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TRANSLATION, CULTURAL ADAPTATION, AND VALIDATION OF THE BULGARIAN VERSION OF THE FORGOTTEN JOINT SCORE-12 (FJS-12) IN PATIENTS WITH KNEE OSTEOARTHRITIS AFTER UNICOMPARTMENTAL KNEE ARTHROPLASTY

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Abstract

Knee osteoarthritis is a major cause of disability worldwide. Although commonly used patient-reported outcome measures effectively assess pain and function, they often demonstrate ceiling effects in high-functioning patients, particularly after unicompartmental knee arthroplasty (UKA). The Forgotten Joint Score-12 (FJS-12) was developed to assess joint awareness during daily activities, reflecting a core goal of arthroplasty: a joint that is no longer consciously perceived. The aim of this study was to translate, culturally adapt, and validate the Bulgarian version of the FJS-12 and to evaluate its clinical utility in patients with knee osteoarthritis.

A two-phase study design was used. Phase 1 involved forward-backward translation, expert committee review, and pilot testing to produce a culturally adapted Bulgarian version of the FJS-12 in accordance with established guidelines for the cross-cultural adaptation of patient-reported outcome measures (PROMs). Phase 2 consisted of psychometric validation in patients with knee osteoarthritis treated with UKA. Internal consistency was assessed using Cronbach's alpha, test-retest reliability using the intraclass correlation coefficient (ICC), and construct validity through correlations with established PROMs, including Western Ontario and McMaster Universities (WOMAC) and Knee Injury and Osteoarthritis Outcome Score (KOOS).

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The Bulgarian FJS-12 demonstrated good comprehensibility and high patient acceptance. The mean FJS-12 score was 79.5 ± 17.0. Internal consistency was high (Cronbach's alpha = 0.958), and test-retest reliability was excellent ($\mathrm{ICC}(3,1) = 0.973$). No floor or ceiling effect was observed. The FJS-12 showed significant negative correlations with WOMAC pain, stiffness, function, total score. In the subgroup with available KOOS data, significant positive correlations were found with KOOS Symptoms, Quality of Life, and total score.

The Bulgarian version of the FJS-12 is a reliable and valid PROM for assessing joint awareness in patients with knee osteoarthritis after UKA. It provides clinically relevant information that complements traditional outcome measures by capturing residual joint awareness not detected by pain- and function-based instruments.

Key words: knee osteoarthritis, unicompartmental knee arthroplasty, patient-reported outcome measures, Forgotten Joint Score-12, validation, Bulgarian

Introduction. The knee is one of the joints most frequently affected by osteoarthritis (OA), representing a major contributor to global disability [1–3]. Although the prevalence of knee OA increases with age and is higher among women, symptomatic knee OA is increasingly observed in younger, active individuals. This is driven by rising rates of obesity, occupational loading, and post-traumatic changes [4]. This demographic shift places greater emphasis on surgical interventions capable of restoring function while preserving native joint kinematics.

For patients with isolated compartmental disease, unicompartmental knee arthroplasty (UKA) has emerged as a highly effective surgical option. By preserving the cruciate ligaments and unaffected compartments, UKA offers more physiological knee motion, faster recovery, and high patient satisfaction when appropriately indicated [1, 5–7]. However, surgical success in UKA is increasingly judged not merely by pain relief, but by how "normal" the knee feels during daily life. Traditional PROMs – such as the Knee Injury and Osteoarthritis Outcome Score (KOOS), the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), and the Oxford Knee Score (OKS) – are effective in tracking symptom relief and functional improvement (Table 1). However, they frequently exhibit ceiling effects in high-performing patients [8]. As a result, they may fail to distinguish between "good" and "excellent" outcomes, a limitation particularly evident after UKA.

The FJS-12 was developed specifically to overcome these limitations by measuring *joint awareness* rather than pain or function alone [9]. A low level of joint awareness indicates successful biomechanical integration and neuromuscular adaptation. The FJS-12 has demonstrated excellent psychometric properties, low ceiling effects, and superior discriminative ability in well-functioning patients [10, 11]. It is particularly well suited for evaluating outcomes after UKA, where patients frequently achieve high functional levels [12]. The FJS-12 comprises 12 activity-

Table 1

Comparison of outcome measures and their clinical focus

Score	Primary domain assessed	What it captures	Limitation observed
WOMAC	Pain, stiffness, function	Symptom severity and activity limitation	May not fully reflect residual joint awareness
KOOS	Symptoms, pain, ADL, sport, QoL	Broad functional and quality-of-life assessment	Ceiling effects in high-functioning patients
FJS-12	Joint awareness	Conscious perception of the joint	Complements pain- and function-based scores

based items assessing joint awareness during daily activities. Each item is rated on a five-point Likert scale (0–4), and total scores are transformed to a 0–100 scale, with higher scores indicating lower joint awareness and better functional integration [9]. Despite its widespread international use, the absence of a validated Bulgarian version has limited its applicability in Bulgarian-speaking populations. This study aims to address that gap.

Materials and methods. ***Study design.*** The study design was adapted from methodological approaches previously used in Bulgarian validation studies of patient-reported outcome measures, including the Boston Carpal Tunnel Questionnaire and other culturally adapted orthopedic instruments [13, 14], ensuring rigorous linguistic and psychometric standards. Patient demographics and baseline characteristics are presented in Table 2.

Table 2

Patient characteristics and psychometric properties of the Bulgarian FJS-12

Parameter	Value
Number of patients	89
Mean age, years	62
Age range, years	45–85
Sex distribution	58% male / 42% female
Mean BMI (kg/m^2)	27.4
Primary diagnosis	Knee osteoarthritis
Surgical treatment	Medial UKA – 81.8% / Lateral UKA – 19.2%
Mean FJS-12 score, mean ± SD	79.5 ± 17.0
Median FJS-12 score (IQR)	85 (77–90)
Range of FJS-12 score	4–100
Cronbach's alpha	0.958
Cronbach's alpha if item deleted	0.952–0.957
ICC (3,1)	0.973
Ceiling effect	1/89 (1.1%)
Floor effect	0/89 (0%)

Phase 1: Translation and cultural adaptation. The translation process followed established international guidelines [15, 16]. First, two independent forward translations were performed by bilingual translators. An expert committee, consisting of orthopedic surgeons and linguists, then synthesized these translations to ensure both semantic and conceptual equivalence. Following this, independent bilingual individuals – who were entirely blinded to the original questionnaire – performed a back-translation. Finally, the pre-final version underwent pilot testing in 15 Bulgarian-speaking patients to assess its clarity, comprehensibility, and cultural relevance.

Phase 2: Psychometric validation. *Participants.* Eligible participants included native Bulgarian-speaking adults diagnosed with primary knee osteoarthritis who had undergone UKA. All participants were required to be able to read and understand Bulgarian sufficiently to complete the patient-reported outcome measures independently and provide informed consent. Exclusion criteria included secondary osteoarthritis (due to inflammatory, infectious, post-traumatic, or neoplastic causes), significant cognitive impairments that could interfere with questionnaire completion, insufficient language comprehension, incomplete questionnaire data, or a refusal to participate. All patients were evaluated at a minimum of 12 months postoperatively, with surgeries performed between 2015 and 2024, corresponding to a stable postoperative phase for assessment of joint awareness.

Instruments. All the participants completed the Bulgarian versions of three instruments: the FJS-12, KOOS, and WOMAC. The Bulgarian versions of KOOS and WOMAC have been previously translated, culturally adapted, and validated in Bulgarian-speaking populations with osteoarthritis [17, 18]. The KOOS evaluates five domains: pain, symptoms, activities of daily living, sport and recreation, and knee-related quality of life [19]. The WOMAC assesses pain, stiffness, and physical function, remaining one of the most widely used instruments for evaluating outcomes in knee osteoarthritis [20]. The FJS-12 specifically measures joint awareness during daily activities, providing complementary information to these traditional pain- and function-based instruments [9].

Statistical analysis. Internal consistency was assessed using Cronbach's alpha, with values ≥ 0.70 considered acceptable, ≥ 0.80 good, and ≥ 0.90 excellent. Test-retest reliability was evaluated using the intraclass correlation coefficient (ICC), where values ≥ 0.75 were interpreted as good reliability and values ≥ 0.90 as excellent. Floor and ceiling effects were assessed as the proportion of patients achieving the minimum and maximum possible scores. Score distribution was assessed using the Shapiro–Wilk test. Construct validity was assessed by calculating correlations between the FJS-12 and the WOMAC and KOOS subscales. Because the distributions deviated from normality, Spearman's rho was used for correlation analysis. Construct validity was further interpreted according to the principles of convergent and divergent validity. Convergent validity was evaluated by examining the strength of correlations between the FJS-12 and related func-

tional domains measured by WOMAC and KOOS, while divergent validity was considered through differences in correlation strength between domains representing distinct constructs.

Results. The preliminary Bulgarian version of the FJS-12 was pilot tested in 15 patients with UKA. All patients completed the questionnaire independently. No items were reported as unclear or culturally inappropriate. Minor linguistic adjustments were introduced after pilot testing. The final Bulgarian version was then administered to all study participants.

A total of 89 patients were included in the final analysis. Mean follow-up time was 6.2 ± 1.4 years. Of these, 58% were male and 42% were female. Mean age was 62 years (range 45–85 years).

The mean FJS-12 score was 79.5 ± 17.0, with a median of 85 (IQR 77–90) and a range from 4 to 100. The mean WOMAC pain score was 6.1 ± 3.7, the mean WOMAC stiffness score was 2.4 ± 1.4, and the mean WOMAC function score was 18.0 ± 10.6. The mean WOMAC total score was 26.5 ± 14.2. The mean global pain score was 2.3 ± 1.9. The distribution of FJS-12 scores is illustrated in Fig. 1a.

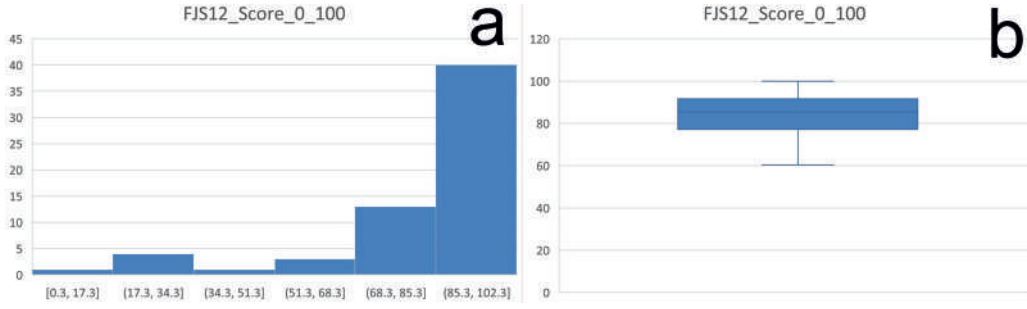


Fig. 1. a) Histogram showing the distribution of FJS-12 scores in the study cohort; b) Boxplot illustrating the distribution, median, and interquartile range of FJS-12 scores

Internal consistency of the Bulgarian version of the FJS-12 was assessed using Cronbach's alpha. The overall Cronbach's alpha coefficient was 0.958. Cronbach's alpha when deleting an item ranged from 0.952 to 0.957, indicating that no single item had a disproportionate effect on the overall score.

Test-retest reliability was assessed using the intraclass correlation coefficient. The ICC$(3, 1)$ was 0.973, indicating excellent test-retest reliability of the Bulgarian FJS-12.

No floor or ceiling effect was observed, with only one of 89 patients (1.1%) achieving the maximum possible score of 100. Additional visualization of score dispersion is presented in Table 2 and Fig. 1b.

The Shapiro–Wilk test showed deviation from normality for the FJS-12 ($W = 0.739$, $p < 0.001$) and the WOMAC subscales for pain ($W = 0.952$, $p = 0.002$), stiffness ($W = 0.912$, $p < 0.001$), and function ($W = 0.802$, $p < 0.001$). Therefore, Spearman's rho was used for correlation analysis.

Table 3

Correlations between the Bulgarian FJS-12 and comparator clinical outcome measures

Outcome measure	**Spearman's ρ**	***p*-value**
WOMAC pain	−0.667	< 0.001
WOMAC stiffness	−0.436	< 0.001
WOMAC function	−0.619	< 0.001
WOMAC total score	−0.703	< 0.001
Global pain	−0.737	< 0.001
KOOS Symptoms*	0.741	0.035
KOOS Pain*	0.673	0.068
KOOS Activities of Daily Living*	0.693	0.057
KOOS Sport/Recreation*	0.704	0.051
KOOS Quality of Life*	0.817	0.013

Construct validity was assessed by correlation analysis between the FJS-12 and the available clinical outcome measures (Table 3). The FJS-12 score showed significant negative correlations with WOMAC pain ($\rho = -0.667$, $p < 0.001$), WOMAC stiffness ($\rho = -0.436$, $p < 0.001$), WOMAC function ($\rho = -0.619$, $p < 0.001$), WOMAC total score ($\rho = -0.703$, $p < 0.001$), and global pain ($\rho = -0.737$, $p < 0.001$).

KOOS data were available for a subgroup of patients ($n = 48$), and correlation analyses were performed within this subgroup. Significant positive correlations were found between the FJS-12 and KOOS Symptoms ($\rho = 0.741$, $p = 0.035$) and KOOS Quality of Life ($\rho = 0.817$, $p = 0.013$). Correlations with KOOS Pain, Activities of Daily Living, and Sport/Recreation did not reach statistical significance.

Discussion. The present study evaluated the psychometric properties and clinical utility of the Bulgarian version of the FJS-12 in patients with knee osteoarthritis treated with UKA. The findings demonstrated high internal consistency, excellent test-retest reliability, absence of floor or ceiling effect, and significant correlations with established outcome measures.

The concept of joint awareness represents a fundamentally different dimension compared to traditional pain- and function-based assessment tools. While WOMAC and KOOS primarily evaluate symptoms, stiffness, function, and quality of life, the FJS-12 specifically reflects the extent to which patients remain consciously aware of the operated joint during daily activities. This concept is closely aligned with the original rationale of the instrument, namely that the ultimate goal of arthroplasty is a joint that the patient can "forget" during everyday life [9]. This makes the FJS-12 particularly relevant after UKA, where patients often achieve good functional recovery and have high expectations regarding knee normality [6, 7, 12].

In the present cohort, the FJS-12 showed significant negative correlations with WOMAC pain, stiffness, function, total score, and global pain. This correlation pattern is consistent with the expected behaviour of a valid measurement instrument, demonstrating convergent validity with related domains and divergent validity with less directly related constructs. In the subgroup with available KOOS data, significant positive correlations were found with KOOS Symptoms, Quality of Life, and KOOS total score. These findings support the construct validity of the Bulgarian FJS-12 and are consistent with previous validation studies reporting meaningful associations between the FJS-12 and related PROM domains. It should be noted that KOOS partially incorporates WOMAC domains, which may influence the observed correlation strength. Therefore, differences between correlations with KOOS and WOMAC should be interpreted with caution when evaluating overlapping constructs [9–11].

The very low ceiling effect observed in this study is also in line with prior reports suggesting that the FJS-12 has better discriminatory ability than conventional PROMs in well-functioning arthroplasty patients [8,11]. This characteristic is especially important after UKA, where many patients achieve favourable pain and function scores and where subtle residual joint awareness may still remain clinically relevant. This suggests that the FJS-12 may provide additional sensitivity in identifying patients who, despite satisfactory conventional outcomes, have not achieved complete biomechanical and perceptual integration of the joint.

From a broader methodological perspective, the present study also contributes to the growing body of Bulgarian-language validation work for patient-reported outcome measures in musculoskeletal practice [13, 14, 18]. The availability of a culturally adapted Bulgarian FJS-12 expands the set of validated instruments that can be used for both routine follow-up and clinical research.

Several limitations should be acknowledged. First, KOOS data were available only for a small subgroup of patients, which limits the strength of the subgroup correlation analysis. Second, although all patients were evaluated in a stable postoperative phase, the exact postoperative interval was not analyzed as a variable, which may influence joint awareness outcomes. Finally, responsiveness to change was not assessed due to the cross-sectional design of the study. Despite these limitations, the present findings provide robust evidence supporting the reliability and clinical utility of the Bulgarian version of the FJS-12. Additionally, the inclusion period spanning from 2015 to 2024 may introduce variability related to changes in surgical techniques, implant design, and rehabilitation protocols over time.

Conclusion. The Bulgarian version of the FJS-12 is a valid patient-reported outcome measure for assessing patients after surgical treatment of knee osteoarthritis. It complements established instruments such as WOMAC, KOOS, and the Knee Society Score by capturing joint awareness, a dimension that may remain insufficiently reflected by conventional measures. The availability of a culturally

adapted Bulgarian version expands the tools available for clinical evaluation and research and supports a more comprehensive assessment of postoperative outcomes after knee arthroplasty.

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