The Knee injury and Osteoarthritis Outcome Score reflects the severity of knee osteoarthritis better than the revised Knee Society Score in a general Japanese population

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ABSTRACT

Purpose: The purposes of this study were to examine population-based reference data for sex- and age-related differences between the 2011 revised Knee Society Score (KSS2011) and the Knee injury and Osteoarthritis Outcome Score (KOOS), to assess the correlation between those scores and radiographic knee osteoarthritis (OA), and to validate the use of the scores in a general Japanese population.
Methods: This cross-sectional study included 963 volunteers (368 males, 595 females; mean age: 54.7 years). Participants were classified into five subgroups by age: under 40, 40s, 50s, 60s, and over 70 years old. The KSS2011 and KOOS were determined using self-administered questionnaires. Weight-bearing radiographs of the bilateral knee were taken and graded according to the Kellgren–Lawrence (KL) scale. The mean KSS2011 and KOOS were compared among age groups. Correlations between the severity of knee OA and each score were assessed using multiple regression analysis.
Results: The overall KSS2011 tended to gradually decrease with age. Most subscales of the KSS2011 did not show sex-related differences. Similarly, the overall KOOS and all its subscales steadily decreased by approximately 20 points per decade with age. Most subscales of the KOOS were significantly decreased in females over 50. The KL grade was significantly related to both the overall KOOS ($\beta = -0.42$, $p < 0.001$) and KSS2011 ($\beta = -0.13$, $p = 0.001$), though the correlation to the KOOS was stronger.
Conclusion: The overall KSS2011 and KOOS appear to decrease with age. In this population, the KOOS reflects the severity of knee OA better than the KSS2011.

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1. Introduction

Knee osteoarthritis (OA) is a common disorder that causes pain and disability to an increasing fraction of the population. Various risk factors associated with the incidence and progression of OA have been identified, including aging, high body mass index (BMI), female sex, previous knee injury, quadriceps muscle strength, and knee malalignment, among others [1–4]. Of these, obesity and quadriceps muscle strength are important for the prevention and suppression of the disease. To relieve knee pain and improve knee function, total knee arthroplasty (TKA) is one of the treatment options for cases of severe knee OA. Over the last two decades, the number of younger and more active patients undergoing TKA has increased [5]. Traditionally, the surgical outcomes after knee surgery have been evaluated objectively using radiographic imaging and the surgeon's assessment of the joint functions,

including the stability, lower limb alignment, and range of motion. To better characterize functional activity in line with the demands of younger patients, the traditional clinical scales have been adapted and new scales have been developed. Furthermore, patient-reported outcome scales also play an important role in the assessment of patients with knee problems after injury or in OA [6].

The Knee Society Knee Scoring System (KSS) was developed to evaluate the function of both knee prostheses and a patient's functional abilities after TKA [7]. This original score was based on only physician-derived variables, leaving an unresolved poor correlation between objective physician-assessed knee scores and patient-derived satisfaction scores. In 2011, the KSS was revised (KSS2011) to better characterize the expectations, satisfaction, and physical activities of a more diverse population of patients [8]. The KSS2011, a questionnaire that includes subjective and objective evaluations, has enabled the comprehensive assessment of patient knee function before and after surgery with high reliability [9,10].

The validation of the KSS2011 was performed in patients with knee OA before and after TKA [11]. The patient satisfaction, expectation, and

Table 1
Number, age, BMI, and radiographic knee OA of the study participants by age group.

	<40		40s		50s		60s		≥70	
	M	F	M	F	M	F	M	F	M	F
Participants number	92	113	55	86	62	130	96	166	63	100
Age (years)	32.1	33.1	45.0	45.0	54.4	55.5	64.0	64.2	75.2	75.0
	31.1 to 33.2	32.2 to 34.0	44.3 to 45.7	44.3 to 45.6	53.7 to 55.1	55.0 to 56.0	63.4 to 64.5	63.8 to 64.6	74.1 to 76.4	74.2 to 75.9
BMI (kg/m²)	23.2	21.0	24.0	22.2	23.5	22.1	23.3	23.1	23.4	22.7
	22.4 to 23.9	20.3 to 21.7	23.2 to 24.7	21.5 to 22.9	22.8 to 24.2	21.6 to 22.7	22.7 to 23.9	22.6 to 23.7	22.6 to 24.2	22.1 to 23.3
Number of participants with radiographic knee OA (%)	3 (3.3)	12 (10.6)	7 (12.7)	22 (25.6)	16 (25.8)	68 (52.3)	37 (38.5)	113 (68.1)	35 (55.6)	84 (84.0)

Values of age and BMI are given as the mean and 95% confidence interval.
BMI: body mass index.

functional activities subscales of the KSS2011 questionnaire were correlated with each subscale of the Short Form-12 (SF-12) score and the Knee injury and Osteoarthritis Outcomes Score (KOOS) [11]. The Japanese version of the KOOS has been validated [12] and is reported to be a useful tool for evaluating the knee condition after TKA [13]. The Japanese version of the KSS2011 has also been used to evaluate patient satisfaction and daily activities after TKA [14]. Based on a study of the general Japanese population, Taniguchi et al. reported that the KSS2011 decreased with age and was correlated with radiographic knee OA in people older than 60 years. However, changes in the KSS2011 by sex and age group in comparison with other objective rating systems and the correlation with severity of knee OA by age group have not yet been reported. The purposes of this large-scale cross-sectional study were to examine the changes in the KSS2011 by sex and age group compared with the KOOS and to assess the correlations between these scores and the severity of knee OA in a general Japanese population.

2. Materials and methods

2.1. Subjects

The subjects in this study were volunteers who participated in the Iwaki Health Promotion project. This annual project, running since 2005, is a community-based program with the goal of improving the average life expectancy by performing general health checkups on the general population living in the Iwaki area of Hirosaki city, which is located in western Aomori prefecture, Japan [15,16]. Informed consent was obtained from all individual participants included in the study, and the protocols used in this study were conducted with the approval of the ethics committee of Hirosaki University School of Medicine. A total of 1045 volunteers from among the 12,000 residents participated in the Iwaki Health Promotion project in 2013. Of these, 23 patients with prior knee surgery, 28 participants who did not receive

Fig. 1. Distribution of the Kellgren–Lawrence (KL) grades in the participants. Most of the participants who had knee OA were female with grade 2.

radiography, and 31 participants who did not complete the questionnaire were excluded from this study, leaving 963 participants who were assessed in the present study. The KSS2011 and KOOS questionnaires for knee condition and radiographs of the knee were taken for these participants.

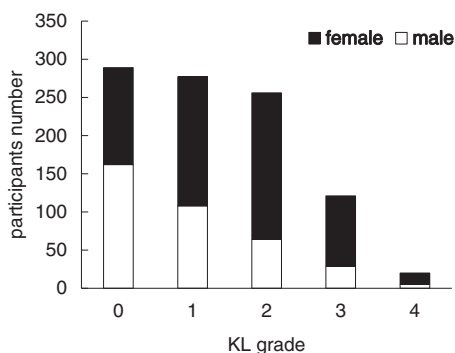### 2.2. Evaluation of knee osteoarthritis

Bilateral weight-bearing and anterior–posterior radiographs of the knees were taken. All of the knee radiographs were graded by two trained orthopedic surgeons blinded to the participant data. The severity of each knee was graded based on the Kellgren–Lawrence (KL) grade [17]. The presence of radiographic knee OA was defined as a KL grade of 2, 3, or 4. The participants were classified as either OA or non-OA using their worse knee score.

2.3. Revised Knee Society Score (KSS2011)

Each participant filled out the self-administered areas of the KSS2011 questionnaire, including "symptoms" (three items; 25 points), "patient satisfaction" (five items; 40 points), and "functional activities" (19 items: 100 points). The "symptoms" section consisted of two numerical rating scales completed by the participants and one question about the frequency of the abnormality. The "patient satisfaction" section consisted of the pain level while sitting or lying in bed and knee function while getting out of bed, performing light household duties, and performing leisure or recreational activities. The "expectation" sections of the questionnaire were excluded because the participants did not plan to undergo TKA. The "functional activities" consisted of "walking and standing", "standard activities" (standing from a seated position and going up and down stairs), "advanced activities" (squatting down deeper and going up a ladder or running), and "discretionary activities" (18 sports activities listed). The score for each subscale was calculated by summing the points for each item listed and was considered independent from the other domains. Higher scores indicate better outcomes in all of the subscales. The discretionary activities score was excluded from further analysis because the response rate for that section was low. The maximum possible score from these questions was 150 points.

2.4. Knee injury and Osteoarthritis Outcome Score (KOOS)

The KOOS is based on 42 knee-related items each scored from 0 to four. Five patient-relevant categories: pain (nine items), other disease-specific symptoms (symptoms; seven items), function in activities of daily living (ADL; 17 items), sport and recreation function (sports/recreation; five items), and knee-related quality of life (QOL; four items) were converted to a 100 point scale [18]. The KOOS items were scored from 0 to four and summed within each subscale. These scores were converted to percentage scores with higher scores