



Patient-Reported Outcome Measure of Knee Function: Knee Injury and Osteoarthritis Outcome Score (KOOS)

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A plethora of instruments have been developed to assess function in patients with knee problems. These measurements have focused on patient-reported measures from the patient's perspective rather than clinician-based measures because of superior validity [1]. Grounded in the psychometric properties such as reliability, validity, and responsiveness, recommended patient-reported measures include the International Knee Documentation Committee (IKDC) Subjective Knee Form, Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), Knee Injury and Osteoarthritis Outcome Score (KOOS), Lysholm Knee Scoring Scale, Cincinnati Knee Rating System, Activity Rating Scale, Knee Outcome Survey Activities of Daily Living Scale, and Oxford Knee Score [1,2]. The IKDC Subjective Knee Form, in particular, was instituted to standardize international documentation of the evaluation after knee surgery or treatment and has strengths in being responsive to change in surgical interventions [2,3]. The WOMAC, initially developed in 1982, was designed to evaluate the progression of disease or efficacy of treatments in patients with knee or hip osteoarthritis (OA). It comprises three domains: pain severity during various positions or movements, severity of joint stiffness, and difficulty performing daily functional activities, with 5, 2, and 17 items, respectively. The Likert version is rated on 5 levels, with scores ranging from 0 ("none") to 4 ("extreme"). Cumulative scores for each domain range from 0–20 for pain, 0–8 for stiffness, and 0–68 for physical function, with higher scores indicating a more severe condition. Self-administered or interview-administered questionnaire takes 5–10 minutes [4,5]. Its psychometric evidence is sufficiently reliable and valid for use in clinical and research setting [1,2,4]. A Korean version of the WOMAC has been authenticated for reliability, validity, and responsiveness [6]. Notably, items from the three WOMAC sub-types are incorporated into the KOOS.

The KOOS, developed based on the WOMAC, offers patient-reported outcome measures to evaluate both short and long-term outcomes. Suitable for assessing knee injuries and/or OA across various age groups, it also gauges the course of the disease and the effect of treatments, interventions, and surgeries [7]. The self-administered KOOS evaluates 5 domains: Pain (9 items); other Symptoms (7 items); Activities of Daily Living (ADL) (17 items); Sport and Recreation function (5 items); and knee-related Quality of Life (4 items) [8]. The KOOS, added to Domains from WOMAC, has been shown in previous studies to be more responsive and sen-

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Table 1. Domains in the WOMAC and KOOS and their respective scoring

	WOMAC	KOOS
Domains (items)	Pain (5) Joint stiffness (2) Daily functional activities (17)	Pain (9) Other Symptoms (7) Activities of Daily Living (17) Sport and Recreation (5) Knee-related Quality of Life (4)
Score range	5-Point Likert scale (0–4) Cumulative scores Pain (0–20) Stiffness (0–8) Physical function (0–68) The higher the score, the worse	Cumulative scores, then converted to 0%–100% The lower the score, the worse
Time (min)	5–10	8–10

WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; KOOS, Knee Injury and Osteoarthritis Outcome Score.

sitive than WOMAC in younger or more active elderly [9,10]. Subsequently, through Rasch analysis, the KOOS Physical Function Short Form (KOOS-PS) was derived from Sport and Recreation function and knee-related Quality of Life subscales of the KOOS, and could quickly evaluates the difficulty level of seven physical functions (rising from bed, putting on socks/stockings, rising from sitting, bending to the floor, twisting/pivoting on injured knee, kneeling, and squatting) over recent weeks due to knee pain. All items of KOOS and KOOS-PS are rated on 5-point Likert scale scored from 0–4. The raw score is the sum of 7 items, and is converted to a score of 0 to 100 using a conversion chart or program. The lower the score, the worse. The KOOS takes 8–10 minutes to complete, while the KOOS-PS takes about 2 minutes [2,8,11]. Although the Sport and Recreation function is more valid for younger patients and ADL subscale for elderly, KOOS has adequate internal consistency, test-retest reliability and construct validity for young and old patients with knee injuries and OA [2,8]. The Korean version of KOOS, as a patient-centric clinical measure for knee injury treatments, has also been verified for validity, reliability and responsiveness [12]. National record-based reference values for KOOS subscale were pain 85.3 (95% confidence interval [95% CI], 84.6–85.9), symptoms 85.1 (95% CI, 84.5–85.8), ADL 86.7 (95% CI, 86.0–87.3), Sport and Recreation function 70.9 (95% CI, 69.8–72.0), and QOL 74.9 (95% CI, 73.9–75.8) [13]. In previous study that confirmed changes in KOOS and WOMAC scores according to patients' age, sex, and BMI in 714 healthy populations, older subjects had a worse score on the ADL and Sport and Recreation function, especially "Sport and Recreation function subscale" [14]. The minimal detectable change for KOOS subscales ranges from 6–12 for knee injuries and from

13.4–21.1 for knee OA, 14.3–19.6 for younger individuals, and >20 for older individuals [2,8]. The minimal important changes in KOOS after rehabilitation after total knee arthroplasty in 148 patients were 16.7 for Pain (sensitivity, 83%; specificity, 82%), 10.7 for Symptoms (sensitivity, 80%; specificity, 80%), and 18.4 for ADL (sensitivity, 82%; specificity, 82%), 12.5 for Sport and Recreation function (sensitivity, 96%; specificity, 78%), and 15.6 for Quality of Life (sensitivity, 88%; specificity, 67%) [15].

In summary, the KOOS was developed based on WOMAC to measure not only knee OA but also various age groups and knee injury. Both KOOS and WOMAC possess robust psychometric evidence, making them suitable for clinical and research outcomes. While the KOOS is more time-consuming than the WOMAC, the burden on respondents is minimal. The KOOS, which integrates the three WOMAC sub-scales, offers comparability with prior WOMAC-based research and may be more advantageous for younger demographics, those with high physical activity levels, or interventions primarily focused on physical function (Table 1). However, missing data might arise in the high level of ADL and Sport and Recreation function subscales for older or less physically active individuals. When selecting an appropriate patient-reported outcome measure of knee function in clinical and research settings, factors like the patient's age, physical activity level, disease characteristics, and intervention types should be considered.

CONFLICTS OF INTEREST

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