Postural Control in Children with Down Syndrome: Evaluation of Functional Balance and Mobility[1]

Controle Postural em Crianças com Síndrome de Down: Avaliação do Equilíbrio e da Mobilidade Funcional[2]

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ABSTRACT: The delay in motor development in children with Down Syndrome (DS), as a consequence of the characteristics and presence of associated disorders, may lead to slowness in the acquisition or limitations of functional abilities. Thus, this study aims to characterize the balance and functional mobility of children with DS, since they enable the execution of daily activities. The cross-sectional study with sample convenience was performed with children with DS, confirmed through karyotype, between the ages of 8 and 12 years old. The evaluation of postural control was performed with two instruments: Pediatric Balance Scale (PBS) and Reach Test (RT). Twenty-one participants with DS, 12 (57%) boys and nine (43%) girls, median age of 10 [8-11] years old, were evaluated. The score obtained in the PBS was 53 (51-54). The distance obtained in the RT was 19 cm (17-23.5). The results showed that the performance of functional activities was little affected, according to the median of the score in the PBS; however, some participants scored between 48 to 51. The measurements obtained in the RT imply a reduction in functional mobility.

KEYWORDS: Special Education. Down Syndrome. Child Development. Physical therapy.

RESUMO: O atraso do desenvolvimento motor em crianças com Síndrome de Down (SD), em consequência das características e da presença dos distúrbios associados, pode levar à lentidão na aquisição ou a limitações das habilidades funcionais. Assim, este estudo teve como objetivo caracterizar o equilíbrio e a mobilidade funcional de crianças com SD, uma vez que possibilitam a execução de atividades do cotidiano. O estudo transversal com amostra de conveniência foi realizado com crianças com SD, confirmado por cariótipo, na faixa etária entre oito e 12 anos. A avaliação do controle postural foi realizada com dois instrumentais: Escala de Equilíbrio Pediátrica (EEP) e Teste de Alcance (TA). Foram avaliados 21 participantes com SD, 12 (57%) meninos e nove (43%) meninas, mediana de idade de 10 [8-11] anos. O escore obtido na EEP foi de 53 (51-54). A distância obtida no TA foi de 19 cm (17-23,5). Os resultados mostraram que a realização de atividades funcionais foi pouco afetada, conforme a mediana do escore na EEP; no entanto, alguns participantes pontuaram entre 48 a 51. As medidas atingidas no TA implicam redução da mobilidade funcional.

PALAVRAS-CHAVE: Educação Especial. Síndrome de Down. Desenvolvimento Infantil. Fisioterapia.

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1 Introduction

Down Syndrome (DS) is a genetic condition caused by three chromosomal abnormalities (trisomy 21, translocation or mosaicism) (Garcia, Flores, & Sagrillo, 2009). The child with DS presents an extra chromosome in pair 21 (Bahniuk, Koerich, & Bastos, 2004), which is clinically characterized by mental retardation, hypotonia of varying degrees, which impair the development of the body schema and present alterations in balance, spatial notion, motor coordination and gait (Bragança, 2010). The motor development of the child with DS occurs more slowly, taking more time to crawl, sit and walk (Lara & Rodrigues, 2008), and this delay may lead to functional limitations.

According to Bonomo and Rossetti (2010), global motor skills are acquired during childhood in the early years of life, which facilitate the development process. In relation to DS, the associated factors can intervene in obtaining motor skills, sometimes leading to impairment in motor learning (Santos, Weiss, & Almeida, 2010) and, consequently, changes in postural control. Postural control is a prerequisite for the acquisition of several postures and functional activities of daily life, at home and in school (Pollock, Durward, & Rowe, 2000). The development of postural control will allow the acquisition of larger and more qualified motor repertoire (Brogren, Hadders-Algra, & Forssberg, 1988).

Postural control is the ability to maintain, achieve, and restore balance in any adopted posture. However, it's existence is not only for maintaining posture, but also for mobility, performance of daily activities in a safe way and in response to external disturbance (Mancini & Horak, 2010).

The maintenance of postural control requires active participation of the sensorimotor system (Steindl, Kunz, Schrott-Fischer, & Scholtz, 2006). Individuals with musculoskeletal and neurological disorders more often have deficits in balance and mobility problems (Mancini & Horak, 2010). In this sense, children with DS may present difficulties in postural control, resulting in a static and dynamic functional balance deficit. Thus, this study aims to characterize the balance and functional mobility of children with DS, since they enable the execution of daily activities, such as those performed at home and at school. Such knowledge will favor the development of school activities that can promote the improvement of postural control, as well as the care to be implemented, since the deficit of balance increases the risk of falls.

2 Method

The cross-sectional study was carried out with children with a diagnosis of DS, confirmed by karyotype, between the ages of 8 and 12 years old and of both genders. Exclusion criteria were children unable to remain in the orthostatic position and those who did not cooperate or did not have enough understanding to perform the tests. The sample was of convenience; however, all children of the Association of Parents of Children with Down Syndrome (APC Down) and the Institute of Education for Exceptional Children from Londrina, state of Paraná, Brazil, were evaluated, according to inclusion and exclusion criteria. The research project and the Free and Informed Consent Form were approved by the Ethics Committee/ State University of Londrina (Opinion no. 1.336.881/2015).

Twenty-one participants with DS were evaluated, 12 (57%) boys and 9 (43%) girls, with a median age of 10 [8-11] years old. Regarding comorbidities, one child (5%) had corrected congenital heart disease, three children (14%) had hypothyroidism and two children (9.5%) used hyperactivity medication.

The identification and characterization data of the participants were collected in an interview with the parents or guardians and in the individual institutional file. The evaluation of postural control was performed through two instruments: the Pediatric Balance Scale (PBS) and Reach Test (RT). The PBS and the RT have been used to evaluate balance and functional mobility in different childhood populations, such as children with cerebral palsy (Vitor, Silva Junior, Ries, & Fujisawa, 2015), hearing impairment (Rodrigues, Bertin, Vitor, & Fujisawa, 2014) and eutrophic and overweight (Gomes, Vitor, & Fujisawa, 2013).

The Berg Balance Scale (BBS) aims to evaluate the risk of falls in elderly individuals; whereas the PBS, based on BBS, was proposed for school-aged children with mild to moderate motor impairment (Franjoine, Gunther, & Taylor, 2003). The purpose of the PBS is to evaluate the static and dynamic functional balance, since the 14 items are based on daily activities such as: getting up and sitting, picking up an object on the floor, and standing on one leg. The Brazilian version of PBS, proposed by Ries, Michaelsen, Soares, Monteiro and Allegretti (2012), was used, which contains 14 items, with a score of 0 to 4, a maximum score of 56 points - in this case, the higher the value, the better the performance. Participants were instructed in the execution of each PBS item, also demonstrated by the evaluator, and a score of 0 to 4 was assigned according to performance.

The RT evaluates the dynamic functional balance in terms of mobility, as it measures the maximum possible distance to be reached forward and to right and left sides, respectively, with the dominant upper, right and left limb, with the feet flat on the floor (Duncan, Weiner, Chandler, & Studenski, 1990). For the RT, the measuring tape was attached to the wall at the child's shoulder length, he/she was requested to perform anterior flexion with the shoulder at 90 degrees and maximum forward displacement, without removing the feet from the floor and not touching the wall or evaluator, holding for three seconds when the maximum possible distance was reached - the difference between the initial and final values was measured. The RT was repeated three times. The highest value was considered for analysis, and only the Anterior Reach Test was performed.

Both RT and PBS were applied by trained evaluators, who were aware of the risk of falling during the performance of the items of greater instability. In the end, the performance report of the participants in both tests was delivered to those in charge of the institutions. A clinical meeting with the members of the multidisciplinary team was also held to discuss the findings of the study, and oriented activities that stimulated the postural control.

Normality in the data distribution was examined using the Shapiro-Wilk test. The Kruskal Wallis and Mann-Whitney tests were also used. The statistical significance was set at $p < 0.05$.

3 Results

The median score in the PBS was 53 (51-54) (Figure 1). The items in which the assigned score was maximum: to move from sitting to standing position, standing position to sitting, to transfer from one chair to another, standing without support, sitting without support, standing with eyes closed, standing with feet together, to rotate 360º, turning to look back, taking an object from the floor. The items in which the participants did not obtain the maximum score in the PBS were: standing with one foot ahead, or Tandem stance: score 4 (n= 13), score 3 (n= 3), score 2 (n= 3) and score 1 (n= 2); standing on one foot: score 4 (n= 2), score 3 (n= 8), score 2 (n= 6), score 1 (n= 4) and score 0 (n=1); placing alternate foot on step: score 4 (n= 19) and score 3 (n= 2); reaching forward with the outstretched arm: score 4 (n= 4), score 3 (n= 16) and score 2 (n= 1). The median distance obtained in the RT was 19 cm (17-23.5) (Figure 2).

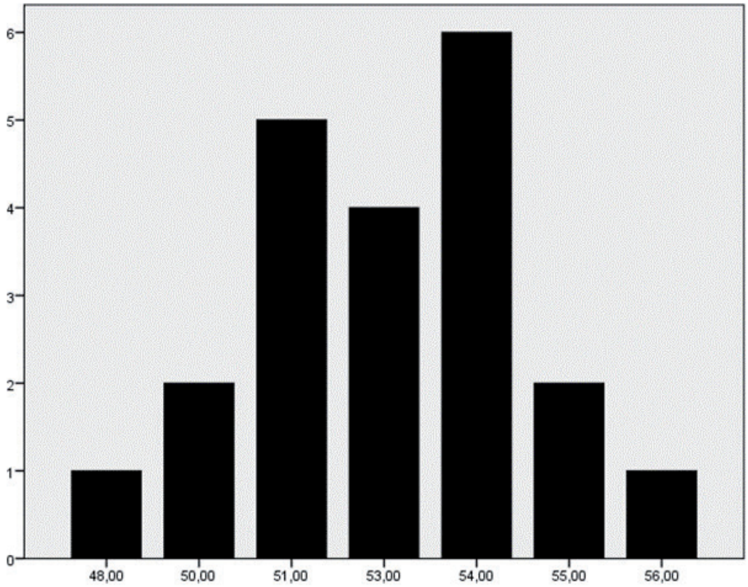

Figure 1. Score obtained in PBS
Source: Elaborated by the authors.

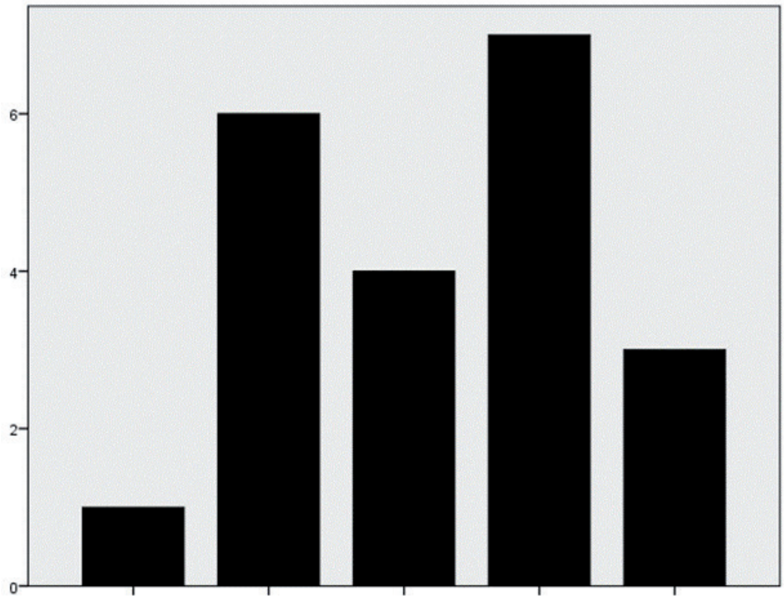

Figure 2 - Distance obtained in RT
Source: Elaborated by the authors.

The following tables present the scores obtained and the distances reached by the groups: age range – G1 (8/9 years old; n=8), G2 (10 years old; n=7) and G3 (11/12 years old; n=6); gender – male (n=12) and female (n=9), and eutrophic (n=9) and overweight (n=12). Table 1 presents the results of the PBS (median and quartiles) of the participants, divided into groups by age range, gender and nutritional classification - *p* value found in the group analysis. Table 2 deals with the participants' RT (cm), divided into groups by age range, gender and nutritional classification - *p* value found in the group analysis.

	PBS	**25%**	**75%**
G1	52	51,0	53,8
G2	53	51,0	54,0
G3	54	50,0	55,3
p	0,69		
MALE	53	51,5	54,8
FEMALE	51	50,0	54,0
p	0,19		
EUTROPHIC	53,0	51,0	54,0
OVERWEIGHT	53,5	50,3	54,0
p	0,80		

Table 1. Results of PBS (median and quartiles) of participants
Source: Elaborated by the authors.

	REACH	25%	75%
G1	18,5	16,2	23,7
G2	22	18,9	23,0
G3	21	16,5	26,5
p	*0,85*		
MALE	18,5	16,3	23,0
FEMALE	22	17,0	14,5
p	*0,60*		
EUTROPHIC	18,	16,0	22,0
OVERWEIGHT	23	17,5	24,7
p	*0,80*		

Table 2. Results of RT (cm) of participants
Source: Elaborated by the authors.

4 Discussion

Regarding the score obtained in the PBS, it is verified that the study participants did not reach the maximum score of 56. Galli, Rigoldi, Mainard, Tenore, Onorati and Albertini (2008) report that people with DS have deficits in postural control, often leading to functional balance disorders. In relation to the items in which the participants did not obtain the maximum score, they were those in which the base of support (tandem stance and unipedal stance) was reduced, since they provoked greater instability, and also those that required greater displacement and agility (reach forward and footrest switch on a stool).

In adults and the elderly, the Berg Scale aims to evaluate the risk of falls and considers the scores obtained as follows: between 56 and 54, each point less corresponds to a 3 to 4% risk of falls; from 54 to 46, an increase of 6 to 8%; below 36, the risk is almost 100% (Shumway-Cook & Woollacott, 2003). PBS was based on the Berg Scale. Although the same cutoff points cannot be used for analysis, it is assumed that there is an increased risk of falls in participants who scored 48-51. Thus, preventive measures must be carried out at home, at school, such as: supervision in situations of risk, monitoring activities and removal of objects that favor the occurrence of falls.

Vitor et al. (2015) evaluated children with typical development for the control group and obtained the following results in the RT: G1 (5/6 years old) 22 cm; G2 (7/8 years old) 25.5 cm; G3 (9/10 years old) 24 cm, it is verified that the measurements obtained in children between 10 (22 cm) to 11/12 years old (21 cm) with DS were close to the control group in the age range of 5 to 6 years old with typical development. The comparison between the values reached by the control group of Vitor et al. (2015), with a median distance reached of all participants with DS to be 19cm, and our study, shows that functional mobility is reduced. Chen, Yeh and Howe (2015) also found a worse performance in the RT of children with DS when compared to children with typical development, that is, reduced distance, and with more postural adjustment strategies recruited. The authors emphasize that, as reaching is part of the functional balance, necessary in the execution of daily activities, their specific training should be inserted in the intervention programs.

Steindl et al. (2006) found that girls have better stability than boys, up to age 11 to 12 years old, relating the results to differences in maturation of the visual and vestibular systems, as well as to greater agitation and less attention of the male participants. In our study, there were no significant differences between genders in PBS and RT, which may be justified by the characteristics of the syndrome and its individuality, which probably interfered more than other factors pointed out in the literature.

Among the participants in this study, 57% were overweight. According to Bertapelli, Pitetti, Agiovlasitis and Guerra-Junior (2016), young people with DS are more likely to be overweight compared to the general population. Neves, Souza and Fujisawa (2017) reported that overweight children with typical development did not change the area of the pressure center, but it modified the anteroposterior and mediolateral velocity, related to the performance of the postural control in the platform of unipedal position. However, in our study, there was no difference between the eutrophic and overweight participants in relation to the performance in the PBS and RT of the children with DS. In the present study and in the study of Neves et al. (2017), the instruments used were different, functional tests and posturography, respectively, being the force platform considered gold standard in the evaluation of postural control.

Postural control improves with advancing age in children with typical development, according to Mickle, Munro and Steele (2011). However, in our study, there was no significant difference in the performance of PBS and RT between groups by age range. Malak, Kotwicka, Krawczyk-Waslelewska, Mojs and Samborski (2013) identified that the motor development of children with DS is associated with cognitive development, especially in the first three years of life, and that balance is closely related to the acquisition of motor skills. Thus, differences in the functional balance of the participants in this study should have occurred, depending on the age range, since, with advancing age, the development of motor skills is greater, however the small sample size associated with the variability in the impairment may have led to the findings.

On the one hand, postural control is a complex and multifactorial mechanism. On the other hand, there is great variability in the cognitive, nervous and motor systems, and changes in the sensory integration mechanism of children with DS which can justify the non-difference in the results related to gender, nutritional classification and age range. It is added that intrinsic factors (e.g. anthropometry, physiological, surgical, medicinal) and extrinsic factors (e.g. footwear, soil types) are also involved in postural control.

According to Horak, Henry and Shumway-Cook (1997), postural control strategies can become more effective and efficient with practice and training. In this sense, play in childhood promotes development in its totality and complexity, and when involving global motor activities, they provide new motor experiences and stimulate postural control strategies. Such activities may occur at home and in the community. In addition, the school can also provide playful activities with its curriculum organization.

In a case study, Anunciação, Costa, and Denari (2015) described the motor development of a student with DS upon intervention carried out in the school environment, in the regular classroom, through playing games (e.g. collective ball games), movements between activities (e.g. tiptoeing, walking with one foot in front of the other, walking backwards), classroom activities, story time, park time (e.g. slides, monkey bars, swings) and support of the riding games. It is worth noting that the intervention proposed by the study of Anunciação et al. (2015) promoted activities with the purpose of stimulating the motor behavior, which, in turn, favored the development of postural control strategies, thus showing that Childhood Education may contribute to the improvement of the functional balance of children with DS.

The children with typical development that participate in activities in sports schools, according to Nazario and Vieira (2014), present better performance in motor skills, according to the requirements, when compared to the group that only did Physical Education in school. In this sense, it may be recommended that the practice of physical/sports activities be encouraged to children with DS, provided their clinical conditions are observed and their interests are considered, since they contribute to the improvement in the performance of motor skills, and therefore, in the evolution of postural control strategies.

Lorenzo, Bracciali and Araújo (2015) show in their study that virtual reality can be an alternative intervention in Occupational Therapy with DS children, since the results obtained contributed to the development of global motricity, balance, body schema/speed and spatial organization. Still, the authors point out that virtual reality presents itself as a possibility of action with the DS child, at the interface between health and education. Silva and Kleinhans (2006), in a literature review, emphasize that Physical Therapy plays a fundamental role in the acquisition of motor stages, and when the child with DS begins to walk, there is a need for activities that promote balance, posture and coordination of movements.

To Ries et al. (2012), reliable instruments that evaluate the functional balance are important in the pediatric clinic, since they justify the intervention and evaluate the results of the procedures used. In addition, the characterization of postural control contributes to the diagnosis of the motor disorder, as well as to its evolution over time (Steindl et al., 2006). In this sense, both PBS and RT are instruments that can be used to evaluate the functional balance. Moreover, due to their easy application, they could possibly be used in clinical and school attendance as a measure of identification and monitoring of motor evolution. In the same way, activities that contribute to the improvement of balance and functional mobility can be developed in the domiciliary, school and clinical settings.

The reduced sample size is a limitation of the study. However, all the participants of both institutions were evaluated, according to inclusion and exclusion criteria and accepted by signing the Free and Informed Consent Form, as already mentioned.

5 Conclusion

The performance of functional activities is little affected, according to the median score obtained in the evaluation of the functional balance through the PBS, but it should be taken into account that between the participants, scores ranged from 48 to 51, which lead to the need for activities to favor the development of postural control, as well as preventive measures regarding the risk of falls. The measures reached in the RT implies a reduction of functional mobility, so children with DS should be stimulated to do activities that promote the development of postural control strategies. The deficit of postural control in children with DS can affect the way they deal with new motor experiences, therefore it interferes with their overall development, including their learning process. The promotion of stimuli to the motor development of children with DS, therefore, with an emphasis on the acquisition and improvement of postural control, is fundamental.

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