

## Review Article

# Evaluation of Knee Injury and Osteoarthritis Outcome Scale (KOOS)

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**Abstract:** Osteoarthritis is a major cause of musculoskeletal disability. Non-pharmacological and non-surgical treatment is preferred for the management of knee osteoarthritis (OA). Osteoarthritis may result after an injury, either as a primary effect or direct damage to articular cartilage or secondarily, due to the greater stress to cartilage resulting from damage to load-attenuating knee tissues. Knee injury was more closely associated with unilateral knee osteoarthritis. Knee injury is believed to be a stronger predictor than obesity of unilateral osteoarthritis. Searching done by using databases such as CINAHL, MEDLINE, Google Scholar, COCHRANE, and other academic journals. The medical subject heading (MeSH) terms used were knee injury, osteoarthritis, knee injury and osteoarthritis outcome scale, KOOS, reliability, validity, responsiveness, and knee outcome scales. Literature and articles included in this independent study must be published from 2002 up to the present and in English.

**Keywords:** Osteoarthritis, knee injury, responsiveness.

## Prevalence of Knee Injury and Osteoarthritis

Knee injuries are the second most common joint involved in athletic injuries<sup>1,2</sup>. It constitutes 29% of the overall sport injuries in the United States from 2005 to 2007<sup>3</sup>. In 2008, Louw and colleagues conducted a large systematic review in adolescent sports in the UK and reported that the global prevalence of knee injury was 10% to 25%<sup>4</sup>. Both higher injury rates and better definition of knee injuries appeared to be somewhat responsible for the increase in incidence. Also in the same year, in the United States, a large epidemiological study on knee injuries in high school athletes revealed a rate of 3.89 knee injuries per 10,000 athletes<sup>5</sup>. The higher rates for knee injuries were reported in football at 6.91 per 10,000, girls soccer at 5.08, wrestling at 3.81, and girls basketball at 3.80<sup>1</sup>. Baseball and softball were associated with the lowest knee injury rates of 1.05 and 1.41 per 10,000 athletes. It is well known that the sporting conditions influence the injury rates. A large number of injuries were reported during competitions (34.6%) compared to the 21.3% sustained during practice, with ligamentous injuries constituting 81.8% of knee injuries<sup>1</sup>. Osteoarthritis is the most common form of arthritis and a leading cause of chronic disability, in large part due to knee and/or hip involvement<sup>6</sup>. It is the most common among the 150 rheumatic disorders as classified and characterised by the Arthritis Foundation and accounts for 60% of physician visits by patients with musculoskeletal complaints<sup>7</sup>. Osteoarthritis may result after an injury, either as a primary effect or direct damage to articular cartilage or secondarily, due to the greater stress to cartilage resulting from damage to load-attenuating knee tissues. Those individuals who have experienced a significant knee injury tend to develop osteoarthritis of this joint at an earlier age, the disease developing up to 20 years earlier than if no injury were sustained<sup>8</sup>.

In a study conducted among 1337 medical students of Johns Hopkins University School of Medicine, participants who reported a history of knee injury had a cumulative incidence of knee osteoarthritis of 13.9% by age 65 compared to the 6% cumulative incidence of those without any history of knee injury<sup>9</sup>. Cross sectional studies have also shown a link between knee injury and osteoarthritis<sup>10,11</sup>. Though linked with both bilateral and unilateral knee osteoarthritis, knee injury was more closely associated with unilateral knee osteoarthritis. Knee injury is believed to be a stronger predictor than obesity of unilateral osteoarthritis.

### **Effects of Osteoarthritis to Patients**

The World Health Organization estimates that osteoarthritis is the cause of disability in at least 10% of the population over the age of 60 years<sup>12</sup> and affects the lives of 20 million Americans<sup>13</sup>. People with osteoarthritis may experience a number of challenges in their lives as a result of their symptoms. Many of these difficulties affect an individual's capacity to contribute to society or enjoy a reasonable quality of life. Several studies have demonstrated that function, pain, and negative feelings were significant factors influencing the lives of patients with osteoarthritis. Patients claimed that their pain was upsetting and that the osteoarthritis is not only causing limitations, but had a big impact on their daily lives<sup>14</sup>. Patients would often feel discomfited that they could not do the things that other people could do<sup>15</sup>. Activities such as social activities, leisure, community work, employment, and heavy house work are the ones most often affected. Pre-task self-efficacy confidence and knee pain were found to affect opinion on physical ability, speed of movement, and post task difficulty ratings<sup>16</sup>. Some individuals even felt of osteoarthritis as negative stereotypes of being old and they were a burden to society<sup>17</sup>.

### **Knee Outcome Assessment Scale**

Recently there have been concerns with the lack of a standardised and acceptable outcome measures for osteoarthritis and orthopaedic surgeries related to osteoarthritis<sup>18</sup>. It has become progressively clear that clinical assessments of key aspects of outcome like physical function, pain, range of joint movement are often not reproducible and inaccurate<sup>19</sup>. Clinical assessments also reflect concerns of clinicians rather than the patients themselves.

Alternative methods have been accomplished which includes patient-based outcome measures of function, pain, quality of life, and satisfaction. These measures, usually questionnaires, are generally utilised as an adjunct for clinical assessments, rather than replacing them. These methods provide information that are standardised, valid, reliable, sensitive to change, and evaluate issues that are of immediate concern to patients<sup>20,21</sup>. An additional value of these measures is that they make large clinical trials more feasible than is the case when all outcomes are to be assessed by clinicians since following up large numbers of patients in a particular period of time is costly and problematic<sup>22</sup>. A number of patient-based general health and condition specific measures are available and utilised for application in the treatment of osteoarthritis like the Lequesne Index and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)<sup>23</sup>.

The Knee Injury and Osteoarthritis Score (KOOS) is one the assessment tools available today developed to evaluate a patient's view about their knee and related issues<sup>24</sup>. It is an addition of the WOMAC Osteoarthritis Index. Ewa Roos initially developed the tool in 1995 with colleagues from Sweden and the United States. It evaluates short term and long term indicators and function in patients with osteoarthritis and knee injury. It was validated with several different populations that underwent surgical procedures as a consequence to knee problems. Validation was done in different population with diverse diseases, age, duration of illness, and levels of activity. This validated and responsiveness questionnaire consists of the following parameters: pain, stiffness, swelling, activities of daily living, sports and recreational activities, and knee related quality of life<sup>25</sup>. Standardised answer options are given, a 5-point scale, and each question gets a score from 0 to 4. The optimal score is 100 points with no symptoms and the worst score is 0 points with severe symptoms. The KOOS is particularly appropriate for use in younger or more active patients whose activities are

affected by knee pain, but whose loss of function is not severe enough to be identified by the WOMAC<sup>26</sup>. The KOOS is self-administered and takes about ten minutes to complete. The KOOS is a complete tool that includes subscales investigating facets of knee injury and knee osteoarthritis that are viewed as significant by patients.

## **Objectives**

**General Objective:** To conduct an in-depth study about the knee injury and osteoarthritis outcome scale (KOOS).

## **Specific Objectives:**

- 1) To determine the reliability of KOOS based on available evidences on literature.
- 2) To determine the validity of KOOS based on available evidences on literature.
- 3) To determine the responsiveness of KOOS based on available evidences on literature.
- 4) To compare KOOS with other knee outcome scales.

## **Methodology**

An independent study was conducted in an attempt to fulfil the objectives of the study through evaluation, summary, and conclusion from a huge volume of data and information available in relation to the topic of knee injury, osteoarthritis, and the KOOS tool. An independent study was necessary to conduct an in-depth investigation on the knee injury and osteoarthritis outcome scale (KOOS) and scrutinise the validity, reliability, and responsiveness of the assessment tool.

## **Search Strategy**

An online search of scientific literature was conducted using databases such as CINAHL, MEDLINE, Google Scholar, COCHRANE, and other academic journals. The medical subject heading (MeSH) terms used were knee injury, osteoarthritis, knee injury and osteoarthritis outcome scale, KOOS, reliability, validity, responsiveness, and knee outcome scales. Titles of articles, abstracts, and information from books retrieved by the online search were reviewed to assess the relevance of data. If deemed potentially relevant, the full text of the article was retrieved.

Literature and articles included in this independent study must be published from 2002 up to the present and in English. For the review process, a full copy of the article or journal must be available online. These studies must evaluate the knee injury and osteoarthritis outcome scale (KOOS) and outcome measures must include reliability, validity, and responsiveness. Both qualitative and quantitative studies were included. Study population must include adult patients who were diagnosed with osteoarthritis, male or female. No gender preference was implemented since osteoarthritis is known to affect both sexes. Primary and secondary data were utilised in this study. Overall, the journals and articles for review must be within the parameters of the research title.

Studies published in languages other than English were excluded. Articles with abstract only were also excluded since they cannot provide the necessary information needed to assess the validity of the tool.

To be fair and objective, the quality of studies included was evaluated using Critical Appraisal Skills Programme (CASP) tool<sup>27</sup>. A critical appraisal is a structured process of analysing research to determine its strengths and weaknesses; therefore, it determines the value of a research. The CASP utilises 10 simple questions to systematically criticise a paper. These guidelines enable the reviewer to appraise the relevance, rigour, and credibility of the study.

## **Results**

### **Reliability**

Three studies have measured and reported the reliability of KOOS (Table 1). These three studies all utilised intraclass correlation coefficient (ICC) in reporting reliability. Rooks and Toksvig-Larsen<sup>28</sup>

reported an ICC between 0.78 and 0.97. De Groot<sup>29</sup> reported the ICC to be 0.70 and above for all subscales of KOOS. Goncalves<sup>30</sup> reported the ICC between 0.82 and 0.94.

**Table 1. Results of Reliability in Three Studies**

Study	Reliability (ICC)
Roos and Toksvig-Larsen <sup>28</sup>	0.78-0.97
De Groot et al. <sup>29</sup>	0.70 and above
Goncalves et al. <sup>30</sup>	0.82-0.94

### Validity

The same three studies have also reported validity of KOOS. Validity in all three studies was reported using Spearman's correlation coefficient and the rate of confirmed predefined hypothesis. In the study of Rooks and Toksvig-Larsen<sup>28</sup>, over 90% of the predefined hypotheses were confirmed. Over 60% of the predefined hypotheses were confirmed in the De Groot<sup>29</sup> study, whilst 87.5% were confirmed in the Goncalves<sup>30</sup> study. Table 2 shows the summary of validity results.

**Table 2. Results of Validity in Three Studies**

Study	Validity
Roos and Toksvig-Larsen <sup>28</sup>	>90%
De Groot et al. <sup>29</sup>	>60%
Goncalves et al. <sup>30</sup>	87.5%

### Responsiveness

Responsiveness was measured through effect sizes in two studies. Roos and Toksvig-Larsen<sup>28</sup> found effect size for pain from 2.28 at 6 months to 2.55 at 12 months after total knee replacement. Goncalves<sup>30</sup> reported effect size for pain from 1.08 to 1.28 at 4 weeks after physical therapy treatments. Table 3 shows the summary of responsiveness results in two studies.

**Table 3. Results of Responsiveness in Two Studies**

Study	Responsiveness (Effect sizes)
Roos and Toksvig-Larsen <sup>28</sup>	2.28 at 6 months-2.55 at 12 months
Goncalves et al. <sup>30</sup>	1.08-1.28 at 4 months

### Comparison of KOOS with Other Knee Outcome Scales

Only literature comparing KOOS with Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) were found and will be reported in this in-depth study.

According to Williams<sup>31</sup>, KOOS is a wider-ranging scale than WOMAC because it not only applies to patients with degenerative diseases but also has questions about sports participation. In KOOS, 5 separate scores are calculated for pain, symptoms, activities of daily living, sport and recreational function, and knee-related quality of life. WOMAC, on the other hand, involves 24 questions related to pain, stiffness, and difficulty with activities of daily living.

The study of Roos and Toksvig-Larsen<sup>28</sup> compared KOOS and WOMAC in terms of validity, and responsiveness. In this study, more than 90% of participants rated the KOOS subscale knee-related quality of life as extremely important and more than 50% rated sport and recreational function as extremely important. WOMAC does not assess these dimensions or aspects of the condition. Hence, the authors viewed KOOS as more valid than WOMAC. In terms of responsiveness, the two assessment scales were found to have equal responsiveness when assessed for pain at 6 and 12 months follow-up period.

## **Discussion**

Knee outcome scales are important to gauge whether the ACL reconstruction or total knee arthroplasty has been beneficial to the patient. Hence, reliability, validity, and responsiveness of the knee outcome scale must be established to ensure the relevance of the assessment scale. This in-depth study was conducted to evaluate the reliability, validity, and responsiveness of the Knee Injury and Osteoarthritis Outcome Scale (KOOS).

Reliability is defined as the consistency of a test or measurement tool<sup>32</sup>. Assessment of reliability can be done in various ways. Across all studies included in this in-depth study, reliability of KOOS was reported using intraclass correlation coefficient (ICC). All studies reported ICC of greater than 0.70, which can be interpreted as a good value. According to Streiner and Norman<sup>33</sup>, an ICC value of 0.70 and above can be considered a good value. This result demonstrates that the reliability and consistency of KOOS over time is good and stable. The same findings were observed in the study of Roos et al.<sup>34</sup> where reliability of foot and ankle outcome scale was also reported using ICC. In their study, foot and ankle outcome scale was reported to have an ICC that ranged from 0.70 to 0.93. This illustrates that KOOS provides consistent and reproducible results for patients with knee injury and osteoarthritis.

Validity is the extent to which an assessment tool measures the construct it is intended to measure. Since there is no available gold standard in measuring validity, the validity in most of the studies is reported through construct validity. Construct validity is the degree to which a specific measure associates with other measures consistent with theoretically derived hypotheses for the constructs that are being measured<sup>35</sup>. The KOOS questionnaire's construct validity in all studies included in this in-depth study was identified by comparing their results with SF-36 and VAS for pain. Classified construct validity as high if 75% of the predefined hypotheses were confirmed; moderate if between 50% and 75% of hypotheses can be confirmed; and low if less than 50% of predefined hypotheses were confirmed. In this in-depth study, 2 studies<sup>28,30</sup> reported high validity for KOOS, with 90% and 87.5% of predefined hypotheses confirmed, respectively. Moderate validity of KOOS was reported in the study<sup>29</sup>. This demonstrates that KOOS is a valid tool to assess the treatment outcomes of patients with knee injuries and osteoarthritis.

Responsiveness is defined as the sensitivity of an assessment or measuring tool to change over time<sup>23</sup>. Responsiveness can be measured using various methods; however, in the studies included in this in-depth study, responsiveness of KOOS was measured using effect size. Cohen defined effect sizes of  $>0.8$  to be significant and large<sup>36</sup>. A significant effect size means that fewer study participants are needed to establish a significant clinical difference. The results of responsiveness evaluation in this in-depth study demonstrates that KOOS has high responsiveness with effect sizes of 2.28 at 6 months and 2.55 at 12 months in the Roos and Toksvig-Larsen<sup>28</sup> study and 1.08 at baseline and 1.28 after 4 weeks of treatment in the study<sup>30</sup>. These results are evidence that KOOS subscales can detect changes over time.

Studies comparing KOOS with other knee outcome scale are not available in literature except for the study<sup>28</sup> which compared KOOS and WOMAC in terms of validity and responsiveness. This in-depth study identified some advantages of KOOS over WOMAC. First, the addition of sport and recreation function subscale to KOOS enhanced its validity. KOOS can evaluate functional improvements not detected by other knee outcome scales such as WOMAC. This implies that KOOS covers a wider range of patient population than WOMAC. KOOS can be utilised to evaluate athletes who underwent knee surgeries.

Another advantage over KOOS over WOMAC is the addition of quality of life subscale. In the study of Roos and Toksvig-Larsen<sup>28</sup>, the knee-related quality of life was rated by more than 90% of patients as extremely important. According to Marx<sup>37</sup>, it is vital for the outcome scales to include subscales that are very important to the patients being assessed. The only disadvantage of KOOS is

the number of items in the questionnaire. KOOS has 42 items against the 24 items of WOMAC. The increased number of questions to be answered can be a burden to the patient.

This in-depth study has several limitations. First, this study was conducted by a sole researcher; hence, the author cannot be blinded during the data gathering process and data analysis. The researcher's participation in the data collection and data analysis might have influenced the results thus can be interpreted as researcher bias. However, the researcher exerted all efforts to reduce bias by being objective and fair while choosing the studies to be included and during data analysis.

Another limitation of this in-depth study is that only the outcome measurements common across all studies included were reported in this study. Other methods of measuring reliability, validity, and responsiveness that are not common on all studies were not reported. For example, in the study of Roos and Toksvig-Larsen<sup>28</sup>, responsiveness was also assessed using the floor and ceiling effects, but since it was not conducted in other studies, it was not reported in this in-depth study.

Since the reliability, validity and responsiveness of this patient-based outcome evaluation are strictly specific to the target population, the psychometric characteristics gathered in the Portuguese and Dutch KOOS studies may be different in other populations affected with knee injuries. This limits the generalizability of the results of this in-depth study.

The small number of included studies might also limit the generalizability of results. This in-depth study included only 3 journals and 1 book as literature to be reviewed. Articles without full texts are excluded in the study despite its relevance to the topic at hand.

Lastly, this in-depth study was not funded by any institutions or organisations; hence, the budget was limited by the financial capability of the sole researcher. A wider range of literature could have been searched if with additional monetary resources. For example, full texts of some potentially relevant journals could have been obtained and available for review.

### **Conclusion and Recommendations**

Reliable, valid, standardised, and responsive knee outcome measurement tools are of significant value to patients with knee injury and osteoarthritis. These measures enable large clinical trials more feasible compared to cases when all outcomes are assessed by clinicians because following up with large numbers of patients in a specific period of time are costly and difficult.

The results of this in-depth study demonstrate that KOOS is a reliable, valid, and responsive tool for measuring treatment outcome in patients with knee injury and osteoarthritis. Compared to WOMAC, KOOS is more valid but equally responsive. The addition of sport and recreation function and knee-related quality of life subscales to KOOS enhanced its validity and applicability to a wider range of patient population.

For future research, this study recommends the inclusion of greater number of data sources. This will ensure the enhanced generalizability of results to the target population. It is also recommended to include in the results of future studies other methods of assessing reliability, validity, and responsiveness. Since there were no studies found that compare KOOS with other knee outcome scale aside from WOMAC, it is greatly recommended to conduct future investigation and comparison.

**Conflicts of interest:** There is no conflict of interest of any kind.

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