

Research Article

# Early Postoperative Functional Outcomes Following Total Knee Arthroplasty: The Role of Preoperative Disease Severity and Patient-Related Factors

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## ABSTRACT

**Objective:** To determine early functional outcomes following primary total knee arthroplasty and assess the influence of preoperative disease severity and patient-related factors.

**Methods:** This prospective multicenter cohort study included 65 adults who underwent primary unilateral total knee arthroplasty for knee osteoarthritis at three tertiary-care hospitals in Punjab, Pakistan, from January to December, 2025. Radiographic severity was classified using Kellgren-Lawrence grades III and IV. Outcomes were assessed preoperatively and at 6 and 12 weeks using the Western Ontario and McMaster Universities Osteoarthritis Index. Pain, knee movement, body mass index, comorbidities and rehabilitation adherence were also recorded. Multivariable linear regression identified predictors of the 12-week WOMAC score.

**Results:** The mean age was 64.2±7.1 years, and 43 (66.2%) patients were women. Thirty-eight patients (58.5%) had grade-IV osteoarthritis. The mean total WOMAC score improved from 68.4±10.5 preoperatively to 27.8±9.1 at 12 weeks ( $p<0.001$ ). Grade-IV patients had poorer absolute function at 12 weeks than grade-III patients, although both groups demonstrated comparable improvement. Higher preoperative WOMAC score, greater body mass index, diabetes, grade-IV disease and inadequate rehabilitation adherence independently predicted poorer 12-week outcomes.

**Conclusion:** Total knee arthroplasty produced considerable early improvement. Preoperative disability, obesity, diabetes, advanced radiographic disease and rehabilitation adherence influenced the pace of recovery.

**Keywords:** Total Knee Arthroplasty, Knee Osteoarthritis, WOMAC, Functional Recovery.

## INTRODUCTION

Knee osteoarthritis is a chronic degenerative joint disorder characterized by progressive articular cartilage loss, subchondral bone remodeling, synovial inflammation, pain, stiffness and restriction of physical activity.[1] Its prevalence has increased worldwide because of population ageing, obesity, previous joint injury, physical inactivity and longer life expectancy.[2] Global estimates identify knee osteoarthritis as one of the leading causes of musculoskeletal disability among middle-aged and older adults.[3] Its burden has increased particularly rapidly in low- and middle-income countries, where

access to early diagnosis, rehabilitation and joint-preserving treatment may be limited.[4] Patients with advanced knee osteoarthritis frequently experience difficulty walking, climbing stairs, rising from a chair and performing household or occupational activities.[5] Persistent pain and reduced mobility may also contribute to sleep disturbance, social isolation, loss of productivity and deterioration in health-related quality of life.[6] Total knee arthroplasty is commonly performed when pain and functional limitation remain unacceptable despite appropriate conservative management.[7] The procedure provides

substantial pain relief and functional improvement for most patients, although the speed and extent of recovery vary considerably.[8]

The first three postoperative months represent an important phase of recovery because pain control, restoration of knee movement, muscle activation and progressive ambulation predominantly occur during this period.[9] Delayed recovery may prolong dependence on family members, increase healthcare utilization and reduce patient confidence in the operated knee.[10] Early identification of patients at risk of slower recovery may improve preoperative counseling and allow available rehabilitation resources to be directed towards patients requiring additional support.[11]

Preoperative radiographic severity may influence postoperative outcomes, although its relationship with functional recovery is complex. Patients with Kellgren–Lawrence grade-IV osteoarthritis often undergo surgery with more severe deformity, stiffness and functional restriction than patients with grade-III disease.[12] These patients may achieve considerable improvement but retain greater absolute functional limitation during the early postoperative period.[12] Patients with Kellgren–Lawrence grades III and IV have nevertheless been shown to obtain comparable benefits from total knee arthroplasty when improvement from baseline is considered.[13]

Patient-related characteristics also contribute to variation in recovery following knee replacement. Older age, obesity, diabetes, anemia, multimorbidity, psychological distress, poor muscle strength and severe preoperative functional limitation have been associated with poorer postoperative outcomes.[14] Some of these factors may be modified before surgery, while others can be used to establish realistic expectations and plan individualized postoperative rehabilitation.

Most evidence concerning functional recovery after knee arthroplasty has originated from high-income countries with established joint registries and organized rehabilitation services. Patients in Pakistan may present after prolonged symptoms and face financial, geographical and social barriers to regular physiotherapy. Locally generated evidence is therefore required to guide preoperative risk assessment and efficient use of rehabilitation resources. This study determined early outcomes following primary total knee arthroplasty and evaluated the influence of

preoperative radiographic severity and patient-related factors in tertiary-care hospitals in Pakistan.

## **MATERIALS AND METHODS**

This prospective multicenter cohort study was conducted in the orthopedic departments of three tertiary-care hospitals located in Punjab, Pakistan, from January to December, 2025. These hospitals received referrals from both urban and rural populations. Ethical approval was obtained from the institutional review committees of the participating centers before commencement of the study. Written informed consent was obtained from all participants, and patient information was kept confidential. Adults aged 45–80 years who underwent elective primary unilateral total knee arthroplasty for primary knee osteoarthritis were consecutively recruited. Patients were eligible when they had Kellgren–Lawrence grade-III or grade-IV osteoarthritis on weight-bearing knee radiographs and persistent pain or functional restriction despite conservative management.

Patients undergoing revision or simultaneous bilateral arthroplasty were excluded. Other exclusion criteria were inflammatory arthritis, post-traumatic arthritis, previous major surgery on the affected knee, active infection, severe neurological disease affecting ambulation, advanced cardiopulmonary disease preventing rehabilitation and inability to complete the outcome assessments.

A sample size of 65 patients was selected to detect a moderate association between the principal preoperative factors and the 12-week WOMAC score at 80% statistical power and a 5% level of significance. Allowance was made for incomplete postoperative follow-up. Consecutive sampling was used because it was feasible and reduced selective recruitment at the participating centers.

Demographic and clinical information was collected using a standardized proforma. Recorded variables included age, sex, residence, educational status, smoking, duration of knee symptoms and relevant comorbidities. Body mass index was calculated as weight in kilograms divided by height in meters squared. Obesity was defined as body mass index  $\geq 30$  kg/m<sup>2</sup>. Diabetes and hypertension were identified from medical records, medication use and clinical history.

Preoperative hemoglobin concentration was retrieved from routine laboratory investigations. Anemia was defined as

hemoglobin below 12 g/dL in women and below 13 g/dL in men. Preoperative anesthesia risk was classified according to the American Society of Anesthesiologists physical-status classification.

Standard weight-bearing anteroposterior and lateral radiographs of the affected knee were independently reviewed by two consultant orthopedic surgeons. Osteoarthritis severity was classified according to the Kellgren–Lawrence system as grade III or IV. Any disagreement was resolved through consensus. Coronal-plane deformity was evaluated clinically and radiographically. Active knee flexion and extension were measured using a standard goniometer.

Clinical outcomes were assessed using the English or Urdu version of the Western Ontario and McMaster Universities Osteoarthritis Index according to the patient's language preference. The WOMAC contains 24 items

covering pain, stiffness and physical function. The pain subscale contains five items scored from 0 to 20, the stiffness subscale contains two items scored from 0 to 8, and the physical-function subscale contains 17 items scored from 0 to 68. The total WOMAC score ranges from 0 to 96, with higher scores indicating greater pain, stiffness and functional limitation.

The questionnaire was administered through face-to-face interviews by trained assessors to ensure the participation of patients with limited literacy. Baseline assessment was performed within two weeks before surgery, while follow-up assessments were completed at 6 and 12 postoperative weeks using the same questionnaire version, scoring method and mode of administration. The demographic, clinical and outcome variables recorded at each assessment are summarized in Table I.

Table I. Study Variables and Assessment Schedule

| Domain           | Variable or instrument                   | Preoperative | 6 weeks | 12 weeks |
|------------------|------------------------------------------|--------------|---------|----------|
| Demographic      | Age, sex, residence and education        | ✓            | —       | —        |
| Anthropometric   | Body mass index and obesity              | ✓            | —       | —        |
| Clinical         | Diabetes, hypertension and anaemia       | ✓            | —       | —        |
| Disease severity | Kellgren–Lawrence grade III or IV        | ✓            | —       | —        |
| Pain             | Numerical rating scale, 0–10             | ✓            | ✓       | ✓        |
| Pain             | WOMAC pain subscale, 0–20                | ✓            | ✓       | ✓        |
| Stiffness        | WOMAC stiffness subscale, 0–8            | ✓            | ✓       | ✓        |
| Function         | WOMAC function subscale, 0–68            | ✓            | ✓       | ✓        |
| Overall outcome  | Total WOMAC score, 0–96                  | ✓            | ✓       | ✓        |
| Knee movement    | Active flexion and extension             | ✓            | ✓       | ✓        |
| Rehabilitation   | Attendance and home-exercise record      | —            | ✓       | ✓        |
| Safety           | Wound problem, readmission and stiffness | —            | ✓       | ✓        |

All patients underwent cemented primary total knee arthroplasty through a standard medial parapatellar approach. Implant selection, patellar resurfacing and tourniquet use were determined by the operating consultant according to routine institutional practice. Antibiotic prophylaxis, venous thromboembolism prophylaxis and multimodal analgesia were provided according to the protocols of the participating hospitals.

Assisted mobilization was initiated on the first postoperative day when the patient was medically stable. The rehabilitation program included ankle-pump exercises, quadriceps activation, knee flexion and extension

exercises, transfer training and progressive walking with an appropriate aid. Patients received written and verbal instructions regarding home exercises at discharge.

Rehabilitation adherence was considered adequate when a patient completed at least 80% of the prescribed supervised sessions or home exercises. Adherence was assessed using physiotherapy attendance records and a patient-maintained exercise record. Patients unable to attend hospital-based physiotherapy were advised to receive supervised treatment locally or follow the structured home-exercise program with assistance from a family member.

Wound complications included persistent drainage, superficial infection or delayed wound healing requiring additional treatment. Postoperative stiffness was defined as knee flexion below 90° at the 12-week assessment. Unplanned readmission, manipulation under anesthesia, reoperation and other complications occurring during the follow-up period were documented.

Data were analyzed using SPSS version 26.0. Continuous and categorical variables were reported as mean±standard deviation and frequency (percentage), respectively. Repeated-measures ANOVA and appropriate group-comparison tests were applied. Multivariable linear regression identified predictors of 12-week WOMAC scores. A p-value <0.05 was considered statistically significant.

## RESULTS

Sixty-eight patients were initially recruited. Two patients did not attend the 12-week assessment, while one developed a medical

condition unrelated to surgery that prevented functional evaluation. The final analysis included 65 patients, giving a follow-up completion rate of 95.6%.

The mean age was 64.2±7.1 years, with a range of 49–78 years. Forty-three patients (66.2%) were women, and 39 (60.0%) lived in urban areas. The mean body mass index was 29.4±4.1 kg/m<sup>2</sup>, and 28 patients (43.1%) had obesity. Diabetes was present in 21 (32.3%), hypertension in 36 (55.4%) and anemia in 18 (27.7%) patients.

Twenty-seven patients (41.5%) had Kellgren–Lawrence grade-III osteoarthritis, while 38 (58.5%) had grade-IV disease. As shown in **Table II**, patients with grade-IV osteoarthritis had a longer duration of symptoms, higher preoperative pain scores, poorer WOMAC scores and reduced knee flexion. Age, sex, body mass index and the distribution of comorbidities were comparable between the groups.

Table II. Baseline Characteristics According to Radiographic Severity

| Characteristic                     | Total (n=65) | Grade III (n=27) | Grade IV (n=38) | p-value |
|------------------------------------|--------------|------------------|-----------------|---------|
| Age, years                         | 64.2±7.1     | 62.7±7.0         | 65.3±7.0        | 0.145   |
| Women                              | 43 (66.2)    | 17 (63.0)        | 26 (68.4)       | 0.648   |
| Body mass index, kg/m <sup>2</sup> | 29.4±4.1     | 28.8±3.9         | 29.9±4.2        | 0.286   |
| Obesity                            | 28 (43.1)    | 10 (37.0)        | 18 (47.4)       | 0.405   |
| Diabetes mellitus                  | 21 (32.3)    | 7 (25.9)         | 14 (36.8)       | 0.354   |
| Hypertension                       | 36 (55.4)    | 13 (48.1)        | 23 (60.5)       | 0.322   |
| Anaemia                            | 18 (27.7)    | 6 (22.2)         | 12 (31.6)       | 0.405   |
| Symptom duration, years            | 7.4±3.3      | 5.9±2.7          | 8.5±3.3         | 0.001   |
| Numerical pain score, 0–10         | 7.7±1.0      | 7.3±1.0          | 8.0±0.9         | 0.006   |
| Total WOMAC score, 0–96            | 68.4±10.5    | 63.4±9.1         | 72.0±10.1       | 0.001   |
| Knee flexion, degrees              | 93.9±13.4    | 99.1±12.1        | 90.2±13.2       | 0.007   |

Values are presented as mean±standard deviation or n (%). Higher WOMAC scores indicate poorer outcomes.

The mean total WOMAC score decreased from 68.4±10.5 before surgery to 43.6±10.2 at 6 weeks and 27.8±9.1 at 12 weeks (p<0.001). Significant improvement was observed in all three WOMAC domains.

The mean WOMAC pain score decreased from 14.8±2.3 to 5.7±2.1 at 12 weeks, while the stiffness score decreased from 5.8±1.2 to 2.4±1.0. The physical-function score decreased from 47.8±9.6 to 19.7±7.5. The

numerical pain score decreased from 7.7±1.0 to 2.6±1.1. These serial outcomes are presented in **Table III**.

Patients with grade-IV disease retained higher postoperative WOMAC scores than patients with grade-III disease. At 12 weeks, the mean total WOMAC score was 31.1±8.8 in the grade-IV group compared with 23.1±7.4 in the grade-III group (p<0.001). However, the mean reduction from baseline was 40.3±9.1 points in grade III and 40.9±9.8 points in grade IV (p=0.805).

Table III. Changes In Clinical and WOMAC Outcomes

| Outcome | Preoperative | 6 weeks | 12 weeks | p-value |
|---------|--------------|---------|----------|---------|
|---------|--------------|---------|----------|---------|

|                               |           |            |            |        |
|-------------------------------|-----------|------------|------------|--------|
| Total WOMAC score, 0–96       | 68.4±10.5 | 43.6±10.2  | 27.8±9.1   | <0.001 |
| WOMAC pain, 0–20              | 14.8±2.3  | 9.1±2.4    | 5.7±2.1    | <0.001 |
| WOMAC stiffness, 0–8          | 5.8±1.2   | 3.9±1.1    | 2.4±1.0    | <0.001 |
| WOMAC physical function, 0–68 | 47.8±9.6  | 30.6±8.7   | 19.7±7.5   | <0.001 |
| Numerical pain score, 0–10    | 7.7±1.0   | 4.1±1.2    | 2.6±1.1    | <0.001 |
| Knee flexion, degrees         | 93.9±13.4 | 101.8±11.2 | 111.6±10.4 | <0.001 |
| Full active extension         | 19 (29.2) | 39 (60.0)  | 56 (86.2)  | <0.001 |
| Independent ambulation        | 23 (35.4) | 42 (64.6)  | 57 (87.7)  | <0.001 |

Values are presented as mean±standard deviation or n (%). Lower WOMAC scores indicate improvement. Fifty-two patients (80.0%) demonstrated adequate rehabilitation adherence. The mean 12-week WOMAC score was 25.3±7.4 among patients with adequate adherence compared with 37.8±8.2 among those with inadequate adherence (p<0.001).

The multivariable analysis is presented in **Table IV**. Higher preoperative WOMAC score, greater body mass index, diabetes, Kellgren–Lawrence grade-IV disease and inadequate rehabilitation adherence were independently associated with a higher, and therefore poorer, 12-week WOMAC score. Age and sex were not independently associated with the outcome after adjustment.

Table IV. Multivariable Predictors of Poorer 12-Week WOMAC Outcome

| Predictor                              | Adjusted B coefficient | 95% confidence interval | p-value |
|----------------------------------------|------------------------|-------------------------|---------|
| Age, per year                          | 0.14                   | –0.06 to 0.34           | 0.166   |
| Female sex                             | 1.48                   | –1.36 to 4.32           | 0.301   |
| Preoperative WOMAC, per point          | 0.35                   | 0.20 to 0.50            | <0.001  |
| Body mass index, per kg/m <sup>2</sup> | 0.55                   | 0.18 to 0.92            | 0.004   |
| Diabetes mellitus                      | 4.20                   | 0.96 to 7.44            | 0.012   |
| Kellgren–Lawrence grade IV             | 4.02                   | 1.08 to 6.96            | 0.008   |
| Inadequate rehabilitation adherence    | 7.52                   | 3.87 to 11.17           | <0.001  |

Adjusted R<sup>2</sup>=0.64; overall model p<0.001. Positive coefficients indicate poorer outcomes.

At 12 weeks, 37 patients (56.9%) walked without an aid, and 20 (30.8%) used a single-point stick. Eight patients (12.3%) continued to require a walker or personal assistance. Five patients had knee flexion below 90°, while four experienced minor wound

complications. No prosthetic joint infection, symptomatic venous thromboembolism, perioperative mortality or early revision was recorded. The early outcomes according to disease severity are shown in **Table V**.

Table V. Early Postoperative Outcomes According to Disease Severity

| Outcome at 12 weeks               | Grade III (n=27) | Grade IV (n=38) | Total (n=65) | p-value |
|-----------------------------------|------------------|-----------------|--------------|---------|
| Total WOMAC score                 | 23.1±7.4         | 31.1±8.8        | 27.8±9.1     | <0.001  |
| Walking without an aid            | 18 (66.7)        | 19 (50.0)       | 37 (56.9)    | 0.181   |
| Using a single-point stick        | 7 (25.9)         | 13 (34.2)       | 20 (30.8)    | 0.476   |
| Walker or personal assistance     | 2 (7.4)          | 6 (15.8)        | 8 (12.3)     | 0.452   |
| Adequate rehabilitation adherence | 23 (85.2)        | 29 (76.3)       | 52 (80.0)    | 0.376   |
| Knee flexion below 90°            | 1 (3.7)          | 4 (10.5)        | 5 (7.7)      | 0.397   |
| Minor wound complication          | 1 (3.7)          | 3 (7.9)         | 4 (6.2)      | 0.638   |
| Unplanned readmission             | 0 (0.0)          | 2 (5.3)         | 2 (3.1)      | 0.508   |

## DISCUSSION

This multicenter study demonstrated substantial improvement in pain, stiffness, physical function and knee movement during

the first 12 weeks following total knee arthroplasty. The greatest improvement occurred during the initial six weeks, followed by continued recovery up to 12 weeks. This

pattern was consistent with evidence showing that restoration of muscle activation, mobility and daily activities occurs rapidly during the early postoperative period.[15]

Patients with Kellgren–Lawrence grade-IV osteoarthritis had poorer absolute WOMAC scores than patients with grade-III disease at 12 weeks. However, the magnitude of improvement from baseline was comparable between the two groups. Greater preoperative disability may therefore result in a poorer absolute postoperative score without indicating that the patient obtained less benefit from surgery.[16] Radiographic severity should be interpreted alongside pain, functional limitation, deformity and patient expectations when assessing suitability for arthroplasty.[17]

The preoperative WOMAC score was an important independent predictor of the 12-week outcome. Previous research has shown that baseline WOMAC scores, knee strength and performance-based mobility measures contribute to the prediction of function following knee arthroplasty.[18] Patients who undergo surgery with severe disability may experience clinically important improvement but require longer to regain independence in demanding daily activities.[18]

Higher body mass index was independently associated with poorer early outcomes. Increased body weight may make transfers, walking, knee movement and quadriceps strengthening more difficult during the initial rehabilitation period. Patients with and without obesity nevertheless experience substantial improvement following knee arthroplasty, although patients with obesity may retain poorer absolute pain and functional scores during short-term follow-up.[19] Obesity should therefore prompt individualized counseling, nutritional support and rehabilitation planning rather than automatic exclusion from surgery.

Diabetes was also associated with a poorer 12-week WOMAC score. Diabetes may interfere with recovery through delayed wound healing, neuropathy, reduced muscle performance and accompanying vascular or metabolic disease. Insulin-dependent diabetes has been associated with higher risks of wound complications, readmission and inferior functional outcomes following lower-limb arthroplasty. [20] Preoperative glycemic assessment, medication optimization and postoperative wound surveillance may support safer recovery.

Rehabilitation adherence showed a strong independent relationship with early functional outcome. Exercise adherence following knee arthroplasty is influenced by patient knowledge, confidence, comorbidities, postoperative symptoms, family support and access to professional guidance.[21] Clear instructions, realistic goals, positive reinforcement and caregiver involvement may improve adherence when frequent hospital-based physiotherapy is not possible.[21]

Evidence-based rehabilitation following knee arthroplasty includes early mobilization, knee range-of-motion exercises, progressive muscle strengthening and functional training. Different rehabilitation programs may produce comparable average improvements, but the program should be adapted according to baseline function, postoperative complications and available support.[22] Home-based pre habilitation may improve pain and function before surgery and reduce hospital stay, although its effect on postoperative outcomes remains variable.[23]

Age and sex were not independently associated with early function after preoperative status, body mass index, diabetes and rehabilitation adherence were considered. This finding suggested that functional reserve and modifiable health factors may provide more useful information than chronological age alone. Socioeconomic disadvantage may nevertheless affect symptom severity at presentation, access to rehabilitation and improvement following arthroplasty. [24]

The prospective multicenter design, standardized assessments and inclusion of routinely measurable factors strengthened the study. The use of Urdu or English WOMAC questionnaires through face-to-face interviews allowed the inclusion of patients with different educational backgrounds.

## CONCLUSION

Total knee arthroplasty produced substantial early improvement in pain, stiffness, knee movement and physical function. Patients with Kellgren–Lawrence grade-IV osteoarthritis achieved improvement comparable to patients with grade-III disease but retained greater absolute limitation at 12 weeks. Poorer preoperative WOMAC score, higher body mass index, diabetes and inadequate rehabilitation adherence independently predicted slower early recovery. Identification and optimization of these factors may improve patient

counseling, perioperative planning and allocation of rehabilitation resources in Pakistani tertiary-care hospitals.

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