skills with greater efficiency[3,4] since balance and postural control are inseparable and complementary. The milestone of sensory maturity regarding stability and postural adjustments occurs at around nine years of age, initially in the visual system, followed by the proprioceptive and, finally, the vestibular[4].

The neurosensory motor development of children diagnosed with cerebral palsy (CP), Down syndrome (DS), and intellectual disability (ID) may present delays or impairments in the different sensory and motor aspects, according to the peculiar characteristics of each clinical picture, as well as the influence of each individual's genetic, biological and environmental factors[5-8].

Therefore, hippotherapy, the first basic equine-assisted therapy program, is considered a promising therapeutic method based on using the horse as a kinesiotherapeutic instrument, becoming an ally in the rehabilitation process of children with varied clinical diagnoses[9]. In hippotherapy, the sensory and motor benefits come from the three-dimensional movement triggered by the horse during walking gait, stimulating the practitioner bodily[10,11]. The sensory-motor stimuli triggered by the horse to the practitioner are transmitted to the central nervous system via the spinal cord and present a pattern of rhythmic oscillation of the pelvis, similar to the movements of human gait[12,13].

Based on the fundamental principles of three-dimensional movement in hippotherapy, research has recently pointed to the benefits of practice in balance, posture, and, consequently, in the postural control of individuals with different physical conditions using different research methodologies[14-18].

According to the information collected, this study is relevant due to the importance and scientific implications of the contributions of hippotherapy to the functional balance of children with CP, DS, and ID associated with specific riding materials for each group. The choice of suitable riding material for each group demonstrates the importance to develop individualized therapeutic planning based on the characteristics of each child, thus configuring the perspectives of evidence-based practice. Therefore, this study evaluated the functional balance of children with sensory impairments submitted to hippotherapy, with the hypothesis that it contributes to improving the functional balance of this population.

METHODS

This study is descriptive, analytical, and cross-sectional, approved by the Research Ethics Committee (CEP) of the Federal University of Triângulo Mineiro (UFTM) under nr. 2.152.117/2017, with the Brazilian Registry of Clinical Trials (ReBec) RBR-4C3FZ2, as well as the approval by the UFTM Ethics Committee on the Use of Animals (CEUA) under nr.426/2017, necessary for studies involving the production, maintenance and the use of animals for research. Before starting collections and interventions, the parents or guardians of the selected children, or both, received clarifications regarding the objectives and procedures to be conducted and those who consented signed the Informed Assent Form.

Twenty-four children, aged between 8 and 15 years, of both sexes, participated in the study. They regularly attended therapeutic and educational support services at a specialized care institution, with independent walking, allocated equally in three groups according to the clinical diagnosis. Therefore, eight participants were distributed to each group with the

respective ages: CP (10.75 ± 2.49 years), DS (11.88 ± 2.85 years), and ID (11 ± 1.69 years).

The children were selected by convenience sampling from the analysis of medical records made available by the institution, once they presented independent gait, and specific clinical diagnoses for each group. In particular, for the CP group, the inclusion of children with spastic diparesis and type I or II classifications according to the Gross Motor Function Classification System (GMFCS) was previously determined[19]. All included participants receive some therapeutic monitoring at the institution, such as speech therapy, physical therapy, occupational therapy, and psychology, according to their demands with the same weekly frequency and varying intensities according to the interventions.However, the risk of bias was minimized by the evaluations conducted before starting equine-assisted therapy sessions as an individual reference point for each child.

Exclusion and non-inclusion criteria were adopted: uncontrolled convulsive crises; scoliosis above 30º; hip dislocation; uncontrollable fear of the animal; associated syndromes/behavioral changes, difficulty in understanding the commands, tasks, or both, requested and two consecutive absences. Concerning the CP group, notably children who received an application of botulinum toxin in the lower limbs in the last six months before the start of data collection and the course of their respective procedures were excluded. Throughout the research development, the number of participants inserted at the beginning remained unchanged until the end, with no loss of individuals.

The consultations were performed in a riding therapy center installed within the special education institution where the participants were selected. The center has an adequate area of approximately three thousand square meters that includes the required spaces for developing the practice with a covered arena, green area, sand track, round pen, stalls, saddlery, horse bedding, and bathing area. However, the arena was covered with a concrete surface and an accessibility ramp for riding for the sessions.

As a protocol for interventions, 15 treatments were used in hippotherapy, once/week, lasting 30 min as established by ANDE-Brazil[9]. During the sessions, no exercise associated with riding was performed, considering only the three-dimensional movement of the horse.

The riding material (saddle or blanket) and positioning of the feet in the stirrups (with or without support) were selected according to each group (ID, DS and CP) from the preliminary study[20]. Thus, the Australian type saddle made of leather was established with the feet supported on the stirrups for children with CP and the blanket made of foam coated in courvin type fabric without the footrest on the stirrups for the DS and ID groups. As for the blanket, the harness was used as an aid to support upper limbs. Regardless of the situation, the helmet was an essential safety device for practice.

The horses used for the sessions showed excellent health conditions with physical characteristics of similar weight and height 1.54 cm/470 kg and 1.54 cm/488 kg, respectively. The walking gait was established based on the ANDE-Brazil[9]protocols for hippotherapy with a frequency of around 56 steps/min and an average speed of 1 m/s controlled by the rider.The average speed was considered from the record of the time of 10 s necessary for the horse to cover a space of 10 m. It is important to consider that throughout the collection and development of the research, both horses were kept according to the first care of each child, respecting the moments of rest as a guarantee of the animal's health conditions.

The validated and adapted Pediatric Balance Scale (PBS) was used to assess functional balance, translated for the Brazilian population, and high reliability for test-retest. The PBS is easy to apply and score, containing 14 items that assess the functional balance (static and dynamic) in children aged 5 to 15 years, with motor changes from mild to moderate. According to the instrument, the score for each item ranges from zero to four, with zero being more difficult with the demand for supervision or assistance to perform the activity and four when there is independence, without difficulty. Thus, the maximum PBS score is 56, considering that the higher the score, the better the balance[21].

The balance skills evolve according to the items of the PBS. Therefore, items 1 to 5 consist of performing transfers from sitting to standing postures (item 1), standing to sitting (item 2), moving from a chair to another (item 3), remain in the standing position (item 4) and sitting (item 5) without support, respectively. From item 6 on, skills require a higher level of complexity in the static position, such as standing with eyes closed (item 6), standing with feet together (item 7), standing with one foot in front of the other (item 8), standing on one foot (item 9). In the last items of the scale, they require greater dynamic ability such as rotating 360° (item 10), turning their look back without moving their feet from the floor (item 11), picking up an object on the floor (item 12), placing their feet alternated on a step or support (item 13) and reach the front with an extended arm without removing their feet from the floor (item 14). Each item is scored according to the time and the need for support for its accomplishment.

Initially, the children were submitted to evaluation through the PBS, and, subsequently, the intervention in hippotherapy started, including 15 sessions for each group at the end of five months. Subsequently, the children were reassessed for functional balance. Therefore, collections made before the first assistance was established as a pre-care moment, and collections performed after the 15th one as a post-care moment.

Statistica® software, version 10.0, was used for statistical analysis, with the Shapiro-Wilk test for normality of data and Bartlett's test for homogeneity of variances. For comparisons between the moments (pre and post-care) of each group (intra-groups), the paired t-test and ANOVA with multiple Bonferroni tests were used for comparisons between the groups at each moment (inter-groups). For all results, $p < 0.05$ was determined as statistically significant differences.

RESULTS

According to PBS, when comparing the functional balance between the pre and post-care times of each group (intra-groups), higher scores are observed in the post-care time for the three evaluated groups (ID, DS, and CP), however with significant differences in the ID (p = 0.003) and DS groups (p = 0.033). In the analysis between groups (inter-groups), at both times, children with CP obtained the lowest scores compared to the others (ID and DS) with significant differences in pre (p = 0.003) and post-care moments (p = 0.002) (Table 1).

In the pre-care assessment, specific to each item of the PBS, children in the ID group had higher mean scores compared to the other groups, DS and CP, while children with CP had the lowest scores (Figure 1).

After 15 sessions, specific assessments for each item of the PBS show higher mean scores for a greater number of items in children with ID, DS, and CP, respectively (Figure 2).

Table 1 — Functional balance assessment of children with ID, DS and CP through PBS.

Parameter		Groups			p[2]-value
		Group ID	Group DS	Group CP	(groups)
PBS	Pre-care	54.3 ± 1.2[a]	52.4 ± 2.8[a]	46.3 ± 6.7[b]	0.003
	Post-care	55.0 ± 1.1[a]	52.9 ± 2.7[a]	48.1 ± 5.3[b]	0.002
	Mean difference (CI95%)	+0.7 (+0.4 to +1.1)	+0.5 (+0.1 to +0.9)	+1.9 (-0.4 to +4.1)	
	p-value (period)[1]	0.003	0.033	0.090	

PBS (Pediatric Balance Scale), CP (cerebral palsy), DS (Down syndrome), ID (intellectual disability), CI95% (confidence interval 95%). [1]Paired t-test. [2]ANOVA. Different letters on the line indicate in which group a statistically significant difference was observed after the Bonferroni multiple comparison test. Values were expressed as mean ± standard deviation.
Mean difference between groups (CI95%): Pre-care: ID x DS = -1.9 (-7.4 to +3.7); ID x CP = -8.0 (-11.7 to -0.6); DS x CP = -6.1 (-11.7 to -0.6).
Mean difference between groups (CI95%): Post-care: ID x DS = -2.1 (-6.6 to +2.4); ID x CP = -6.9 (-1147 to -2.4); DS x CP = -4.8 (-9.3 to -0.2).

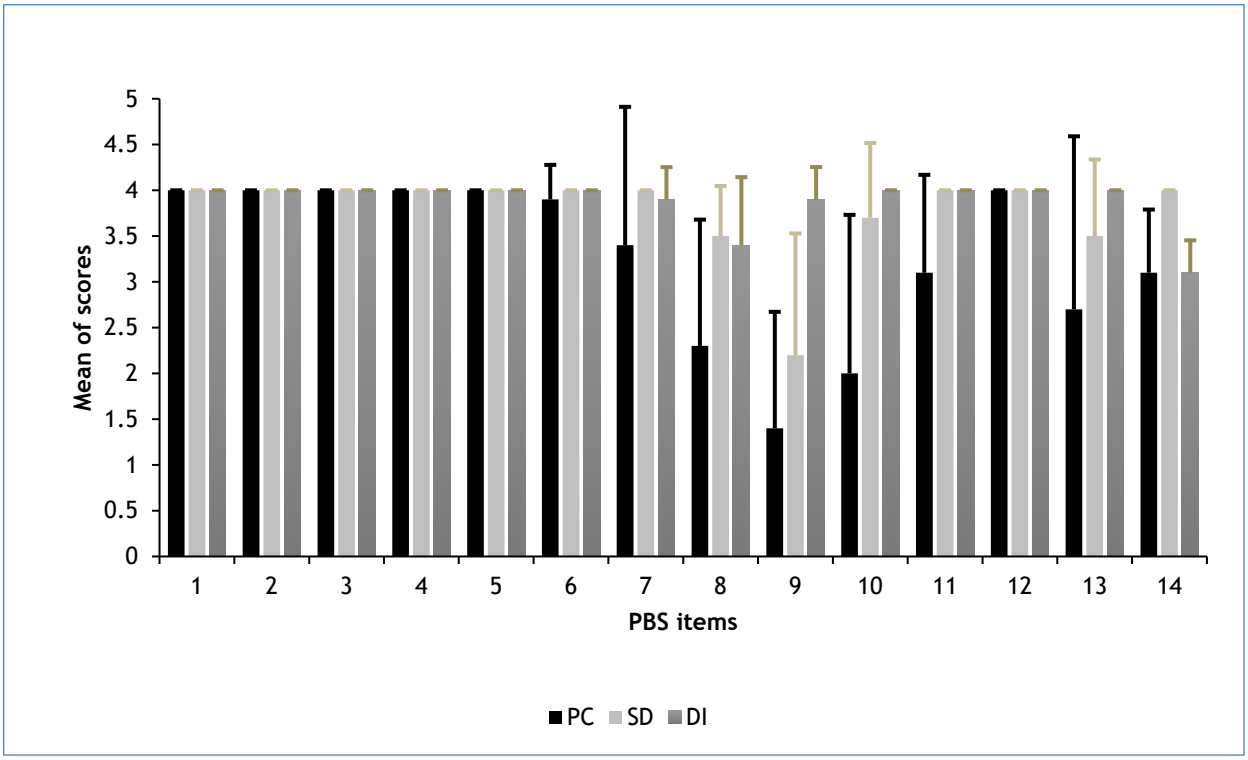

Figure 1 — Pre-care assessment of PBS items for the CP, DS and ID groups (mean and standard deviation). PBS (Pediatric Balance Scale), CP (cerebral palsy), DS (Down syndrome), ID (intellectual disability).

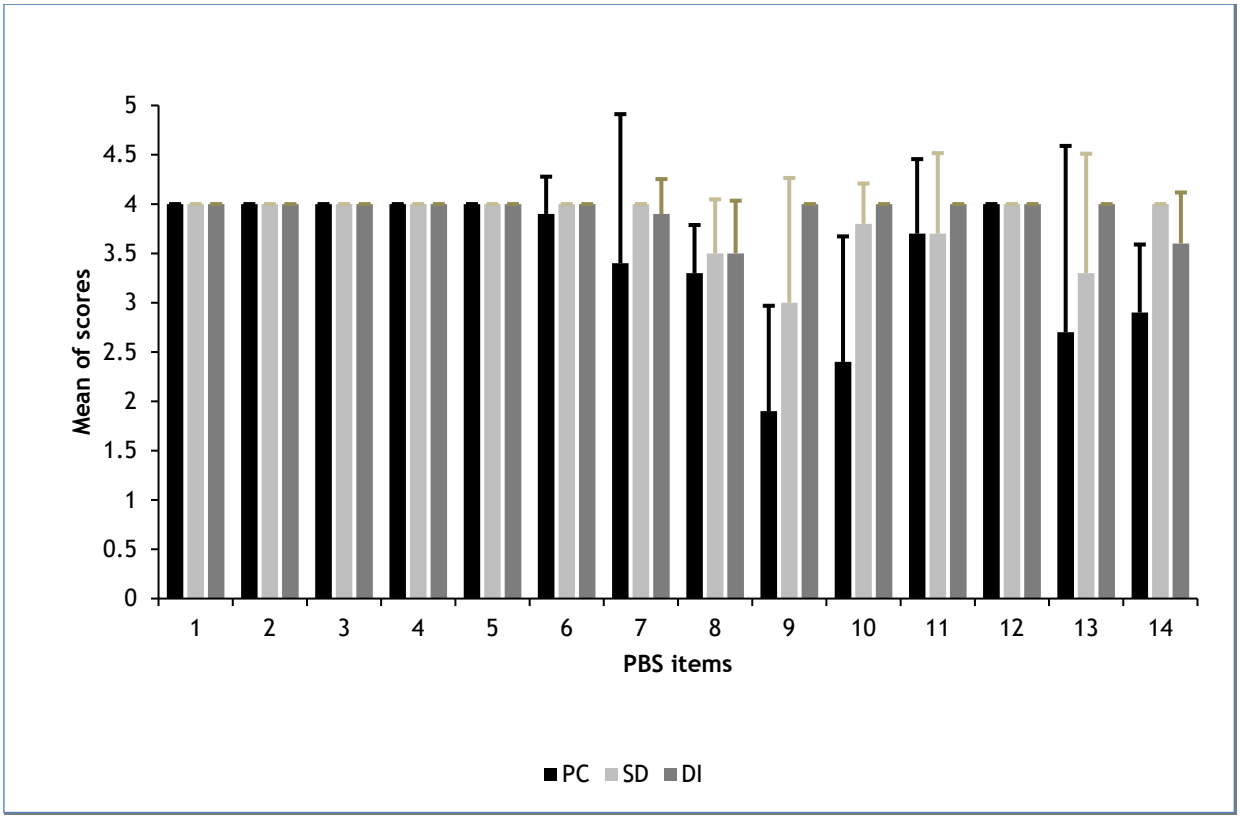

Figure 2 — Post-care evaluation of PBS items for the CP, DS and ID groups (mean and standard deviation). PBS (Pediatric Balance Scale), CP (cerebral palsy), DS (Down syndrome), ID (intellectual disability).

DISCUSSION

Following the objective of assessing the functional balance of children with CP, DS, and ID undergoing hippotherapy, the results indicated an increase in the scores in the post-care PBS, regardless of the clinical condition, thus validating the hypothesis that hippotherapy contributes to improving the functional balance of these children. The beneficial results observed in terms of sensory aspects reproduce and corroborate scientifically with recent research developed in the scope of hippotherapy[14,15,17,18]. For Uzun[22], "Horse-riding are itself a stimulus for balance".

Body balance is a process of capturing and complex sensory integration with information from the visual, vestibular, and somatosensory systems[1,2], so it is considered one of the most relevant skills of human postural control for keeping the physical system stable, even with the influence of forces acting on it[2].

Among the groups analyzed, children with ID were the ones who showed the most significant results and with the lowest standard deviations between the pre- and post-intervention moments. This fact is related to the level of sensory-motor impairment of the selected participants, considering that the ID group presented cognitive impairment exclusively and excellent functional balance according to the results observed in the PBS before the first intervention (pre-), reaching scores close to the maximum, that is, 56 points. Our findings corroborate a study that evaluated the static balance of typical individuals and ID through the force platform, where similarity was observed between the typical and atypical groups, concluding that ID does not influence the static postural balance of children aged seven to 13 years[23].

In the context of hippotherapy, adolescents with mild ID and ages between 15 and 17 years had benefits in balance with hippotherapy practice after three months compared to the control group that did not perform the intervention. According to the study, parameters such as the center of pressure (COP) were evaluated using the force platform in the sagittal and frontal planes, concluding that the absence of changes in these balance parameters in the control group concerning the findings in the experimental group demonstrates the significant development of balance in boys with mild ID and ages 15 to 17 years[24].

However, children in the DS and CP groups, besides intellectual impairment, had specific neuromuscular characteristics according to their pathology, which may have influenced more discrete results, but still significant for children with DS.According to the literature, DS is distinguished with a picture of global hypotonia25 and CP frequently with spasticity associated with hypertonia and hyperreflexia[5,26,27], which directly influence motor and sensory skills such as motor coordination, balance, postural control, and spatio-temporal organization[6,27-30]. Despite not showing changes in muscle tone, children with ID may have difficulties elaborating, planning, and

performing activities (adaptive behavior) due to the inability of intellectual functioning[8]. However, this group had no limitations regarding the results of functional balance in this research.

Thus, the neurofunctional characteristics of global hypotonia associated with the sensory dysfunction of participants with DS and spastic diparesis with type I or II classification according to the GMFCS of those with CP may justify the findings of this study about the performance of both groups during the balance tests using the PBS, inferring greater difficulty in the CP group due to the more significant sensory-motor impairment presented in type II spastic diparesis.

According to the literature, sensory maturation regarding stability and postural adjustments initially occurs in the visual system, followed by the proprioceptive and finally the vestibular one, with its functional maturity being nine years[4]. In this sense, children with DS and CP selected for this study may have presented losses compared to those with exclusively ID due to the higher incidence of visual changes commonly found in DS and the proprioceptive and vestibular dysfunctions present in DS and CP, which does not seem to be evident in individuals with ID.

As a tool for assessing functional balance, BBS, a version of PBS for young people, adults, and the elderly, has been used in the context of hippotherapy to assess the benefits of therapy in the static and dynamic balance of practitioners with different characteristics, such as individuals with Huntington's disease16, stroke[31,32] and elderly[14,33]. Simultaneously, PBS was adopted in a study involving children diagnosed with cerebral palsy[34]. As it is a translated, validated, and adapted instrument for Brazilian children[21], the PBS is a methodology with easy access and applicability but gaps for more complex analyses on postural balance.

The benefits of hippotherapy in body balance occur concerning posture and consequently postural control, due to the muscular adjustments necessary to keep the practitioner on the horse's back during the continuous displacement of the horse riding[10,11], which activates a considerable amount of kinetic chains in different regions, which favor body alignment[35].

Thus, the results obtained from hippotherapy from the fundamental principles of three-dimensional movement, promoted by the horse in walking gait, infer clinical contributions and implications for the functional balance of children with ID, DS, and CP by using PBS as an investigative method. However, horse-assisted therapy demonstrates its relevance in terms of the sensory aspects of this population since they may present delays in children's motor neurosensory development due to their individual and pathophysiological characteristics.

As a limitation of the research, we can consider the need to associate the results of the PBS with a gold standard instrument for assessing postural balance to conduct a more complex analysis regarding the sensory aspects of individuals. The number of children participating in this study can also be a limiting factor for more elaborate statistical analysis. However, it is worth mentioning that the sample established for this study was at the expense of maintaining the specific characteristics within a well-defined age group, avoiding bias regarding the clinical variations found for the investigated populations and, consequently, making it challenging to distribute participants in an experimental and control group.

CONCLUSION

Hippotherapy improved the functional balance of children with CP, DS and ID through PBS, who present distinct sensory impairments according to their respective clinical diagnoses. It can be considered a therapeutic method with relevant benefits for the children's neurosensory motor development.

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