

## Reproducibility and responsiveness of a Danish Pedi-IKDC subjective knee form for children with knee disorders

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**The modified International Knee Documentation Committee Subjective Knee Form (Pedi-IKDC) is a widely used patient-reported tool ranging on a scale from 0 to 100. We aimed to translate Pedi-IKDC into Danish and assess its reproducibility and responsiveness in children with knee disorders. The translation complied with the international guidelines. Reproducibility was assessed in 53 children (15 years) responding Pedi-IKDC at baseline and after 3–14 days. For analysis of responsiveness, 94 children (15 years) responded Pedi-IKDC again after 3 months. Test–retest reliability was excellent. Intraclass correlation coefficient was 0.9, standard error of measurement was 4.1 points, and smallest detectable change**

**(SDC) was 11.3 points. Evaluating responsiveness as a large effect was found in children reporting improvement compared with children reporting deterioration. The change score was correlated to the external anchor Global Rating Scale consisting of 15 answers from –7 “A very great deal worse” to +7 “A very great deal better,” with a Spearman’s rho of 0.45 ( $P > 0.001$ ). The minimal clinically important changes was 12.0. In conclusion, excellent test–retest reproducibility was found at group level, but at individual level the SDC was high. The Pedi-IKDC showed adequate responsiveness and is suitable for assessing improvement or deterioration in children with knee disorders.**

Sports-related injuries among children and adolescents are common (Micheli et al., 2000; Maffulli & Caine, 2005; Caine et al., 2008; Straccolini et al., 2013), with an increasing prevalence in recent years (Fabricant et al., 2013; Ladenhauf et al., 2013). Sports-related injuries are prevalent in children down to 5 years of age (Ladenhauf et al., 2013), and in European countries injuries are often associated with contact sports such as football and handball (Price et al., 2004; Rotterud et al., 2011; Faude et al., 2013). Despite a high number of sports-related injuries affecting the knee joint (Kocher et al., 2005; Straccolini et al., 2013), only a few outcome measures have been developed that targeted children and adolescents. One patient-related outcome tool is the recently developed Knee Injury and Osteoarthritis Outcome Score for Children (KOOS-Child) (Ortqvist et al., 2012, 2014). The KOOS-Child is a modified version of the KOOS for adults and has been translated into Danish. The KOOS-Child consists of 39 items divided into five subscales: pain, symptoms, difficulty during daily activities, function in sports and play, and knee-related quality of life. The result can be plotted as an outcome profile with the score of each subscale ranging from 0 to 100; a total score cannot be calculated.

Another patient-related outcome tool is the modified International Knee Documentation Committee Subjective Knee Form (Pedi-IKDC) (Iversen et al., 2010; Kocher et al., 2011), which was developed from the widely used International Knee Documentation Committee Subjective Knee Form (IKDC-SKF) (Irrgang et al., 2001). The IKDC-SKF is validated for adults with a variety of knee conditions. The output is a summed score from the individual items transformed to a scale from 0 to 100, making it possible to evaluate knee-related health with one total score (Irrgang et al., 2001). It was developed to detect improvement or deterioration of symptoms, function, and sports activities experienced by the patients (Irrgang et al., 2001, 2006). The Pedi-IKDC was developed through cognitive interviews with the participation of 30 children between 10 and 18 years (Iversen et al., 2010). The psychometric properties of the Pedi-IKDC were evaluated by the participation of 589 children; overall, the form demonstrated acceptable reliability, validity, and responsiveness with an output score ranging from 0 to 100 points (Kocher et al., 2011). The aim of the present study is to translate and culturally adapt the Pedi-IKDC into Danish and, furthermore, to assess its reproducibility, internal consistency, and responsiveness.

**Methods**

Translation and cross-cultural adaptation

The Pedi-IKDC was cross-culturally and conceptually translated according to the guidelines reported by Beaton et al. (2000) in compliance with the international guidelines by the World Health Organization (WHO, 2006). The process of translation and adaptation is illustrated in Fig. 1. Two independent panels made two forward translations of the original Pedi-IKDC into Danish. Panel 1 was the informed panel consisting of three healthcare profes-

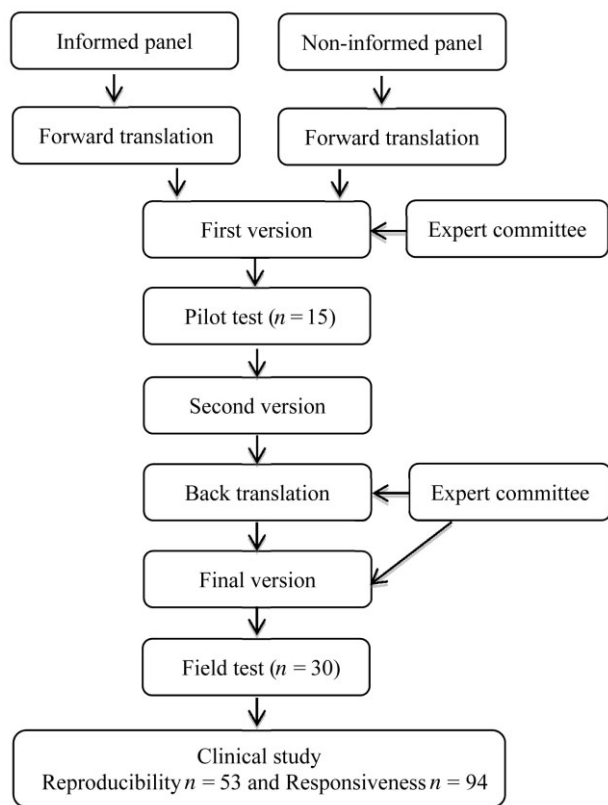


Fig. 1. Process of cross-cultural translation and test of reproducibility and responsiveness of the Danish International Knee Documentation Committee Subjective Knee Form.

sionals with extensive knowledge of the concepts translated. Panel 2 was the non-informed panel consisting of three healthcare students and one person with expertise in English language and communication. Danish was the mother tongue of all members of the two panels and English was thus a second language. The two forward translations were synthesized as the first version of the Pedi-IKDC at a meeting between all members of the two panels.

The first version of the Pedi-IKDC was pilot tested in 15 children with different knee conditions with a median age of 14 (10–15) years. The knee disorders included patellofemoral pain syndrome, meniscus tear, insufficiency of the medial patellofemoral ligament, anterior cruciate ligament tear, and injury of the medial collateral knee ligament. The children were invited to participate in the study at Bispebjerg University Hospital and Aarhus University Hospital. Each child completed the form and participated in a semi-structured interview to test their understanding of the single items and the chosen response according to cognitive interview theory (Beatty & Willis, 2007). All interviews were transcribed and analyzed. Based on the interview test results reported by the children (Table 1), the form was adjusted by the members of the two panels and in consultation with the original developer Maura Daly Iversen. A translator with English as her mother tongue, who was blinded to the original version, made a back translation of the second version into English. An expert committee consisting of the members of the two panels, the original developer and the back translator, made small final adjustments assessing all translations and comparing them to the original version of the form.

Another 30 children with knee conditions were interviewed to test the final version of the Pedi-IKDC. They were all treated at either Bispebjerg University Hospital or Aarhus University Hospital, and had a median age of 14 (8–16) years. Subsequently, the form was finally tested among 10 children with different knee conditions with a median age of 14 (10–15) years.

**Clinical study**

The reproducibility, internal consistency, and responsiveness of the Danish version of the Pedi-IKDC were evaluated in a clinical study on children with different knee conditions. Participating children completed the Pedi-IKDC at three occasions. The form was completed two times ( $X_1$  and  $X_2$ ) during a stable period 3–14 days before either surgical or non-surgical treatment, and the form was completed the third time approximately 4 months after treatment had begun ( $X_3$ ). Parents or caregivers were allowed to help children complete the form, if necessary. Children were encour-

Table 1. Comments to the Danish version from 45 semi-structured interviews

| Item/text  | Comprehension, <i>n</i> | Problematic term/phase                                  | Changes   |
|--|-------------------------|---|---|
| Pilot test of the first version of the Danish Pedi-IKDC ( <i>n</i> = 15) |                         |   |   |
| Introduction   | 3                       | Following questions                                     | Questions below   |
| Item 1   | 1                       | Badminton as hard activity                              | Heavy lifting as hard activity                                    |
| Item 1, 6, 9   | 1                       | Low awareness of the time frame, today                  | Today was moved to the end of the sentence                        |
| Item 1, 6, 9, 10   | 1                       | Slalom skiing   | Skiing  |
| Item 2   | 7                       | How often . . . during the last 4 weeks or since injury | During the last 4 weeks or since injury how much of the time. . . |
| Item 9   | 2                       | Injured knee cannot carry you                           | Injured knee will break   |
| Item 11C   | 2                       | Kneel   | As to propose was added to the item                               |
| Item 11H   | 4                       | To land on your injured knee                            | To land on your injured leg                                       |
| Item 13  | 1                       | Low awareness of the time frame                         | Today was added in ( ) to the item                                |
| Test of the Danish Pedi-IKDC ( <i>n</i> = 30)                            |                         |   |   |
| Item 2, 4, 5, 7, 8   | 12                      | During the last 4 weeks or since injury                 | During the last 4 weeks, or since injury                          |
| Item 9   | 5                       | Injured knee will break                                 | Giving away of the injured knee                                   |

Issues reported by the children when completing the first version of Danish International Knee Documentation Committee Subjective Knee Form (Pedi-IKDC). *n* = number of children.

aged to complete the form with the same amount of help from parents or caregivers at all three occasions.

### Subjects

From August 2013 to October 2014, 99 children treated for their knee condition at either Bispebjerg University Hospital or Aarhus University Hospital gave informed consent to participate. Children were not included if they complied with the following criteria: (a) cognitive or mental difficulties that may affect their response to the Pedi-IKDC; (b) unstable knee condition; and (c) unable to speak and understand Danish.

### Sample size

Based on the study by Hopkins (2000), we defined the sample size *a priori* from the standard error of measurement (SEM). With a test and a retest, we found the error around the SEM acceptable with a sample size of 50 participants (Hopkins, 2000). The choice of 50 is based on the width of the 95% confidence interval around the SEM, where a sample size of at least 50 is needed to give an adequate precision of the estimate of the change of the SEM (Hopkins, 2000). This sample size has also been recommended by others to give an adequate precision of the intraclass correlation coefficient (ICC) and to evaluate the responsiveness of a patient-related outcome (Terwee et al., 2007).

### Statistics

Data were entered twice into the data management program EpiData (version 3.02 Aarhus University, Denmark), and divergences were corrected according to the original material. Statistically significant differences in mean scores between the first and second response and the first and third response to the form, respectively, were analyzed with paired *t*-tests as data were normally distributed. Agreement concerns the absolute measurement error, i.e., how close the repeated scores are, expressed in the unit of the measurement scale at issue. The measurement error was reported as a Bland Altman plot with the limits of agreement included in the plot, and as SEM by the equation  $SEM = SD_{\text{difference}}/\sqrt{2}$  (Hopkins, 2000), indicating the measurement error at group level. The smallest detectable change (SDC) also called the minimum detectable change defined as the measure of statistically significant change between two measurements was calculated by the equation  $1.96*\sqrt{2}*SEM$  and indicate the measurement error at individual level. Reliability was calculated as the ICC using a two-way fixed-effect model (two-way analysis of variance) including systematic error in the ICC estimate. The ICC is the ratio of the variance between subjects divided by the total variance;  $ICC > 0.70$  was considered acceptable (Terwee et al., 2007). Internal consistency indicating the homogeneity of the items in the form was determined from the first preoperative response evaluated with Cronbach's alpha; Cronbach's alpha  $> 0.70$  was considered acceptable (Terwee et al., 2007). Responsiveness to change in health status was evaluated using both an anchor-based method and a distribution-based method. In the anchor-based method, we used both convergent and discriminative methods. First, we plotted the absolute change score of the Pedi-IKDC and the external anchor Global Rating Scale (GRS) (Jaeschke et al., 1991; Juniper et al., 1994). The GRS consists of 15 answers from -7 "A very great deal worse" to +7 "A very great deal better." Second, we assessed Spearman's correlation of the absolute change score of the form and the GRS. Third, we drew receiver-operating characteristic (ROC) curves of the absolute change in score of the Pedi-IKDC to evaluate its ability to correctly classify patients as improved or not improved according to the external anchor GRS. To draw the ROC curves, we classified

patients with GRS responses below 2 as not improved, and patients with responses above 1 as improved. The responses to GRS of below 2 includes "A very great deal worse (-7), a great deal worse (-6), a good deal worse (-5), moderately worse (-4), somewhat worse (-3), a little worse (-2), almost the same, hardly any worse at all (-1), no change (0), almost the same, hardly any better at all (1)." The answers to GRS above 1 includes "A little better (2), somewhat better (3), moderately better (4), a good deal better (5), a great deal better (6), a very great deal better (7)." The area under the ROC curve was calculated, and an area under the curve of 0.7 was considered acceptable (Terwee et al., 2007). The minimal clinically important change (MCIC) was defined as the mean change in score between baseline and follow-up for patients who recorded improvement according to GRS ( $GRS > 2$ ) (Jaeschke et al., 1991). Using a distribution-based method, the standardized response mean (SRM) was calculated with the equation  $(\text{mean } X_3 - X_1) / SD$  ( $\text{mean } X_3 - X_1$ ) in patients reporting a change of "worse" ( $GRS < 2$ ) or "better" ( $GRS > 1$ ). Effect sizes of 0.2, 0.5, and 0.8 are interpreted as small, medium, or large, respectively. The significance level was 0.05 and STATA 11.2 (StataCorp, College Station, Texas, USA) software package was used for data analysis.

### Ethics

This study complies with the Helsinki Declaration and was notified the Central Denmark Region Committee on Biomedical and Research Ethics (155/2013). The Danish Data Protection Agency gave permission for the handling of personal data (1-16-02-404-13).

## Results

### Translation and cross-cultural adaptation

Synchronizing the two forward translations revealed minor difficulties regarding the process of translation and cultural adaptation. The following changes were made in order to adapt the Pedi-IKDC to the Danish language. The most you could do in items 1, 6, 9, and 10 was changed to the Danish word of toughest. Basketball in items 1, 6, 9, and 10 was changed to handball. Heavy lifting in items 1, 6, 9, and 10 was changed to lift of heavy objects. In item 5 puffy (or swollen) was merged to swollen. Get stuck in place (lock) was changed to the Danish phase of got stocked (locked) in item 7. Feeling like it can't hold you up in item 9 was changed to giving away. Squat in item 11D was changed to crouch down.

During the field study, the comments made by the children resulted in corrections illustrated in Table 1. The last test on the 10 children did not reveal any further corrections, and the original developer finally approved the form. The Danish version of the Pedi-IKDC can be found in Appendix S1.

### Clinical study

Of the 99 included children (Table 2), 53 children (28 boys) with a median age of 15 (11–18) years correctly returned the first and second response of the Pedi-IKDC, and 94 children (45 boys) with a median age of 15 (9–18) years correctly returned the first and third

Table 2. Patient characteristics at baseline

| Patient characteristics                                    | Total group<br>(n = 99) |
|--|-------------------------|
| Age (range)  | 14 (9–18)               |
| Boys (number)  | 50                      |
| Diagnoses n (%)  |                         |
| ACL injury   | 55 (56)                 |
| ACL and MCL injury   | 3 (3)                   |
| Meniscus injury  | 1 (1)                   |
| Patellar dislocation                                       | 27 (27)                 |
| Anterior tibial spine fracture                             | 1 (1)                   |
| Osteochondritis  | 3 (3)                   |
| Patellofemoral pain syndrome/idiopathic anterior knee pain | 5 (5)                   |
| Osgood–Schlatter instead disease                           | 4 (4)                   |
| Treatment received from baseline to follow-up n (%)        |                         |
| Surgery  | 5 (5)                   |
| Surgery + physiotherapy                                    | 77 (78)                 |
| Physiotherapy  | 17 (17)                 |

ACL, anterior cruciate ligament; MCL, medial collateral ligament.

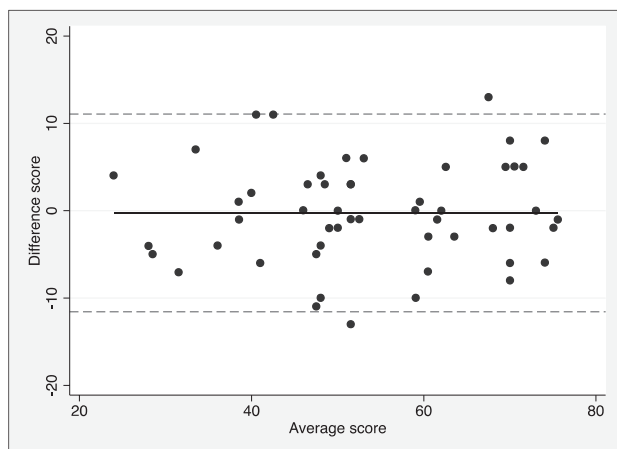


Fig. 2. Absolute Change Score of the International Knee Documentation Committee Subjective Knee Form (black line) with limits of agreement (dashed lines). The black line,  $y = 0$  indicates perfect average agreement.

response of the form. The median period between the first and second response was 5 (3–13) days, and the median period between the first and third response was 4 (3–12) months.

### Reproducibility

The mean scores of the first and second response showed no systematic differences {53.9 [standard deviation (SD) 14.2] points vs 54.1 [SD 13.9] points,  $P = 0.8$ }. Equally, the Bland Altman plots with 95% limits of agreement revealed no systematic differences between the two responses and illustrated acceptable agreement between the two outcome measures (Fig. 2). The SEM of the two preoperative scores was 4.1, indicating the measurement error at group level. The SDC of the two preoperative

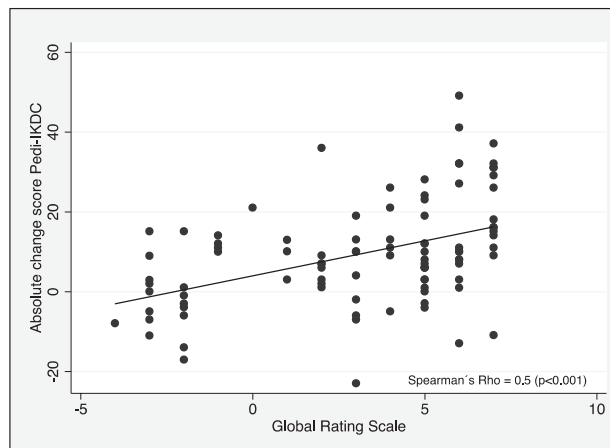


Fig. 3. Illustrates the agreement between the absolute change score of the International Knee Documentation Committee Subjective Knee Form and the Global Rating Scale.

scores was 11.3, indicating the measurement error at individual level. The reliability measured by ICC was 0.9.

### Internal consistency

The analysis of internal consistency resulted in a Cronbach's alpha of 0.9, indicating a high correlation between the items in the form.

### Responsiveness

The analyses of responsiveness showed that the score of the third response [61.3 (SD 12.4) points] was significantly higher compared with the score of the first response [51.8 (SD 14.1) points] ( $P < 0.001$ ). The GRS and the Pedi-IKDC were correlated as illustrated in the Fig. 3 and Spearman's rho was 0.5 ( $P < 0.001$ ). The area under the ROC curve was 0.7 (0.6, 0.8). The MCIC was 12.0 (SD 13.5) points. SRM showed a large effect size in children reporting improvement (SRM = 0.9,  $n = 67$ ) and a small effect size in children reporting deterioration (0.2,  $n = 25$ ).

### Discussion

The Danish version of the Pedi-IKDC showed acceptable absolute test–retest reproducibility at group level together with excellent relative test–retest reliability. At an individual level, the SDC was relatively high meaning that considerably large changes are needed to detect true change in an individual over time. The Pedi-IKDC and the GRS were correlated suggesting that both scores are responsive to change over time.

### Strength and limitations

First, it is a strength that the Pedi-IKDC was cross-culturally and conceptually translated according to inter-

national guidelines. Second, the original developer was involved throughout the translation process and approved the final version. Third, the study is strengthened because we were able to include more than 50 children, which has been recommended as an appropriate sample size in reliability studies (Hopkins, 2000; Terwee et al., 2007). The most important limitation of the present study is the fairly low correlation between the Pedi-IKDC and the GRS, which also affects the ROC curves. The area under the ROC curve was 0.70, which is just at the limit of what has earlier been recommended as a criterion for adequate responsiveness of health-related outcome measures (Terwee et al., 2007). The use of the GRS as an external anchor has earlier been questioned as the reliability and validity of patient-reported global assessments is unclear (Mokkink et al., 2010; Schmitt & Abbott, 2015). Still, no gold standard exists for measuring change in a patient-related outcome as in the Pedi-IKDC. Using patient-reported global assessments as the GRS thus remains the best currently available solution.

### Reproducibility

Compared with other studies, our value of the ICC is equal to the ICC of the American version of the Pedi-IKDC (ICC = 0.9) (Kocher et al., 2011) and similar to the ICC of the KOOS-Child (ICC = 0.78–0.91) (Ortqvist et al., 2014) and the IKDC-SKF (ICC = 0.77–0.97) (Grevnets et al., 2014). The SEM in our study is in line with the reported SEM values of the KOOS-Child (SEM = 5.3–8.1) (Ortqvist et al., 2014) and the IKDC-SKF (4.4–4.6). The SDC in our study is lower than the SDC of the KOOS-Child (SDC = 14.6–22.6) (Ortqvist et al., 2014) and the IKDC-SKF (MDC = 15.6) (Grevnets et al., 2014). However, the SDC is high, and considerable changes are needed to detect true change in an individual over time. This phenomenon is known and consistent with other patient-reported outcome measures (De Vet et al., 2001). The SEM and SDC values of the American version of the Pedi-IKDC have not been published, and therefore no comparison can be made.

### Internal consistency

The estimation of internal consistency of 0.9 indicates a high correlation between the items in the form, and the estimate lies in the high end of the reported values of the American version of Pedi-IKDC, the IKDC-SKF, and the KOOS-Child, which is reported between 0.59 and 0.91 (Kocher et al., 2011; Grevnets et al., 2014; Ortqvist et al., 2014).

### Responsiveness

The ability of the Pedi-IKDC to measure change over time is of great importance. Responsiveness was evaluated by comparing the GRS and the change score of the

form. The correlation between the scores was fair ( $\rho = 0.5$ ), similar to the correlation found when assessing the responsiveness of the KOOS-Child ( $\rho = 0.38$ – $0.57$ ) (Ortqvist et al., 2014) and the IKDC-SKF ( $\rho \geq 0.7$ ) (Grevnets et al., 2014). The SRM showed a low effect in patients reporting their condition as worse and large in patients reporting their condition as better (Fayers & Machin, 2007). SRM of the American version was calculated in all children and not subdivided into groups according to improvement or not. The SRM of the American version of the form was higher than in the present study (SRM = 1.35) (Kocher et al., 2011) but also interpreted as a large effect. The SRM in the American Pedi-IKDC was evaluated 3 months later than our assessment, which could explain the higher value of SRM compared with our result. The SRM of the original IKDC-SKF was 0.9–4.4, similar to the SRM in the present study in children who reported their condition as better (Irrgang et al., 2006; Grevnets et al., 2014). The area under the ROC curve has been reported for the IKDC-SKF with a value of  $\geq 0.7$ , which is equal to the value found in the present study. The minimal important change (MIC) has been reported for the KOOS-Child with values ranging from 2 to 32 from patients reporting “better,” and 10–26 points for patients reporting their health as “much better” (Ortqvist et al., 2014). Our value of the MCIC reflects the same as the MIC and is in line with the reported values of the KOOS-Child (Ortqvist et al., 2014), meaning that the clinical meaningfully change present at similar change scores. The minimal clinical important difference (MCID) reflects the same as the MCIC and MIC. The MCID for the IKDC-SKF is similar to our value of the MCIC (MCID = 6.3–20.5) (Irrgang et al., 2006; Grevnets et al., 2014). Neither the MCIC nor the SDC was reported for the American version of the Pedi-IKDC and therefore no comparison can be made.

### Generalizability

Overall, we believe that the generalizability of our results is good. We included children with a rather large age span from 9 to almost 18 years, with different knee conditions, and with varying levels of resulting functional limitations. Furthermore, more than 75% of the invited patients accepted participation, reducing the risk of potential selection bias.

In conclusion, acceptable test–retest reliability was found at group level, and the Pedi-IKDC showed adequate responsiveness and is suitable for assessing improvement or deterioration in children with knee disorders.

### Perspective

The modified version of the Pedi-IKDC was successfully translated into Danish and is a suitable patient-reported

outcome measure to evaluate level of physical function of the knee in a broad pediatric population with knee disorders. As opposed to the KOOS-Child, the Pedi-IKDC provides a total output score ranging from 0 to 100 points, which may be beneficial in both comparative and longitudinal designs when one outcome parameter is wanted. Overall the Pedi-IKDC demonstrated good psychometric properties comparable with the psychometric properties of the KOOS-Child, the American version of Pedi-IKDC, and the IKDC-SKF (Kocher et al., 2011; Grevnets et al., 2014; Ortgqvist et al., 2014).

A score of 4 and 11 Pedi-IKDC points is needed at group and individual level, respectively, to detect true change over time. The Pedi-IKDC gives a valid assessment of physical function in a pediatric population; by

monitoring children with the Pedi-IKDC, it may also be possible to improve the quality of clinical care.

**Key words:** Reliability, agreement, PRO, patient-related outcome, internal consistency, minimal clinically important change, MCIC.

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### References

- Beaton DE, Bombardier C, Guillemin F, Ferraz MB. Guidelines for the process of cross-cultural adaptation of self-report measures. *Spine* 2000; 25: 3186–3191.
- Beatty PC, Willis GB. Research synthesis: the practice of cognitive interviewing. *Public Opin Q* 2007; 71: 287–311.
- Caine D, Maffulli N, Caine C. Epidemiology of injury in child and adolescent sports: injury rates, risk factors, and prevention. *Clin Sports Med* 2008; 27: 19–50.
- De Vet HC, Bouter LM, Bezemer PD, Beurskens AJ. Reproducibility and responsiveness of evaluative outcome measures. Theoretical considerations illustrated by an empirical example. *Int J Technol Assess Health Care* 2001; 17: 479–487.
- Fabricant PD, Jones KJ, Delos D, Cordasco FA, Marx RG, Pearle AD, Warren RF, Green DW. Reconstruction of the anterior cruciate ligament in the skeletally immature athlete: a review of current concepts: AAOS exhibit selection. *J Bone Joint Surg* 2013; 95: e28.
- Faude O, Rössler RF, Junge A. Football injuries in children and adolescent players: are there clues for prevention? *Sports Med* 2013; 43 (9): 819–837.
- Fayers PM, Machin D. Quality of Life – The assessment, analysis and interpretation of patient-reported outcomes. Chichester, West Sussex, England: John Wiley & Sons Ltd., 2007.
- Grevnets HT, Terwee CB, Kvist J. The measurement properties of the IKDC-subjective knee form. *Knee Surg Sports Traumatol Arthrosc* 2014; 1–9.
- Hopkins WG. Measures of reliability in sports medicine and science. *Sports Med* 2000; 30: 1–15.
- Irrgang JJ, Anderson AF, Boland AL, Harner CD, Kurosaka M, Neyret P, Richmond JC, Shelborne KD. Development and validation of the international knee documentation committee subjective knee form. *Am J Sports Med* 2001; 29: 600–613.
- Irrgang JJ, Anderson AF, Boland AL, Harner CD, Neyret P, Richmond JC, Shelbourne KD. International knee documentation committee. Responsiveness of the international knee documentation committee subjective knee form. *Am J Sports Med* 2006; 34: 1567–1573.
- Iversen MD, Lee B, Connell P, Andersen J, Anderson AF, Kocher MS. Validity and comprehensibility of the international knee documentation committee subjective knee evaluation form in children. *Scand J Med Sci Sports* 2010; 20: e87–e95.
- Jaeschke R, Guyatt GH, Keller J, Singer J. Interpreting changes in quality-of-life score in N of 1 randomized trials. *Control Clin Trials* 1991; 12: 226S–233S.
- Juniper EF, Guyatt GH, Willan A, Griffith LE. Determining a minimal important change in a disease-specific quality of life questionnaire. *J Clin Epidemiol* 1994; 47: 81–87.
- Kocher MS, Garg S, Micheli LJ. Physeal sparing reconstruction of the anterior cruciate ligament in skeletally immature prepubescent children and adolescents. *J Bone Joint Surg* 2005; 87: 2371–2379.
- Kocher MS, Smith JT, Iversen MD, Brustowicz K, Ogunwale O, Andersen J, Yoo WJ, McFeely ED, Anderson AF, Zurakowski D. Reliability, validity, and responsiveness of a modified International Knee Documentation Committee subjective knee form (Pedi-IKDC) in children with knee disorders. *Am J Sports Med* 2011; 39: 933–939.
- Ladenhauf HN, Graziano J, Marx RG. Anterior cruciate ligament prevention strategies: are they effective in young athletes – current concepts and review of literature. *Curr Opin Pediatr* 2013; 25: 64–71.
- Maffulli N, Caine D. The epidemiology of children’s team sports injuries. *Med Sport Sci* 2005; 49: 1–8.
- Micheli LJ, Glassman R, Klein M. The prevention of sports injuries in children. *Clin Sports Med* 2000; 19: 821–834.
- Mokkink LB, Terwee CB, Knol DL, Stratford PW, Alonso J, Patrick DL, Bouter LM, de Vet HC. The COSMIN checklist for evaluating the methodological quality of studies on measurement properties: a clarification of its content. *BMC Med Res Methodol* 2010; 10: 22.
- Ortgqvist M, Iversen MD, Janarv PM, Brostrom EW, Roos EM. Psychometric properties of the Knee Injury and Osteoarthritis Outcome Score for Children (KOOS-Child) in children with knee disorders. *Br J Sports Med* 2014; 48: 1437–1446.
- Ortgqvist M, Roos EM, Brostrom EW, Janarv PM, Iversen MD. Development of the Knee Injury and Osteoarthritis Outcome Score for children (KOOS-Child): comprehensibility and content validity. *Acta Orthop* 2012; 83: 666–673.
- Price RJ, Hawkins RD, Hulse MA, Hodson A. The Football Association medical research programme: an audit of injuries in academy youth football. *Br J Sports Med* 2004; 38 (4): 466–471.
- Rotterud JH, Silversten EA, Forssblad M, Engebretsen LF, Aroen A. Effect of

gender and sports on the risk of full-thickness articular cartilage lesions in anterior cruciate ligament-injured knees: a nationwide cohort study from Sweden and Norway of 15 783 patients. *Am J Sports Med* 2011; 39 (7): 1387–1394.

Schmitt J, Abbott JH. Global ratings of change do not accurately reflect functional change over time in clinical practice. *J Orthop Sports Phys Ther* 2015; 45: 106–111.

Stracciolini A, Casciano R, Levey Friedman H, Meehan WP,

Micheli LJ. Pediatric sports injuries: an age comparison of children versus adolescents. *Am J Sports Med* 2013; 41: 1922–1929.

Terwee CB, Bot SD, de Boer MR, van der Windt DA, Knol DL, Dekker J, Bouter LM, de Vet HC. Quality criteria were proposed for measurement properties of health status questionnaires. *J Clin Epidemiol* 2007; 60: 34–42.

World Health Organization (WHO). *Proces of translation and adaptation of instruments*. 2006. Available:

[http://www.who.int/substance\\_abuse/research\\_tools/translation/en/](http://www.who.int/substance_abuse/research_tools/translation/en/) [2013 May 8].

### Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

**Appendix S1.** Danish version of Pedi-IKDC.