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Functional performance assessment of children with cerebral palsy according to motor impairment levels

Avaliação do desempenho funcional de crianças com paralisia cerebral de acordo com níveis de comprometimento motor

Rosangela L. M. Vasconcelos, Thayse L. Moura, Tania F. Campos, Ana R. R. Lindquist, Ricardo O. Guerra

Abstract

Background: Several studies have evaluated motor function among children with cerebral palsy (CP), but little is known about how mobility impairment, self-care and social function interrelate with their functional skills and caregiver assistance. **Objectives:** To identify functional differences among children with CP at different levels of motor dysfunction, and to investigate the relationship between these differences and the domains of mobility, self-care and social function in functional skills and caregiver assistance. **Methods:** An analytical cross-sectional study was conducted among 70 children and their families. The children were aged 4 to 7.5 years and received care at the Children's Rehabilitation Center. The instruments used were the Pediatric Evaluation Disability Inventory (PEDI) and the Gross Motor Function Classification System (GMFCS). Data analysis was performed by means of ANOVA and Pearson's correlation. **Results:** The results showed significant functional variability among the children with CP at different levels of motor dysfunction severity. This variation was observed in the domains of mobility, self-care and social function. The results also showed a strong correlation between mobility and self-care and between mobility and social function. **Conclusions:** In view of the variability shown by the children, it was necessary to apply PEDI and GMFCS, which appears to increase the understanding of how gross motor function relates to activities of daily living. This correlation demonstrates the extent to which mobility is a determinant for evaluating functional performance and guiding therapeutic practice to develop children's potentials and instruct caregivers in stimulation.

Key words: cerebral palsy; functional skills; mobility; performance assessment.

Resumo

Contextualização: Diversos estudos têm avaliado a função motora de crianças com Paralisia Cerebral (PC), entretanto pouco se sabe sobre as inter-relações entre comprometimentos da mobilidade, autocuidado e função social relacionadas às habilidades funcionais da criança e à assistência do cuidador. **Objetivos:** Identificar diferenças funcionais de crianças com PC em diferentes níveis de disfunção motora e correlacioná-las com os domínios mobilidade, autocuidado e função social na habilidade funcional e na assistência do cuidador. **Métodos:** Realizou-se uma pesquisa analítica de corte transversal com 70 crianças/famílias, com idades de 4 a 7,5 anos, atendidas no Centro de Reabilitação Infantil, por meio do *Pediatric Evaluation Disability Inventory* (PEDI) e do *Gross Motor Function Classification System* (GMFCS). A análise dos dados foi realizada por meio da ANOVA e teste de correlação de Pearson. **Resultados:** Os resultados indicaram importante variabilidade funcional das crianças com PC em diferentes níveis de severidade da disfunção motora. Essa variação foi observada nos domínios mobilidade, autocuidado e função social. Os resultados apresentaram, também, forte correlação entre os domínios mobilidade e autocuidado e mobilidade e função social. **Conclusões:** Diante da variabilidade apresentada pelas crianças, percebe-se a necessidade de aplicação do PEDI e GMFCS, o que parece aumentar o entendimento sobre a relação entre funções motoras grossas e atividades da vida diária. Essa correlação demonstra o quanto a mobilidade é determinante para avaliar o desempenho funcional e orientar a prática terapêutica no sentido de desenvolver as potencialidades das crianças, bem como orientar o cuidador na estimulação.

Palavras-chave: paralisia cerebral; habilidades funcionais; mobilidade; avaliação do desempenho.

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Department of Physical Therapy, Universidade Federal do Rio Grande do Norte (UFRN), Natal (RN), Brazil

Correspondence to: Ana Raquel Rodrigues Lindquist, Universidade Federal do Rio Grande do Norte, Centro de Ciências da Saúde - Departamento de Fisioterapia, Av. Senador Salgado Filho, 3.000, Caixa Postal 1524, CEP 59072-970, Natal (RN), Brazil, e-mail: araquel@ufrnet.br; raquellindquist@gmail.com

Introduction

It is well known that, among children with cerebral palsy (CP), the main disorder is motor impairment, which causes several changes due to the encephalopathy with subsequent modifications in body biomechanics. Additionally, children can suffer from cognitive, sensitive, visual and hearing impairments which, combined with motor changes and task or environmental restrictions, reflect on their functional performance in different ways[1-8]. The heterogeneity of the health conditions of children with CP does not allow a classification of motor impairment levels, and it is also a challenge for multi-professional rehabilitation teams to use measures based on children's functional performance. This occurs because several studies[5,9-14] present the functional scenario of the severity levels of CP in daily activities but do not describe the impact of the isolated disorder or the disability during the performance of these tasks.

In the literature, some studies have proposed that the combination of the Pediatric Evaluation of Disability Inventory (PEDI) and the Gross Motor Function Classification System (GMFCS) could improve the classification of these children in terms of functionality. Thus, the GMFCS would help to classify motor impairment into severity levels according to the limitations and to the need for assistive technology while the PEDI would assess children's functional capacity, skills and performance. This would allow the early detection of disorders at higher levels of impairment[9-13].

In this context, it has been suggested that the combination of PEDI and GMFCS would be a way to assess the impact of motor disability on the performance of functional activities, associating the children's functional differences and their characteristics in the mobility, self-care and social function domains. These domains provide information about important aspects of the children's functionality so that therapeutic actions can be planned according to their actual level of impairment and stimuli can be given to reach their full potential[13-15]. Thus, the goals of the present study were to identify the functional differences between CP children with different levels of motor impairment and to investigate the relationship between these differences with the mobility, self-care and social function domains, in functional skills and in caregiver assistance.

Methods

This was an observational and descriptive study that included 70 children/families aged 4 to 7.5 years. The study included all children of that age group with a medical diagnosis of CP assisted at the Children's Rehabilitation Center in Natal, Rio Grande do Norte, Brazil. The sample selection was non-randomized and based on the evaluation of the children's medical charts at the previously cited center. Those who did not have a confirmed diagnosis of CP were submitted to a medical evaluation before they were enrolled in the study. Children with progressive brain injuries were excluded from the study. All types of CP were included and there was no sample loss. This study was approved by the Research Ethics Committee of the Health Sciences Center of Universidade Federal do Rio Grande do Norte (protocol 016/04). The guardians signed an informed consent form allowing the children's participation.

Procedures

Initially, two physical therapists were trained to administer the PEDI and GMFCS protocols. The interrater reliability test for the PEDI, based on the assessment of 30 children, showed levels of intra-class correlation (ICC) higher than 0.90 for all assessed categories. All children were evaluated by the GMFCS, then by the PEDI.

Assessment tools

The GMFCS proposed by Palisano et al.[1] was used to assess the severity of a child's neuromotor impairment. Based on this instrument, children were grouped according to the following levels of severity: levels I and II refer to those children with lower functional impairment and that are able to walk without restrictions; level III refer to those children that need help; level IV/V includes the children that use assistive technology to ambulate[15,16].

To assess functional performance, we used the PEDI translated, adapted and validated by Mancini[17] to suit Brazilian sociocultural characteristics. This instrument evaluates the child's functional skills through a structured interview administered by the caregiver. It is composed of 197 items, subdivided into three domains: mobility (59 items, involving tub transfers, toilet transfers, indoor and outdoor locomotion, and climbing stairs); self-care (73 items involving eating, dressing, grooming); and social function (65 items related to communication with comprehension and expression, problem-solving, interactions with peers and adults and safety awareness). Each item scores (0) for "unable" to perform the activities or (1) for "capable"[1,17]. The PEDI also evaluates the caregiver assistance, showing the child's level of independence through eight self-care tasks, seven mobility tasks and five social function tasks.

The amount of necessary assistance is evaluated through a five-point scale, where 5 indicates the child's independence; 4, need of supervision; 3, minimal assistance; 2, moderate assistance; 1, total caregiver assistance. In the first part of the test, three overall net scores are given on the performance in the self-care, mobility and social function areas. The comparison between the functional areas or domains is quite limited because each scale has a different number of items. Thus, to make this comparison possible, the net scores obtained in the PEDI were added and then converted to continuous scores according to the children's levels of disability (0-100)[1,9,17].

Statistical analysis

The data was analyzed with the software Statistical Package for the Social Science (SPSS 15.0). The significance level was set at <5% for all statistical tests. After verification of normal distribution through the Kolmogorov-Smirnov test, analysis of variance (ANOVA) was used with Bonferroni's post hoc test to identify the existence of significant differences between the severity levels of the gross motor function and functional skills and caregiver assistance. Pearson's correlation test was applied to analyze the performance in the three domains (mobility, self-care and social function) at each level of motor function.

Results

The characteristics of the evaluated children are shown in Table 1. Of the 70 children, 46 (65.7%) were classified at levels IV/V of the GMFCS. The different levels showed associated vision, speech and language problems, mental disorders and random, heterogeneous seizures. These disorders were mainly evidenced at levels IV/V.

The descriptive analysis of functional abilities: mobility, self-care and social function showed the variability of the children. As seen in Table 2, the medians of these functional skills according to severity of motor function ranged from 14.24 to 59.91, and some scores of the most severely impaired children are above the mean for their group. An example can be observed in level III of the mobility item, where scores of 48.11 were found when the limits in the children from level II ranged from 38.28 to 52.76, and those from level I, from 40.41 to 63.81 (Table 2).

The ANOVA results showed that, within functional skills, there are significant differences between the mobility (p=0.0001), self-care (p=0.0001) and social function (p=0.0001) domains (Figure 1). When analyzing mobility, the Bonferroni test showed that the children from levels IV/V had a significantly poorer functional performance than those from levels I (p=0.0001), II (p=0.0001) and III (p=0.0001), while the children from level I were significantly better than those from level IV/V (p=0.02). There were no significant differences between levels I and II, III and IV. In the activities related to self-care, the children from level IV/V had significantly lower differences compared to those from level I (p=0.0001), II (p=0.001) and III (p=0.0001). There were no significant differences between the children from level I, II and III. Regarding social function, the children with level IV/V motor impairment were significantly more impaired than those from the other groups, with significant differences between the means from levels IV/V and I (p=0.0001), II (p=0.017) and III (p=0.002). There was no significant difference between levels I, II and III, concerning social function.

Table 1. Sample characterization with respect to age, sex, type of CP, socioeconomic level and the presence of comorbidities.

Variables	Groups		Level I n (%)	Level II n (%)	Level III n (%)	Levels IV/V n (%)
Age (years)	4		7 (29.2)	-	3 (12.5)	14 (58.3)
	5		2 (15.4)	-	2 (15.4)	9 (69.2)
	6		3 (13.0)	2 (8.7)	1 (4.3)	17 (73.9)
	7		2 (20.0)	2 (20.0)	-	6 (60.0)
Sex	Male		11 (26.2)	2 (4.8)	3 (7.1)	26 (61.9)
	Female		3 (10.7)	2 (7.1)	3 (10.7)	20 (71.4)
Type of CP	Hemiplegia		9 (69.2)	4 (30.8)	-	-
	Diplegia		4 (30.8)	-	4 (30.8)	5 (38.5)
	Quadriplegia		-	-	-	37 (100)
	Dyskinesia		1 (20.0)	-	2 (40.0)	2 (40.0)
	Mixed		-	-	-	2 (100)
Attends school/day care	Yes		14 (45.2)	4 (12.9)	4 (12.9)	9 (29.0)
	No		-	-	2 (5.1)	37 (94.9)
Comorbidities (associated disorders)	Vision	Yes	1 (8.3)	-	-	11 (91.7)
	Speech/Language	Yes	6 (10.5)	3 (5.3)	3 (5.3)	45 (78.9)
	Mental disorder	Yes	6 (14.0)	2 (4.7)	3 (7.0)	32 (74.4)
	Seizures/ Epilepsy	Yes	2 (6.1)	1 (3.0)	2 (6.1)	28 (84.8)

CP=cerebral palsy.

Table 2. Descriptive analysis of the continuous functional skill scores of children with cerebral palsy (CP) in mobility (M), self-care (SC) and social function (SF) according to level of motor function severity.

			Level I (n=14)	Level II (n=4)	Level III (n=6)	Levels IV/V (n=46)
Functional skill	Mobility	Mean	54.70	46.91	43.28	23.66
		SD	8.49	7.12	4.52	7.8
		Median	53.92	48.31	43.87	14.24
	Self-care	Mean	62.62	50.99	56.83	25.74
		SD	15.37	14.17	10.20	11.40
		Median	59.00	51.35	58.26	22.11
	Social function	Mean	63.73	59.38	60.18	33.71
		SD	13.93	12.14	15.53	16.59
		Median	59.91	59.68	60.54	35.67
Caregiver assistance	Mobility	Mean	70.73	60.54	57.55	7.50
		SD	11.99	7.65	8.35	11.54
		Median	69.60	59.61	54.86	0.0
	Self-care	Mean	71.61	57.16	63.37	14.91
		SD	9.46	18.36	11.75	20.53
		Median	70.48	58.93	66.11	0.0
	Social function	Mean	61.96	54.50	60.30	23.77
		SD	18.86	20.17	18.16	21.16
		Median	62.00	51.78	60.71	22.53

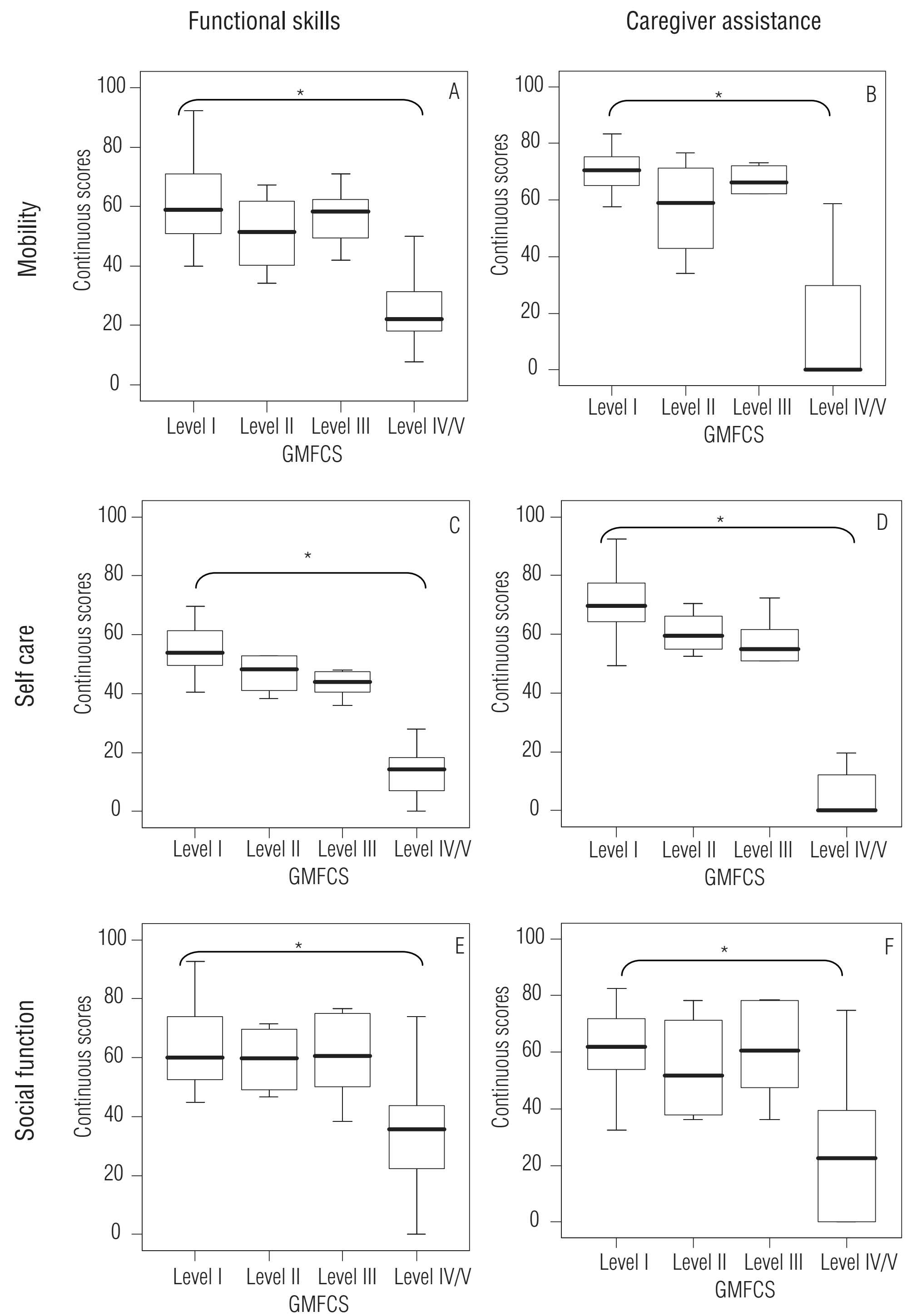
The ANOVA results for caregiver assistance also showed significant differences between mobility (p=0.0001), self-care (p=0.0001) and social function (p=0.0001). The results of the Bonferroni test for mobility, self-care and social function showed similar results to those shown above (Figure 1). Regarding the results of the functional skills assessment, Pearson's test found a correlation between the mobility and self-care in levels I (r=0.716; p=0.004) and IV/V (r=0.561; p=0.0001); between mobility and social function in level I (r=0.836; p=0.0001) and IV/V (r=0.468; p=0.001); and between self-care and social function in level I (r=0.694; p=0.006) and IV/V (r=0.775; p=0.0001). The same correlations between the three domains were found for caregiver assistance.

There were also correlations between functional skills and caregiver assistance in the mobility, self-care and social function domains. There were correlations for mobility at levels I and IV/V (I: r=0.927; p=0.001; and IV/V: r=0.540; p=0.001) and for self-care at level I, II and IV/V (I: r=0.899; p=0.0001; II: r=0.996; p=0.004; and IV/V: r=0.753; p=0.001). Social function had a strong correlation in all levels (I: r=0.938; p=0.0001; II: r=0.982; p=0.018; III: r=0.997; p=0.001; and IV/V: r=0.879; p=0.001).

Discussion

The results of the present study indicated a functional variability of the CP children, i.e. a significant variation in functionality within the different levels of motor impairment severity in the mobility, self-care and social function domains (Table 2). The Bonferroni tests showed a greater difference between the means of levels I and IV/V, indicating that the children of level IV/V had greater motor severity and functional impairment, therefore greater dependence on the caregiver. The variability is clearly shown by the fact that some children presented functionality above the group mean. i.e. when evaluated with the PEDI, they showed similar functionality to the groups with mild impairment, according to the GMFCS classification. These findings corroborate those of Ostenjo, Calberg and Vollestad[11] and Allegretti, Mancini and Schwartzman[13], who also indicated functional variability of CP children in the three domains.

Considering motor function severity, 65.7% of the subjects were classified in levels IV/V (Figure 1), a fact that demonstrates a higher prevalence of children with a poorer functional performance in all domains when both functional skills and caregiver assistance were assessed. This fact is consistent, as motor function is directly related to the functional skills and caregiver assistance items. Thus, children with more severe motor impairment showed less independence in functional skills and, consequently, more dependence on caregiver assistance. It was also observed that the greater mobility impairments seen in the children of level IV/V are related to poorer performances in self-care and social function. Mobility also seems to influence the performance of self-care tasks, so that the children classified as level I are very independent in these tasks while those classified as level IV/V are very dependent on the caregiver. In this context, it is worth noting that this is restricted



*Statistically significant difference.

Figure 1. Analysis of the differences between severity levels of gross motor function and the functional skill and caregiver assistance domains.

to the comparison between the previously mentioned groups. When level I is compared to level II and III, there is no significant difference and, although they have greater motor impairment, functionality is preserved. This fact can be explained by the presence of small changes between these levels, not directly implying total dependence on caregiver assistance[13,17].

It must be taken into account that, the child's socioeconomical status may interfere in their classification, as there are children who do not move because they do not have the financial means to afford a wheelchair or other modalities of assistive technology[11,13,18,19]. In the present study, 26 of the 46 children who were unable to walk did not have a wheelchair, a fact that limits locomotion in their own environment, and 37 of the 46 children did not attend school. This fact may aggravate their current social status, as social function may be related to environmental restrictions and to language and mental comorbidities.

When the performance of the children of level I was compared to that of moderate levels II and III in all domains, both in functional skills and caregiver assistance, no significant difference was found (Figure 1). Therefore, it must be noted that, although neuromotor impairment influences the functional performance of the children classified in the extreme categories, caregivers may directly influence the performance of the moderate children. When the caregiver did not stimulate the child to use his/her abilities in social function and self-care, they became more dependent than the mildly impaired children, regardless of their similar behavior. Thus, the caregiver acts as an environmental factor of negative effect, limiting the child's potential, and it is crucial that the caregiver's assistance be limited to those situations where it is indispensable[13,19-27].

It was also observed that there is a strong correlation between mobility and self-care, and mobility and social function, for both, functional skills and caregiver assistance. This indicates that children in level I with better mobility skills also need some help from caregivers in self-care and in social function. The opposite was observed in the children of level IV/V, i.e. poorer mobility skills were associated with less ability in self-care and social function, requiring more caregiver assistance. These results show the negative impact of severe motor impairment in the performance of the daily activities and in the children's functional independence. According to Mancini et al.[19], intrinsic and extrinsic aspects limit children's functional possibilities, hampering their performance of everyday activities. The more dependent the children are on caregiver assistance for the execution of routine tasks, the fewer the chances to interact with their environment. For these children, most of the task restrictions are negative, further preventing their motor development[8].

The analysis of the results by level showed correlations between functional skills and caregiver assistance for mobility in levels I and IV/V, for self-care in levels I, II and IV/V and, for social function, in all the levels (Figure 1). Similar results were found in the study by Ostenjo, Calberg and Vollestad[11], who found statistically significant differences for social function in levels III, IV, V. Their study, however, found only this type of correlation, not considering the correlation between the domains when comparing functional skills and caregiver assistance, so it is not possible to determine the relationship between mobility and functional independence. In the present study, the close relationship was found between mobility and functional independence. This relationship is important because it demonstrates that higher levels of mobility and the presence of fewer associated disorders allow greater functional independence. It is also important to highlight that, although mobility is intrinsically linked to functional independence and that this independence is one of the main objectives of physical therapy intervention, the influence of comorbidities associated with CP cannot be underestimated. This emphasizes the need for an interdisciplinary approach that considers all aspects of development and reaches better therapy results[5,7,8].

Although the children of levels I, II and III had significantly greater functionality than those of level IV/V and although there was no significant difference between the three levels, the children of level III showed a peculiarity in the self-care domain: they were more disabled in "walking" than the children of level I, but not in self-care. This result is contrary to that of Wassenberg-Severijnen et al.[28], who found better indices in mobility than in self-care and social function. This fact may be explained by two reasons: the first is that the self-care item from PEDI is more related to manual skills and the second involves the characteristics of the children of level III in this sample group. Most of the children evaluated in this study were diplegic, i.e. more functional in self-care for manual skills, while those of level II were mostly hemiplegic, more functional in walking. However, Allegretti, Mancini and Schwartzman[13] emphasize that, although musculoskeletal impairment in children with diplegic CP is more evident in lower limb function, certain upper limb functional activities can also be impaired. Thus, it become crucial to evaluate and classify the children in a standardized manner in order to improve the communication among professionals and to organize the information and evidence available in the literature about a particular disease or pathological process. This information may help the professionals involved in these children's rehabilitation process, indicating the type of activities that must be evaluated and included in the therapeutic approach[3,29,30]. To avoid underestimating the children's capacity, it is important to carefully observe the variations in functionality in order to conduct a proper investigation of the functional potential of each individual.

Thus, the results of the present study showed the variability and heterogeneity of the functionality of CP children within the different levels of motor function severity in the mobility, self-care and social function domains. A strong correlation was also found between the mobility and self-care domains and between mobility and social function, both regarding functional skills and caregiver assistance. Considering this, there is some proximity in the functional daily activities in spite of the differences in levels of gross motor function.

This correlation demonstrates how the domains are interconnected and interfere in the child's development, showing the negative impact of the severe motor impairment on the performance of daily activities and on children's functional independence. This reinforces the need to consider the variability from these patients and their peculiarities in clinical practice.

Given this variability, there is a clear need to use the PEDI and GMFCS assessment protocols, which demonstrate the importance of mobility in the evaluation of children's functional performance. This fact improves the understanding of the relationship between gross motor function and activities of daily living through a better classification of motor impairment and of the impact on functional activities. With this information, it is possible to guide therapists in planning the most efficient intervention for patients to develop their potential, as well as to instruct caregivers to stimulate the children according to their characteristics, thus improving functional skills and quality of life.

References

1. Palisano R, Rosenbaum P, Walter S, Russell D, Wood E, Galuppi B. Development and reliability of a system to classify gross motor function in children with cerebral palsy. Dev Med Child Neurol. 1997; 39(4):214-23.

2. Kavcic A, Vodusek DB. A historical perspective on cerebral palsy as a concept and a diagnosis. Eur J Neurol. 2005;12(8):582-7.

3. World Health Organization. International classification of functional and disability, beta-2 version. Geneva: WHO; 1999.

4. Dzienkowski RC, Smith KK, Dillow KA, Yucha CB. Cerebral palsy: a comprehensive review. Nurse Pract. 1996;21(2):45-8, 51-4, 57-9; quiz 60-1.

5. Knox V, Evans AL. Evaluation of the functional effects of a course of Bobath therapy in children with cerebral palsy: a preliminary study. Dev Med Child Neurol. 2002;44(7):447-60.

6. Awaad Y, Tayem H, Munoz S, Ham S, Michon AM, Awaad R. Functional assessment following intrathecal baclofen therapy in children with spastic cerebral palsy. J Child Neurol. 2003;18(1):26-34.

7. Schwartzman JS. Paralisia cerebral. Arquivos Brasileiros de Paralisia Cerebral. 2004;1(1):4-17.

8. Manoel EJ, Oliveira JA. Motor developmental status and task constraint in overarm throwing. Journal of Human Movement Studies. 2000;39:359-78.

9. Oeffinger DJ, Tylkowski CM, Rayens MK, Davis RF, Gorton GE 3rd, D'Astous J, et al. Gross motor function classification system and outcome tools for assessing ambulatory cerebral palsy: a multicenter study. Dev Med Child Neurol. 2004;46(5):311-9.

10. Haley SM, Coster WJ, Ludlow LH, Haltiwanger JT, Andrellos PJ. Pediatric evaluation of disability inventory: development, standardization and administration manual. Boston: New Englang Medical Center; 1992.

11. Ostensjo S, Carlberg EB, Vollestad NK. Everyday functioning in young children with cerebral palsy: functional skills, caregiver assistance, and modifications of the environment. Dev Med Child Neurol. 2003;45(9):603-12.

12. Mancini MC, Coster WJ. Functional predictors of school participation by children with disabilities. Occup Ther Int. 2004;11(1):12-25.

13. Allegretti ALC, Mancini MC, Schwartzman JS. Estudo do desempenho funcional de crianças com paralisia cerebral diparética espástica utilizando o pediatric evaluation of disability inventory (PEDI). Arquivos Brasileiros de Paralisia Cerebral. 2004;1(1):35-40.

14. Feldman AB, Haley SM, Coryell J. Concurrent and construct validity of the pediatric evaluation of disability inventory. Phys Ther. 1990;70(10): 602-10.

15. Wood E, Rosenbaum P. The gross motor function classification system for cerebral palsy: a study of reliability and stability over time. Dev Med Child Neurol. 2000;42(5):292-6.

16. Palisano RJ, Hanna SE, Rosenbaum PL, Russell DJ, Walter SD, Wood EP, et al. Validation of a model of gross motor function for children with cerebral palsy. Phys Ther. 2000;80(10):974-85.

17. Mancini MC. Inventário de avaliação pediátrica de incapacidade (PEDI) - manual da versão brasileira adaptada. Belo Horizonte: Editora UFMG; 2005.

18. Cury V, Mancini M, Melo APP, Fonseca ST, Sampaio RF, Tirado MGA. Efeitos do uso de órteses na mobilidade funcional de crianças com paralisia cerebral. Rev Bras Fisioter. 2006;10(1):66-73.

19. Mancini MC, Alves ACM, Schaper C, Figueiredo EM, Sampaio RF, Coelho ZAC, et al. Gravidade da paralisia cerebral e desempenho funcional. Rev Bras Fisioter. 2004;8(3):253-60.

20. Mancini MC. Avaliando o desenvolvimento neuromotor: uma análise crítica. Arq Neuropsiquiatr. 2001;59 Suppl 1:33-4.

21. Ketelaar M, Vermeer A, Hart H, van Petegem-van Beek E, Helders PJ. Effects of a functional therapy program on motor abilities of children with cerebral palsy. Phys Ther. 2001;81(9):1534-45.

22. Mittal S, Farmer JP, Al-Atassi B, Montpetit K, Gervais N, Poulin C, et al. Functional performance following selective posterior rhizotomy: long-term results determined using a validated evaluative measure. J Neurosurg. 2002;97(3):510-8.

23. Durigon OFS, Sá CSS, Sitta LV. Validação de um protocolo de avaliação do tono muscular e atividades funcionais para crianças com paralisia cerebral. Revista Neurociências. 2004;12(2):87-93.

24. Hage SRV, Joaquim RSS, Carvalho KG, Padovani CR, Guerreiro MM. Diagnóstico de crianças com alterações específicas de linguagem por meio de escala de desenvolvimento. Arq Neuropsiquiatr. 2004;62(3A): 649-53.

25. Haley SM, Ludlow LH. Applicability of the hierarchical scales of the tufts assessment of motor performance for school-aged children and adults with disabilities. Phys Ther. 1992;72(3): 191-202.

26. Nordmarck E, Jarnlo GB, Hägglund G. Comparison of the gross motor function measure and pediatric evaluation of disability inventory in assessing motor function in children undergoing selective dorsal rhizotomy. Dev Med Child Neurol. 2000;42(4): 245-52.

27. Kothari DH, Haley SM, Gill-Body KM, Dumas HM. Measuring functional change in children with acquired brain injury (ABI): comparison of generic and ABI-specific scales using the pediatric evaluation of disability inventory (PEDI). Phys Ther. 2003;83(9):776-85.

28. Wassenberg-Severijnen JE, Custers JW, Hox JJ, Vermeer A, Helders PJ. Reliability of the dutch pediatric evaluation of disability inventory (PEDI). Clin Rehabil. 2003;17(4):457-62.

29. Bax MC. Terminology and classification of cerebral palsy. Dev Med Child Neurol. 1964;6:295-7.

30. Farias N, Buchalla CM. A classificação internacional de funcionalidade, incapacidade e saúde da organização mundial da saúde: conceitos, usos e perspectivas. Rev Bras Epidemiol. 2005;8(2):187-93.