



Correlation of the squat-and-smile test against other patient-reported outcome scores in knee pathology

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Abstract

Background

The use of patient-reported outcome measures (PROMs) for knee pathology may be affected by socioeconomic factors, language barriers and time constraints in busy outpatient clinics. The squat-and-smile test (SST) is an example of such a test that has previously been validated for femur fractures. The aim of this study was to validate the SST against other PROMs in patients with knee pathology.

Methods

Patients presenting to a subspecialist knee clinic in a large hospital in sub-Saharan Africa were approached to participate. They were asked to squat and the depth of the squat as well as the need to support themselves were classified into four categories. To describe their pain, participants also selected one of three smiley faces (unhappy, neutral, smiling). These test scores were correlated to the patient's Knee injury and Osteoarthritis Outcome Score (KOOS), Tegner Lysholm score and EQ-5D scores.

Results

Seventy patients (median age 53.4 years) were included. The squat depth correlated moderately with the KOOS score ($r=0.56$) and poorly with the EQ-5D and Lysholm scores ($r=0.46$; $r=0.43$). The need for squat support had poor correlations with the KOOS, EQ-5D and Lysholm scores ($r=0.29$; $r=0.31$; $r=0.31$), as did the smiley face component ($r=0.40$; $r=0.32$; $r=0.30$).

Conclusion

For patients with knee pathology, the squat depth correlates moderately with other PROMs. It could therefore be used in settings for which conventional PROMs have limited application. Support needed to squat, and a visual analogue scale of smiley faces, had poor correlation when compared to other knee PROMs and should not be used for the assessment of knee pathology.

Level of evidence: Level 4

Keywords: squat and smile, KOOS, PROM, smiley faces, outcome score

Introduction

Patient-reported outcome measures (PROMs) are crucial to determine functional deficits and monitor clinical improvement as well as scientific outcomes.¹ However, PROMs can be time-consuming and, especially in developing countries, language barriers as well as the use of translators may lead to an incorrectly reported outcome.²

For knee pathology in particular, a multitude of measures are available to reliably test functional status and monitor improvement after treatment, but no specific PROMs have been developed for a resource-limited setting.³⁻⁵ PROMs assess, among other criteria, the patient's ability to perform activities of daily living (ADLs). The need to squat to complete ADLs differs across cultural and socioeconomic groups. A lower socioeconomic background has

been linked to an increase in squatting requirements, and likewise the presence of fewer chairs and tables in a household.⁶ In countries like Malawi, Nigeria, Zambia, India and Pakistan, squatting has been shown to be associated with praying, food preparation, eating and using pit latrines.⁶⁻¹⁰ Therefore, in these cultures squatting is a critical function.

The squat-and-smile test (SST) was developed to assess union in femur shaft fractures in low-resource settings¹⁰ and could potentially be useful to assess knee pathology. The original SST consisted of asking a patient to squat, and then assessing and grading three components: the depth of the squat, the need for hand support to steady oneself during the squat, and the facial expression during the squat (unhappy, neutral or happy). Our primary aim of the study was therefore to validate the SST against other commonly used knee PROMs.

Methods

Recruitment and demographics

Participants presenting to a knee unit of a large public university hospital in sub-Saharan Africa were recruited via a cluster random sampling process. Patients above the age of 18 years and patients with knee pain were included. Patients who were unable to walk and had visual impairment were excluded from the study. Demographic information was recorded, as well as the level of education, which was graded as either high (completed tertiary education), intermediate (completed secondary schooling such as high school) or low education (did not complete secondary schooling) or none (did not complete basic schooling). After consultation with an orthopaedic surgeon, the diagnosis was recorded based on history, clinical examination and radiological investigation. Institutional approval and written consent were obtained.

Squat-and-smile test

The SST consisted of testing three separate components based on the patient performing a squat in the clinic: the depth of the squat itself, the need to support oneself during the squat, and the patient afterwards selecting an emoticon or 'smiley face' that best conveyed how they experience squatting. The depth of the squat was divided into four different levels (*Table 1*) based on the height of the patient's hips. The squat was performed between two chairs, and the amount of support needed was also subclassified into four levels. For the smile component, patients were then asked to select one of three emoticons (*Figure 1*) which best described their pain during squatting. This test is, therefore, a modification of the original SST which was described previously,^{10,11} highlighting the influence of squatting activities of daily living.^{7,8} The same domains were used in this study; however, the ability to smile while squatting was replaced using the visual analog score of smiley faces.¹⁰

Scores

Apart from the SST, the Knee injury and Osteoarthritis Outcome Score (KOOS), Lysholm score, and the EQ-5D score were recorded.

Knee injury and Osteoarthritis Outcome Score (KOOS) physical short form (PS)

The KOOS assesses daily living and function, sports and recreational activity as a seven-item questionnaire. The measure is scored by converting this raw sum of the items to a Rasch-based interval score provided in the KOOS-PS user guide to range from no difficulty (0) to extreme difficulty (100). It assesses the functional status of patients with knee arthritis or ligament injuries, and responses are coded from 0 to 4, none to extreme.⁵ The questionnaire is scored by summing the raw response (range 0–28) and then converted using a nomogram to a true interval score. Each question must have a response (i.e., no missing data). The smallest detectable difference is 18.6.¹² The KOOS score has been validated for multiple languages, for traumatic knee injuries and for osteoarthritis.¹³

Tegner Lysholm score

The Tegner Lysholm score⁴ is one of the most commonly used knee scores in studies for multiligament knee injuries and proposed by experts as a patient-specific outcome metric for knee dislocations.¹⁴ It has various questions on knee function regarding limping, pain, locking, stair-climbing, support, instability, swelling and squatting, which can be rated. An overall score is given and less than 65 is poor, 65–83 is fair, 84–90 is good, and more than 90 points represents excellent knee function. In the normal population the average Lysholm score is 94 (range 43–100), and the average

Table 1: The three components of the squat-and-smile test

Squat depth component	Points
Unable to squat at all	0
Squats with hips above knees	1
Squats with hips to level of knees	2
Squats with hips below level of knees	3
Support component	Points
Unable to squat	0
Requires support with both hands	1
Requires support with one hand	2
Does not require support while squatting	3
Smile component	Points
Selected 'unhappy' face	0
Selected 'neutral' face	1
Selected 'happy' face	2

Tegner activity level is 5.7 (range 1–10). The minimum detectable change for Lysholm is 8.9 and for Tegner is 1. Both the Lysholm (intraclass correlation coefficient = 0.9) and Tegner (intraclass correlation coefficient = 0.8) scores have an acceptable test-retest reliability.¹⁵

EQ-5D

The EQ-5D was designed by EuroQol, a network of researchers of measurements of health status.¹⁶ This short questionnaire measures the generic health status and is applicable for clinical as well as economic evaluation of the delivery of healthcare.¹⁷ It can be self-completed and accurately evaluates change after an orthopaedic intervention.¹⁸ Although it is not a knee-specific outcome score, it has comparable practicality and construct validity to other knee scores and is appropriate to assess interventions which are designed to alleviate knee pain.¹⁹ The minimal clinically important difference for this score is 0.074.²⁰ The score can be compared to mean population ratings.

Statistical analysis and sample size

A sample size calculation prior to the study showed that 19 participants would achieve 80% power to detect a mean of paired differences of 4.5, with a known standard deviation (SD) of differences of 7.0 and with a significance level (alpha) of 0.05 using a two-sided paired Z-test. We recruited a higher number of participants to enable a potential subgroup analysis.

Internal consistency for the KOOS-PS, EQ-5D, and Lysholm score was calculated using Cronbach's alpha. The SST responses were correlated with the other standardised scores and Spearman rank correlation coefficient (r_s) was calculated. This result was interpreted as follows: poor correlation (less than 0.3), fair or moderate correlation (0.3–0.5), moderately strong correlation (0.6–0.8) and a very strong correlation (0.8 and above).²¹ The

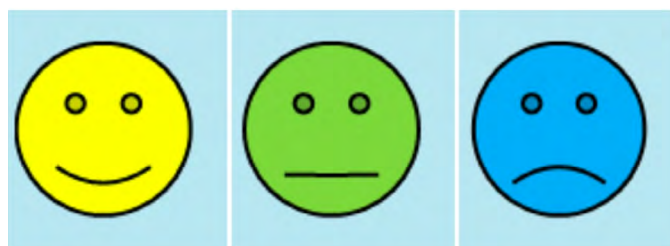


Figure 1. Smiley face (yellow), neutral face (green) and unhappy face (blue) as emoticons patient could select to rate their pain during squatting

Table II: Patient demographics

Age (yr, SD)	54.4 (17.3)
Sex (n, %)	
Male	29 (41.4)
Female	41 (58.6)
First language (n, %)	
English	38 (54.3)
Afrikaans	23 (32.9)
isiXhosa	9 (12.9)
Income	
Unemployed	30 (42.9)
<\$5 260 p.a.	19 (27.1)
\$5 260–\$1 8410 p.a.	7 (10)
>\$1 8410 p.a.	6 (8.6)
Unavailable	8 (11.4)
Side (n, %)	
Right	32 (45.7)
Left	23 (32.9)
Bilateral	15 (21.4)
Knee pathology (n, %)	
Arthropathy	43 (61.4)
Ligamentous injury	18 (25.7)
Meniscus/cartilage	7 (10)
Unknown	2 (2.9)

standardised test scores and each category of the SST were compared using Kruskal–Wallis test for which the condition for statistical significance was kept at $p < 0.05$, post Bonferroni correction, and a post-hoc power ($1 - \beta$ error) calculation was performed. The statistical analyses were performed in G* Power v.3.1.9.^{22,23} and IBM SPSS v.26 (Armonk, NY: IBM Corp).

Results

Demographics

Seventy patients (median age of 53.4 years, IQR: 27.25 years) were included in the study. Forty-five (64%) were female and 25 male (36%). Their demographic information and knee pathology are summarised in *Table II*. Three patients with incomplete questionnaires were excluded.

Table III: Correlation between squat-and-smile components and outcome scores displayed in r-value

Variables	KOOS	EQ-5D	Lysholm	SST Squat	SST Support	SST Smile
KOOS	1.00	0.61	0.71	0.56	0.29	0.40
EQ-5D	0.61	1.00	0.62	0.46	0.31	0.32
Lysholm	0.71	0.62	1	0.43	0.31	0.30

KOOS: Knee injury and Osteoarthritis Outcome Score; SST: squat-and-smile test; Squat: depth of squat; Support: support needed to squat; Smile: facial expression score

Squat depth

Of the 70 participants, 12 (17%) were able to squat with their hips lower than their knees, 15 (21%) with the hips at the level of the knees, 34 patients (49%) with their hips above the knees, and nine patients (43%) were unable to squat. The squat depth had moderate correlation with the KOOS score, and poor correlation with the EQ-5D and the Tegner Lysholm score. (*Table III*). The correlation between the modified SST and the KOOS score increased with squat depth ($p < 0.05$) (*Figure 2*).

Squat support

Fifty-two of the 70 participants were able to perform a squat without any support (74%), and 18 required support (26%). Of these, nine patients (13%) were unable to perform a squat, four required a single arm support (6%) and five required the support of both arms (7%). Squat support correlated poorly with the KOOS, Lysholm and EQ-5D scores (*Table III*) (*Figure 3*).

Smiley face component

A happy face was selected by 28 (40%) participants, a neutral face by 17 (24%), and an unhappy face by 25 (36%) to describe their pain during squatting (*Figure 1*). The face selection correlated poorly with the KOOS, Lysholm and EQ-5D (*Figure 4*).

Discussion

This study showed that there was a moderate to poor correlation of the index score to the KOOS (r -value=0.56), Lysholm (r =0.38) and EQ-5D (r =0.44), although the correlation with the KOOS score increased with squat depth. Among the KOOS, Lysholm and EQ-5D scores, there was moderate to good correlation ($r=0.61$; $r=0.71$; $r=0.62$).

Barriers to the use of PROMs have previously been reported as the time spent on completing the score, patient health literacy, and socioeconomic status.^{2,24} These barriers were also present in our

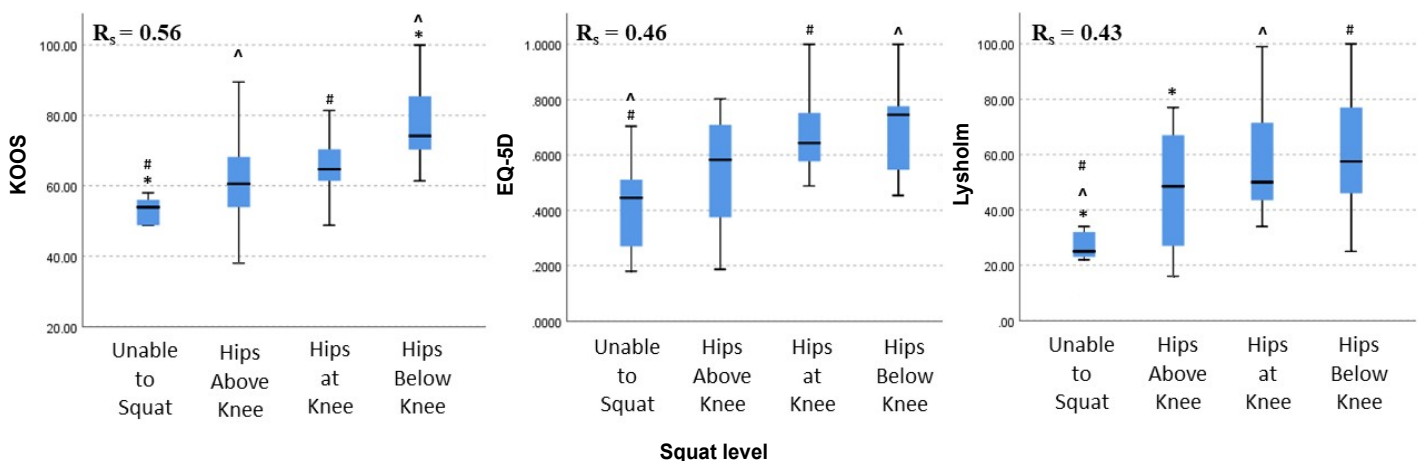


Figure 2. The correlation of the squat depth with the Knee injury and Osteoarthritis Outcome Score (KOOS), the EQ-5D and the Lysholm scores, as displayed in r-value. The squat depth had a fair correlation with the KOOS score, and a poor correlation with the EQ-5D and Lysholm scores.

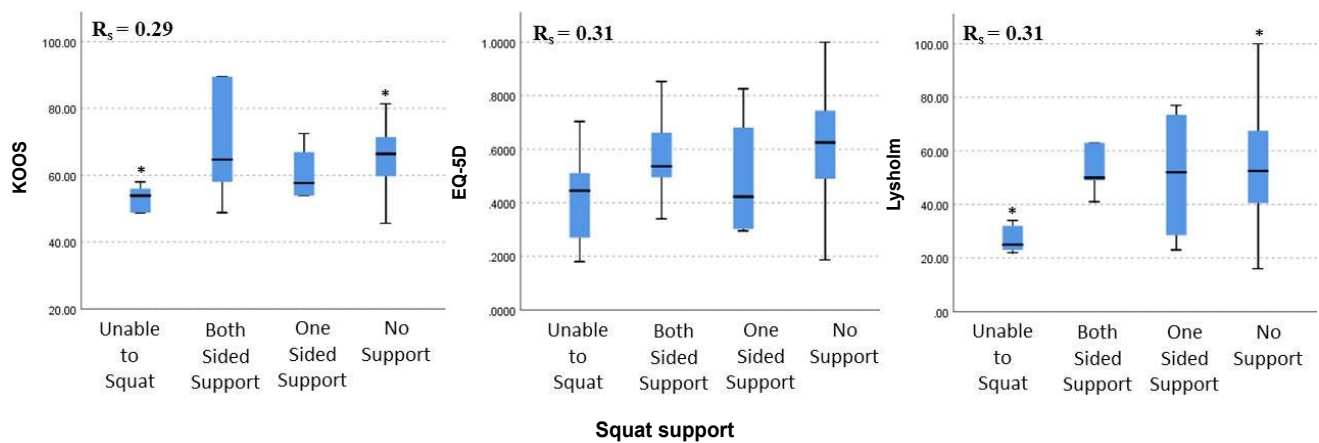


Figure 3. The correlation of the squat support with the Knee injury and Osteoarthritis Outcome Score (KOOS), the EQ-5D and the Lysholm scores, as displayed in r-value. The squat support had poor correlation with the PROM scores.

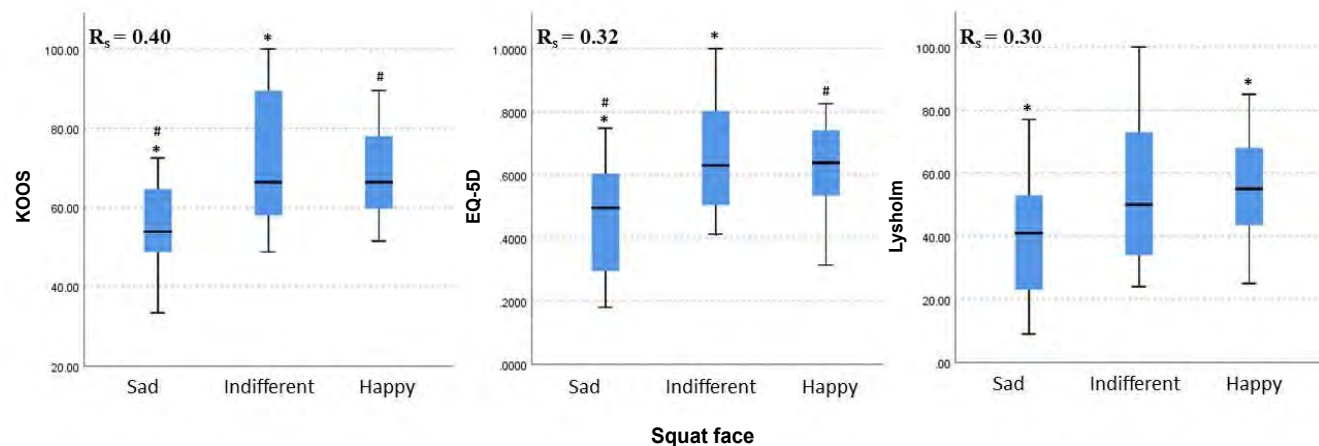


Figure 4. The correlation of the smile-while-squatting component with the Knee injury and Osteoarthritis Outcome Score (KOOS), the EQ-5D and the Lysholm scores, as displayed in r-value. The smile-while-squatting had poor correlation with the PROM scores.

study population. Sixty-four patients (74%) did not complete their secondary schooling, 32 patients (46%) did not speak English as their first language, and at least 49 patients (70%) had a household income of less than \$5 260 per annum. This was one of our main drivers to establish a simple, acceptable and valid outcome measure tool. Wu et al.¹⁰ described the SST for a similar setting to assess healing in femur fractures, but we could not achieve similar results for our patients assessing knee pathology.

Although the inability to squat has previously been associated with hip and knee injuries and surgery,^{8,25,26} the squat component of this test had fair correlation with the KOOS and poor correlation with the Lysholm and EQ-5D scores.²¹ The squat support, although previously found to have good correlation with femur shaft non-union, had a poor correlation when assessing knee pathology.¹⁰ Rating of knee pain with smiley faces also correlated poorly with the other PROMs, also noted by Wu et al.¹⁰ using a similar 'smile-while-squatting' component.

Although a single examiner captured the data and there was consistency in the examination and observation techniques, this study has limitations. Concomitant pathology in the ipsilateral lower limb or contralateral knee pathology could possibly have confounded the scores. The body mass index (BMI) was also not recorded for the participants. However, these would also reflect in reference PROMs and should therefore not affect the correlation of the SST to these scores.

As previously mentioned, the requirement to squat has been shown to be an important activity of daily living in some low- and middle-income countries, where the squatting position may be used while cooking, praying, using pit latrines and eating,⁷ and

requires almost full range of motion of the hips and knees.²⁷ The activities for daily life might be affected differently with the cultural need for squatting. As such, we did not test a specific patient cohort regarding the cultural need for squatting.

Conclusion

Although the squat component of the SST had a moderate correlation with other PROMs, squat support and a visual analogue scale based on smiley faces had weak correlation. A graded scale of squatting can therefore be used as an outcome measure for knee pathology when the collection of conventional PROMs is challenging. Future research should focus on validating PROMs in cultural groups with varying needs for squatting to perform ADLs and validating the SST for other lower limb pathology.

Ethics statement

The authors declare that this submission is in accordance with the principles laid down by the Responsible Research Publication Position Statements as developed at the 2nd World Conference on Research Integrity in Singapore, 2010. Prior to commencement of the study ethical approval was obtained from the University of Cape Town Human Research Ethics Committee (HREC), no. 144/3030. Written consent was obtained from the patients included in this study.

Declaration

The authors declare authorship of this article and that they have followed sound scientific research practice. This research is original and does not transgress plagiarism policies.

Author contributions

JIR: Primary author; design, data contribution, manuscript preparation
RD: Design, data analysis, manuscript preparation

ASD: Conceptualisation, design, manuscript preparation
OT: Conceptualisation, design, data collection
ML: Conceptualisation, design, manuscript preparation
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