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HEALTH SERVICES RESEARCH

Extensive Validation of the Pain Disability Index in 3 Groups of Patients With Musculoskeletal Pain

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Study Design. A cross-sectional study design was performed.
Objective. To validate the pain disability index (PDI) extensively in 3 groups of patients with musculoskeletal pain.
Summary of Background Data. The PDI is a widely used and studied instrument for disability related to various pain syndromes, although there is conflicting evidence concerning factor structure, test-retest reliability, and missing items. Additionally, an official translation of the Dutch language version has never been performed.
Methods. For reliability, internal consistency, factor structure, test-retest reliability and measurement error were calculated. Validity was tested with hypothesized correlations with pain intensity, kinesiophobia, Rand-36 subscales, Depression, Roland-Morris Disability Questionnaire, Quality of Life, and Work Status. Structural validity was tested with independent backward translation and approval from the original authors.
Results. One hundred seventy-eight patients with acute back pain, 425 patients with chronic low back pain and 365 with widespread pain were included. Internal consistency of the PDI was good. One factor was identified with factor analyses. Test-retest reliability was good for the PDI (intraclass correlation coefficient, 0.76). Standard error of measurement was 6.5 points and smallest detectable change was 17.9 points. Little correlations between the PDI were observed with kinesiophobia and depression, fair correlations with pain intensity, work status, and vitality and moderate correlations with the Rand-36 subscales and the Roland-Morris Disability Questionnaire.
Conclusion. The PDI-Dutch language version is internally consistent as a 1-factor structure, and test-retest reliable. Missing items seem high in sexual and professional items. Using the PDI as a 2-factor questionnaire has no additional value and is unreliable.
Key words: chronic pain, fibromyalgia, validity, reliability, acute pain, spine, disability measurement, health measurement scale, translation. **Spine 2013;38:E562–E568**

The pain disability index (PDI) is a widely used and studied instrument for measuring and evaluating disability associated with pain.[1,2] The PDI has been constructed in the United States and has been translated into various languages including French[3] and Finnish.[4] The main advantages of the PDI compared with disease-specific disability questionnaires such as the Roland-Morris Disability Questionnaire (RMDQ)[5] or the Quebec Back Pain Disability Questionnaire,[6] are its short length (7 questions) and the fact that it is based on an interval scale. Additionally, the PDI can be used for all diagnoses in which pain is a disabling factor.

Studies on the PDI demonstrate conflicting evidence regarding factor structure. Both 1- and 2-factor structures were observed, with the first factor focusing on disabilities at the level of participation (Voluntary scale) and the second factor at the level of activity (Obligatory scale).[7] The test-retest reliability is conflicting and was observed to be moderate[2] to good,[2,4] depending on time interval between the first and second measurement and stability of patients. Another point of discussion is a previously reported nonresponse of approximately 20% on the sexual item in Canadian claimants admitted to rehabilitation.[8] The magnitude of this nonresponse in other countries is unknown. Concurrent validity of the PDI with the Oswestry Disability Questionnaire is good ($r = 0.81$) and moderate with pain intensity ($r = 0.69$)[4] and responsiveness and minimal clinically important change of the PDI-DLV is sufficient.[9]

In the Netherlands, the PDI is frequently used and studied. However, it has never been translated officially, which raises questions concerning validity and reliability of the Dutch language version PDI (PDI-DLV). The objectives of this study were 2-fold: (1) To translate the existing PDI-DLV formally.

(2) To extensively test its reliability and validity in a broad sample of patients with pain.

MATERIALS AND METHODS

Procedures

With approval, this study was performed as a multicenter study in the Groningen Spine Center of the University Medical Center Groningen and Adelante Centre of Expertise in rehabilitation, Hoensbroek. Patients filled out a comprehensive set of questionnaires including the PDI, Rand-36, pain intensity, RMDQ, EuroQol-5D, work status, depression, and fear of movement, depending of subgroup of patients. Data were collected within care as usual. Patients gave written informed consent for use of their anonymous data for study purposes. The medical ethical committee of the University Medical Center Groningen gave approval for the test-retest study.

Patients

Three groups of patients were included in this study. Data of patients were collected between January 2009 and December 2011. The first group consisted of patients with acute and subacute back pain (<3 mo). The second group consisted of patients with chronic low back pain (CLBP) (>3 mo). CLBP was considered if the primary pain location was located in the lower back and no pain was reported in other regions of the body except for possible leg pain in case of lumbar or sacral radiculopathy. The third group consisted of patients with chronic widespread pain (WSP) of the musculoskeletal system, who were admitted for a pain rehabilitation program. WSP was considered when patients reported pain in at least 2 body regions other than the combination low back and leg. In the WSP group, additional questionnaires concerning

kinesiophobia and depression were administered, whereas the RMDQ was not administered in the WSP group because they did not experience isolated back pain. Administration time of all questionnaires was approximately 30 minutes. All administered questionnaires per group are presented in Table 1.

Measurements

Pain Disability Index

The PDI is a 7-item questionnaire to investigate the magnitude of the self-reported disability in different situations such as work, leisure time, activities of daily life, and sports. The questionnaire is constructed on an 11-item numeric rating scale in which 0 means no disability and 10 maximum disability. The mean administration time varies between 1 and 2 minutes. The original version of the PDI measures 2 factors: factor 1 measuring voluntary activities (PDI items 1 to 5; family/home responsibilities; recreation; social activity; occupation; and sexual behavior) and factor 2 measuring obligatory activities (items 6 and 7; self-care and life support activity). Concurrent validity of the PDI with the Oswestry Disability Questionnaire is good ($r = 0.81$), and with pain intensity moderate ($r = 0.69$).[4] Reliability is moderate to good.[2,4]

Quality of Life

The Euroqol-5D is a 6-item questionnaire to investigate quality of life.[10] The DLV of the Euroqol-5D was used.[11] The Euroqol-5D categories measure 5 dimensions: mobility, self-care, activities of daily life, pain and anxiety/depression. For all states, utility indices were assigned and in this study the Dutch utility index was used.[11] The scale of the Dutch Tariff ranges from −0.33 to 1.00 with higher scores reflecting higher quality of life (QOL) and 0 reflecting QOL equal to death. The validity and reliability is sufficient.[12]

Roland-Morris Disability Questionnaire

The RMDQ contains 24 questions selected from the sickness impact profile.[5] The questionnaire is constructed with dichotomous items (Yes/No) and the total range varies from 0 to 24 with higher scores reflecting higher disability. The Dutch version was used and was previously observed to be reliable in patients with CLBP.[13,14] The validity and reliability has been shown adequate.[5]

Pain Intensity

Current pain intensity was measured with an 11-point numeric rating scale, in the range 0 (no pain) to 10 (worst pain ever). Reliability and validity of the pain numeric rating scale is sufficient.[15]

Kinesiophobia

Fear of movement was measured with the Tampa Scale of Kinesiophobia. The Tampa Scale of Kinesiophobia is a 17-item questionnaire scored on a 4-point Likert scale. Scores range from 17 to 68 with lower scores reflecting lower kinesiophobia.[16] Validity and reliability has been shown to be adequate in patients with CLBP and fibromyalgia.[17]

TABLE 1. Assumed Relations of the PDI With Other Questionnaires

	Acute Back Pain	Chronic Low Back Pain	Widespread Pain
Pain intensity	Fair	Fair	Fair
TSK	N/A	N/A	Fair
BDI II	N/A	N/A	Fair
Work status	Fair	Fair	N/A
EQ-5D	Fair	Fair	N/A
RMDQ	Good	Good	N/A
Rand-Physical Functioning	Moderate	Moderate	Moderate
Rand-Vitality	Fair	Fair	Fair
Rand-Social Functioning	Moderate	Moderate	Moderate

Pain indicates current pain intensity measured with NRS; TSK, Tampa Scale of Kinesiophobia; BDI, Beck Depression Inventory II; EQ-5D, Euroqol-5D; RMDQ, Roland-Morris Disability Questionnaire; N/A, not administered; PDI, pain disability index.

TABLE 2. Baseline Characteristics of Patients			
Variable	Acute Back Pain (N = 178)	Chronic Low Back Pain (N = 425)	Widespread Pain (N = 365)
Sex (female, %)	99; 56	205; 48	267; 73
Age (mean, SD)	49.9 (16.7)	48.8 (15.4)	43.6 (11.4)
Work status			
Full contract (%)	36	28	20
Part time (%)	18	16	23
Sick leave in the past month (%)	72	45	86*
Student (%)	4	5	2
Retired (%)	14	17	0
Household (%)	11	9	13
Other (%)	5	12	39
Pain duration (mean, SD)	7.0 wk	10.3 (10.2) yr	51% > 5 yr†
Pain intensity (0–10) (mean, SD)	7.3 (1.9)	7.3 (1.7)	6.9 (1.6)
TSK	N/A	N/A	35.9 (8.4)
RMDQ (mean, SD)	13.4 (6.1)	14.3 (4.9)	N/A
Euroqol-5D (mean, SD)	0.43 (0.29)	0.47 (0.29)	N/A
PDI (mean, SD)	38.0 (15.9)	36.5 (13.8)	41.4 (10.9)
BDI-II	N/A	N/A	17.3 (9.2)
Rand-36			
Physical functioning (mean, SD)	40.7 (24.5)	40.5 (22.4)	40.7 (20.2)
Pain (mean, SD)	30.9 (17.7)	35.3 (18.6)	32.7 (18.5)
Vitality (mean, SD)	49.1 (19.4)	47.9 (18.6)	35.9 (18.3)
Social functioning (mean, SD)	49.6 (30.1)	56.7 (24.8)	45.6 (24.2)

*Sick leave in the past 2 mo.

†Pain duration was asked on a 7 point Likert scale: All subjects had complaints longer 6 mo; 49%, 0.5–5 yr; and 51%, > 5 yr.

% indicates percentage; TSK, Tampa Scale of Kinesiophobia; RMDQ, Roland-Morris Disability Questionnaire; PDI, pain disability index; BDI-II, Beck Depression Inventory II; NA, not administered.

Depression

Depression was measured with the Beck Depression Inventory (BDI) II. The BDI-II is a 21-item questionnaire scored on a 4-point Likert scale. Scores range from 0 to 63 with higher scores indicating higher depression.[18] The BDI-II was only administered to the WSP group. The validity and internal consistency is good in patients with chronic pain.[19]

Work Status

Work status was measured with 2 different questions: (1) "What is your normal work status?" (Answer categories: full-time working on payroll; part-time working on payroll; retired; student; voluntary work; working freelance; self-employed.) (2) "Did you report sick listed the last month because of your complaints?" (Answer categories: Yes/No.) Data of patients who work either fulltime or part-time on payroll, on freelance basis, or self-employed, and who reported work absence in

the last month because of their complaints were considered to be on sick leave. Work status was only administered by the acute and CLBP group.

Health Status

Self-reported health was measured with the Rand-36. The Rand-36 is a generic health questionnaire covering 9 domains of self-reported health.[20] For the analyses, the subscales Physical Functioning, Vitality, and Social Functioning were included. Each scale can range from 0 to 100, with higher scores indicating better health status. The validity and reliability is good.[21]

Statistics

Patients

Data were gathered at baseline. Descriptive statistics were provided for each patient and data were checked for normality.

Criteria for reliability and validity were made according to criteria of the COnsensus-based Standards for the selection of health Measurement INstruments. taxonomy.[22] Reliability was tested with internal consistency, test-retest reliability, and measurement error. Validity items being addressed were cross-cultural validity (translation process) and construct validity (structural validity and hypothesis testing). Missing items are presented and were resolved as follows: patients were allowed to miss at most 1 question on the PDI. In this case, the missing value was replaced by the patient cluster mean. Because the PDI only consists of 7 questions, if patients missed more than one question on the PDI, the patient was excluded from the study. Floor and ceiling effects more than 15% are considered relevant. *P* values less than 0.05 were considered statistically significant. All statistics were done with SPSS-18 (SPSS Inc. 233 South Wacker Drive, Chicago, IL).

Reliability

Internal Consistency

At the first stage, unidimensionality was tested by factor analyses. Principal Component Analyses with varimax rotations were performed for each group. For each PDI subscale, a Cronbach α was calculated including 95% confidence intervals.[23] Factors with Eigenvalues more than 1.0 were selected. A Cronbach α between 0.70 and 0.90 is considered as acceptable internal consistency.[23] A minimum of 100 subjects per group was recommended.[22]

Test-Retest Reliability

To test the test-retest reliability, patients who reported to be stable were included. At least 50 patients were asked to fill in the PDI twice.[23] There was a 2-week interval was used.[23] Patients filled out the first version by computer and the second by print version. A previous study observed no differences between print and electronic versions.[24] Test-retest reliability was tested with intraclass correlation coefficients (ICCs) model 1,1 including 95% confidence intervals. ICCs were interpreted as follows: ICC more than 0.90 is excellent and sufficient for clinical testing; good when ICC is between 0.75 and 0.90, and poor to moderate when ICC is less than 0.75.[25]

Measurement Error

To test measurement error, standard error of measurement (SEM) and smallest detectable change (SDC) were calculated. SEM and SDC were calculated using the following formula's:

$$SEM = s_x \sqrt{(1 - r_{xx})}.[25]$$

SDC was calculated using the formula:

$$SDC = 1.96 \times \sqrt{2} \times SEM.[26]$$

Validity

Cross-cultural Validity

The original PDI version has been translated into Dutch (PDI-DLV) in 1999 for clinical purposes, but no formal backward translation has been performed. Therefore, a formal backward translation was performed by 2 independent professional native English translators, who were blinded for the original version. Discrepancies were resolved with the primary researcher afterwards. After translation, the translated version was sent to the original author for approval.

Hypothesis Testing

Evidence for construct validity was considered when more than 75% of the hypotheses were met.[27] Relations of disability with pain intensity, fear of movement, depression, work status, and quality of life are previously described. Based on these results, we expected little to fair positive correlations ($0.25 < r > 0.50$) of the PDI with fear of movement,[3,7] depression, pain intensity,[3,28] work status,[28] and QOL.[3,7] We hypothesized to observe good to excellent correlations ($r > 0.75$) between the PDI and the RMDQ. For the Rand-36, no relations are identified in previous studies. We expect to find moderate to good correlations ($0.50 < r < 0.75$). We expect to observe at best fair correlations with the Rand-36 subscale Vitality, because this item is not included in the PDI (Table 1). Interpretation of correlations: 0.00 to 0.25, little or none; 0.26 to 0.50, fair; 0.51 to 0.75, moderate to good; above 0.75, good to excellent.[25]

RESULTS

Patients

In total, 968 patients were included in the study. Included were 397 males and 571 females, consisting of 178 patients with acute back pain, 425 patients with CLBP, and 365 with WSP. Characteristics of patients and baseline measures are presented in Table 2. In the acute sample, 10% of the sexual item was missing. Other missing items were below 6%. In the CLBP group, 13% of the sexual item and 8% of the professional item was missing. In the WSP group, 3% of the sexual item was missing; all other missing values were below 2%. Patients excluded because of more than one missing item were 1 in the WSP group, 30 in the CLBP group, and 6 in the acute back pain group. There were no floor and ceiling effects in the CLBP and WSP group. In the acute back pain group, 1% reported no disability.

Cross-cultural Validity

The objective of this study was to continue from previously translated PDI-DLV; therefore, a backward translation led to a nonliteral translation into English. No relevant differences were observed. The current version of the PDI-DLV was approved by the original authors.

Reliability

Reliability statistics are presented in Table 3. Factor analyses revealed 1 factor with Eigenvalue more than 1.0 and Cronbach α's in the range of 0.65 to 0.89 in the acute and CLBP group. A 2-factor structure of the PDI was identified in the WSP group with Eigenvalues more than 1.0. Cronbach α's of the Obligatory scale in all 3 groups were below 0.70 (0.58–0.65) and ranged from 0.83 to 0.89 for the Voluntary

TABLE 3. Reliability Analyses: Factor Analysis, Cronbach α, Test-Retest Reliability, and Measurement Error

	Acute Back Pain (N = 178)			Chronic Low Back Pain (N = 425)			Widespread Pain (N = 365)	
	EV >1	Fact 1	Fact 2	EV >1	Fact 1	Fact 2	Fact 1	Fact 2
Q1* Family and domestic responsibilities	0.83	0.84	0.23	0.78	0.80	0.19	0.73	0.31
Q2* Recreation	0.81	0.85	0.12	0.69	0.77	0.04	0.80	0.19
Q3* Social activities	0.88	0.83	0.33	0.84	0.79	0.32	0.79	0.30
Q4* Occupation	0.84	0.83	0.27	0.77	0.77	0.20	0.81	0.01
Q5* Sexual activities	0.75	0.63	0.42	0.75	0.66	0.35	0.32	0.55
Q6* Personal care	0.72	0.45	0.67	0.70	0.42	0.68	0.22	0.73
Q7* Basic needs	0.58	0.12	0.95	0.50	0.06	0.91	0.02	0.83
Cronbach α	0.89	0.89	0.65	0.85	0.85	0.63	0.83	0.58
95% CI of α	0.86–0.91	0.86–0.91	0.53–0.74	0.83–0.87	0.83–0.87	0.57–0.68	0.80–0.86	0.50–0.65
R^2	0.62	0.74		0.53	0.67		0.62	
ICC (95% CI)†	Total PDI: 0.76 (0.62–0.85)							
	Voluntary scale 0.80 (0.69–0.88)							
	Obligatory scale: 0.58 (0.37–0.73)							
SEM	6.5							
SDC	17.9							

*Representing factor loadings.

†N = 54.

EV indicates Eigenvalue; fact, factor; Q, question; R^2, percentage of explained variance; ICC, intraclass correlation coefficient; SEM, standard error of measurement; SDC, smallest detectable change; PDI, pain disability index; CI, confidence interval.

scale. For test-retest reliability, 54 patients were included. Test-retest reliability was good (ICC = 0.78).

Measurement Error
SEM was 6.5 points and the smallest detectable change was 17.9 points (Table 3).

Hypothesis Testing
Correlations of the PDI with other scales are presented in Table 4. Of all 20 hypotheses, 17 were not rejected and 3 were rejected.

DISCUSSION
The data presented in this study support the hypotheses concerning reliability and validity of the PDI-DLV. Test-retest reliability of the PDI-DLV is sufficient (ICC = 0.78) and evidence for construct validity was provided. In multiple studies, test-retest reliability of the PDI was addressed.[2,4] In the study of Tait et al,[2] a Pearson correlation of 0.44 was observed. However, in this study, no control for stability was reported. In the study by Grondblad et al,[4] an ICC value of 0.91 was observed for the Finnish PDI version in a 1-week interval with stable patients. In this study, 54 stable patients filled out the PDI twice. According to previous research,[2] the factor obligatory activities is insufficiently reliable for test-retest reliability as well as for internal consistency (Cronbach α <0.70 with significant lower 95% confidence interval). Additionally, responsiveness of this factor has previously been observed to be insufficient.[9] Within the WSP group, the sexual item seemed to load more on factor obligatory activities, but still, the Cronbach α remained insufficient for this scale. Based on these and previous results, it is recommended not to use the Obligatory scale as a subscale. Using the total PDI as a 1-factor questionnaire is recommended because it provides extra data concerning obligatory activities and explains a higher proportion of variance, as is presented in Table 3. It provides more insight in the total construct of a patient's disability compared with solely using the Voluntary scale. In case clinicians are only interested in functioning on activity level, the factor voluntary activities provides sufficient information.

The amount of missing items in the Sexual and Professional scale are concerning in the acute and CLBP group, but not in the WSP group (3% sexual item; others <2%). After studying the data, it seemed that the mean age in the WSP was significantly lower (6 yr) than in the CLBP and acute group. The amount of missing items is lower than described

TABLE 4. Correlations of PDI With Other Health Related State Measures

	Acute Back Pain	Chronic Low Back Pain	Widespread Pain	Hypotheses Met?
Pain intensity (0–10)	0.48	0.49	0.36	Yes
TSK	N/A	N/A	0.19	No
BDI II	N/A	N/A	0.36	Yes
Work status (sick leave = 1)*	0.33	0.31	N/A	Yes
EQ-5D	−0.59	−0.53	N/A	Yes
RMDQ	0.57	0.65	N/A	No
Rand-Physical Functioning	−0.65	−0.64	−0.54	Yes
Rand-Vitality	−0.48	−0.44	−0.33	Yes
Rand-Social Functioning	−0.57	−0.57	−0.58	Yes

*Point biserial correlation.

PDI indicates pain disability index; pain, current pain intensity measured with numeric rating scale; TSK, Tampa Scale of Kinesiophobia; BDI, Beck Depression Inventory II; EQ-5D, Euroqol-5D; RMDQ, Roland-Morris Disability Questionnaire; N/A, not administered.

in a previous study, in which 20% missing data were reported in a study sample of workers.[8] The amount of missing items is most probably due to questions asked to patients which do not exactly fit the targeted group. Many of the patients in this study are not working in paid functions or may be sexually inactive which may have led to a response bias. The mean age of patients with CLBP who did not fill out the Sexual scale was 59 years compared with 49 years in the total population ($P < 0.01$). Previously, a study proposed to replace a sexually related item of the Oswestry Low Back Pain Disability Questionnaire because of the large proportions of missing values.[29] This may also be the case for the PDI if administered in general population.

For validity, PDI correlates significantly with pain intensity, kinesiophobia, quality of life, and health status. Seventeen of 20 hypotheses were confirmed, which is above the minimal recommended percentage of confirmed hypothesis of 75%.[27] However, the correlation of the PDI with the RMDQ, was lower than expected (r, 0.49–0.62). One hypothesis can be that the RMDQ focuses on specific activities, and the PDI on global live participation levels, therefore measuring distinct levels. Additionally, the construct of the RMDQ is not solely related to disability related to low back pain, but also addresses questions related to eating and emotional situations.

There are some limitations to this study. Within the translation process, only a backward translation was performed. Forward translation into Dutch had already been performed in 1999 by the University Medical Centre Maastricht. Some minor text parts in the introduction section of the PDI-DLV were different from the original text but were considered equally in interpretation by the original PDI authors. One remark was made on potential interpretation conflict. This concerned an interpretation difference in doing household activities as asked in Question 1 of the PDI, and being a homemaker in Question 4 of the PDI. Forward/backward translation seemed to have led to synonyms for both equivalents in Dutch, but have slightly different meaning in English.

It was concluded that the PDI-DLV is internally consistent as a 1-factor structure, and reliable in stable patients. Using the PDI as a 2-factor questionnaire has no additional value and the subscale Obligatory Activities is unreliable. Missing items on the Sexual and Professional scales are frequently reported and should be regarded as potential threat for validity. It is recommended to use the PDI-DLV outcome as a 1-factor structure or to use only factor 1 as measurement of disability related to voluntary activities.

➢ Key Points

- ❑ The Dutch version of the PDI is valid and reliable in 3 groups of patients with musculoskeletal pain.
- ❑ Using the PDI as a 1-factor questionnaire is recommended.
- ❑ The "obligatory activities" factors is not reliable and internal consistent.

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