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The Japanese version of the anterior cruciate ligament-return to sport after injury (ACL-RSI) scale has acceptable validity and reliability

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Abstract

Purpose The anterior cruciate ligament-return to sports after injury (ACL-RSI) scale assesses the psychological impact of returning to sports (also referred to as psychological readiness) after ACL reconstruction. The aim of this study was to evaluate important measurement properties of the Japanese version of ACL-RSI scale.

Methods Ninety-three participants who underwent ACL reconstruction filled out the Japanese version of ACL-RSI scale, the Tampa scale for kinesiophobia (TSK), the International Knee Documentation Committee-Subjective Knee Form (IKDC-SKF), and Knee injury and Osteoarthritis Outcome Score (KOOS). To assess test re-test reliability, 50 of the 93 participants re-answered the Japanese version of ACL-RSI scale within 10 days. Floor and ceiling effects, internal consistency, construct validity, and reliability of the Japanese version of ACL-RSI scale were analysed.

Results There were no floor and ceiling effects. The Japanese version of ACL-RSI scale showed good internal consistency (Cronbach's alpha = 0.912). It was positively correlated with total points of IKDC-SKF and the Lysholm score, and with the all sub-categories of the KOOS, and it was negatively correlated with the TSK. Reliability of the Japanese version of ACL-RSI scale was satisfactory.

Conclusion The Japanese version of ACL-RSI scale has acceptable measurement properties. It can be a useful for evaluation of psychological readiness for return to sports in Japanese athletes who undergo primary ACL reconstruction. Information provided by the Japanese version of the ACL-RSI scale may also help to identify athletes who find return to sport a challenge, and guide conversations regarding treatment and rehabilitation plans.

Level of evidence II.

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Introduction

Reconstruction surgery is often recommended for athletes with an anterior cruciate ligament (ACL) tear [12]. In general, athletes are permitted to return to play at 6–12 months after the reconstruction [15, 19]. In one study, only 44% of competitive athletes returned to pre-injury level sports after ACL reconstruction (ACLR) [5]. Some of the reasons why athletes do not return to competitive sports after ACLR include fear of re-injury and pain [1, 35], lack of confidence in knee function [1], and other negative psychological factors such as concerns about not playing well and kinesiophobia [24]. By contrast, athletes who achieved a return to pre-injury level demonstrate high self-efficacy and low fear of re-injury [32]. A recent systematic review indicated

that positive psychological responses are associated with a higher rate of return to sports following sports injury [2].

The Tampa Scale for Kinesiophobia (TSK) is a questionnaire used to assess psychological aspects of movement related pain, fear and re-injury [20, 37]. The measurement properties of TSK are well established and the Japanese version has established validity [20, 21]. Although the TSK had been used in ACL injured athletes [13], it was originally developed for people with chronic pain such as low back pain and whiplash neck injury [20, 37].

Webster et al. [36] developed and validated the ACL-return to sport after injury (ACL-RSI) scale. ACL-RSI scale has 12 questions for emotions, confidence in performance and risk appraisal of athletes in relation to return to sports following ACL injury and/or surgery. The ACL-RSI scale has good construct validity with other patient-reported outcomes, such as TSK, International Knee Documentation Committee Subjective Knee Form (IKDC-SKF), and Knee injury and Osteoarthritis Outcome Score (KOOS) [6, 14, 23]. ACL-RSI scores have been shown to be positively associated with the proportion of athletes who return to the pre-injury level of sports [1]. A Japanese version of ACL-RSI scale has recently been developed [16]. However, the measurement properties of the Japanese version of ACL-RSI scale have not been fully established and therefore this was the aim of the current study. It is important that translations of the scale into other languages are validated to ensure cross cultural relevance. The important role psychological factors play in the recovery of ACL injury is well recognized; a validated Japanese version of the ACL-RSI scale could be used clinically to identify patients who may find return to sport a challenge and to initiate conversations regarding psychological recovery in the shared decision making of rehabilitation plans. It was hypothesized that a Japanese version of the ACL-RSI scale would have good construct validity with TSK, IKDC-SKF, and KOOS, and demonstrate substantial reliability as a patient-reported outcome for athletes who undergo ACL reconstruction.

Materials and methods

All participants underwent unilateral ACL reconstruction and were a minimum of 3 months (range 3–63) post-surgery at the time of participating in the study. The 3-month time point was chosen based on previous research [24, 31]. This is the timepoint that typically corresponds with a return to more strenuous activities after surgery. At 3 months, participants were allowed to run and perform double-leg jumping training. This study was approved by our institutional review board (M2016-252). Inclusion criteria were as follows: (1) over 15 years old; (2) over 5 points of Tegner activity scale at pre-injury; (3) intending to return to sports; (4) training

or exercising at least once a week prior to ACL injury; and (5) the ability to read and write in Japanese. Athletes who underwent bilateral ACL reconstruction, revision surgery, and multi-ligament reconstruction were excluded from this study. All participants provided informed consent before participating in this study.

The validated Japanese version of the TSK, IKDC-SKF, KOOS, and the Lysholm score were used as the reference scales. TSK was used to assess psychological aspect, such as fear of movement-related pain and re-injury. TSK comprises 17 questions using a four-point Likert scale. The total score of the TSK ranges from 17 to 68, where 68 indicates the highest level of fear [21]. The average and standard deviation of TSK for the athletes at 4 month after ACL reconstruction who did return to preinjury level of sport by 12 months after surgery is 35.6 ± 6.0 [4]. IKDC-SKF measures knee symptoms and function. IKDC-SKF score ranges from 0 to 100, with 100 signifying the absence of symptoms and highest levels of knee function [17]. The ACL reconstructed athletes who did return to preinjury level of sport demonstrated 87.6 ± 8.1 on IKDC-SKF at 12 months follow-up [4]. KOOS was used to evaluate symptoms, pain, function in daily life (ADL), function during sport and recreational activities (Sport/Rec), and knee-related quality of life (QoL). In the KOOS, the score for each subscale ranges from 0 to 100, with high scores signifying good knee function [29]. For example KOOS pain subscale and KOOS Sports/Rec subscale, the ACL reconstructed athletes demonstrate 86.4 ± 12.9 and 74.2 ± 21.4, respectively, at the 13.6 ± 11.0 months after surgery [14]. The Lysholm score is an eight-item questionnaire designed to assess patients following knee ligament injury, and ranges from 0 (worst symptoms) to 100 (best symptoms), with 25 points attributed to pain, 15 to locking, 10 to swelling, 25 to instability, 10 to stair climbing and 5 points each to limping, use of a support and squatting [33]. The ACL reconstructed athletes 94.5 ± 8.0 on Lysholm score at the 13.6 ± 11.0 months after surgery [14].

Demographic and clinical characteristics of the study participants were summarized descriptively. Additionally, the descriptive analyses were presented in the form of means, standard deviations, and percentages. Internal consistency of the Japanese version of the ACL-RSI scale was assessed using Cronbach's alpha test, which indicates homogeneity between items within questionnaire. A Cronbach's alpha value ranging from 0.70 to 0.95 was considered to be adequate [34]. We analysed score distribution and the presence of floor and ceiling effects. The Shapiro–Wilk normality test was used to confirm the normality of distribution. The presence of floor and ceiling effects were judged from means and standard deviations, and were defined as 15% of the participants achieving the minimum (0) or maximum (100) of the total score, respectively [26, 34].

Construct validity was determined by comparing the Japanese version of ACL-RSI scale and the TSK, IKDC-SKF, KOOS, and the Lysholm score by the Spearman's Rank Correlations; the correlation was considered to be "strong" ($\rho = 0.5$), "medium" ($0.5 < \rho < 0.3$) or "weak" ($0.3 < \rho < 0.1$) [8].

To determine the test–retest reliability of Japanese version of the ACL-RSI scale, the intraclass correlation coefficient (ICC) with corresponding 95% confidence intervals (CI) between the first and second administration was used. About 5 days after first administration, each participant who was invited to re-test study was sent an email with an electronic link to the scales. They answered the Japanese version of the ACL-RSI scale again. The ICC is considered to be satisfactory at 0.70 and above ($r = 0.81$–1.0, excellent; 0.61–0.80, very good; 0.41–0.60, good; 0.21–0.40, fair; and 0.00–0.20, poor). To estimate the agreement of the two assessments, Bland–Altman plots were created, including the mean difference and the limits of agreement (mean difference $\pm 1.96 \times$ SD of the difference). The mean difference with 95% CI between the first and second administration was calculated.

A power analysis was performed using previously published data [31] to determine the required sample size to detect correlations between ACL-RSI scale and patient-reported outcome for knee disorders. Based on these data, a sample size of 93 participants was required to achieve a power of 0.80, with alpha level of 0.05. The sample size calculation was performed with G*power statistical software. A subset of 50 participants were invited to assess the test–retest reliability of the Japanese version of ACL-RSI scale at 5–10 days after their first administration. The intervals between administrations and sample size were determined with reference to previous studies [6, 23, 34]. Data were analysed using IBM SPSS Statistics 23.0 software.

Results

Participants

Ninety-three participants who underwent unilateral ACL reconstruction completed all questionnaires (Fig. 1). Participants were 26 years (SD 10.2; range 16–54) of average age and 8 months (SD 6.9) after surgery, with the highest number of soccer players (Table 1).

Description of the results

The average score of the Japanese version of ACL-RSI scale was 61.7 ± 18.2 (range 20.8–99.2) and was normally distributed (Fig. 2). Floor and ceiling effects for each question were not observed. Nobody achieved the minimum (0) or maximum (100) of score of the Japanese ACL-RSI scale, and 5.7% of participants scored ≥ 90 points.

Internal consistency

Internal consistency of the Japanese version of ACL-RSI scale based upon strength of the correlations among the 12 items was "excellent" with a Cronbach's alpha statistics of 0.912.

Construct validity

The Japanese version of ACL-RSI scale was correlated positively with total points of IKDC-SKF and the Lysholm score, and with the all KOOS sub-categories, and correlated negatively with the TSK (Table 2).

Reliability

The mean scores at first and second administrations were 60.1 ± 19.2 and 61.8 ± 20.0, respectively. The ICC was 0.916 (95% CI 0.857–0.951) indicating excellent reliability. The mean difference was -1.6 ± 7.9 (95% CI -3.9 to 0.6) with the 95% CI containing zero indicating no fixed bias in the Bland–Altman plots (Fig. 3). There was no correlation between difference and average of the two measurement, indicating no proportional bias.

Discussion

The most important finding of this study was that the Japanese version of ACL-RSI scales was an internally consistent, valid, and reliable questionnaire for athletes who had undergone primary/unilateral ACLR.

Internal consistency

The internal consistency of the Japanese version of ACL-RSI scale based on the strength of the correlation among the 12 items was "excellent" and was similar to the values of the other language version of ACL-RSI scales [6, 14, 23, 31]. These findings suggest that the Japanese version of ACL-RSI scale has good internal consistency compared to other language versions.

Construct validity

The construct validity of the Japanese ACL-RSI scale was tested through of the correlations with four reference scales. The ACL-RSI scale is the first scale to specifically assess the psychological impact of returning to sports after
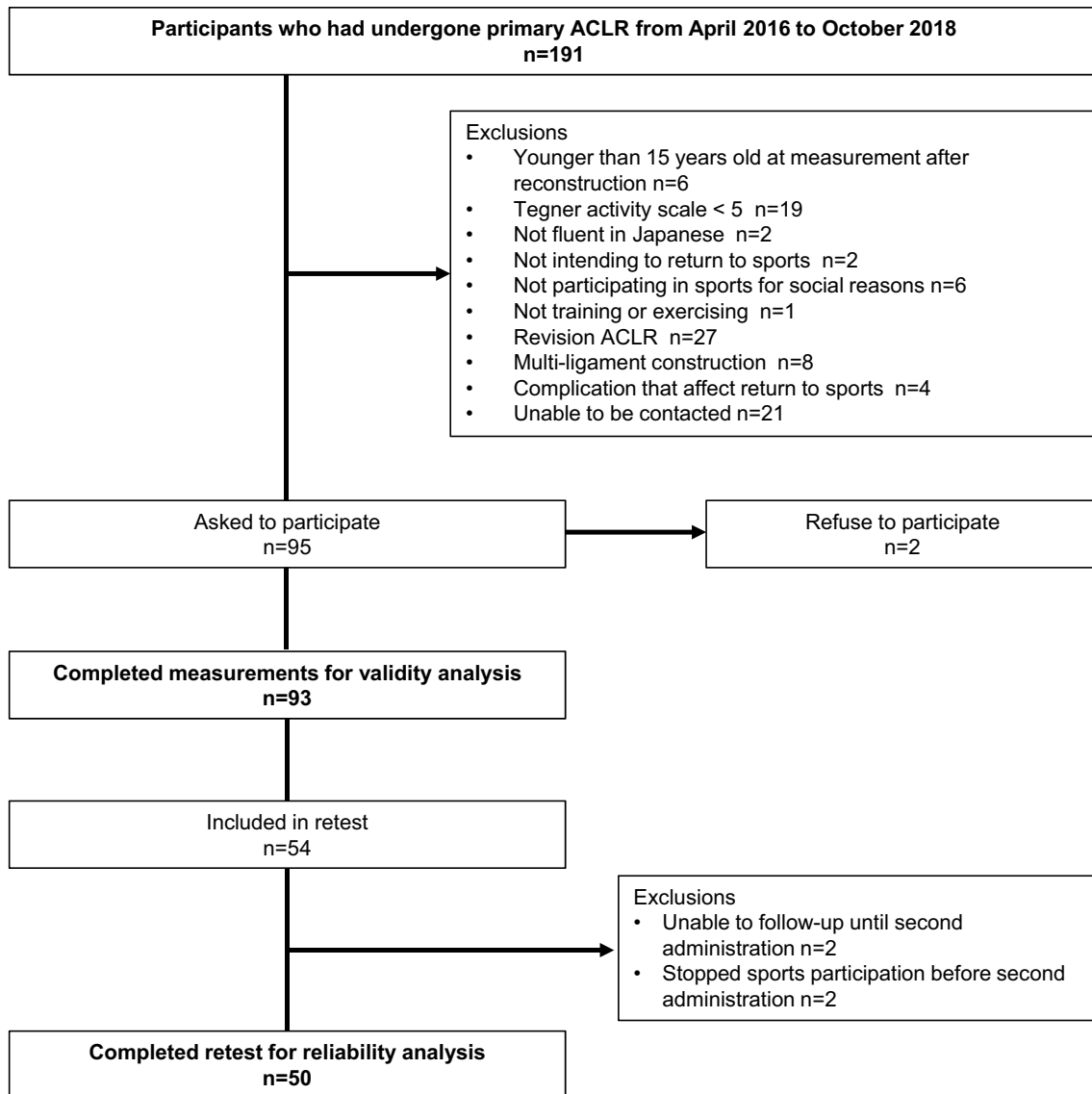
Fig. 1 Flow diagram illustrating participants enrolment

ACL injury [6, 36] and as such we used scales that should have moderate level of similarity with the ACL-RSI scale.

Kinesiophobia and fear of re-injury has been shown to hinder the return to sports [3, 10, 25, 32]. TSK is used to assess the kinesiophobia for several diseases (e.g.: chronic musculoskeletal pain disorder [27], low back pain [11, 20]). In a previous study, it was reported that individuals who could not return to sport had higher TSK scores following ACLR [22]. In our study, there was a significant negative correlation between the Japanese version of ACL-RSI scale and TSK. It suggests that increased psychological readiness to return to sport was associate with reduced kinesiophobia. The strength of relationship was comparable with that in the previous studies [7, 14, 23, 31].

There were positive correlations between ACL-RSI scale and the other three knee-related outcomes. A medium correlation was found between the Japanese version of ACL-RSI scale and the IKDC-SKF ($r = 0.40$) which was similar to the results of other language versions [6, 7, 14, 30, 31].

The weak to medium correlations were found between the Japanese ACL-RSI scale and the subscales of KOOS ($r = 0.27$–0.39). The Sport/Rec subscale in KOOS was most related to ACL-RSI scale. In previous studies, the Swedish and French versions of the ACL-RSI scale were most strongly correlated with the KOOS QoL subscale than other subscales [6, 23], although the correlation in the Dutch version was similar to that in our own study [31]. According to the systematic review about measurement properties of

Table 1 Demographic information of 93 participants who underwent ACL reconstruction

Age (years)	25.8 ± 10.2 (16–54)
Time from surgery to evaluation (months)	8.2 ± 6.9 (3–63)
Gender	
Female, *n* (%)	51 (54.8)
Athletics event	
Soccer, *n* (%)	27 (29.0)
Judo, *n* (%)	13 (14.0)
Basketball, *n* (%)	12 (12.9)
Volleyball, *n* (%)	10 (10.8)
Ski, *n* (%)	5 (5.4)
Lacrosse, *n* (%)	3 (3.2)
Handball, *n* (%)	3 (3.2)
Classic ballet, *n* (%)	3 (3.2)
Field and track, *n* (%)	3 (3.2)
Baseball, *n* (%)	3 (3.2)
Soft tennis, *n* (%)	2 (2.2)
Gymnastics, *n* (%)	2 (2.2)
Rugby, *n* (%)	2 (2.2)
Badminton, *n* (%)	2 (2.2)
Others, *n* (%) (Futsal, Karate, Cheer dance)	3 (3.2)
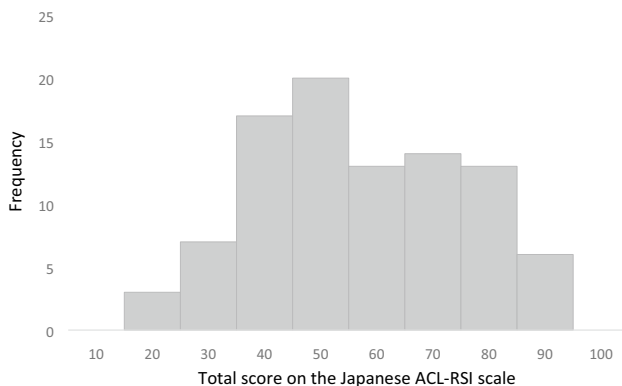
Fig. 2 Histogram of the score of ACL-RSI scale

KOOS for patients with ACL injury, QoL and Sport/Rec have the highest content validity, demonstrate the greatest room for improvement, and show largest effect sizes following surgical ACLR [9]. These correlations between the ACL-RSI scale and the subscales of KOOS in our study are comparable to the results of other language versions.

A weak correlation was found between the Japanese version of ACL-RSI scale and the Lysholm score ($r = 0.21$). Jia et al. [18] reported the strongest correlation ($r = 0.564$) between the Chinese version of ACL-RSI scale and the Lysholm score. The gap between the Japanese and Chinese

versions may be due to the differences of time after ACLR in participants. The average of the Lysholm score (87.8 ± 9.4) in the Chinese study [18] was lower than that in our study (96.3 ± 5.1). In our study, participants who underwent unilateral ACLR at least 3 months before participating were recruited. By contrast, in the Chinese version study [18], 23% of the participants were less than 3 months out of surgery. The Lysholm score was developed to determine the functional status of the patient after ACLR [33]. The Lysholm score is known to increase with the time from surgery to evaluation for post-ACLR surgery athletes and a ceiling effect is observed after 6 months [28]. A ceiling effect was observed with the Lysholm score in this study as well, where the mean time from surgery to evaluation was 8.2 months. The results of a Chinese study [18] indicated that a ceiling effect was not observed by including patients with a short time from surgery to evaluation; thus, a strong correlation was found between the ACL-RSI scale and the Lysholm score.

Reliability

The Japanese ACL-RSI scale showed almost perfect reliability between repeated measure (ICC = 0.916 95% CI; 0.857–0.951). Similar findings were reported by Bohu [6], Harput [14], and Slagers [31]. There was no systematic error in the Bland–Altman plots. Therefore, we judged that the reliability of the Japanese ACL-RSI scale was satisfactory.

There are some potential limitations to the current investigation to consider when applying these results in a clinical setting. First, although most participants were participating in jump-cutting sports, we could only collect a small amount of data from athletes participating in collision sport, such as football and rugby. Second, we only collected data at one point in time for the validity analysis and did not collect data on the percentage of patients who had returned to their preinjury level of sports. Finally, the research was a single-center study and may not represent the entirety of Japanese speaking people.

Conclusion

The Japanese version of ACL-RSI scale has satisfactory measurement properties. It has been shown to be valid, reliable and comparable to the English version. It can be a useful for evaluation of psychological readiness for return to sports in Japanese athletes who undergo primary ACL reconstruction.

Fig. 3 Bland–Altman plot for data from test–retest study, with the presentation of the limits of agreement (dashed line), from −1.96 SD to +1.96 SD
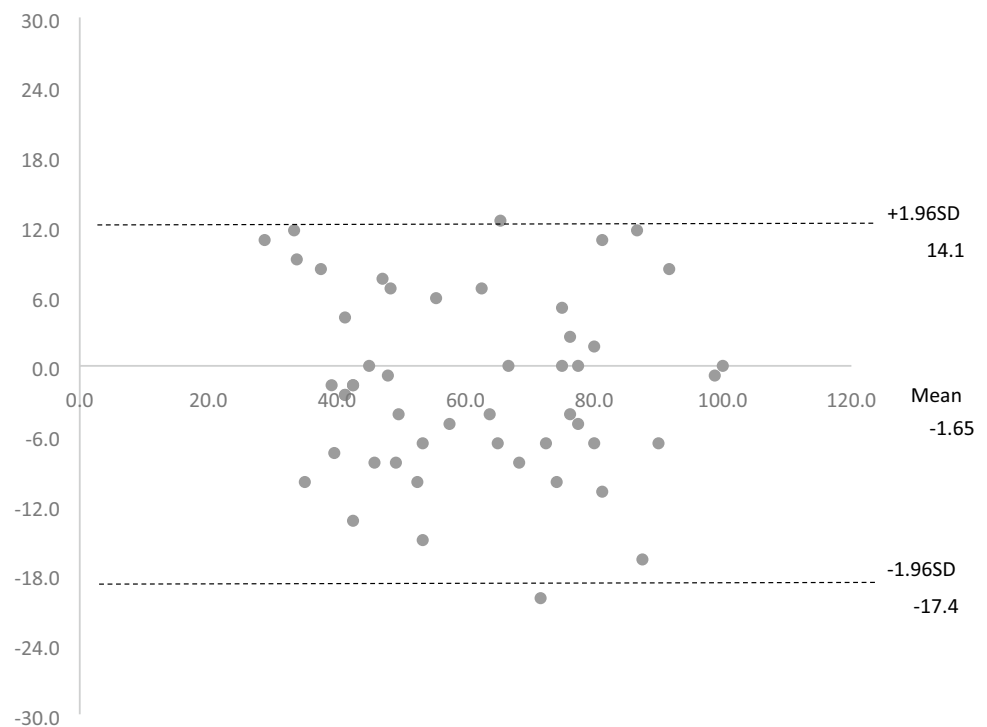

Table 2 Correlations between the Japanese ACL-RSI scale and IKDC-SKF, Lysholm score, KOOS, and TSK

	Median (IQR)	ρ value
IKDC-SKF	82.7 (19.8)	0.41
Lysholm score	100.0 (5.0)	0.21
KOOS symptom/stiffness	89.3 (14.3)	0.31
KOOS pain	94.4 (11.8)	0.29
KOOS ADL	100.0 (2.94)	0.37
KOOS Sport/Rec	85.0 (20.0)	0.35
KOOS QoL	75.0 (25.0)	0.26
TSK	36.0 (9.0)	−0.34

ACL-RSI anterior cruciate ligament-return to sport after injury, *IQR* interquartile range, *IKDC-SKF* international knee documentary committee subjective knee form, *KOOS* knee injury and osteoarthritis outcome score, *ADL* activity of daily living, *Sport/Rec* Sport and Recreation function, *QoL* quality of life, *TSK* Tampa scale for Kinesiophobia

Compliance with ethical standards

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