



# Effect of horse riding equipment in activity of trunk and lower limb muscles in equine-assisted therapy

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**ABSTRACT.** Equine-assisted therapy uses the horse in rehabilitation and/or education of people, such as Down syndrome (SD), cerebral palsy (PC) and intellectual disability (DI). In context, the rehabilitation program and horse riding equipment should be used according to the specific characteristics of each individual, becoming an ally in the quest for excellence in equine-assisted therapy programs. The aim was to evaluate the effect of riding equipment used in equine-assisted therapy on the muscular activity of trunk and lower limb of individuals with SD, PC and DI. The study included 15 individuals equally assigned to each group: SD, PC and DI with a mean age of 16.2 ( $\pm$  1.10), 16 ( $\pm$  1.22) e 16 ( $\pm$ 0) years, respectively. The analysis of muscle activity was performed through surface electromyography, using four variations of horse riding equipment: saddle with and without feet supported on the stirrups and blanket with and without feet supported on the stirrups. Sigma Stat 3.5<sup>®</sup> software was used for statistical analysis. The Shapiro Wilk's test was used for normality of the data, the Bartlett test for homogeneity of the variances and the Kruskal-Wallis test for repeated measures with no normal distribution. Statistically significant differences were observed for  $p < 0.05$ . The SD group presented a greater muscular activity of trunk and lower limbs with blanket equipment without the feet supported in the stirrups ( $H = 15.078$ ,  $p = 0.002$ ), as in the DI group ( $H = 8.302$ ,  $p = 0.040$ ), while in PC group was the saddle with feet supported in the stirrups ( $H = 11.137$ ,  $p = 0.011$ ). The choice of riding equipment used in equine-assisted therapy interferes differently in the pattern of muscular activation of the trunk and the lower limbs, according to the pathological processes of the practitioners. It should be an important aspect to consider when planning a treatment.

**Keywords:** equine-assisted therapy; electromyography; down syndrome; cerebral palsy; intellectual disability.

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## Introduction

In Brazil, hippotherapy as the first program of equine-assisted therapy has health as its area of performance, where the horse acts mainly as a kinesiotherapeutic instrument for sensory-motor benefits (ANDE-BRASIL)<sup>1</sup>. In this way, the practitioner, who performs the equine-assisted therapy, does not have autonomy during the horse riding, receiving via the spinal cord the sensory and motor stimuli produced by the three-dimensional movement, through the practitioner's contact with the horse's back (Kandel, Schwartz, Jessel, Engelhardt, & Esbérard, 2000; Spink, 1993).

During horse riding, postural disorders provide greater sensory and afferent activation, establishing strategies of anticipatory and compensatory adjustments, favoring adjustment of muscle tone, improvement of balance, strength and muscular flexibility (Janura, Peham, Dvorakova, & Elfmark, 2009; Barreto, Gomes, Silva, & Gomes, 2007; Medeiros & Dias, 2002), as well as the improvement of motor coordination and postural adjustments (Menezes, Flores, Vargas, Trevisan, & Copetti, 2015; Prestes, Weiss, & Araujo, 2010; Murphy, Kahn-D'angelo, & Gleason, 2008; Hammer et al., 2005).

In the last five years, hippotherapy has gained prominence in the scientific context due to the biopsychosocial benefits provided to the individual by the interaction between man and animal resulting from horse-assisted therapy (Mandr , Moretti, Avezum, & Kuroishi, 2019). Among them, studies related to

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the motor, sensory, psycho-emotional and social aspects of individuals, mostly with different commitments, such as brain stroke, multiple sclerosis (Anguita Córdova, González Díaz, Villagra Parra, Navarrete Hidalgo, & Sanhueza Inzunza, 2019) cerebral palsy (PC) (Lopes, Prieto, Santos, Smaili, & Gutierrez Filho, 2019; Prieto, Silva, Silva, Santos, & Gutierrez Filho, 2018), Down syndrome (SD) (Chaves & Almeida, 2018; Ribeiro et al., 2016) among other disabilities and/or syndromes (Sônego, Cavallante, Souza, & Quaggio, 2018; Zamo & Trentini, 2016). However, research involving specific groups such as healthy young people (Rigoni, Paiva, & Souza, 2017) and elderly (Diniz et al., 2020; Araujo et al., 2018) without comorbidities has also shown its relevance in the context of equine-assisted therapy.

Considering the benefits of the three-dimensional movement by horse step, horse riding equipment in equine-assisted therapy become determinant in the performance and evolution of the practitioners, especially if we consider the demands of the pathological processes found in the environment of hippotherapy with its clinical specificities as syndromes (Espindula et al., 2014), brain injuries and visual impairment (Espindula et al., 2012a; Silva & Nabeiro, 2012).

Among the horse riding equipment, the saddle and the blanket stand out with possibilities of variations with regard to the positioning of the feet supported or not in the stirrups (Espindula et al., 2014; 2012a), as proposals for the development of an hippotherapy plain of excellence. The Australian-style saddle has been the research model for having a hand strap that allows the practitioner to keep the upper limbs supported (Espindula et al., 2012a). However, for the blanket because does not have support for upper limbs, it uses the vaulting surcingle to support them (Garner & Rigby, 2015) promoting greater contact of the practitioner with the horse (Kwon et al., 2015).

The analysis of dynamic variables, such as muscular electric activity during the use of different horse riding equipment, is determinant in the interaction between the practitioner and the horse by the contact surface, making it essential to evaluate empirical methods used in clinical approaches such as hippotherapy. Thus, the problem of the study was which horse riding equipment promotes greater muscular electric activity of the trunk and lower limbs in individuals with SD, PC e DI? Therefore, the hypothesis is that the horse riding equipment influences the muscle activity of the trunk and lower limbs of individuals with SD, PC and intellectual disability (DI) during the practice of equine-assisted therapy.

The aim of this study was to analyze the effect of horse riding equipment used in equine-assisted therapy on the muscular activity of the trunk and lower limbs of individuals with cerebral palsy, Down syndrome and intellectual disability.

## Material and methods

This is a cross-sectional, analytical and quantitative study, part of the research project entitled “Electromyographic analysis of trunk and lower limbs in hippotherapy compared with independent gait of Down Syndrome, Non Progressive Chronic Encephalopathy in Childhood and Intellectual Disability”, approved by the Ethics and Research Committee (CEP) according to the opinion 118632/2016 and the Brazilian Registry of Clinical Trials (ReBec) RBR-4C3FZ2. The parents and / or guardians of the individuals who accepted to participate in the study received explanations regarding the objectives and procedures performed and signed the Free and Informed Consent Form, the Informed Consent Term for image release and the Authorization Form for Equine-Assisted Therapy.

The sample consisted of 15 individuals of both genders, selected by convenience, aged 15 to 18 years, equally allocated to three groups: five with SD, five with PC and five with DI. Anthropometric data such as weight and height were collected for later analysis of body mass index (BMI). Therefore, the sample was obtained by convenience from the survey of the number of individuals registered in the institution by means of a specific medical diagnosis for each group, as well as it was based on sample of the previous studies about the muscle electrical activity of the trunk in different horse riding equipment carried out with groups similar diagnoses, but different age groups (Espindula et al., 2014; 2012a). After the selection process the subjects were analyzed individually using the inclusion criteria, not inclusion, exclusion, and discontinuity.

Inclusion criteria included the presence of independent gait, ability to understand verbal commands, and classification of the diparetic spastic type for the PC group using the Gross Motor Function Classification System (GMFCS) for evaluation. GMFCS was used as a reference instrument to classify the abilities and limitations of gross motor function of individuals with PC (Palisano et al., 1997), which has been validated

and translated specifically for the Brazilian population (Hiratuka, Matsukura, & Pfeifer, 2010; Pfeifer, Silva, Funayama, & Santos, 2009). Thus, four participants were at level I and one at level II, according to their abilities and functionalities, taking into consideration that all presented independent gait without the need of manual devices for mobility. For the SD and DI groups, the criterion of inclusion adopted were age and clinical diagnosis, although it is important to note that all individuals had moderate intellectual disability.

The study did not include individuals with uncontrolled seizures, spinal instabilities, shoulder and/or hip dislocations, scoliosis above 30 degrees, hydrocephalus with uncontrolled valve, associated syndromes, or frequent use of drugs that may promote changes in muscle activity such as botulin toxin. Individuals who presented uncontrollable fear of the animal and/or behavioral changes that compromised the collections were excluded from the survey.

The study was accomplished at Equine-assisted Therapy Center. It has a covered area, with ring, bays, saddlery and platform of access for the practitioners.

Two horses were selected, non-defined race, aged 9 and 21 years, height of 1.54 and 1.56 meters and weight of 465 to 480 kilos respectively, trained to practice hippotherapy, in perfect conditions of health. Both horses had to forestep, to overlap to overstep.

Analyses were performed using an Australian saddle made of leather and a foam blanket lined with a courvin type fabric. In both horse riding equipment, the stirrups were coupled for analysis of the feet with and without support.

The investigation was based only single hippotherapy care, lasting approximately 30 minutes. During hippotherapy, all the participants were accompanied by a guide assistant, by a qualified hippotherapist, used safety equipment, following the rules of ANDE-BRASIL and did not perform any exercise in order to evaluate only the effects of the horse's three-dimensional movement. Four moments were adopted for electromyographic (EMG) collections during a single hippotherapy care, according to the established horse riding equipment, blanket or saddle with or without feet supported on stirrups and the route time. A three-minute time was adopted for adaptation to the horse riding equipment and between the moments of the EMG, with EMG collection times of 30 seconds, according to Table 1.

**Table 1.** Moments of EMG analysis during a single hippotherapy care according to the horse riding equipment.

Moments of analysis during hippotherapy	Route time/EMG collection times	Horse Riding Equipment
First	3 minutes/30 seconds	Blanket with feet resting on stirrups
Second	3 minutes/ 30 seconds	Blanket without feet supported on stirrups
Third	3 minutes/30 seconds	Saddle with feet resting on the stirrups
Fourth	3 minutes/30 seconds	Saddle without feet supported on stirrups

The EMG analyses were performed bilaterally according to the Surface Electro MyoGraphprotocol for Non-Invasive Muscle Evaluation [SENIAM] (2008): multifidus, rectus abdominis, rectus femoris, and tibialis anterior. The procedures for the analyses were standardized, and electromyographic records were performed for 30 seconds on an eleven meters path, marked by a fixed line on the ground, according moments of analysis during single hippotherapy care and the horse riding equipment used, blanket or saddle with or without feet supported on stirrups. In the EMG800RF model, from EMG System of Brazil®, with eight wireless channels there the reference electrode is not applied.

Surface electrodes, size 4.4 x 3.2 cm (Solidor®) were included in pairs, the motor point located in the belly muscles, with the distance of two centimeters between the centers. Before the placement of the electrodes, the skin was cleaned with 70% alcohol-soaked cotton and tricotomy (when necessary), in order to reduce the electrical resistance of the skin, improve electrode fixation and consequently improve the electromyographic signal, minimizing possible interferences (Hermes, Freriks, Disselhorst-Klug, & Rau, 2000). After the electrodes were properly placed and coupled to the transmission box wirelessly, the electromyographic collection was started according to the four moments, route time/EMG collection times and pre-set horse riding equipment.

Electromyographic analyses were obtained using Root Mean Square (RMS) in raw data. The maximum voluntary contraction, for processing and normalization of RMS data, was not performed because of the cognitive difficulty presented by the participants of the study and because no intergroup analysis was performed.

Statistical analysis was performed using SigmaStat 3.5® Software (Systat Software, 2006). The regularity of the data was verified using the Shapiro-Wilk test and the homogeneity of the variances using the Bartlett test. As the distribution was not normal, the Kruskal-Wallis test was used for repeated measures. Statistically significant differences were observed in which the probability was less than 5%,  $p < 0.05$ .

## Results and discussion

Based on the individual characteristics of the participants, age, weight, height and BMI, we can observe that the means between PC, SD and DI groups were similar in relation to age and BMI (Table 2).

**Table 2.** Characterization of participants with PC, SD and DI for the horse riding equipment EMG analysis.

Characteristics		PC	SD	DI
Age (years)	Mean	16	16.2	16
	SD	1.22	1.10	0
Weight (Kg)	Mean	70.340	51.380	69.060
	SD	9.27	5.09	17.55
Height (m)	Mean	1.69	1.51	1.74
	SD	0.07	0.05	0.10
BMI (Kg m <sup>-2</sup> )	Mean	24.33	22.73	22.58
	SD	4.74	3.51	4.69

PC (cerebral palsy), SD (Down syndrome), DI (intellectual disability), SD (Standard Deviation), BMI (Body Mass Index), kilograms (kg), m (meters), kilograms/square meters (kg m<sup>-2</sup>).

The EMG analysis of each group was necessary to perform bilateral grouping of the trunk muscles and lower limbs (multifidus, rectus abdominis, rectus femoris, tibialis anterior) when comparing the saddle and blanket equipment (with and without feet supported on the stirrups). Thus, the SD group presented greater trunk and lower limb muscle activity using the blanket without feet resting on the stirrups ( $H = 15.078$ ,  $p = 0.002$ ), as in the DI group ( $H = 8.302$ ,  $p = 0.040$  respectively), while in the PC group there was greater muscle activation in the use of the saddle with the feet supported in the stirrups ( $H = 11.137$ ,  $p = 0.011$ ), according to Table 3.

**Table 3.** Analysis of the muscular activity of trunk and lower limbs of practitioners with SD, PC and DI with different horse riding equipment.

Groups		SD	PC	DI
N		5	5	5
Samples		40	40	40
Blanket with stirrups	Average	7.571	7.058	6.338
	25% - 75%	6.443-8.673	6.145-8.248	5.560-7.256
Blanket without stirrups	Average	9.414*	7.216	6.952*
	25% - 75%	7.587-10.160	5.997-8.400	6.596-9.000
Saddle with stirrups	Average	7.419	8.156*	6.714
	25% - 75%	6.395-8.660	6.847-8.892	5.528-7.447
Saddle without stirrups	Average	7.176	6.733	6.774
	25% - 75%	6.639- 9.049	5.877-7.707	5.362-8.103
Value de p		0.002**	0.011**	0.040**

RMS average regarding trunk and lower limb muscle grouping. SD (Down syndrome); PC (cerebral palsy); DI (intellectual disability). N: Number of individuals included in the study. Samples: Bilateral grouping of the evaluated muscles (multifidus right and left, rectus abdominis right and left, rectus femoris right and left, tibialis anterior right and left), totaling 40 samples. \*Horse riding equipment suitable for groups. Statistical test: Kruskal-Wallis,  $p < 0.05$ \*\*.

In view of the aim of the study, it is important to emphasize that the horse riding equipment used in the equine-assisted therapy sessions are relevant factors in the therapeutic planning and influence the muscular activity of the trunk and lower limbs of the practitioners. Moreover, it is dependent on the degree of neuropsychomotor impairment, to the detriment of the specific characteristic of each pathological process, thus validating the hypothesis of this research.

The groups were similar in age as standardization for the sample of the individuals analyzed and the participants presented mean values according to normality standards established by the World Health Organization [WHO] (2007).

The analysis of the muscular activity of trunk and lower limbs of practitioners with PC, evidenced greater electrical activity of the muscles evaluated in the equine-assisted therapy with the use of the saddle with the feet supported in the stirrups. These results corroborate with the findings of the literature, in which

electromyographic analyses of PC practitioners using different horse riding equipment (saddle and blanket) were performed, varying the position of the feet in the stirrups (Espindula et al., 2012a). However, it is relevant to consider that both results were similar, although the study by Espindula et al. (2012a) involved participants with hemiparetic type PC and analysis of the trunk muscles (upper trapezius fibers, thoracic paravertebral, multifidus and rectum). Thus, it can be inferred that the saddle with feet supported in the stirrups promotes greater muscle activity of the trunk and lower limbs in practitioners with PC. This result may have been favored by the positioning of individuals in the saddle that allowed greater abduction and hip retroversion due to the fact that the characteristic of the riding material that has a more rigid structure (leather) and lower limb flexion by height of the stirrups and the positioning of the feet supported on the stirrups.

The positioning of the practitioner associated with the adequate choice of horse riding equipment promotes inhibition of the extensor spastic and adductor pattern of the lower limbs, due to the greater activation of the antagonist muscles, such as the anterior tibial muscle, present in individuals with spastic diparetic type PC. The increase in the muscular activity of lower limbs shows upward behavior during the course of ten session of equine-assisted therapy, decreasing until the 25<sup>th</sup> session. This fact, according to authors, infers that there was a motor learning from the tenth session on (Ribeiro et al., 2019).

Among the horse riding equipment analyzed in the SD group, the blanket without feet supported in the stirrups was the one that presented greater activation of the trunk muscles and lower limbs. Recent research involving practitioners with SD indicates that the blanket without feet supported in the stirrups promotes greater electrical activity of the trunk muscles as upper fibers of the trapezius, thoracic paravertebral, multifidus and rectus abdominis (Espindula et al., 2014), reaffirming the results found in the present study. This result may be related to the greater postural adjustments necessary to remain on the horse using the blanket without the feet resting on the stirrups, because the blanket is a horse riding equipment made of foam and covered with courvin that provides greater contact with the horse's back surface, promoting greater perception of the horse's three-dimensional movement and consequently greater imbalances and muscle activity. For individuals with SD, the greater activity of the trunk and lower limbs musculature observed with the use of the blanket without the feet supported in the stirrups becomes an important ally in hippotherapy treatment since hypotonia is a prevalent characteristic in this group.

The increase in lower limb muscle activity in individuals with SD during the course of ten sessions was observed in the frequency of once or twice a week, but after a two-month interval without the practice of equine-assisted therapy this behavior declined (Ribeiro, Espindula, Ferreira, Souza, & Teixeira, 2017). The same was observed in studies that analyzed the trunk and abdominal muscles of individuals with SD after being submitted once a week to ten sessions of equine therapy (Espindula, Ribeiro, Souza, Ferreira, & Teixeira, 2015). During horse riding the postural adjustments triggered by the three-dimensional movement of the horse are able to promote increased muscle activity and consequently stimulate the development of motor acquisitions (Ribeiro et al., 2017).

Similar to the SD group, individuals with DI also showed greater activation of the trunk muscles and lower limbs with the blanket without feet supported on the stirrups. It is believed that the finding is related to the greater postural instability and the greater contact of the practitioner with the horse, provided by the use of the blanket, as well as the withdrawal of the feet from the stirrups. Therefore, the results observed, infer responses similar to those found in practitioners with DS regarding postural adjustments, balance and muscle activity, even though they are considered groups with different characteristics between them. Individuals with DI may present changes in balance and motor coordination (Rezende, Moreira, & Torres, 2014) and, consequently, indirectly compromise neuromuscular aspects such as muscle strength and tone, which determines a likely need for greater muscle activity to maintain the posture on the horse during hippotherapy. However, studies with electromyographic analysis in DI practitioners, using different horse riding equipment were not found.

Literature reports did not present similar studies with DI, but it was possible to identify a method of equine-assisted therapy with the use of a blanket without feet in the stirrups was used to evaluate muscle flexibility before and after hippotherapy sessions (Espindula et al., 2012b). In the context of equine-assisted therapy, research with groups of practitioners with DI is still scarce. This fact may be related to the statistics of the population with DI in Brazil, representing a lower prevalence (1.4%) among the deficiencies researched by the last Census conducted in 2010 and published in 2013 (Instituto Brasileiro de Geografia e Estatística [IBGE], 2013).

However, even with a limited number of participants, the study was cautious in selecting a sample with a similar anthropometric characteristics according to the clinic diagnose of each group analyzed (PC, SD and DI). In this way, the results achieved should be considered as clinic relevance in the elaboration of equine-assisted therapy plans, referring to the choice of horse riding equipment specific for practitioners with PC, SD and DI.

As limitations of the study we can consider the small “n” due to the characteristic of the sample and data were collected only in single hippotherapy care, suggesting that new studies be developed but with a larger population, as well as the number of sessions.

## Conclusion

The choice of horse riding equipment used in equine-assisted therapy interferes differently in the pattern of muscular activation of the trunk and the lower limbs, according to the pathological processes of the practitioners. It must be an important aspect to consider when planning treatment.

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