

Reliability of the Pediatric Evaluation of Disability Inventory (PEDI)

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ABSTRACT. Pediatric Evaluation of Disability Inventory (PEDI) is an instrument for evaluating function in children with disabilities aged 6 months to 7.5 years. The PEDI measures both functional performance and capability in three domains: (1) self-care, (2) mobility, and (3) social function. The PEDI has recently been translated into Norwegian. The purpose of this study was to investigate the inter-rater, inter-respondent and intra-rater reliability of the Norwegian version of the PEDI. Reliability was investigated in a sample of 30 Norwegian children without disabilities between 1.0 and 5.0 years. Interviews with parents were conducted twice by the same occupational therapist, and once by a physio-

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61

therapist. Kindergarten teachers were also interviewed by the occupational therapist. Using children without disabilities allows us to set up a standard for functional ability. Deviation from the point may indicate improvement or worsening of the state. The inter-rater and intra-rater part of the study showed excellent agreement of the observations, indicated both by small differences and high Intraclass Correlation Coefficients (ICC) (0.95-0.99). The discrepancy between the different interviews was highest between the reports from the parents and the kindergarten teachers (inter-respondent reliability), indicated by ICC from 0.64-0.74. Results of this study indicate that improved reliability is secured when the same interviewer interviews the same respondent, as well as when two trained interviewers interview the same respondent. The consistency of scores should be reviewed when different respondents are interviewed. Professionals administering the PEDI needs to be trained following a required procedure in order to secure consistency in their rating. [Article copies available for a fee from The Haworth Document Delivery Service; 1-800-HAWORTH. E-mail address: <docdelivery@haworthpress.com> Website: <<http://www.HaworthPress.com>> © 2004 by The Haworth Press, Inc. All rights reserved.]

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INTRODUCTION

Pediatric Evaluation of Disability Inventory (PEDI) is a clinical assessment instrument used for the evaluation of functional capabilities, performance and changes in functional skills in children with disabilities aged 6 months to 7.5 years (Engelbert et al., 1997; Eliasson, 1999; Coster, Haley & Baryza, 1994; Fehlings, Rang, Glazier & Steele, 2000; Nordmark, Jarnlo & Hagglund, 2000; Graveline, Young & Hwang, 2000; Palta, Sadek-Badawi, Evans, Weinstein & McGuinness, 2000). However, in case of functional delays, it can also be used in the evaluation of older children (Haley, Coster, Ludlow, Haltiwanger & Andrellos, 1992). The content of PEDI is developed in accordance with WHO's International Classification of Impairments, Disabilities and Handicaps (ICIDH) (WHO, 1980).

The instrument measures capability and performance of selected functional activities within the domains of self-care, mobility and social function on three scales: I. *Functional skills* (current capability of se-

lected tasks). II. *Caregiver assistance* (the extent of help the caregiver provides). III. *Modifications* (i.e., environmental or technical modifications needed to enhance the children's function).

Scoring the PEDI

Part I, the *functional skills scale*, consists of 197 items, each scored 'unable' (0) or 'capable' (1). The items are divided into three domains: the self-care domain (73 items) covers eating, grooming, dressing, and personal hygiene. The mobility domain (59 items) covers transfers, for example, in and out of bed, wheelchair and bathtub, indoor and outdoor locomotion, and stairs. The social function domain (65 items) covers communication, problem-solving, play with peers, and safety. Each domain yields an aggregate score. Parts II and III, the *caregiver assistance scales* and *modification scales*, each consist of 20 items in the domains *self-care* ($n = 8$), *mobility* ($n = 7$) and *social function* ($n = 5$). Each item of the caregiver assistance scale is rated from 5 (independent, where no assistance is given or required) to 0 (total, where the child is completely dependent on assistance). Aggregate scores are defined as the sum of each domain. In the modification scales, the same 20 items are rated according to whether technical adaptations or environmental adaptations are used to enhance performance. The items are scored N (none), C (child-oriented modification), R (rehabilitation equipment or assistive devices required), E (extensive modifications required). Only frequency counts are used on the modification scale to summarize the modifications used.

The assessment is based on a detailed, structured interview with parents, professionals and/or other caregivers that know the child well. PEDI can be used in hospitals, outpatient clinics, kindergartens and schools. PEDI can be used by physical therapists, occupational therapists, speech pathologists, nurses, special educators, psychologists or other professionals measuring function in young children with disabilities, and is administered in 45-60 minutes.

Previous Studies

The authors of PEDI completed a series of studies, investigating the reliability of the instrument, during the development of PEDI. Interrater reliability was investigated by the members of the PEDI research team (Haley, Coster, Ludlow, Haltiwanger & Andrellos, 1992) in a sample of disabled children. The reliability of parental and professional

agreement (Sundberg, 1992), was also studied. Several authors (Ketelaar, Vermeer & Helders, 1988; Reid, Boschen & Wright, 1988; Wright & Boschen, 1993; Nichols & Case-Smith, 1996; McCarthy et al., 2002) have evaluated the reliability of PEDI, but few have investigated the reliability in a population based study, only in institutionalized children.

PEDI was recently translated into Norwegian (Berg, Jahnsen, Holm & Hussain, 2003; Jahnsen, Berg, Dolva & Høyem, 2002) and is used by most of the regional pediatric rehabilitation teams in Norway. Studies have shown that reliability assessment is likely to vary when an instrument is translated and applied in a different culture (Kvamme et al., 1998).

Evidence suggests that applying an instrument to measure functional ability developed in a different cultural context and practical set-up may not be applied directly without measuring its applicability of the instrument in the recipient country's cultural and practical context. Therefore, it is of scientific and practical importance to measure the validity and reliability of the instrument in Norway.

Purpose of the Study

The purpose of this study was to examine the reliability of PEDI in relation to inter-rater, intra-respondent, and intra-rater reliability in a sample of children without disabilities between 1.0 and 5.0 years in Norway.

MATERIALS AND METHODS

Subjects

A list of children without disabilities was collected from the National Registry of Inhabitants in Norway. According to the Norwegian Census Bureau (1998), 1411 children between 0-5 years were living in the county of Nesodden. The list of 1411 children was sorted according to age and postal area code, with a systematic selection of every 15th child. This procedure was adopted in order to secure a selection of children from the whole county. With the previous experience of non-response in other studies, the parents of 94 children received a mailed letter of invitation to participate in the study, and 40 parents accepted the invitation. An additional sample of convenience of 12 parents was interviewed later

in order to complete the projected sample. Forty-eight mothers and 4 fathers were interviewed. The mean length of education of the mothers was 15.6 years (range 9-21 years). As reported by parents, no children had any mental or physical disorders. The 52 non-disabled children (28 girls and 24 boys) aged from 1.0 - 5.0 years were divided into ten age groups (6 month intervals), with 3 - 7 children in each group.

Children whose age category changed during the course of the study, or whose parents agreed only to participate in one interview, were excluded from the analysis. Accordingly, 22 children were excluded. Thirty children were investigated for the reliability analysis. Of the 30 children, 18 parents were interviewed twice, 6 were interviewed three times, and 6 were interviewed four times. The length of time between the interviews was not longer than 21 days. This procedure gave 19 interview pairs for investigating inter-rater reliability, 14 interview pairs for investigating inter-respondent reliability, and 15 interview pairs for investigating intra-rater reliability (Table 1). All analyses were based on the raw scores, as the normative standard scores were found not appropriate for Norwegian children (Berg, Frey Frøslie & Hussain, 2003), since specific items related to personal hygiene, opening shirt and fasteners, toileting, and managing seat belt were found to be culturally influenced.

The testers in this study both had participated in training, and translated the PEDI from English to Norwegian (Berg, Jahnsen, Holm & Hussain, 2003; Jahnsen, Berg, Dolva & Høyem, 2000), and thus had detailed knowledge about the administration and scoring criteria of the test.

TABLE 1. Distribution of the Interviews According to Inter-rater Reliability, Inter-respondent Reliability, Intra-rater Reliability, Gender and Age.

	Inter-rater	Inter-respondent	Intra-rater	Total
2 interviews	9	5	4	18
3 interviews	4	3	5	6
4 interviews	6	6	6	6
	n = 19 interview pairs	n = 14 interview pairs	n = 15 interview pairs	30 children (78 interviews)
Girls/boys	8/11	6/8	7/8	14/16
Age in years				
Mean (SD)	3.5 (1.4)	4.5 (0.6)	3.8 (1.4)	3.6 (1.3)
Range [min, max]	[1.0, 5.4]	[3.2, 5.4]	[1.2, 5.4]	[1.0, 5.4]

Scoring the PEDI

The PEDI consists of three main scales: Functional Skills Scale, Caregiver Assistance Scale, and Modification Scale. Each main scale is divided into three different domains: Self-Care, Mobility and Social Functions. Each domain is comprised of several questions (items) within different content areas. The Self-Care Domain includes activities of daily living. The Mobility Domain includes floor mobility, simple transfers, and mobility in different environments. The Social Function Domain is concerned with living with others in a community and interacting with family members. Content areas within this domain are functional communication, comprehension, and other cognitive skills.

Functional Skills Scales (Part I), consists of 197 items (divided in 41 content areas), scored 'unable' (0) or 'capable' (1). In order to avoid unnecessary misinterpretation and different interpretation acquiring the data, we decided to use a fixed term of "doing the item more than 50% of the time" to obtain score 1. The frequency of desired function (for example personal hygiene and dressing tasks) is not defined in the original manual. Self-care tasks are indicative of children's functional ability, but children often do not perform these functions on a daily basis due to time-shortages, mood changes, motivation, etc., especially at young ages. Sum scores (Raw scores) were obtained by adding the items within each domain and each content area.

Caregiver Assistance Scales (Part II) consists of 20 items, each representing a content area, was scored in accordance with the scoring criteria in the manual. Each item was rated in relation to a scale from independent (5), supervision (4), minimal help (3), moderate help (2), maximum help (1) and total help (0), with specific scoring criteria for each level. Most of the time, it was necessary to read the different options of scoring criteria for each level to the parents, in order to determine the correct score for the child.

Modifications Scale (Part III) is rated in relation to the 20 items in part II. Environmental or technical adaptations to enhance the child's performance use a scale of None, Child-oriented modification, Rehabilitation equipment and Assistive Devices, and Extensive modification required. This scale is highly relevant for children with disabilities, but of less interest in a non-disabled sample and therefore the results are not presented.

Statistical Methods

Summary scores (raw scores) were obtained by adding the scorings within each domain. The means and standard deviations (SD) of the summary scores were calculated. Differences in scorings between different interviews were investigated by descriptive statistics (Bland & Altman, 1986). The reliability was quantified by Intraclass Correlation Coefficients (ICC). The ICCs were computed for consistency of average measures in two-way random models. This ICC is also known as Cronbach's alpha (McGraw & Wong, 1996).

Plots of the mean scores for each content area obtained in different interviews were also included, to illustrate the discrepancy in different content areas between interviews.

The software program SPSS manual (SPSS, 1999) was used for data registration and statistical analyses.

A p-value equal to or less than 0.05 was considered statistically significant.

RESULTS

Inter-Rater Reliability

Descriptive statistics for the summary scores and differences of summary scores as well as ICCs for the inter-rater reliability are presented in Table 2. The first interview (Int. 1) was conducted by an occupational therapist. The second interview (Int. 2) was conducted by a physiotherapist. The mean differences and ranges of differences indicate excellent inter-rater agreement in mobility, social function and self-care, with the ICCs from 0.95-0.99. An ICC of 0.80 or higher per domain were considered to be an acceptable level of reliability (Deitz, 1989; Benson & Clark, 1982). In the present study, the inter-rater agreement was acceptable for all domains.

Figure 1 presents mean scores obtained in the two interviews conducted by the occupational and the physical therapists. The plots show the match of scorings in different content areas. Figure 1 shows excellent agreement between the interviews, except for the content areas of self-care: hairbrushing, nose-care, handwashing, washing body and face and fasteners, and of social function. The agreement between interviews was also less for caregivers' assistance in the areas of functional

TABLE 2. Descriptive Statistics for Sum Scores and Differences of Sum Scores. Intraclass Correlation Coefficient for Inter-rater Reliability (n = 19)

Domain			Mean (SD)	Mean difference (SD of differences)	Range of differences [min,max]	ICC
Self-care	Functional skill	Int. 1 Int. 2	44.2 (18.8) 45.2 (19.1)	1.00 (3.3)	[-5,7]	0.99
	Caregiver's assistance	Int. 1 Int. 2	20.4 (11.3) 20.2 (11.7)	-0.26 (3.2)	[-8,4]	0.98
Mobility	Functional skill	Int. 1 Int. 2	49.3 (10.8) 49.7 (9.4)	0.42 (2.0)	[-3,5]	0.99
	Caregiver's assistance	Int. 1 Int. 2	28.5 (8.2) 28.6 (7.3)	0.05 (1.9)	[-2,5]	0.98
Social function	Functional skill	Int. 1 Int. 2	48.3 (14.2) 47.3 (14.9)	-1.05 (3.3)	[-8,6]	0.99
	Caregiver's assistance	Int. 1 Int. 2	16.6 (7.3) 17.8 (6.2)	1.26 (2.9)	[-4,7]	0.95

Int. 1 = interview conducted by an occupational therapist

Int. 2 = interview conducted by a physical therapist

comprehension and functional expression, where the physical therapist scored higher than the occupational therapist.

Inter-Respondent Reliability

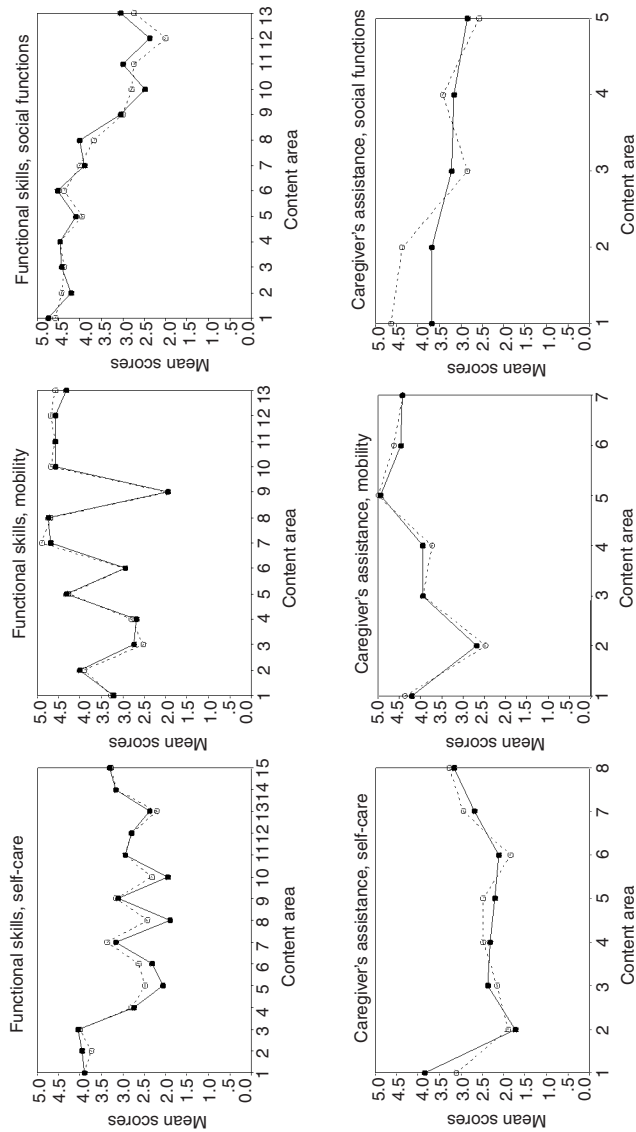
Descriptive statistics for the sum scores and differences of sum scores as well as ICCs for the inter-respondent reliability are given in Table 3. All interviews were conducted by the same interviewer both for the parents and the kindergarten teachers. The kindergarten teachers had not observed all the items within the self-care and mobility domains. It was therefore not possible to calculate sum scores within these domains other than social function.

The mean difference and range of difference indicate only moderate inter-respondent agreement in social function, with the ICCs ranging from 0.64-0.74. This analysis also showed a difference in agreement between the parents' and kindergarten teachers' perception of social function. This is considered less than acceptable agreement.

Figure 2 presents mean scores obtained by parents and kindergarten teachers. For functional skills domain of self-care, the kindergarten teachers scored higher than the parents in relation to handwashing, fasteners, pants, and toileting tasks. In the caregiver assistance domain of self-care, the kindergarten teachers scored lower (giving more help than the parents) in relation to dressing and toileting. There was good agree-

Mean

FIGURE 1. Inter-Rater Reliability.



— interview conducted by occupational therapist
..... interview conducted by physical therapist

TABLE 3. Descriptive Statistics for Sum Scores and Differences of Sum Scores. Intraclass Correlation Coefficient for Inter-respondent Reliability (n = 14)

Domain			Mean(SD)	Mean difference (SD of differences)	Range of differences [min, max]	ICC
Social function	Functional skills	Int. 1	56.3 (3.1)	-1.00 (3.8)	[-4,8]	0.74
		Int. 2	56.3 (5.1)			
	Caregiver's assistance	Int. 1	20.8 (2.5)	-0.79 (3.2)	[-3,9]	0.64
		Int. 2	20.0 (3.6)			

Int. 1 = interview with parents

Int. 2 = interview with kindergarten teachers

ment between kindergarten teachers' and parents' perception of mobility performance. For the functional skills domains of social functions, parents scored higher than kindergarten teachers in the areas of functional use of communication, peer interaction, play with objects, household chores and community function. For the caregiver assistance domain of social function, parents also scored their children higher than kindergarten teachers in the areas of functional expression, joint problem solving and peer play.

Intra-Rater Reliability

Descriptive statistics for the sum scores and differences for sum scores as well as ICCs for intra-rater reliability are presented in Table 4. The same interviewer conducted all interviews, and respondents were the parents interviewed twice. The length of time between the interviews was not longer than 21 days.

The mean difference and range of difference indicate excellent intra-rater agreement in the domains of mobility and social function and self-care. A mean difference of 2.00 was observed for self-care: functional skills. None of the ICCs observed were below 0.99. Hence, the intra-rater agreement was considered acceptable for all domains.

Figure 3 presents mean scores obtained by the first and second interview of parents. Figure 3 shows good agreement in all domains, with the exception of functional skills: domain of self-care, where the parents reported increased function in the content areas of tooth brushing, hair brushing, hand washing, washing body and face and fasteners at the second interview.

FIGURE 2. Inter-Respondent Reliability.

Mean

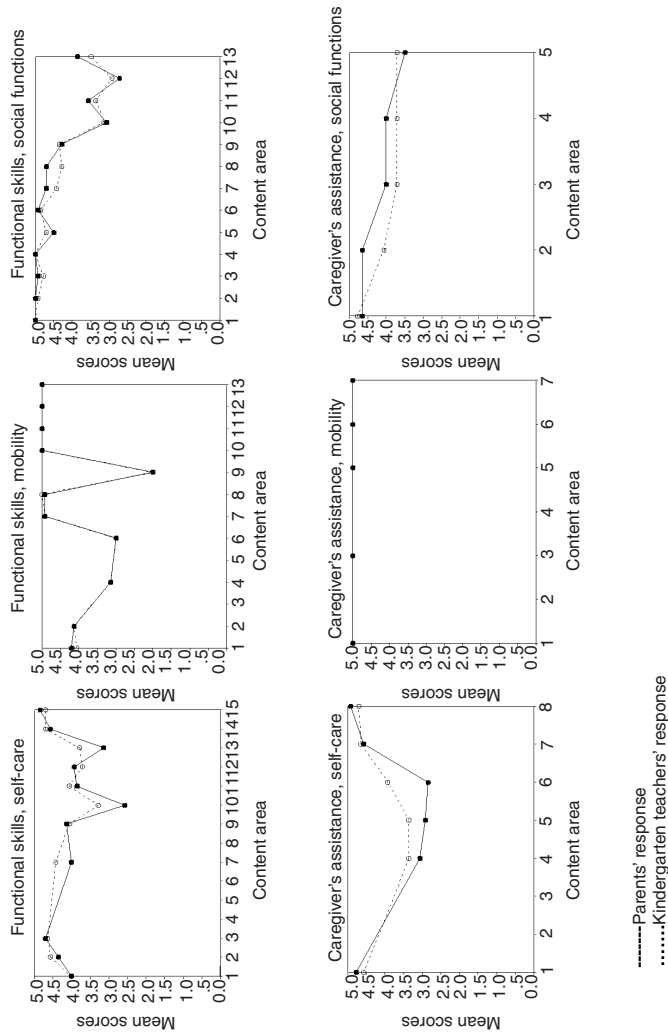


TABLE 4. Descriptive Statistics for Sum Scores and Differences of Sum Scores. Intraclass Correlation Coefficient for Intra-rater Reliability (n = 15)

Domain			Mean(SD)	Mean difference (SD of differences)	Range of differences [min, max]	ICC
Self-care	Functional skills	Int. 1	47.2 (17.3)	-2.00 (3.0)	[-7,2]	0.99
		Int. 2	49.2 (15.7)			
	Caregiver's assistance	Int. 1	22.3 (10.8)	-0.13 (1.5)	[-3,3]	> 0.99
		Int. 2	22.5 (9.9)			
Mobility	Functional skills	Int. 1	51.4 (8.1)	0.07 (1.6)	[-2,4]	0.99
		Int. 2	51.3 (7.9)			
	Caregiver's assistance	Int. 1	29.9 (7.4)	0.07 (1.6)	[-3,2]	0.99
		Int. 2	29.9 (6.9)			
Social function	Functional skills	Int. 1	50.0 (13.5)	0.47 (2.5)	[-5,4]	0.99
		Int. 2	50.5 (12.4)			
	Caregiver's assistance	Int. 1	16.9 (7.0)	0.13 (1.5)	[-4,2]	0.99
		Int. 2	17.1 (6.8)			

Int. 1 = first interview conducted by an occupational therapist
Int. 2 = second interview conducted by the same investigator

DISCUSSION

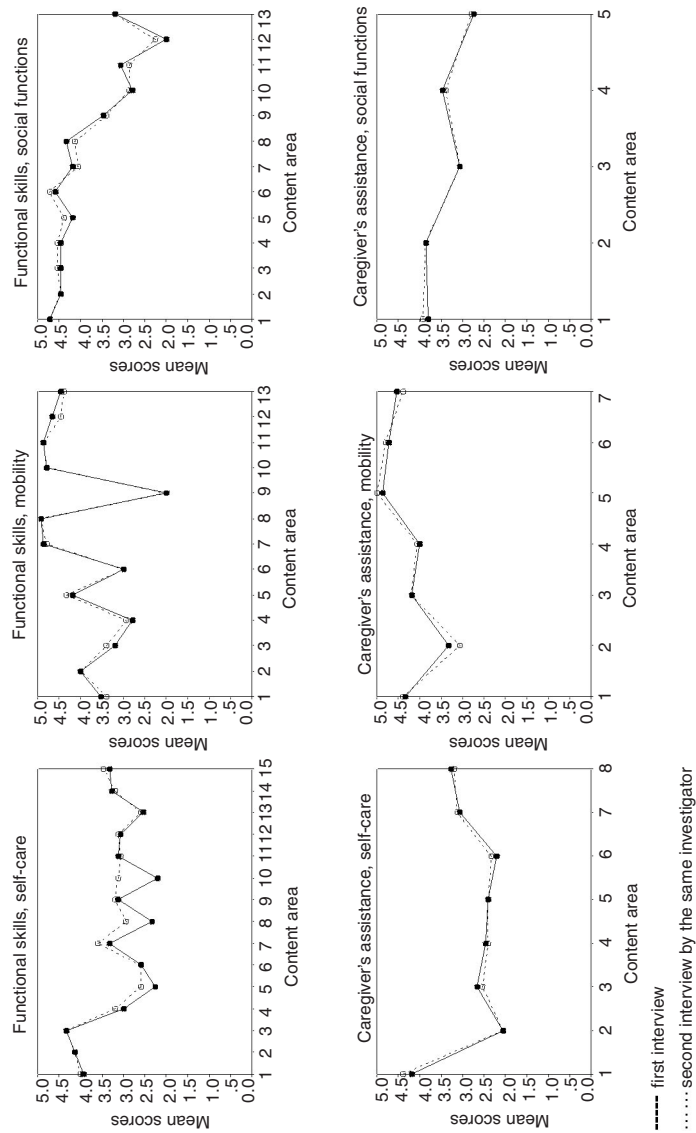
The results of the present study support that the Norwegian version of PEDI is a reliable instrument for evaluation of young children. The inter-rater reliability ranged from ICC = 0.95-0.99 for all domains, and none of the ICCs observed in intra-rater reliability were below 0.99. However, a mean difference of 2.00 was observed in the domain of self-care, functional skills, where function increased with repeated interviews. The discrepancy was highest between the reports from parents and kindergarten teachers (inter-respondent) (ICC 0.64-0.74).

The present study was a random population based study, with a systematic sampling procedure, in order to secure participation from the whole community. Forty-eight mothers and 4 fathers was interviewed. The mean length of education of the mothers was 15.6 years: range 9-21 years. In the general population, 59.2% of the women in the age group 30-39 years had 12 years education and 32.8% had college/university education in 1999. Thus, the mothers in the sample of the present study represented nationwide data, according to education.

In the present study, the instrument was tested in a population of Norwegian children without disabilities. A marked levelling of the developmental curves occurs when non-disabled children are 3-4 years old. At

Mean

FIGURE 3. Intra-Rater Reliability.



this age, most of the basic functional skills are present (Nordmark, 2000), and the children are likely to master most of the items in PEDI when they are around six years old. It was therefore chosen not to include children above five years of age. Excellent inter-rater reliability was observed. Lowest agreement was observed for social function (caregiver assistance).

Trained interviewers performed the interviews. The second interview was conducted by a physical therapist which scored slightly higher in the functional skills domain of self-care in the content areas of hair-brushing, nose-care, hand washing, washing body/face and fasteners. Parents reported that the initial set of PEDI questions motivated them to focus on functional skills, and thus their children increased their performance of the tasks.

There was a difference of agreement between parents' and kindergarten teachers' perception of social function. However, a low sample size and limited variation of age for the inter-respondent study may have limited the applicability of the results. Previous studies of PEDI were also found to be less reliable in the domain of social function. The authors of PEDI (Haley, Coster, Ludlow, Haltiwanger & Andrellos, 1992) reported low reliability for the Social Function content area (ICC = 0.30). Both Custers, Hoijtink, van der Net and Helders (2000) and Nordmark (2000) found that the item-level analysis fitted scores deviated from the normative score in the social function domain, both in Netherlands and Sweden.

Nichols and Case-Smith (1996) studied inter-respondent reliability using therapists and parents as respondents. ICC ranged from 0.18-0.94 for content areas within the different domains. Items with inconsistent ratings were typically not observed in the clinic. Based on graphed respondent scores, there was a tendency in Nichols and Case-Smith's study for the parents to rate the child as more capable than did the therapists across all domains. The parents tended to rate the children as requiring less assistance than did the therapists for most content areas of the Mobility and Social Function, but more assistance than the therapists for the Self-care domain. This was also generally the case in the inter-respondent results of our study. These results are in accordance with the findings by Sexton, Thompson, Perez et al. (1990) that maternal and professional estimates of developmental function are highly correlated. However, mothers systematically provide higher estimates across the developmental domains.

Nichols and Case-Smith investigated intra-rater reliability ($n = 23$) and inter-respondent reliability ($n = 17$) in a sample of convenience of

children with disabilities. In the intra-rater study parents were interviewed using the PEDI two times, with one week between interviews. ICCs were high for the sum scores for each domain, and moderate to good for the content areas (Nichols & Case-Smith, 1996).

A different context (other adults and children) and environment may affect the child's functional skills, and thereby caregiver assistance needed, especially in relation to social function. Many parents reported that they did not observe their child in interaction with other children, except for siblings, family or other children familiar to their child. This may be one of several explanations for parents rating their children's performance better than the kindergarten teachers. Fewer adults in kindergarten may offer help and thus affect the child's performance. Parents or primary caregivers who know the child's functional ability at home and professionals who work with the child in the school or clinic may produce low to moderate correlation related to the children's different performance in each environment (Nichols & Case-Smith, 1996).

The graph of the self-care domain of functional skills showed that children are rated more capable in relation to toileting and dressing by the kindergarten teachers, who reported that many children chose not to use the toilet for bowel management. Some parents reported that they preferred to use trousers without buttons in the kindergarten to enhance their child's independence in toileting; this may explain differences in perception related to these content areas.

Self-care tasks are influenced by the parents' expectations and the child's own motivation. A number of parents were interviewed several times. During the first interview, the respondents had no prior knowledge to the items of the instrument. Several parents were not certain of their children's capability for some items. Knowing that they were going to be interviewed a second, and perhaps a third time, in addition to their kindergarten teacher being interviewed, this may have motivated them to observe their child, with increased precision of answers regarding their child's performance as a result.

The interview itself may also have raised the awareness of the items related to capability. Parents may have asked their children to perform the tasks, where the children were usually helped. The increased focus during the interview sessions may have led to increased mastery of performance; especially for self-care tasks. This phenomenon is also observed while using PEDI in the clinic with disabled children.

The results of the present study indicate that enhanced reliability is secured when the same interviewer interviews the same respondent, as well as when two trained interviewers interview the same respondent.

However, different respondents, for example, parents and primary caregivers or other professionals, who know the child in different settings, may differ in their understanding of the child's performance. The consistency of scores should be reviewed when different respondents are interviewed.

Children's capability of self-care tasks is influenced by parent's expectations, the child's motivation and thus seems to improve with additional attention. While evaluating outcome of treatment for disabled children, this should be taken into consideration. Increased focus and use of PEDI may, as such, increase children's independence in self-care skills. The use of PEDI might thus increase disabled children's self-care skills and be an effective treatment as such. Further, professionals applying PEDI need to be trained following a required procedure in order to secure consistency in their rating.

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