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Comparative, validity and responsiveness of the HOOS-PS and KOOS-PS to the WOMAC physical function subscale in total joint replacement for Osteoarthritis

A. M. Davis†‡§‖¶*, A. V. Perruccio†#, M. Canizares†, G. A. Hawker‖††‡‡, E. M. Roos§§‖‖, J.-F. Maillefert¶¶## and L. S. Lohmander‖‖

† *Division of Health Care and Outcomes Research and Arthritis Community Research and Evaluation Unit, Toronto Western Research Institute, Toronto, Canada*
‡ *Department of Physical Therapy, University of Toronto, Toronto, Canada*
§ *Department of Rehabilitation Science, University of Toronto, Toronto, Canada*
‖ *Department of Health Policy, Management and Evaluation, University of Toronto, Toronto, Canada*
¶ *Institute of Medical Science, University of Toronto, Toronto, Canada*
# *Dalla Lana School of Public Health, University of Toronto, Toronto, Canada*
†† *Division of Rheumatology, Department of Medicine, Women's College Hospital, Toronto, Canada*
‡‡ *Department of Medicine, University of Toronto, Toronto, Canada*
§§ *Institute of Sports Science and Clinical Biomechanics, University of Southern Denmark, Odense, Denmark*
‖‖ *Department of Orthopaedics, Clinical Sciences Lund, Lund University, Sweden*
¶¶ *Dijon University Hospital, University of Burgundy, Dijon F-21079, France*
INSERM U887, University of Burgundy, Dijon F-21079, France

Summary

Objective: To evaluate the internal consistency of the Hip disability and Osteoarthritis Outcome Score-Physical Function Short-form (HOOS-PS) and the Knee injury and Osteoarthritis Outcome Score-Physical Function Short-form (KOOS-PS) in total hip replacement (THR) and total knee (TKR) replacement. Construct validity and responsiveness were compared to the Western Ontario McMaster Universities' Osteoarthritis Index (WOMAC) Likert 3.0 physical function (PF) subscale and the PF excluding the items in the short measures (PF-exclusions).

Methods: Participants completed the full HOOS or KOOS, measures of fatigue, anxiety, depression and the Chronic Pain Grade (CPG) pre-surgery and the HOOS or KOOS 6 months post-surgery. Internal consistency for the HOOS-PS and KOOS-PS was calculated using Cronbach's alpha. For construct validity, it was hypothesized that correlations between the HOOS-PS or KOOS-PS and PF and PF-exclusions with fatigue, CPG, anxiety and depression and HOOS/KOOS pain scales would differ by magnitudes of <0.1. Standardized response means (SRMs) were calculated for the HOOS-PS, KOOS-PS, PF and PF-exclusions and hypothesized to be >1.

Results: The THR group ($n=201$) had a mean age of 62.3 years; 53.2% were female. The TKR group ($n=248$) had a mean age of 64.5 years; 63.7% were female. Cronbach's alpha was 0.79 and 0.89 for the HOOS-PS and KOOS-PS, respectively, confirming that the measures represented a homogeneous construct. The correlation of the HOOS-PS to the PF and PF-exclusions was 0.90 and 0.86, respectively; $r=0.90$ (PF) and $r=0.85$ (PF-exclusions) for the KOOS-PS. The results supported the construct validity hypotheses. For THR, the SRM was 1.5, 1.7 and 1.7 for the HOOS-PS, PF and PF-exclusions; for TKR, the SRM was 1.4, 1.5 and 1.7, respectively.

Conclusions: The short HOOS-PS and KOOS-PS represent homogenous short measures of PF with similar construct validity and responsiveness to the 17-item PF. The HOOS-PS and KOOS-PS are parsimonious, valid and responsive for evaluating PF in THR and TKR.

Key words: HOOS-PS, KOOS-PS, Validity, Responsiveness, Total joint replacement, WOMAC.

Introduction

Osteoarthritis (OA) is one of the most prevalent diseases in the developed world and is a major cause of pain and physical disability[1,2]. It is most common in the hip and knee, is a leading cause of activity limitation, loss of independence, decreased quality of life and is a significant economic burden in terms of health care costs[1,3–6]. Hence, change in physical function (PF) as a result of intervention is a critical outcome. The Western Ontario McMaster Universities' Osteoarthritis Index (WOMAC)[7,8] is one of the most commonly used outcome measures; it includes a PF subscale of demonstrated reliability, validity and responsiveness for people with hip and/or knee OA. However, the subscale has 17 items and, when clinicians or researchers

*Address correspondence and reprint requests to: Aileen M. Davis, Division of Health Care and Outcomes Research, and Arthritis Community Research and Evaluation Unit, Toronto Western Research Institute, 399 Bathurst Street, MP11-322, Toronto, Ontario M5T 2S8, Canada. Tel: 1-416-603-5543; Fax: 1-416-603-6288; E-mail: adavis@uhnresearch.ca
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Table I
Items in the HOOS-PS and KOOS-PS and their subscale of origin

Subscale of origin from HOOS or KOOS	HOOS-PS (five items)	KOOS-PS (seven items)
Activities of Daily Living subscale*	Sitting	Rising from bed
	Descending stairs	Putting on sock/stockings
	Getting in/out of bath/shower	Rising from sitting
		Bending to the floor
Sport and Recreation subscale	Running	Twisting/pivoting on your injured knee
	Twisting or pivoting on your loaded leg	Kneeling
		Squatting

*Subscale subsumes the 17 PF items of the WOMAC Likert 3.0.

are using a battery of measures they often require parsimonious measures to limit respondent burden. Additionally, concerns have been expressed that the WOMAC PF subscale assesses a limited range of functional disability and has redundant items[9–11]. Given these potential limitations of the WOMAC PF, members of our group developed short measures of PF for hip and knee OA[12,13].

The Hip disability and Osteoarthritis Outcome Score-Physical Function Short-form (HOOS-PS) and Knee injury and Osteoarthritis Outcome Score-Physical Function Short-form (KOOS-PS) were developed from the Activities of Daily Living subscale (which subsumes the 17 PF items of the WOMAC Likert 3.0) and the Sport and Recreation subscale of the HOOS and the KOOS, respectively[14–16]. The items included in the HOOS-PS and KOOS-PS are presented in Table I. Having been developed by ensuring fit of the data to the Rasch model, these short measures provide interval (as opposed to ordinal) level scores that can appropriately be subjected to inferential statistics[12,13]. Additionally, the measures represent a measure solely of PF by virtue of their meeting the requirements of strict unidimensionality[12,13]. However, these short measures were purposely developed to represent the spectrum of hip and knee OA and included those from community samples, those who received conservative management, surgery other than total joint replacement (TJR) (e.g., osteotomy), as well as those who were scheduled for hip or knee replacement surgery. The measures have not yet been tested for responsiveness. Given that total hip replacement (THR) and total knee replacement (TKR) are the treatment of choice with known effectiveness for people with end stage arthritis, the measurement properties of these short measures need to be evaluated in this patient group.

The purpose of this study was to evaluate the internal consistency of the HOOS-PS and KOOS-PS and to evaluate their construct validity and responsiveness as compared to the WOMAC Likert 3.0 PF subscale in people undergoing THR and TKR.

Methods

This study included 201 people who had primary THR and 248 people who had primary TKR for OA who had 6 months of follow-up post-surgery. The surgery occurred at one of four academic hospitals in Toronto, Canada. Individuals were eligible for inclusion in the study if they were over the age of 18 years, were undergoing primary THR or TKR for OA, were able to read and comprehend English in order to complete the questionnaires and consented to participate. Exclusion criteria included joint replacement for inflammatory arthritis, fracture, tumour or acute trauma, hemi-arthroplasty and revision arthroplasty. The study was approved by the human subject review board of each of the participating institutions.

The participants completed a battery of self-report questionnaires by mail within 2 weeks prior to their joint replacement surgery; the full HOOS or KOOS, a measure of fatigue from the Profile of Mood States (POMS)[17], the Hospital Anxiety and Depression Scale (HADS)[18] and the Chronic Pain Grade (CPG)[19–21]. The HOOS or KOOS also was completed at 6 months post-surgery.

The HOOS-PS and KOOS-PS scores were derived from the responses to full HOOS and KOOS as accrual to the sample began in April 2006, prior to the development of the short measures. The HOOS-PS consists of five items and the KOOS-PS has seven items; both are scored 0–100 with zero scores representing no difficulty[12,13]. Similarly, the WOMAC Likert 3.0 17-item PF subscale was extracted from the HOOS/KOOS, respectively, and summed to create a 0–68 score in which zero represented no difficulty. Given that the HOOS-PS and KOOS-PS include items from the WOMAC, we also created a PF score based on only the items of the WOMAC that were not included in the short measures (PF-exclusions). The PF-exclusion score ranged from 0 to 56 for the THA group and 0–48 for the TKA group with zero representing no difficulty. The PF-exclusion scores avoid over-estimation of the correlations calculated for construct validity and of the standardized response mean (SRM) for responsiveness in comparison to the short measures.

The WOMAC Likert 3.0 pain scale, the POMS fatigue subscale, the CPG and the anxiety and depression scores from the HADS were used for testing construct validity. The WOMAC Likert 3.0 pain scale[7] was extracted from the HOOS or KOOS. The score ranges from 0 to 20. The POMS fatigue subscale includes five items with a total score ranging from 0 to 20[17]. Both the anxiety and depression subscale scores range from 0 to 21[18]. The CPG score ranges from 0 to 27[19–21]. For all of these measures zero represents no symptoms. These measures all have reported reliability and validity[2,7,17–22].

Descriptive statistics were calculated for sample characteristics as appropriate to the type of data. Cronbach's alpha was calculated as a measure of internal consistency[23]. As a test of construct validity, it was hypothesized that correlations between each of the measures of PF (HOOS-PS or KOOS-PS, PF and PF-exclusions) and the POMS, CPG, HADS anxiety and depression and WOMAC pain scales would differ by magnitudes of less than 0.1. Additionally, we expected the correlations among the measures of PF (HOOS-PS or KOOS-PS, PF and PF-exclusions) to be higher than with the correlations with the pain, fatigue and anxiety and depressions measures. Based on the distribution of the data, Pearson correlation coefficients were calculated. The SRM[24] was calculated for each of the HOOS-PS or KOOS-PS and for the PF and PF-exclusions and was hypothesized for all measures to be large and greater than 1. Analyses were conducted separately for the THR and TKR participants.

Results

The mean age of the THR group was 62.3 years (range 31–86) whereas the mean age of the TKR group was 2 years older at 64.5 years. Just over 53% were female in the THR group compared with 63% in the TKR group. Table II presents the sample characteristics. These data are similar to

Table II
Characteristics of the study sample undergoing primary THR or TKR for OA

	THR ($n = 201$)	TKR ($n = 248$)
Age: mean (sd)	62.3 (12.1)	64.5 (10.3)
Sex: M:F	1:1.3	1:1.7
BMI		
<25	4 (2%)	1 (0.4%)
25–29	61 (30.3%)	36 (14.5%)
30–34	66 (32.8%)	70 (28.2%)
≥35	61 (4.5%)	101 (40.7%)
Missing	9 (4.5%)	40 (16.1%)
Marital status		
Single	18 (9.0%)	22 (8.9%)
Married or living with someone	183 (91.0%)	204 (82.2%)
Missing	0	22 (8.9%)

BMI = body mass index in kg/m^2.

the description of those individuals reported in the Canadian Joint Replacement Registry for those surgeons reporting to the Registry[25].

As assessed by Cronbach's alpha, the internal consistency of the HOOS-PS was 0.79 and 0.89 for the KOOS-PS confirming that the measures represented a homogeneous construct. Table III shows the correlation coefficients for the tests of construct validity and demonstrates that the findings for the HOOS-PS and KOOS-PS are similar. For all the measures of PF, the correlations are highest with the WOMAC pain subscale, ranging from 0.70 to 0.80. In contrast, the correlations for all PF measures with fatigue, CPG and depression subscales are moderate ranging from 0.33 to 0.66; for anxiety the correlations for the HOOS-PS was 0.19 as compared to 0.38 for the KOOS-PS. In keeping with the hypotheses, the PF measures correlated with the given constructs (i.e., each of WOMAC pain, fatigue, the CPG, anxiety and depression) within 0.10. As hypothesized, the associations among the PF measures were higher than among the pain, fatigue and anxiety and depression measures (i.e., associations for similar constructs were higher than for dissimilar constructs). The correlations of the HOOS-PS to the PF and PF-exclusions were 0.90 and 0.86, respectively. The KOOS-PS was highly correlated with the PF ($r = 0.90$) and the PF-exclusions ($r = 0.85$).

From pre-surgery to 6 months post-surgery, both the THR and TKR groups had significant and large improvements in PF as measured by the short measures, the WOMAC PF and the PF-exclusions (Table IV). For the THR group, the SRM ranged from 1.5 to 1.7 and for the KOOS-PS from 1.4 to 1.7. Again our *a priori* hypothesis was supported by these data.

Table III
Construct validity of the HOOS-PS and KOOS-PS: Pearson's correlation coefficients

	WOMAC pain	CPG	POMS fatigue	HADS anxiety	HADS depression
THR					
HOOS-PS	0.70	0.56	0.38	0.19	0.36
PF	0.80	0.62	0.40	0.19	0.35
PF-exclusions	0.80	0.62	0.38	0.19	0.33
TKR					
HOOS-PS	0.73	0.56	0.42	0.39	0.42
PF	0.80	0.66	0.52	0.36	0.47
PF-exclusions	0.78	0.64	0.48	0.39	0.46

Table IV
Responsiveness of the HOOS-PS, KOOS-PS, WOMAC PF and the WOMAC items not included in the PS scales (PF-exclusions)

	Pre-surgery (mean, sd)	6 Months post-surgery (mean, sd)	SRM
THR			
HOOS-PS	55.9 (16.7)	25.4 (16.1)	1.5
PF	35.5 (12.0)	12.4 (10.9)	1.7
PF-exclusions	30.3 (9.6)	10.7 (9.1)	1.7
TKR			
KOOS-PS	55.3 (13.2)	36.9 (14.1)	1.4
PF	50.9 (18.0)	21.6 (16.6)	1.5
PF-exclusions	23.4 (8.1)	10.7 (9.1)	1.7

Discussion

This work has demonstrated that the five-item HOOS-PS and seven-item KOOS-PS have similar construct validity and responsiveness to the WOMAC Likert 3.0 17-item PF subscale within a sample of people undergoing THR or TKR. In addition to limiting response burden, particularly when a battery of measures evaluating different constructs is used, the HOOS-PS and KOOS-PS have the advantage of including more demanding activities[12,13] such that they can be used across the spectrum of severity of hip and knee OA.

Prior work has suggested that the WOMAC PF subscale includes redundant items that provide little additional information[9–11]. This was supported in the current study as the correlations among the three measures of PF were high (range 0.85–0.90), irrespective of the hip or knee sample, suggesting that the measures are providing similar information. Most notably, the correlation of the HOOS-PS and KOOS-PS to PF and PF-exclusions differed by only 0.04 (hip) and 0.05 (knee).

Given the high correlation of the physical measures, the relationships of the HOOS-PS and KOOS-PS to the constructs of WOMAC pain, chronic pain, fatigue, anxiety and depression should be similar in magnitude to those reported in the literature for the 17-item WOMAC PF subscale. Similar to this study, the data for hip and knee OA in general support that the WOMAC PF subscale is moderately correlated with measures of pain, fatigue, and mood in community samples and in patients managed by non-surgical modalities[7,22,26,27]. However, it should be noted that these studies, while using measures of similar constructs, did not use the same measures. There is little specific data for total joint replacement, particularly at the evaluation times of the current study, but the data similarly report moderate correlations ranging from 0.4 to 0.6[28–30]. It should be noted that the correlation with the WOMAC Likert 3.0 pain subscale is higher (magnitudes of 0.73 and above) than the correlation with the CPG in this study. Terwee *et al.* similarly reported an association of 0.74 between the WOMAC pain and PF subscales in people with TKR[30]. This higher correlation is not surprising as the association of the WOMAC pain subscale and the PF subscale is likely confounded by asking about pain on specified activities[31].

The large SRMs for the HOOS-PS and KOOS-PS indicate the effectiveness of THR and TKR further suggest that these short measures maintain their psychometric properties. For the THR group, the SRM differed among the measures by 0.2 with the HOOS-PS having the smallest SRM of 1.5 compared to the PF and PF-exclusions; the KOOS-PS SRM differed by 0.3 with a magnitude of 1.4. These smaller SRMs for the HOOS-PS and KOOS-PS likely result from the more difficult items demonstrating less change in the joint replacement group. For example, people undergoing joint replacement may not 'run', an item in the HOOS-PS, such that this item in the questionnaire may not reflect change following surgery or change in only a portion of the group. However, emerging research suggests that people are looking to be able to participate in more than routine activities of daily living following joint replacement[32]. Additionally, there is controversy over what recreational activities are considered safe following hip or knee replacement[33]. Hence, the relevance of including these higher demand activities in outcome measures is yet to be determined.

While the studies in the literature similarly report large responsiveness statistics, comparison to this study is limited

by the variability in the time at which responsiveness is reported and by the variability in how responsiveness is calculated. Wright *et al.* have shown that different methods of calculating responsiveness result in different magnitudes and interpretation[33]. In this study, we reported responsiveness at 6 months post-surgery and used the SRM, thereby accounting for the paired nature of the data. The studies by Wright *et al.* and Lingard *et al.* in patients with primary THR and TKR, respectively, both reported a SRM of 1.4 at 1-year post-surgery[34,35]. It should be noted that the study by Wright *et al.* included those undergoing primary THR for other than OA. In research, the critical issue of the magnitude of the SRM is related to sample size requirements as the larger the effect, the fewer study participants who are required for a given level of power. However, given how large the SRM is for the HOOS-PS and KOOS-PS, respectively, as compared to the WOMAC PF subscale, the effect on sample size is negligible.

The major limitation of this study is that, since the short measures did not exist at the time of the inception of the cohort, the HOOS-PS and KOOS-PS were extracted from the full HOOS and KOOS as opposed to their completion in random order as measures separate from the full measure. Additionally, through a mailed survey it is not possible to prevent individuals from looking to prior answers given that the short measures contain the items with identical wording even had the short and longer versions of the questionnaires been used. Interviewer administration would be required.

In summary, this first study to our knowledge of the HOOS-PS and KOOS-PS in people with THR or TKR provides evidence of construct validity and responsiveness of the measures as compared to the longer WOMAC Likert 3.0 PF subscale. While further testing in additional samples is required, the evidence from this work suggests that these short measures are viable and maintain their psychometric quality for use in joint replacement, particularly when respondent burden and feasibility are of concern.

Conflict of interest

None of the authors has any conflict of interest or disclosures to report in relation to this work.

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