incidence of total knee arthroplasty (TKA) has increased in recent years, whereas the median age of patients undergoing the surgery has decreased. Pain is the primary reason for joint arthroplasty. However, for many patients, TKA also offers an opportunity to regain functional ability. Patients have differing levels of expectation regarding postoperative functional improvement and returning to exercise and sporting activity. In particular, functional level for performing advanced sporting and recreational activities over and above those required for activities of daily living (ADL) can be very important for some patients.

In recent years, patient views and satisfaction have become a major focus in the assessment of TKA outcomes. Self-report questionnaires, in particular, are instruments that reflect individuals’ perceptions of, and satisfaction with, their own health status. Moreover, it has been found that physical function is better characterized by patients themselves than by health professionals. Self-report questionnaires can show whether patient expectations are fulfilled after TKA or whether additional therapy input is indicated.

The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) is a self-administered questionnaire that has been recommended by the Outcome Measures in Rheumatology Clinical Trials group as the gold standard for TKA outcomes. Though widely used in clinical trials, this disease-specific instrument was developed for the elderly to assess osteoarthritis-induced pain, stiffness, and functional limitation. Subsequently, the Knee Injury and Osteoarthritis Outcome Score (KOOS) was developed.
developed to extend the WOMAC for use in a younger and more active patient group with knee injuries or knee osteoarthritis.26 The KOOS reflects the increasingly younger and more active demographic of people undergoing TKA. In addition to evaluating pain, symptoms, and quality of life, the KOOS claims to capture a broader range of patient-relevant functional ability using subscales that include leisure activities as well as ADL.

The KOOS is a 42-item self-report questionnaire that has 5 reported dimensions: pain (9 items), other symptoms (7 items), function in daily living (17 items), function in sport and recreation (5 items), and knee-related quality of life (4 items). The scoring system of the KOOS utilizes a 5-point Likert scale, with anchors of zero (no problems) to 4 (extreme problems). Scores are transformed to a 0-to-100 scale, with zero representing extreme knee problems and 100 representing no knee problems. This transformed score is calculated using the following formula: 100 − [(actual raw score × 100)/possible raw score range]. An aggregate score is not calculated from the KOOS. Instead, the authors of the KOOS26 recommend that each dimension be analyzed and interpreted separately. Seven items from the function in daily living and function in sport and recreation subscales of the KOOS are available as a short-form (KOOS-PS). The KOOS-PS was developed using Rasch-based measurement methods.23 A user’s guide, scoring file, and questionnaires in different languages can be downloaded from http://www.koos.nu.

Although the KOOS is reported to have clinically acceptable psychometric properties in patients with knee injuries,2,25,29 there is a paucity of research evaluating other aspects of clinical utility, such as feasibility, appropriateness, and interpretability.

Clearly, choosing the most appropriate outcome measurement to evaluate treatment efficacy is important. The aim of this study was to review and summarize the evidence regarding the psychometric properties of the KOOS in people undergoing TKA. This information will support researchers and clinicians in making an informed decision about using the KOOS in this patient population.

**METHODS**

A comprehensive review of the existing literature was undertaken using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for systematic reviews. **TABLE 1** provides an overview of the properties that were assessed in each of the articles.

### **TABLE 1** Evaluated Measurement Properties in the Articles Based on the Recommendations of the COSMIN Checklist

<table>
<thead>
<tr>
<th>Property</th>
<th>Davis et al21</th>
<th>de Groot et al8</th>
<th>Ornetti et al22</th>
<th>Xie et al27</th>
<th>Kessler et al22</th>
<th>Roos and Toksvig-Larsen23</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal consistency reliability</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Test-retest reliability</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Measurement error</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Content validity (including face validity)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Construct validity (hypothesis testing)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Construct validity (cross-cultural validity)</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Criterion validity (predictive validity)</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Responsiveness</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>


**Study Selection**

Following the search of databases, 1 of the authors (M.A.P.) selected the studies to be included in the review. Relevant titles and abstracts from the database searches were reviewed to see if they met the selection criteria. Where there was insufficient information to determine its eligibility, the full article was checked. The selected papers were then divided into 3 categories: useful, unsure, and reject. A final decision was made on inclusion or rejection of articles in the useful and unsure categories by 1 of the authors (M.A.P.). Reference sections of relevant articles were also manually searched.
for other potential studies. Papers written in both English and German were analyzed.

Studies were included in the review if they fulfilled the following criteria: (1) assessed psychometric properties of the KOOS or KOOS-PS; (2) included male and female participants/patients who were over the age of 18 years, diagnosed with severe osteoarthritis and on a waiting list for TKA, or who underwent primary knee joint replacement surgery or a revision of the primary TKA; (3) assessed patient-reported physical function by using the KOOS or KOOS-PS; and (4) assessed other aspects of clinical utility such as feasibility, appropriateness, or interpretability pertaining to the KOOS or KOOS-PS.

The term physical function is often applied differently. In recent years, the focus has shifted toward the development of condition-specific “core sets,” according to the International Classification of Functioning, Disability and Health. In making the linkage to osteoarthritis, it was found that limitations of activity and participation were most important for this clinical population group, followed by the component body functions. For the purpose of this review, the term physical function implies the “body function” and “activity and participation” components of the International Classification of Functioning, Disability and Health.

Studies were excluded if they (1) considered patients with TKA due to a pathological process other than osteoarthritis, such as inflammatory arthritis or tumor; (2) involved patients with meniscus injuries or fracture; (3) recruited patients who had undergone hemi-arthroplasty surgery; or (4) did not evaluate psychometric properties of the KOOS or KOOS-PS.

**Quality Assessment of the Included Studies**

Methodological quality in regard to reliability, validity, and responsiveness of the included articles was assessed by 1 author (M.A.P.), using the recommendations of the Consensus-based Standards for the Selection of Health Measurement Instruments (COSMIN) checklist. The items relating to each criterion were indicated by the term yes when the exact answer was given in the paper. Classification of the methodological quality of included studies is presented schematically, as there is no rating system for the COSMIN checklist. Statistical methods used to determine the psychometric properties were defined as key factors and accordingly deemed desirable to define the included paper as robust.

### TABLE 2

<table>
<thead>
<tr>
<th>Key Words Used in the Literature Search</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Combination</strong></td>
</tr>
<tr>
<td>1. knee AND (replacement OR arthroplasty OR prosthesis OR osteoarthritis)</td>
</tr>
<tr>
<td>2. “Knee injury and Osteoarthritis Outcome Score” OR “KOOS” OR “KOOS-PS” OR “Knee injury and Osteoarthritis Outcome Score-Physical Function Short-Form” AND (function* OR reliable* OR valid* OR responsive*)</td>
</tr>
</tbody>
</table>

### TABLE 3

<table>
<thead>
<tr>
<th>Descriptive Information of the Included Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Author</strong></td>
</tr>
<tr>
<td>Davis et al</td>
</tr>
<tr>
<td>de Groot et al</td>
</tr>
<tr>
<td>Ornetti et al</td>
</tr>
<tr>
<td>Xie et al</td>
</tr>
<tr>
<td>Kessler et al</td>
</tr>
<tr>
<td>Roos and Toksvig-Larsen</td>
</tr>
</tbody>
</table>

**Time Interval**

- 6 mo
- 3 wk
- 2 wk
- 6 d
- 3 mo
- 6 and 12 mo

**Abbreviations:** CPG, Chronic Pain Grade; EQ-5D, European Quality of Life-5 Dimensions; HADS, Hospital Anxiety and Depression Scale; HOOS, Hip disability and Osteoarthritis Outcome Score; KOOS, Knee injury and Osteoarthritis Outcome Score; OA, osteoarthritis; OAKHQOL, Osteoarthritis Knee and Hip Quality of Life questionnaire; POMS, Profile of Mood States; PS, Physical Function Shortform; SF-12, Medical Outcomes Study 12-Item Short-Form Health Survey; SF-36, Medical Outcomes Study 36-Item Short-Form Health Survey; TKA, total knee arthroplasty; VAS, visual analog scale.
Reliability
The term reliability contained the following 3 dimensions: internal consistency, test-retest reliability, and measurement error. For the purpose of this review, acceptable internal consistency of the KOOS or KOOS-PS was defined as a Cronbach alpha value of greater than .70. An intraclass correlation coefficient (ICC) value of 0.70 or greater was necessary to determine the test-retest reliability of the outcome instrument as clinically acceptable. To evaluate measurement tool reliability, it is important that measurement error is minimized. Measurement error was evaluated using the standard error of measurement, the smallest detectable change, or the limits of agreement.

Validity
Validity was evaluated by assessing content, construct, and criterion validity. Content validity assesses the degree to which a questionnaire adequately illustrates defined themes. Face validity is considered a special case of content validity, which is sometimes referred to as logical validity. For this kind of validity, no statistical estimation can be provided. Evaluation often uses expert and patient opinion regarding suitability of questions to defined themes or is performed indirectly using factor analysis. Criterion validity can be indicated by correlation coefficients that evaluate the agreement of scores of the new measurement with a gold standard instrument. For this review, a correlation coefficient of greater than 0.50 was defined as being strong, 0.35 to 0.50 as moderate, and less than 0.35 as weak.

Responsiveness
Responsiveness, or assessing outcome changes over time, is important when demonstrating the usefulness of an outcome instrument. Mokkink et al suggest that the receiver operating characteristic and the relationship between change scores and a gold standard measure of improvement can be an appropriate method of evaluating responsiveness. A receiver-operating-characteristic value between 0.70 and 0.90 is described as indicating a clinically useful instrument.

Data Extraction
One investigator (M.A.P.) extracted data from the selected studies using standardized forms. Close attention was given by the investigator to documenting information about the sample characteristics, measurement details, and the methodological quality of the studies. Results pertaining to reliability, validity, and responsiveness were presented schematically. If available, information regarding feasibility, appropriateness, and interpretability was recorded.

RESULTS

Literature Search and Study Selection
The search strategy yielded 240 references in CINAHL, MEDLINE, and SPORTDiscus, 41 in the Cochrane Library, 108 in PEDro, 256 in PubMed, and 185 in Scopus. This number was reduced to 14 by a process that discarded duplicate articles and those with titles and abstracts deemed irrelevant. After examination of the reference lists of these 14 papers for further relevant studies, no further additions were made. Application of the inclusion and exclusion criteria resulted in the inclusion of 6 relevant articles for this review. Common reasons for exclusion included the participants not meeting the defined selection criteria, the lack of assessment of psychometric properties, and the research being a Rasch analysis. TABLE 3 demonstrates descriptive information of the included studies.

Internal Consistency Reliability
KOOS-PS and KOOS A Cronbach alpha of .89 was reported for the KOOS-PS. Internal consistency of the Singaporean English and Chinese versions of the KOOS was lower (α = .70) than that observed for the KOOS-PS.

KOOS Subscales
Ornetti et al reported Cronbach alpha values that ranged from .76 to .93. De Groot et al obtained Cronbach alpha values greater than .71, except for the other symptoms subscale (α = .56) in participants with severe osteoarthritis. Similarly, Cronbach alpha values of .64 and .65 were observed in the Chinese version for the subscales of other symptoms and pain, respectively. Kessler et al reported values that ranged between .74 and .95 but did not disclose details of the statistical methods used.

Test-Retest Reliability
KOOS Subscales
Four papers evaluated the test-retest reliability of the KOOS by calculating ICC values. All of which demonstrated a value greater than 0.70 for all subscales, except for that of function in sport and recreation in the Dutch version (ICC = 0.45) and the English version (ICC = 0.65). In addition, the knee-related quality of life subscale of the Chinese version achieved an ICC value of 0.60. It is important to note that de Groot et al only evaluated the reliability using patients who had a revision of the TKA. In addition, only half of the patients completed the retest in 2 studies. Kessler et al used Spearman rank correlation coefficients and obtained test-retest reliability values for the KOOS that ranged from 0.69 to 0.78.

Measurement Error
Measurement error was obtained by evaluating the standard error of measurement, smallest detectable change, or Bland-Altman limits of agreement (within 2 standard deviations). Standard error of measurement values ranged between 7.2 and 24.6 for the TKA revision group. The smallest detectable change ranged from 13.4 to 21.1.

Content Validity
In the studies reviewed, 90% of the patients agreed that self-reported improvement in pain, symptoms, and ADL subscales were extremely important. Moreover, knee health was also ranked as a very important aspect of quality of life.
TABLE 4  Descriptive Information of the Validity Results

<table>
<thead>
<tr>
<th>Author</th>
<th>Cross-Cultural Validity</th>
<th>Construct Validity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Davis et al(^2)</td>
<td>Pearson correlation coefficient</td>
<td>• KOOS-PS and HOOS-PS measure similar construct</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• All measurements of physical function had high correlation with the WOMAC pain subscale (range, 0.70-0.80)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Moderate correlation of the physical function measures with fatigue of the POMS, the CPG, and the depression subscale (range, 0.33-0.66). Anxiety measure: HOOS-PS, (r_s = 0.19); KOOS-PS, (r_s = 0.38)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• High correlation of the KOOS-PS with the physical function (r_s = 0.90) and the physical function exclusion (r_s = 0.85)</td>
</tr>
<tr>
<td>de Groot et al(^8)</td>
<td>Spearman correlation coefficient ((r_s))</td>
<td>• Severe OA (r_s = 0.03) to 0.72</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• VAS for pain (r_s = -0.43) to -0.19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Primary TKA (r_s = 0.22) to 0.83</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• VAS for pain (r_s = -0.27) to 0.70</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Revision of the TKA (r_s = 0.00) to 0.54</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• VAS for pain (r_s = -0.47) to -0.21</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Predefined hypotheses (r_s = 0.60); TKA greater than 45% (severe OA, revision TKA) ((P&lt;0.05))</td>
</tr>
<tr>
<td>Ornetti et al(^22)</td>
<td>Spearman correlation coefficient ((r_s))</td>
<td>• Moderate correlations (r_s = 0.62)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• KOOS-ADL versus OAKHQOL physical activities, (r_s = 0.65)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• KOOS pain versus OAKHQOL pain, (r_s = 0.42)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• KOOS-ADL versus OAKHQOL pain, (r_s = 0.48)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• KOOS pain versus OAKHQOL physical activities, (r_s = 0.45)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Weak correlation of the KOOS sport and recreation subscale with all domains of the OAKHQOL ((P&lt;0.05))</td>
</tr>
</tbody>
</table>

Table continues on page 25.

(91%).\(^27\) Functional improvement in activities such as squatting, kneeling, jumping, turning/twisting, and running in the function in sport and recreation subscale was also extremely or very important for patients (51%).\(^27\) **Construct Validity and Criterion Validity**

All 6 studies defined the central characteristics of construct validity, such as convergent and divergent validity. Hypotheses involving correlation or mean differences were formulated a priori in 5 of the studies.\(^2,8,13,17,30\) No assessment of criterion validity was undertaken in any of the included studies.

Davis et al\(^7\) reported the construct validity of the KOOS-PS relative to the WOMAC physical function subscale and the WOMAC physical function subscale without the items included in both the KOOS-PS and the WOMAC. The overall KOOS-PS score was strongly correlated with the physical function score \((r_s = 0.90)\) and the physical function exclusion score \((r_s = 0.85)\) from the WOMAC. In contrast, only moderate correlations were found between the KOOS-PS and a measure of fatigue in the Profile of Mood States, the Chronic Pain Grade questionnaire, and the Hospital Anxiety and Depression Scale \((r\) values ranged from 0.33 to 0.66).

De Groot et al\(^8\) observed that the correlations between the subscales of the KOOS and the Medical Outcomes Study 36-Item Short-Form Health Survey \((SF-36)\) bodily pain and physical functioning subscales were the strongest. Roos and Toksvig-Larsen\(^27\) reported a strong correlation between the KOOS and SF-36 subscales \((KOOS pain subscale and SF-36 bodily pain subscale, \(r = 0.62\); KOOS ADL subscale and SF-36 physical functioning subscale, \(r = 0.48)\).

Xie et al\(^22\) reported strong-to-moderate correlation between the KOOS and the European Quality of Life-5 Dimensions questionnaire. However, the function in sport and recreation subscale correlated weakly with the SF-36 bodily pain subscale \((r\) ranged from -0.01 to 0.47).

Kessler et al\(^8\) obtained a strong correlation between KOOS subscales and the Medical Outcomes Study 12-Item Short-Form Health Survey \((SF-12)\) and visual analog scale for pain. Notable exceptions were the pain and other symptoms subscales in their correlation with the SF-12, and the correlation of the other symptoms subscale with the visual analog scale for pain.

Ornetti et al\(^22\) reported Spearman rank correlation coefficients that indicated strong or moderate correlations between the KOOS pain, other symptoms, and ADL subscales and the Osteoarthritis Knee and Hip Quality of Life \((OAKHQOL)\) physical activities and pain subscales \((r\) values ranged from 0.29 to 0.65). A strong correlation between the KOOS quality of life subscale and all OAKHQOL domains was observed \((r=0.53)\), except for the social support subscale \((OAKHQOL r = 0.08)\). Weak correlations \((r<0.30)\) were reported between the function in sport and recreation subscale of the KOOS and the subscales of the OAKHQOL. **TABLE 4** illustrates in detail the descriptive information of the validity results.

**Responsiveness**

Davis et al\(^7\) reported a standardized response mean \((SRM)\) that ranged from 1.4 to 1.7 for the KOOS-PS. Calculation of the SRM by Ornetti et al\(^22\) for the KOOS produced a value that ranged from 0.89 to 1.93 \((effect size [ES], 1.31-2.8)\).\(^22\) Moreover, Roos and Toksvig-Larsen\(^27\) determined an SRM of 1.60 \((ES, 2.86)\) for the knee-related quality of life subscale of...
the KOOS after 6 months, and an SRM of 1.99 (ES, 3.54) after 12 months. This study also reported an SRM for the pain subscale of 1.67 (ES, 2.28) after 6 months and 2.12 (ES, 2.55) after 12 months. For the function in sport and recreation subscale of the KOOS, the SRM was 0.81 (ES, 1.18) after 6 months and 0.88 (ES, 1.08) after 12 months. Kessler et al reported good responsiveness for all subscales, with the exception of the other symptoms and function in sport and recreation subscales, when the mean and standard deviation were compared prior to TKA and at 3 months post-TKA.

Feasibility
It has been reported that 10 minutes are required for patient completion and clinician analysis of the KOOS. Minimal (less than 5%) or no missing data and high prevalence of patient completion (99.5%) support the ease of use of the KOOS. The items pertaining to the function in sport and recreation subscale were not applicable for 74% of patients in 1 study and were thus treated as missing items. In addition, only 3.2% of the items of the pain, other symptoms, ADL, and knee-related quality of life subscales were missing. The KOOS questionnaire was observed to have a response rate of 92% after 6 months and 86% after 12 months. Similarly, in the Kessler et al research, after 3 months, 92.2% of the patients mailed back the completed questionnaire.

DISCUSSION
Overall, 5 studies assessed psychometric properties of the KOOS and 1 study evaluated the KOOS-PS. Four of the 6 papers adapted the KOOS into different languages. 

Reliability
All included studies reported a good level of internal consistency (Cronbach α > .70) for all individual subscales of the KOOS and for the overall score of the KOOS-PS. Observed results in patients following a TKA were similar to reported reliability calculations in the group with knee injuries and comparable to those observed for the physical functioning and pain subscales of the WOMAC. However, the other symptoms subscale of the KOOS did not achieve the recommended threshold, thereby indicating only moderate internal consistency. Interestingly, a lower value for the other symptoms subscale (Cronbach α = .25) was reported by Salavati et al, who also observed a Cronbach alpha of .64 for the knee-related quality of life subscale. A reason for the lower result of the other symptoms subscale might be that patients typically present with differing patterns of symptoms and, accordingly, this subscale may vary more than other subscales.

The results for test-retest reliability followed a trend similar to that of internal consistency, in that the ICC values were greater than 0.70 for all subscales, apart from the function in sport and recreation subscale in both the Singapore English version and the Dutch version (ICC = 0.65 and 0.45, respectively). The Dutch version showed poor test-retest reliability of the function in sport and recreation subscale, particularly in the revision TKA group. Xie et al observed that the Cronbach alpha and the ICC values of the Singapore English and Chinese versions of the KOOS should be interpreted with caution, because different modes of administration were used. The first assessment consisted of a face-to-face interview, and the retest was in the...
form of a telephone interview. This fact might have influenced the consistency of the results and, consequently, slightly reduced their reliability. However, research by Pollard et al concluded that questionnaire reliability is not affected by the mode of administration when interview or self-administration formats are used.

Validity

The papers reviewed reported that, in patients with knee osteoarthritis on the waiting list for surgery, improvements in pain, other symptoms, function in ADL, and knee-related quality of life were extremely or at least very important when deciding to undergo TKA. In addition, function in sport and recreation activities was reported to have the same significance. These findings concur with a survey conducted by Weiss et al.

For evaluation of validity, KOOS correlation coefficients reported with TKA participants were in agreement with studies involving patients with knee injuries. Strong or at least moderate correlations were obtained when comparing the KOOS subscales with the SF-12 and with the SF-36 physical health subscales for bodily pain and physical functioning. Interestingly, a low correlation was found when comparing the KOOS subscales with the SF-36 mental health measure.

In contrast, Ornetti et al observed a moderate-to-strong correlation of the OAKHQOL mental health subscale with all subscales of the KOOS, except for function in sport and recreation.

A strong correlation was reported between the KOOS-PS and the WOMAC pain subscale, which is consistent with the findings of Stratford and Kennedy. These researchers also identified a limitation of the WOMAC in detecting changes due to the overlapping of the subscales of pain and physical functioning. Terwee et al concluded that self-reported measures of physical function are more affected by pain than are performance-based instruments. The same authors also argued that self-reported physical function instruments are less valid when they have a high correlation with pain. This has important implications, as both subscales ask about pain with regard to specific activities. Therefore, it might be more appropriate to assess dimensions of pain in discrete subscales rather than in connection with specific activities.

Several studies reported weak correlations between the KOOS function in sport and recreation subscale and other outcome measurements. This may be due to a broader evaluation of physical function by the KOOS than that normally determined by condition-specific outcome instruments. Some items of the function in sport and recreation subscale may not be immediately relevant following TKA, with some patients reporting that certain activities were not part of their usual ADL. However, continued inclusion of more difficult items of physical function has been recommended, along with ongoing use of the KOOS at various stages after surgery.

Responsiveness

Due to the lack of a gold standard statistical method for evaluation of responsiveness, and the different possibilities that exist for its estimation, the most common method used in the included studies for reporting responsiveness was the SRM and the ES. The studies reviewed reported SRM values greater than 0.80 for the KOOS-PS and for each subscale of the KOOS, thereby indicating a high degree of responsiveness. These findings contrast those of research examining the WOMAC subscales, which reported values ranging between 0.63 and 1.99. In the studies included, all values for the ES reached 0.80; however, values for the function in sport and recreation subscale were the lowest (ES, 0.81 and 0.88, respectively). In contrast, McConnell et al reported a lower ES for the WOMAC pain subscale and a higher value for the physical functioning subscale of the WOMAC. Notably, a KOOS validation study on patients with focal cartilage lesions obtained higher responsiveness values for the function in sport and recreation subscale (ES, 0.98). Comparatively lower values observed for the KOOS function in sport and recreation subscale may be due to a data collection period that was too short to assess change during recovery. Beaton suggested that timing of data collection is decisive for the evaluation of changes and should be considered when interpreting the results and applying them to clinical settings.

Feasibility

The findings of this review indicate that the KOOS is a feasible outcome instrument in both the clinical and research settings. Although completion time for the 17-item WOMAC physical functioning subscale is comparatively quicker (mean ± SD, 6.17 ± 2.21 minutes), time burden for the more comprehensive KOOS is still relatively low (mean, 10 minutes). Furthermore, ease of administration and a high completion rate similar to that of the WOMAC indicate that the KOOS is an acceptable instrument for patients. None of the studies included examined interpretability of the KOOS or KOOS-PS.

Limitations

There are several limitations associated with this review. First, the number of included studies was relatively small. The COSMIN checklist employed for this review was a novel quality-assessment tool with relatively untested interrater reliability. In addition, this review included patients receiving TKA due to knee osteoarthritis. Hence, the extent to which these findings are generalizable to assessment of patients undergoing surgery due to another knee joint disease (eg, inflammatory arthritis, tumor, menisceal injuries or fractures) or after a hemi-artroplasty surgery is unclear. A further limitation is that, in 4 of the 6 included studies, the research team included the developer of the KOOS, which might have introduced experimenter bias and thereby influenced the significance of the results.
CONCLUSION

The findings of this review indicate that the KOOS and KOOS-PS exhibit clinically acceptable psychometric properties, with large ES to measure outcomes over time. However, the function of the sport and recreation subscale appears to be an exception, with weak-to-moderate reliability and weak construct validity. There is some evidence that the KOOS and KOOS-PS are feasible for research and clinical use. Further rigorous studies are needed, particularly to investigate the function in sport and recreation subscale of the KOOS. Research examining the influence of pain on physical function may improve validity and reliability of this subscale. Evaluation of the psychometric properties of the KOOS-PS in different languages is recommended to develop an outcome instrument that can measure sociocultural differences.

Regarding the ongoing process of establishing psychometric properties of an outcome instrument within a patient group, the finding of this review should be considered carefully. The aim was not to reach a conclusion pertaining to the measurement properties of the KOOS and KOOS-PS but rather to present data from published studies to support researchers and clinicians in making an informed decision about using the KOOS and KOOS-PS in patients undergoing TKA.

KEY POINTS

**FINDINGS:** The KOOS and KOOS-PS exhibit clinically acceptable psychometric properties, with large ES to measure outcomes over time. An area of weakness identified was the function in sport and recreation subscale of the KOOS.

**IMPLICATIONS:** The KOOS and KOOS-PS may be appropriate instruments for measuring self-reported physical function in patients undergoing TKA.

**CAUTION:** The results of only 6 relevant studies were included. Caution is advised when interpreting scores from the KOOS function in sport and recreation subscale.

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