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## Measuring Functional Change in Turkish Children with Cerebral Palsy Using the Pediatric Evaluation of Disability Inventory (PEDI)

**Aim:** The purposes of this study were to evaluate the activities of daily living (ADL) of Turkish children with cerebral palsy (CP) using the Turkish version of the Pediatric Evaluation of Disability Inventory (PEDI) measurement, and to investigate the functional changes during inpatient rehabilitation.

**Materials and Methods:** A total of 90 consecutive children with spastic CP, aged between 6 months and 7 years, were included in the study. The Swedish classification of CP syndromes was applied. CP severity was classified with Gross Motor Function Classification System (GMFCS). ADL were assessed in children with CP using the Turkish version of the PEDI measurement before rehabilitation (BR) and after rehabilitation (AR). Paired sample T test was applied to investigate whether there was any significant difference in PEDI subscale scores BR and AR.

**Results:** Types of CP in the children were spastic diplegia (n = 38), spastic quadriplegia (n = 35), and spastic hemiplegia (n = 17). Symptoms were grouped by severity according to the GMFCS; 18.9% were classified at level II, 21.1% at level III, 30.0% at level IV, and 30.0% at level V. Limitations in self-care, mobility and social activities increased progressively with GMFCS level. A statistically significant increase was determined in all PEDI subscale scores AR, when compared to BR results (T test, P < 0.05).

**Conclusions:** PEDI is a sensitive and useful outcome measurement method that indicates functional changes in children with CP.

**Key Words:** Pediatric Evaluation of Disability Inventory, cerebral palsy, rehabilitation outcomes

## Serebral Palsili Türk Çocuklarda Fonksiyonel Değişimin Pediatrik Özürülük Değerlendirme Envanteri (PÖDE) ile Ölçümü

**Amaç:** Bu çalışmanın amaçları; Pediatrik Özürülük Değerlendirme Envanterinin (PÖDE) Türkçe versiyonunu kullanarak, yatarak rehabilitasyon uygulanan Serebral Palsili (SP) Türk çocukların günlük yaşam aktivitelerini (GYA) değerlendirmek ve bu çocuklardaki fonksiyonel değişimi araştırmaktır.

**Yöntem ve Gereç:** Çalışmaya yaşları 6 ay ile 7 yaş arası olan, ardışık 90 spastik tip SP'li çocuk dahil edildi. SP tiplendirmesinde, İsveç klasifikasyonu kullanıldı. SP ciddiyeti, Kaba Motor Fonksiyon Klasifikasyon Sistemi (KMFKS) ile sınıflandırıldı. SP'li çocukların GYA'ları, PÖDE'nin Türkçe versiyonu kullanılarak rehabilitasyon öncesinde (RÖ) ve sonrasında (RS) değerlendirildi. RÖ ve RS PÖDE'nin alt skala skorlarında anlamlı bir farklılık olup olmadığı T testi ile araştırıldı.

**Bulgular:** Çocuklardaki SP tipleri; spastik dipleji (n = 38), spastik kuadripleji (n = 35), ve spastik hemipleji (n = 17) şeklindeydi. Semptomlar ciddiyet açısından KMFKS'ine göre gruplandırıldığında, çocukların % 18.9'u seviye II, % 21.1'i seviye III, % 30.0'i seviye IV ve % 30.0'i seviye V te yer alıyordu. KMFKS seviyesi arttıkça, kendine bakım, hareket ve sosyal aktivitedeki kısıtlılıklar artmıştı. RÖ ile kıyaslandığında; RS tüm PÖDE alt skala skorlarında istatistiksel olarak anlamlı artış saptandı (T testi, P < 0.05).

**Sonuç:** PÖDE, SP'li çocuklardaki fonksiyonel değişiklikleri gösteren, duyarlı ve faydalı bir sonuç ölçüm metodudur.

**Anahtar Sözcükler:** Pediatrik Özürülük Değerlendirme Envanteri, Serebral Palsi, Rehabilitasyon Sonuçları

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## Introduction

Cerebral palsy (CP) is one of the most common causes of disability in childhood leading to functional limitations. CP describes a group of permanent disorders of the development of movement and posture, causing activity limitation, that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain. The motor disorders of CP are often accompanied by disturbances of sensation, perception, cognition, communication and behavior, by epilepsy, and by secondary musculoskeletal problems (1).

Measuring functional independence is particularly important in designing a rehabilitation program and in assessing the outcome. However, there are only a few evaluation methods to measure the functional independence of children with disability. The Functional Independence Measure of Children (WeeFIM®) and Pediatric Evaluation of Disability Inventory (PEDI) are the most commonly used methods for pediatric functional evaluation (2,3). PEDI is a wide-range clinical evaluation measure developed by Haley et al. (3) in order to determine functional skill and performance of children aged between 6 months and 7 years. A child's daily activities are evaluated with respect to both skill and performance. It is a known fact that self-care skills, motor functions, and communication and social cognition of these children obviously vary depending on age, environmental factors and the sociocultural status. Thus, measurement methods of functional independence need standardization considering the possible variables, and also require clinical efficiency, reliability and validity (4). We translated PEDI into Turkish in our previous study, and proved its validity and reliability (5). The objectives of our current study were to evaluate the independency level of Turkish children with CP in their activities of daily living (ADL) using the Turkish version of PEDI measurement, and to investigate the functional changes during inpatient rehabilitation. Functional assessment of Turkish children with CP has only been performed using the WeeFIM® instrument (6). The PEDI instrument has not been studied in Turkish children with CP previously.

## Materials and Methods

Ninety children with spastic CP, between 6 months and 7 years of age, who were hospitalized and rehabilitated at Ankara Physical Medicine and Rehabilitation Education and Research Hospital, were included in the study. The Swedish classification of CP syndromes was applied (7). CP severity was classified with Gross Motor Function Classification System (GMFCS) before the rehabilitation period. GMFCS is a standardized measure that classifies gross motor functions in children with CP. It is a five-level system defined by dividing patients into four age groups. It especially emphasizes sitting and walking functions of the child, focusing on self-initiation of the action. Children in level I are very independent in motor functions while those in level V are the least independent (8-10). Children at GMFCS level I are those that are able to walk without limitation, with problems only in very advanced motor skills, who need no support to walk, and are capable of running and jumping functions (9).

Activities of daily living of children with CP were evaluated by the same physiatrist before rehabilitation (BR) and after rehabilitation (AR) with PEDI Functional Skills (FS) and PEDI Caregiver Assistance (CA) scales. Interviews concerning PEDI were made with the mothers for 75 children (83.3%), with fathers for 4 children (4.4%), and with other relatives for 11 children (12.2%). PEDI manual and software program was obtained from the Center for Rehabilitation Effectiveness, Sargent College, Boston University, USA. The Turkish version of PEDI, the validity and reliability of which were proven in our previous study, was used in this study (5).

The PEDI includes three sets of measurement scales: Functional Skills (FS), Caregiver Assistance (CA), and Modifications (M). The FS scale consists of 197 items in total, divided as 73 items in the self-care domain, 59 items in mobility domain, and 65 items in social function domain. Each item in this part is scored as unable (0) or capable (1) (3). The CA scale consists of 20 domains in total, divided as 8 items in the self-care domain, 7 items in mobility and 5 items in social function domains. CA for each item is rated from 5 (independent) to 0 (totally

dependent), yielding an aggregate score for each domain (3). The M scale has the same 20 items as in CA section. This scale is rated on the modifications part (i.e., environmental or technical adaptations required to facilitate performance) as follows: N (none), C (child-oriented modification), R (rehabilitation equipment or assistive devices required), or E (extensive modifications required).

The PEDI consists of three FS scales, three CA scales, and three M scales in the content domains of self-care, mobility and social function. These subscales are FS self-care (FS-sc), FS mobility (FS-m), FS social function (FS-sf), CA self-care (CA-sc), CA mobility (CA-m) and CA social function (CA-sf), M self-care (M-sc), M mobility (M-m), and M social function (M-sf). No formal scaling technique was applied to the three Modification scales, as they represent only frequency counts of modifications within each content domain. Thus, the Modification section was not employed for evaluation in this study (3).

Children were admitted to the inpatient rehabilitation program. This program included physiotherapy combining conventional and Bobath therapy methods, speech therapy, school recreation, play activities and psychological therapy. The intensity of physiotherapy was 2 hours/day, 5 days/week for the hospitalization period. This physiotherapy program was also taught to the children's caregiver in the hospital, who applied the program during the remaining 2 days of the week. In addition, for children with speech and language problems, a therapy was applied 3 days per week by a speech therapist.

In the present study, PEDI software program was used for data storage and for the generation of individual score profiles. Six subscale raw scores were thus obtained as follows: FS-sc, FS-m, FS-sf, CA-sc, CA-m and CA-sf. The raw scores of these six subscales were used in the statistical analyses. Statistical analyses were performed using SPSS software (version 11.0). Paired sample T test was used in order to investigate whether there was any significant difference between BR and AR PEDI scores. A level of  $P < 0.05$  was considered statistically significant.

## Results

Demographical and clinical properties of children with CP included in the study are given in Table 1. The children in GMFCS level I are able to walk without limitation, with problems only in very advanced motor skills. They need no support to walk and are capable of running and jumping functions (9). In our hospital, children with CP in GMFCS level I are not given an in-patient rehabilitation program but they are followed on an outpatient basis with home programs. Thus, no children in GMFCS level I were included in our study. The children in GMFCS level II consisted of 9 (5.2%) hemiplegic and 8 (47.1%) diplegic cases, while the children in GMFCS level III consisted of 14 (73.7%) diplegic, 3 (15.8%) hemiplegic and 2 (10.5%) quadriplegic cases. The children in GMFCS level IV consisted of 16 (59.3%) quadriplegic, 10 (37.0%) diplegic and 1 (3.7%) hemiplegic cases, whereas GMFCS level V group included 17 (63.0%) quadriplegic, 6 (22.2%) diplegic and 4 (14.8%) hemiplegic cases.

Table 1. Demographic and clinical characteristics of the children with cerebral palsy.

Characteristics	N (%)
Sex	
Female	27 (30)
Male	63 (70)
Mean age $\pm$ SD	48.41 $\pm$ 16.41 months
Age range, mo	18-83 months
Mean hospitalization period $\pm$ SD	52.31 $\pm$ 17.15 days
Types of CP	
Spastic diplegia	38 (42.2)
Spastic quadriplegia	35 (38.9)
Spastic hemiplegia	17 (18.9)
GMFCS	
Level II	17 (18.9)
Level III	19 (21.1)
Level IV	27 (30.0)
Level V	27 (30.0)

CP: cerebral palsy; GMFCS: Gross Motor Function Classification System.

Mean and standard deviation values of PEDI scores BR and AR according to GMFCS are provided in Table 2. Mean and standard deviation values of BR and AR PEDI scores with respect to involvement type are given in Table

3. Comparison of BR and AR PEDI scores (paired sample T test) are given in Table 4. Statistically significant increases were observed in all PEDI sub-scores AR when compared to BR results.

Table 2. Pediatric Evaluation of Disability Inventory scores according to Gross Motor Function Classification System levels before and after rehabilitation.

PEDI scores		Level II	Level III	Level IV	Level V
FS-sc scores	BR	46.47 ± 13.23	42.00 ± 13.86	32.81 ± 17.67	20.37 ± 13.65
	AR	48.94 ± 12.88	45.47 ± 11.92	35.30 ± 17.07	23.81 ± 13.64
FS-mo scores	BR	39.18 ± 13.41	30.11 ± 8.56	19.63 ± 12.50	6.52 ± 4.40
	AR	42.06 ± 12.33	35.53 ± 7.31	25.30 ± 11.77	11.04 ± 5.98
FS-sf scores	BR	47.12 ± 13.56	43.89 ± 13.88	34.74 ± 17.18	25.07 ± 18.38
	AR	47.76 ± 13.70	44.89 ± 13.42	36.37 ± 17.45	26.14 ± 18.41
CA-sc scores	BR	23.00 ± 10.07	19.21 ± 9.66	13.22 ± 9.76	7.07 ± 7.43
	AR	25.76 ± 9.44	22.26 ± 8.16	16.85 ± 9.41	9.63 ± 7.46
CA-mo scores	BR	21.53 ± 7.58	18.53 ± 5.70	11.22 ± 8.63	4.15 ± 4.53
	AR	25.88 ± 6.16	23.16 ± 4.60	16.07 ± 7.43	7.70 ± 5.86
CA-sf scores	BR	17.41 ± 6.20	15.58 ± 6.12	11.52 ± 6.81	8.63 ± 7.39
	AR	17.65 ± 6.01	16.63 ± 5.62	13.15 ± 6.71	9.15 ± 7.59

PEDI: Pediatric Evaluation of Disability Inventory; BR: before rehabilitation; AR: after rehabilitation; FS-sc: Functional Skill self-care; FS-mo: Functional Skill mobility; FS-sf: Functional Skill social function; CA-sc: Caregiver Assistance self-care; CA-mo: Caregiver Assistance mobility; CA-sf: Caregiver Assistance social function.

Table 3. Pediatric Evaluation of Disability Inventory scores before and after rehabilitation according to types of cerebral palsy.

PEDI scores		Spastic diplegia	Spastic quadriplegia	Spastic hemiplegia
FS-sc scores	BR	42.45 ± 16.44	22.66 ± 13.26	36.35 ± 17.42
	AR	45.26 ± 15.50	25.69 ± 13.10	39.59 ± 16.34
FS-mo scores	BR	26.32 ± 12.97	10.91 ± 9.24	33.06 ± 18.43
	AR	31.60 ± 11.57	15.80 ± 10.49	36.29 ± 17.25
FS-sf scores	BR	42.53 ± 15.35	27.97 ± 18.32	38.53 ± 18.18
	AR	43.76 ± 15.14	29.22 ± 18.43	39.24 ± 18.27
CA-sc scores	BR	18.84 ± 10.67	8.91 ± 7.91	16.23 ± 11.70
	AR	21.71 ± 9.82	11.80 ± 8.10	19.88 ± 11.01
CA-mo scores	BR	15.87 ± 7.85	6.71 ± 7.18	17.35 ± 11.01
	AR	20.39 ± 7.59	11.20 ± 6.99	20.88 ± 11.37
CA-sf scores	BR	15.66 ± 6.16	8.91 ± 6.98	13.47 ± 8.02
	AR	16.29 ± 6.23	10.06 ± 7.09	14.53 ± 7.64

PEDI: Pediatric Evaluation of Disability Inventory; BR: before rehabilitation; AR: after rehabilitation; FS-sc: Functional Skill self-care; FS-mo: Functional Skill mobility; FS-sf: Functional Skill social function; CA-sc: Caregiver Assistance self-care; CA-mo: Caregiver Assistance mobility; CA-sf: Caregiver Assistance social function.

Table 4. Comparison of Pediatric Evaluation of Disability Inventory scores before and after rehabilitation.

	Before Rehabilitation	After Rehabilitation	T	P
FS-sc scores	33.60 ± 17.77	36.57 ± 17.14	-9.207	0.000*
FS-mo scores	21.60 ± 15.59	26.34 ± 15.02	-13.147	0.000*
FS-sf scores	36.11 ± 18.17	37.25 ± 18.14	-6.291	0.000*
CA-sc scores	14.48 ± 10.80	17.51 ± 10.41	-9.344	0.000*
CA-mo scores	12.58 ± 9.46	16.91 ± 9.32	-13.043	0.000*
CA-sf scores	12.62 ± 7.44	13.53 ± 7.35	-5.433	0.000*

FS-sc: Functional Skill self-care; FS-mo: Functional Skill mobility; FS-sf: Functional Skill social function; CA-sc: Caregiver Assistance self-care; CA-mo: Caregiver Assistance mobility; CA-sf: Caregiver Assistance social function. \* statistically significant.

## Discussion

The Pediatric Evaluation of Disability Inventory (PEDI) is a wide-scope functional status scale that measures the performances and skills of children aged between 6 months and 7 years in their ADL (3). The PEDI has been used in children with CP in order to assess their ADL and to measure their rehabilitation outcomes and the effects of intrathecal baclofen, botulinum toxin type A and selective dorsal rhizotomy treatments (11-14). It is a sensitive measurement method used to evaluate rehabilitation outcomes of children with brain injury and to indicate their functional changes (15). PEDI's sensitivity was demonstrated to be excellent in determining the changes occurring during the treatment period or during the healing period following the brain damage (16-18). Iyer et al. (16) showed in a mixed group consisting mostly of brain-damaged children that PEDI is a measurement method capable of measuring minimal clinical changes in children rehabilitated in hospital. The purpose of this study was to evaluate functional changes during inpatient rehabilitation in children with CP.

In our study, functional skills of children in self-care, mobility and social function domains improved significantly, and the need for assistance decreased. Knox et al. (19) applied Bobath therapy to 15 children with CP, aged between 2-15 years, and evaluated them using PEDI and Gross Motor Function Measure (GMFM) before and after Bobath therapy, and during follow-ups. They demonstrated that important progress occurred in the

self-care and mobility scales of PEDI. They did not show progress in the social domain of PEDI, as only 3 patients had speech and language training. Although our findings showed similarities with Knox's results, a certain degree of improvement was observed in PEDI's social domain in our study. Social functions are complex and affected by various factors such as age, learning difficulty and speech problems. We attributed the improvement in social domain to the application of speech therapy, school recreation and play activities. Haley et al. (3) stated that the social function domain of PEDI was less sensitive and less reliable. There are a limited number of studies that evaluate rehabilitation outcomes using PEDI for children with CP. Ödman et al. (20) compared the effectiveness of two intensive training programs using PEDI-FS and GMFM. They did not find any significant differences between these training programs.

Using PEDI together with GMFCS makes it easier to understand functional limitation. Ostensjø et al. (21) evaluated 95 children with CP using PEDI and GMFCS. They showed that a child's GMFCS level may strongly predict the success rate of the activities in self-care, mobility and social function domains in the functional skill scale. Ostensjø et al. also found that limitation in achievement of activities and need for assistance increased progressively with GMFCS level. In our study, we also determined that as GMFCS level increased, PEDI functional skill scores in self-care, mobility and social function domains reduced, and consequently the need for assistance increased.

Pediatric Evaluation of Disability Inventory is a useful measurement method that can be used to evaluate functional levels and rehabilitation outcomes of children

with CP. Applying GMFCS together with PEDI provides important information on the success levels in ADL in children with CP.

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