

Clinical Prediction Rules for the Severity of Functional Disability in Knee Osteoarthritis

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Abstract

Background: Knee osteoarthritis (KOA), is a chronic degenerative joint pathology with a global prevalence of 22.9% in individuals aged 40 and over. It is a leading cause of disability and poor quality of life worldwide due to musculoskeletal pain and functional limitations.

Aim of Study: This study aimed to investigate and identify the clinical prediction rules for the severity of functional disability in KOA.

Subjects and Methods: Eighty patients between 50-65 years old suffering from KOA from both genders were recruited for this study. Every patient was assessed by the visual analogue scale (VAS) to measure pain intensity and the Western Ontario and McMaster University Arthritis Index (WOMAC) Arabic version to assess knee functional disability.

Results: Multivariate analysis revealed that the most significant predictors of severity of functional disability in knee osteoarthritis were pain intensity followed by functional disability, with p -value ($p < 0.05$).

Conclusion: Pain intensity, functional disability are significant predictors of KOA progression. These factors should be closely monitored and targeted in clinical practice to effectively manage and potentially slow the progression of knee osteoarthritis.

Key Words: Knee osteoarthritis – Clinical prediction rules – Functional disability.

Introduction

KNEE osteoarthritis KOA is considered as progressive wear and tear of articular cartilage. However, recent evidence has suggested that it is an inflammatory disease of the entire synovial joint, comprising not only mechanical degeneration of articular

cartilage but also concomitant structural and functional change of the entire joint [1]. The higher prevalence of symptomatic OA that estimated 9.6% of men and 18% of women aged 60 years and older, it is approximated that 250 million people all over the world suffer from OA [2]. The prevalence of KOA increased significantly over the last decades and continues to rise, partially because of the increasing prevalence of obesity and other risk factors, but also independently, of other causes [3].

Knee osteoarthritis OA develops gradually over several years. However, 3.4% of adults at risk for KOA will develop an accelerated form of KOA, while no single risk factor can accurately predict who is at risk for accelerated KOA, it would be beneficial to recognize the combinations and interactions of risk factors that identify people at risk for accelerated KOA [4].

Clinical prediction rules CPR of KOA, refer to a set of guidelines or criteria used by healthcare professionals to predict and assess the likelihood of KOA, in individuals based on various clinical factors. Besides, can help optimize patient care by improving diagnostic accuracy, facilitating early intervention, and guiding treatment choices [5].

Pain is one of the primary symptoms of KOA and is often the main reason why individuals seek medical attention. Pain can vary from mild to severe and can be intermittent or constant. It is typically felt in and around the knee joint, and it may worsen with activity, overuse of the joint, or prolonged periods of inactivity. Clinicians and researchers use pain intensity as a valuable outcome measure when evaluating the effectiveness of treatments for KOA [6]. Pain is indeed considered a significant predictor of knee osteoarthritis (KOA) outcomes. In the context of KOA, pain is both a symptom and a factor

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that can influence the progression and severity of the condition. Persistent or worsening pain is often associated with more severe joint damage, reduced function, and poorer quality of life [7].

Functional disability is a crucial prognostic factor in knee osteoarthritis (KOA), representing the extent of limitations in daily activities caused by joint pain, stiffness, and dysfunction key characteristics of KOA. The degree of functional disability not only reflects the current severity of the condition but also serves as a predictor for its future progression [8]. The aim of this study is to investigate the predictive factors of knee osteoarthritis (KOA) outcomes, specifically focusing on the roles of pain and functional disability in determining the progression and severity of the disease.

Patients and Methods

Study design: The study was a cross-sectional.

Subjects: Eighty patients from both sexes suffering from KOA participated in this study. They were recruited in this study from the outpatient clinic, Faculty of Physical Therapy, Cairo University in the period between Jan 2024 to Apr 2024. They were referred by orthopedic surgeons with diagnosis of KOA. They aged from 50 to 65 years old. In this investigation, patients were assessed by visual analogue scale VAS to measure pain intensity and the Western Ontario and McMaster Universities Arthritis Index (WOMAC) Arabic version to assess functional disability.

Sample size calculation: Sample size has been calculated using G power software, using effect size (0.641), power (0.80), two-tailed, and α of 0.05 giving a sample size of (80).

Ethical committee: The Ethical Committee of the Faculty of Physical Therapy, Cairo University granted the study approval number (P.T.REC/012/005352). All participants signed informed consent after a thorough explanation of the goals of the study. The Helsinki Declaration was followed throughout the study procedures.

The inclusion criteria were as follow: The study included patients of both genders, male and female, aged between 50 and 65 years old. All participants had symptomatic KOA, with a clinical and radiological diagnosis confirming KOA at grade 2 or 3 (KOA Grade 2 refers to mild osteoarthritis, where there is definite bone growth and possibly slight narrowing of the joint. KOA Grade 3 indicates moderate osteoarthritis, with more pronounced joint space narrowing and bony changes) [9].

Exclusion criteria: All patients were excluded if they had one or more of the following: Deformities due to previous lesions on the bones of the lower extremity, a history of surgical procedures affecting

the lower extremity, or any neurological disorder in the lower extremity.

Materials:

- *The Visual Analogue Scale (VAS):* Is a commonly utilized instrument for assessing subjective experiences such as pain, with robust evidence supporting its validity and reliability. It exhibits strong content, construct, and criterion validity, demonstrating high correlations with other standardized pain assessment methods. The VAS also shows substantial test-retest and intra-rater reliability, particularly in the evaluation of moderate to severe symptoms. However, variability may be observed in patients with mild symptoms or those who have difficulty accurately marking the scale. Despite these limitations, the VAS remains a reliable and valid tool for the quantification of subjective symptoms in clinical and research settings [10].

- *The Arabic version of the Western Ontario and McMaster Universities Arthritis Index (WOMAC):* has been validated and shown to be reliable for assessing pain, stiffness, and physical function in patients with osteoarthritis. It maintains strong content validity by covering key domains of osteoarthritis and has been culturally adapted for Arabic-speaking populations. Its construct validity is supported by correlations with other established measures like the Visual Analogue Scale (VAS) for pain, while criterion validity is confirmed through its association with clinical measures of osteoarthritis severity. The Arabic WOMAC also demonstrates high internal consistency, with Cronbach's alpha values typically exceeding 0.8, and excellent test-retest reliability, producing stable results over time. The translation and cultural adaptation process, including back-translation, ensures that the psychometric properties of the original instrument are retained, making the Arabic WOMAC a valid and reliable tool for use in Arabic-speaking populations [11].

Procedures:

Visual analog scale VAS: Every patient was assessed by VAS to evaluate the sense of pain under the supervision of the primary investigator then, the patient was asked to mark a 100 mm line to indicate pain intensity the score was measured from zero to the patient's mark [10].

Western Ontario and McMaster Universities Arthritis Index (WOMAC) Arabic version: Each patient was instructed to thoroughly read each category of the WOMAC index in Arabic and rate their level of each item on a five-point Likert scale, with response levels ranging from none (0) to extreme (4). The index comprised 24 items divided into three subscales: Pain (5 items), which included questions about pain related to walking, using stairs, in bed, sitting or lying, and standing upright; Stiffness (2 items), which addressed stiffness severity upon first waking in the morning and later in the day; and Physical Func-

tion (17 items), which covered aspects such as using stairs, rising from sitting, standing, bending, walking, getting in/out of a car, shopping, putting on/taking off socks, rising from bed, lying in bed, getting in/out of a bath, sitting, getting on/off a toilet, and performing heavy and light domestic duties. Scores for each subscale were determined by summing the component item scores (Pain: 0–20, Stiffness: 0–8, Physical Function: 0–68), and the final total aggregated score (range: 0–96) was obtained by summing the subscale scores, with higher scores indicating greater impairment [11].

Statistical analysis:

Reported data were analyzed using the statistical package for social sciences, version 23.0 (SPSS Inc., Chicago, Illinois, USA). The quantitative data were presented as mean \pm standard deviation and ranges when their distribution was parametric (normal). Also, qualitative variables were presented as number and percentages. Data were explored for normality using Kolmogorov-Smirnov and Shapiro-Wilk Test.

Results

Demographic data: 80 patients, 46 (57.5%) were male and 34 (42.5%) were female, with no statistically significant difference in gender distribution between KOA Grade 2 and Grade 3 ($p>0.05$). The mean age of the patients was 56.14 ± 3.93 years,

ranging from 50 to 64 years. A highly significant difference in age was observed, with older mean age in Grade 3 compared to Grade 2 ($p<0.001$). The mean height was 169.80 ± 8.11 cm, ranging from 155 to 182 cm, with no significant difference between both KOA grades ($p>0.05$). The mean weight was 77.70 ± 5.24 kg, ranging from 69 to 88 kg, with a significantly higher mean weight in Grade 3 compared to Grade 2 ($p<0.001$). Additionally, the mean BMI was 27.06 ± 2.58 , ranging from 23.66 to 34.38, with a statistically significant higher mean BMI in Grade 3 compared to Grade 2 ($p<0.05$) (Table 1).

Pain intensity: The mean of VAS was 6.50 ± 1.65 and ranged 4–9 for all patients, while there was a highly statistically significant highest mean value of VAS in KOA grade 3 was 7.94 ± 1.06 compared to grade 2 was 5.38 ± 1.03 , with p -value ($p<0.001$) (Table 2).

Functional disability: The mean of WOMAC scale was 53.48 ± 15.69 and ranged 22 to 88 for all patients, while there was a highly statistically significant highest mean value of WOMAC scale in KOA grade 3 was 65.40 ± 10.87 compared to grade 2 was 44.20 ± 12.23 , with p -value ($p<0.001$).

Multivariate analysis revealed that the most significant predictors of the severity of functional disability in KOA were pain intensity measured by VAS, followed by functional disability measured by WOMAC scale (Table 4).

Table (1): Comparison between Grade 2 and Grade 3 KOA according to Demographic data.

Demographic data	Total (n=80)	KOA Grade 2 (n=45)	KOA Grade 3 (n=35)	Test value	p -value	Sig.
Gender:						
Female	34 (42.5%)	20 (44.4%)	14 (40.0%)	0.159	0.690	NS
Male	46 (57.5%)	25 (55.6%)	21 (60.0%)			
Age (years):						
Mean \pm SD	56.14 ± 3.93	54.04 ± 2.96	58.83 ± 3.36	45.593	0.001	HS
Range	50–64	50–62	52–64			
Height (cm):						
Mean \pm SD	169.80 ± 8.11	169.09 ± 7.73	170.71 ± 8.61	0.788	0.377	NS
Range	155–182	155–182	155–182			
Weight (kg):						
Mean \pm SD	77.70 ± 5.24	75.27 ± 3.80	80.83 ± 5.22	30.417	0.001	HS
Range	69–88	69–82	70–88			
BMI [wt/ (ht)²]:						
Mean \pm SD	27.06 ± 2.58	26.42 ± 2.17	27.87 ± 2.85	6.670	0.012	S
Range	23.66–34.38	23.66–29.97	25–34.38			
Level:						
Normal	25 (31.3%)	25 (55.6%)	0 (0.0%)	35.671	0.001	HS
Overweight	44 (55.0%)	20 (44.4%)	24 (68.6%)			
Obese	11 (13.8%)	0 (0.0%)	11 (31.4%)			

Using: t : Independent Sample t -test for Mean \pm SD.

Using: χ^2 : Chi-square test for Number (%) or Fisher's exact test, when appropriate.

NS: Non-significant. S: Significant. HS: Highly significant.

Table (2): Comparison between grade 2 and grade 3 according to VAS and represent VAS.

Visual analogue scale	Total (n=80)	KOA Grade 2 (n=45)	KOA Grade 3 (n=35)	Test value	p-value	Sig.
Mean \pm SD	6.50 \pm 1.65	5.38 \pm 1.03	7.94 \pm 1.06	119.624	0.001	HS
Range	4-9	4-8	4-9			
<i>Level:</i>						
Moderate	41 (51.3%)	40 (88.9%)	1 (2.9%)	58.323	0.001	HS
Sever	39 (48.8%)	5 (11.1%)	34 (97.1%)			

Using: t -Independent Sample t -test for Mean \pm SD.

Using: χ^2 : Chi-square test for Number (%) or Fisher's exact test, when appropriate.

NS: Non-significant. S: Significant. HS: Highly significant.

Table (3): Comparison between Grade 2 and Grade 3 according to WOMAC scale score and represent for WOMAC scale score.

WOMAC scale	Total (n=80)	KOA Grade 2 (n=45)	KOA Grade 3 (n=35)	Test value	p-value	Sig.
Mean \pm SD	53.48 \pm 15.69	44.20 \pm 12.23	65.40 \pm 10.87	65.125	0.001	HS
Range	22-88	22-60	43-88			
<i>Level:</i>						
Moderate	19 (23.8%)	19 (42.2%)	0 (0.0%)	55.141	0.001	HS
Sever	34 (42.5%)	26 (57.8%)	8 (22.9%)			
Very severe	27 (33.8%)	0 (0.0%)	27 (77.1%)			

Using: t -Independent Sample t -test for Mean \pm SD.

Using: χ^2 : Chi-square test for Number (%) or Fisher's exact test, when appropriate.

NS: Non-significant. S: Significant. HS: Highly significant.

Table (4): Multivariate logistic regression analysis for factors as predictors for severity of functional disability in KOA.

Factors	β	S.E.	Wald	Sig.	Odds ratio	95% C.I. for OR	
						Lower	Upper
Visual analogue scale	1.95	0.42	5.194	0.016*	7.06	3.09	16.13
WOMAC scale	0.18	0.04	3.974	0.023*	1.20	1.10	1.30

β : Regression coefficient. SE: Standard error. CI: Confidence interval.

Discussion

Knee osteoarthritis (KOA), is a chronic degenerative joint pathology with a global prevalence of 22.9% in individuals aged 40 and over [12]. It is a leading cause of disability and poor quality of life worldwide due to musculoskeletal pain and functional limitations [13,14].

Current concepts define OA as a whole joint disease with a multifactorial pathogenesis [15]. To date, OA prediction has largely been driven by epidemiological studies that associate risk factors with the likelihood of developing [16]. A few risk factors recur: for knee OA, these are age, high BMI, low physical activity, high physical activity, muscle weakness, previous injury/surgery (ACL injury and

reconstruction, meniscal damage and partial meniscus removal), gender and depression [17].

The current study was conducted to investigate and identify the clinical prediction rules for the severity of functional disability in KOA. Eighty patients with knee osteoarthritis from both sexes, aged between 50-65 years old were recruited in this study. Every patient was assessed by VAS to evaluate pain intensity and WOMAC Arabic version to assess functional disability.

Pain intensity:

The results of current study demonstrated the effectiveness of determining pain intensity for KOA, and thus the pain intensity profile was a good predictor of KOA condition; Therefore, our results

were consistent with Devez et al., [18] who showed that the identification of different pain trajectories supports the hypothesis that several knee OA phenotypes exist, with a minority of them associated with a rapidly invalidating disease. In particular, these results showed that, among the vast majority of patients with knee OA having a constant level of pain over the years, only 14% of them suffered from a constant moderate/severe pain. Moreover, 7% of the subjects presented a worsening in pain trajectory in the mid-term follow-up. The understanding of the predictive factors for this subpopulation of patients could help to properly define a prognosis and provide the most suitable treatment approach for the affected patients.

The pattern and intensity of the pain are essential indicators for predicting and determining the progression phases of KOA, which agreed with a previous study by Carlesso et al., [19] who illustrated that KOA stages are reflected by the frequency of pain as being intermittent, constant, or a mix of constant and intermittent, whereby people experience intermittent activity-related pain, then constant pain as the disease progresses, and finally the late stage of disease is demarcated by constant pain overlaid by more severe, often unpredictable, intermittent pain. Based on this understanding, a new measure, the Intermittent and Constant Osteoarthritis Pain (ICOAP) scale, was developed to capture these pain patterns, thus allowing for an improved understanding of pain in the different phases of the disease.

Our results have shown an association between pain intensity and KOA severity that aligns with Nicholls et al., [19] which found that greater severity and longer duration of KOA are associated with a greater likelihood of constant plus intermittent pain compared with neither pain type being present. In addition, longer KOA duration is also associated with constant pain only versus intermittent pain only. These results suggest the possibility that differing pain mechanisms underlie intermittent and constant pain. For example, constant pain found in later stages of disease severity may be representative of central pain sensitization, whereas earlier intermittent pain may be largely peripherally driven by nociceptive input.

Our results indicated that this difference is highly statistically significant, suggesting that patients with Grade 3 KOA experience significantly more pain than those with Grade 2 KOA. This reflects the expected progression of the disease, where more advanced KOA (Grade 3) is associated with greater structural damage and pain intensity, likely due to increased joint degeneration, inflammation, and reduced joint space compared to the less severe Grade 2 but in the relevant literature, results have been conflicting as some studies [21,22] reported no association between pain scores and radiographic features in addition to Individuals with radiographic

evidence of KOA may be asymptomatic at any time. and others [23,24,25] found that radiographic features of OA were significantly associated with knee pain.

Cubukcu et al., 2012 [26] found that it is possible that pain bears a stronger relationship to radiographic features in patient with severe disease. On the other hand, conventional radiography which is the most commonly used imaging modality may not identify bony changes related to pain in early knee OA. Radiographs demonstrate structural changes rather than disease severity. Conventional radiography permits only limited assessment of the three knee compartments, provides only an approximation of articular cartilage change with measurement of joint space narrowing, and poorly characterizes other soft tissues.

Functional disability:

Our study findings indicate a correlation between functional disability and the severity of KOA, with greater functional disability associated with increased KOA severity, and vice versa. Additionally, our results suggest that functional disability can serve as a predictor of the current state of KOA and may provide insights into the future progression of the condition. These results agreed with Roos and Lohmander, & Goodman et al., [27,28] who proved that the population with low physical activity levels was more prone to KOA and poor quality of life.

the findings of current study align with the findings of Gorial et al., [29] that reported knee pain, stiffness and duration of disease may affect the functionality in patients with KOA. Consequently, it would be better to consider the functional status of patients in parallel with clinical and radiological findings in daily clinical practice.

Our results indicated that a greater tendency to engage in daily physical activities among KOA patients associated with a more significant reduction in KOA pain which is consistent with Lo et al., [30] that supported the idea that walking is beneficial from both a structural and symptomatic perspective of knee osteoarthritis.

In our results, the comparison between Grade 2 and Grade 3 KOA in terms of functional disability shows a highly significant difference. This indicates that patients with Grade 3 KOA experience substantially greater functional disability and symptom severity compared to those with Grade 2 KOA. However, few studies [23,31,32] attempted to assess the relationship between radiographic features and function in patients with knee OA. Larsson et al., [32] reported that radiographic diagnosis of osteoarthritis was not related to functional capacity. Also in some studies, correlation between self-reported disability and radiographic change could not be established [23,31]. In contrast to these findings, it was demonstrated that knee pain and reduced function

were more likely to be found if radiographic OA features were present in both tibiofemoral (medial and/or lateral) and also patellofemoral compartments rather than the involvement of only either of them [33].

Limitations: Pain intensity was self-reported, introducing potential bias due to individual variations in pain perception and daily fluctuations in symptoms. Besides, the study's cross-sectional nature limits the ability to establish causal relationships between pain intensity, functional disability, and the progression of knee osteoarthritis. Besides, VAS as a subjective tool for measuring pain perception, presents a limitation in its ability to differentiate between constant and intermittent pain patterns precisely.

Conclusion:

In view of the findings revealed by this study. It be could concluded that the most significant predictors of the severity of functional disability in knee osteoarthritis are pain intensity followed by functional disability. Therefore, our results suggest that targeted interventions focusing on applying effective pain management strategies, may be pivotal in reducing functional disability in KOA patients.

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Competing interests: Nil.

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قواعد التنبؤ السريري لشدة الإعاقات الوظيفية في مرضى التهاب مفصل الركبة

يُعتبر التهاب مفصل الركبة حالة مرضية تنكسية مزمنة في المفاصل، ويبلغ معدل انتشاره عالمياً ٩, ٢٢٪ بين الأفراد الذين تبلغ أعمارهم ٤٠ عاماً فأكثر. يُعد هذا المرض من الأسباب الرئيسية للإعاقة وتدهور جودة الحياة في جميع أنحاء العالم بسبب الألم العضلي الهيكلي والقيود الوظيفية.

هدف الدراسة: هدفت هذه الدراسة إلى التحقيق في تحديد القواعد التنبؤية السريرية لشدة الإعاقة الوظيفية في التهاب مفصل الركبة.

الأشخاص وطرق البحث: تم اختيار ثمانين مريضاً تتراوح أعمارهم بين ٥٠ و٦٥ عاماً يعانون من التهاب مفصل الركبة من كلا الجنسين للمشاركة في هذه الدراسة. تم تقييم كل مريض باستخدام مقياس الألم التناظري البصري (VAS) لقياس شدة الألم، ومؤشر التهاب مفاصل الركبة بجامعة ويسترن أونتاريو وماكماستر (WOMAC) النسخة العربية لتقييم الإعاقة الوظيفية للركبة.

النتائج: أظهرت التحليلات المتعددة المتغيرات أن أهم المتنبئات لشدة الإعاقة الوظيفية في التهاب مفصل الركبة كانت شدة الألم يليها الإعاقة الوظيفية، مع قيمة احتمالية $(p > 0.05)$.

الاستنتاج: تُعد شدة الألم والإعاقة الوظيفية متنبئات هامة لتطور التهاب مفصل الركبة. يجب مراقبة هذه العوامل عن كثب واستهدافها في الممارسات السريرية لإدارة الحالة بفعالية والحد من تقدم التهاب مفصل الركبة.