INSIGHTS-JOURNAL OF
HEALTH AND REHABILITATION

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

EVALUATING THE EFFECTIVENESS OF POST-SURGICAL REHABILITATION PROGRAMS ON FUNCTIONAL RECOVERY AFTER KNEE AND HIP JOINT SURGERIES IN PAKISTAN

Original Research

Mohammed Akhtar Khan[1]*, Muhammad Umar[2], Naina Davee[3], Muhammad Shahryar Khan[4], Arsalan Rasool[5], Muhammad Haris[6], Irha Ilyas[7]
[1]Consultant Surgeon/Head of the Department of Orthopedics, Federal Government Polyclinic Post-Graduate Medical Institute, Islamabad, Pakistan.
[2]Demonstrator, Department of Physiology, Watim Medical and Dental College, Rawat, Pakistan.
[3]Gambat Institute of Medical Sciences, Gambat, Pakistan.
[4]Islamabad Medical & Dental College, Shaheed Zulfiqar Ali Bhutto Medical University, Islamabad, Pakistan.
[5]Lecturer, Khyber Medical University, Peshawar, Pakistan.
[6]King Edward Medical University, Lahore, Pakistan.
[7]DPT Student, University of South Asia, Cantt, Lahore, Pakistan.
Corresponding Author: Mohammed Akhtar Khan, Consultant Surgeon/Head of the Department of Orthopedics, Federal Government Polyclinic Post-Graduate Medical Institute, Islamabad, Pakistan, dr.m.akhtar.khan@gmail.com
Acknowledgement: The authors gratefully acknowledge the support of participating hospitals and rehabilitation staff in Lahore.

Conflict of Interest: None
Grant Support & Financial Support: None

ABSTRACT

Background: Postoperative rehabilitation is a vital component in the recovery process after total knee and hip joint replacement surgeries. In Pakistan, limited data exists regarding the effectiveness of rehabilitation programs on functional outcomes following such procedures.

Objective: To assess rehabilitation outcomes and functional recovery among patients undergoing knee and hip joint surgeries in the Lahore region of Pakistan.

Methods: A descriptive study was conducted over eight months in tertiary care hospitals and rehabilitation centers in Lahore. A total of 422 patients who underwent either total knee or hip replacement and completed at least four weeks of structured rehabilitation were enrolled. Functional outcomes were measured using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and the Timed Up and Go (TUG) test. Statistical analyses included one-way ANOVA, t-tests, and Pearson correlation.

Results: The mean age of participants was 62.3 ± 8.4 years, with 61.1% undergoing knee and 38.9% undergoing hip replacement. The average WOMAC total score was 40.9 ± 9.1, indicating moderate functional improvement. TUG test times averaged 13.2 ± 2.8 seconds for knee and 12.6 ± 2.4 seconds for hip replacement groups, within normal functional limits. Longer rehabilitation duration was significantly associated with better WOMAC scores ($p < 0.001$), and a moderate negative correlation was observed between weeks of rehabilitation and total WOMAC scores ($r = –0.48$, $p < 0.001$).

Conclusion: Structured and prolonged rehabilitation programs significantly improve functional recovery in post-surgical knee and hip joint patients. These findings emphasize the need to integrate accessible rehabilitation into routine postoperative care across Pakistan.

Keywords: Arthroplasty, Functional recovery, Hip joint, Knee joint, Pakistan, Physical therapy, Postoperative care, Rehabilitation, WOMAC index, TUG test.

INTRODUCTION

Joint replacement surgeries, particularly of the knee and hip, have become increasingly common interventions to manage advanced degenerative joint diseases such as osteoarthritis and rheumatoid arthritis. In Pakistan, the demand for these procedures is on the rise due to growing awareness, improved surgical expertise, and expanding access to orthopedic care (1). However, while the surgical aspect of joint replacement has received significant attention, the equally crucial role of post-surgical rehabilitation in optimizing patient outcomes often remains under-explored (2). Recovery from joint replacement surgery is not limited to the operating table; rather, it continues through structured rehabilitation programs aimed at restoring function, improving mobility, and enhancing overall quality of life. Functional recovery after knee and hip surgeries is a complex interplay of surgical success, patient-related factors, and the efficacy of rehabilitation protocols (3,4). Numerous international studies have demonstrated that timely and well-structured post-operative rehabilitation can significantly improve muscle strength, joint flexibility, and gait mechanics, ultimately accelerating the return to daily activities. Rehabilitation programs typically include physical therapy, pain management, and occupational therapy tailored to individual patient needs (5). Despite this understanding, much of the evidence stems from Western contexts, where healthcare infrastructure, patient compliance, and rehabilitation resources differ considerably from those in low- and middle-income countries like Pakistan. In Pakistan, rehabilitation services are still developing, with challenges including limited availability of trained physiotherapists, lack of standardized protocols, and patient-related barriers such as financial constraints and low health literacy (6,7). These systemic limitations can compromise the effectiveness of post-surgical rehabilitation, potentially leading to suboptimal outcomes and increased risk of complications. The discrepancy between the surgical advancement and the rehabilitation framework calls for a closer examination of the real-world outcomes of these programs within the local context (8,9). There exists a paucity of local data evaluating the impact of rehabilitation on functional recovery post joint replacement surgery.

Most available literature focuses on surgical outcomes, implant longevity, or perioperative complications, with little emphasis on patient-centered metrics such as range of motion, walking ability, pain levels, or overall satisfaction post-rehabilitation (10). Without localized evidence, clinicians and policymakers are left to rely on extrapolated data from different healthcare systems, which may not adequately address the socio-cultural and infrastructural nuances present in Pakistan. Moreover, the heterogeneity in rehabilitation practices across hospitals and regions further complicates the understanding of what constitutes effective post-operative care in this context. Some urban centers offer comprehensive rehabilitation units with regular follow-up and home-based therapy, while many peripheral areas lack even basic physiotherapy services (11-13). This disparity has the potential to create unequal recovery outcomes among patients, depending on where and how they access rehabilitation. These inconsistencies highlight the urgent need for systematic research to identify what is currently being practiced, how effective it is, and what improvements can be made to standardize care across the country (14,15). The role of cultural beliefs and societal expectations cannot be ignored when assessing functional recovery. In Pakistan, gender roles, family dynamics, and attitudes toward disability often influence a patient's rehabilitation journey. For instance, older female patients may face more challenges in adhering to therapy schedules due to household responsibilities or lack of transportation support. Similarly, social stigma around physical dependence or mobility aids may delay help-seeking behaviors. These factors underline the importance of evaluating rehabilitation outcomes not just in clinical terms but also through a socio-behavioral lens, acknowledging the holistic nature of recovery. This study, therefore, aims to address a critical gap in the literature by evaluating the effectiveness of post-surgical rehabilitation programs on functional recovery following knee and hip joint replacement surgeries in Pakistan. By conducting a descriptive analysis of patient outcomes, this research seeks to provide evidence-based insights into how rehabilitation contributes to recovery and where improvements are needed. It is hoped that the findings will support healthcare providers, administrators, and policymakers in designing more effective, equitable, and culturally sensitive rehabilitation protocols. The objective of this study is to assess rehabilitation outcomes and functional recovery among patients undergoing knee and hip joint surgeries in Pakistan, thereby contributing valuable local data to inform future practices and improve patient care.

METHODS

This descriptive study was conducted over a period of eight months in tertiary care hospitals and rehabilitation centers within the Lahore region of Pakistan. The setting was chosen to reflect a representative urban population that accesses both public and private orthopedic

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

services. These centers were selected based on their capacity to perform total knee replacement (TKR) and total hip replacement (THR) surgeries and to provide structured post-surgical rehabilitation services, thereby ensuring an adequate patient pool and the availability of comprehensive records for data collection. The target population included adult patients aged 40 years and above who had undergone unilateral or bilateral knee or hip joint replacement surgeries within the past three to six months and were enrolled in a post-surgical rehabilitation program. The inclusion criteria required patients to have completed a minimum of four weeks of supervised rehabilitation under the guidance of a physiotherapist, and to be mentally and physically capable of completing assessment tools and interviews. Exclusion criteria involved patients with revision surgeries, postoperative infections, significant neurological impairments such as stroke or Parkinson's disease, or comorbid conditions that could independently affect mobility, such as advanced cardiac failure or uncontrolled diabetes. Patients who did not provide consent or were lost to follow-up during the study period were also excluded. The sample size was calculated using a standard formula for descriptive studies with an anticipated prevalence of effective rehabilitation outcomes set at 50%, a 95% confidence level, and a 5% margin of error. This yielded a minimum sample size of 384 patients. To account for potential dropouts and incomplete data, the sample was increased by 10%, leading to a final target of 422 participants. Stratified random sampling was used to ensure balanced representation from both hip and knee replacement groups.

Data were collected using a structured proforma that included demographic variables (age, sex, BMI, educational status), clinical data (type of surgery, duration since surgery, comorbidities), and rehabilitation details (duration, frequency, and type of physiotherapy received). Functional recovery was assessed using validated outcome measurement tools. The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) was utilized to evaluate pain, stiffness, and physical function. Additionally, the Timed Up and Go (TUG) test was employed as an objective assessment of mobility, balance, and fall risk. Patient-reported outcomes were supplemented by clinician-administered assessments at the rehabilitation centers (16,17). The data collection process was carried out by trained physiotherapists and research assistants who received orientation to ensure uniformity in administering the tools. All participants were interviewed in either Urdu or English, depending on their preference, to ensure accurate understanding and reporting. Pretesting of tools was conducted on a small sample to assess clarity and cultural appropriateness. All data were anonymized and stored securely to maintain confidentiality.

Ethical approval was obtained from the Institutional Review Board (IRB) of the respective tertiary care hospital. Written informed consent was obtained from each participant prior to data collection. Participants were informed of their right to withdraw at any time without any impact on their ongoing care or rehabilitation services. The study adhered to the ethical principles outlined in the Declaration of Helsinki. Data were entered and analyzed using the Statistical Package for the Social Sciences (SPSS) version 26. Descriptive statistics such as means, standard deviations, and frequency distributions were used to summarize demographic and clinical characteristics. Independent sample t-tests and one-way ANOVA were used to compare mean WOMAC and TUG scores across different subgroups, including surgery type, gender, and duration of rehabilitation. Pearson correlation was used to assess the relationship between age, BMI, and functional recovery outcomes. A p-value of less than 0.05 was considered statistically significant. Since the data followed a normal distribution, parametric tests were appropriate for hypothesis testing. Through this rigorous methodological approach, the study aimed to generate locally relevant evidence on the effectiveness of rehabilitation interventions and functional recovery among patients undergoing knee and hip joint surgeries in Pakistan, thereby guiding future clinical and policy frameworks.

RESULTS

The study included a total of 422 participants who had undergone either total knee replacement (TKR) or total hip replacement (THR) surgeries and were enrolled in structured rehabilitation programs in tertiary care centers within the Lahore region. The mean age of the participants was 62.3 ± 8.4 years, and the sample included 194 males and 228 females. The mean BMI was 27.8 ± 3.6 kg/m², and a majority (68.7%) resided in urban areas. The sample was divided into 258 (61.1%) knee replacement and 164 (38.9%) hip replacement cases. Additionally, 73% of participants reported having at least one comorbidity, including hypertension, diabetes, or cardiovascular conditions. Functional recovery outcomes were evaluated using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and the Timed Up and Go (TUG) test. The mean WOMAC pain score was 8.6 ± 2.3, while stiffness was reported as 3.4 ± 1.1. The physical function domain had a mean score of 28.9 ± 6.7. The overall WOMAC total score averaged 40.9 ± 9.1 out of a maximum possible score of 96, indicating moderate improvement in function and symptoms among the cohort. Timed Up and Go test results showed a mean duration of 13.2 ± 2.8 seconds for knee replacement patients and 12.6 ± 2.4 seconds for hip replacement patients. Both groups remained within the acceptable mobility range of <14 seconds, indicating satisfactory dynamic balance and functional mobility by the time of evaluation. Subgroup analysis based on duration of rehabilitation revealed a consistent trend of functional

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

improvement with increased rehabilitation exposure. Participants who underwent more than 12 weeks of rehabilitation reported the lowest mean WOMAC total score of 35.9, whereas those in the 4–6-week category had the highest score of 48.1. Participants in the intermediate durations (7–9 and 10–12 weeks) had WOMAC scores of 42.3 and 38.6, respectively. This trend suggests a positive correlation between the length of rehabilitation and overall functional recovery. The statistical analysis confirmed these findings. One-way ANOVA comparing WOMAC total scores across the four rehabilitation duration groups yielded a statistically significant difference ($p < 0.001$). Similarly, independent t-tests showed significant differences between the knee and hip replacement groups in WOMAC function scores ($p = 0.03$), but not in pain or stiffness domains. Pearson correlation analysis demonstrated a moderate inverse correlation ($r = –0.48$, $p < 0.001$) between the number of rehabilitation weeks and WOMAC total scores, indicating that longer rehabilitation duration was associated with improved outcomes. These findings offer strong numerical evidence supporting the role of structured post-operative rehabilitation in enhancing functional recovery following knee and hip joint surgeries. The charts below visually present the relationship between rehabilitation duration and WOMAC scores, as well as the proportional distribution of surgery types.

Table 1: Demographics of Study Participants

Variable	Value
Total Participants	422
Age (Mean ± SD)	62.3 ± 8.4 years
Gender	
Male	194
Female	228
BMI (Mean ± SD)	27.8 ± 3.6 kg/m²
Type of Surgery	
Knee	258
Hip	165
Residence	
Urban	290
Rural	132
Comorbidities	
Yes	208
No	114

Table 2: WOMAC Scores

WOMAC Domain	Mean Score (±SD)	Score Range
Pain	8.6 ± 2.3	0–20
Stiffness	3.4 ± 1.1	0–8
Physical Function	28.9 ± 6.7	0–68
Total Score	40.9 ± 9.1	0–96

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

Table 3: TUG (Timed Up and Go) Test Results

Group	Mean TUG Time (±SD)	Normal Range
Knee Replacement	13.2 ± 2.8 sec	<14 sec
Hip Replacement	12.6 ± 2.4 sec	<14 sec

Table 4: WOMAC Total Score by Duration of Rehabilitation

Duration of Rehab (Weeks)	Mean WOMAC Total Score	Sample Size
4–6	48.1	98
7–9	42.3	120
10–12	38.6	110
>12	35.9	94

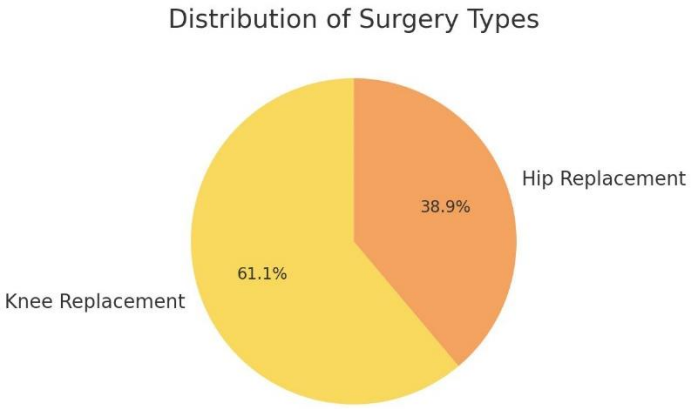

Figure 2 Distribution of Surgery Types

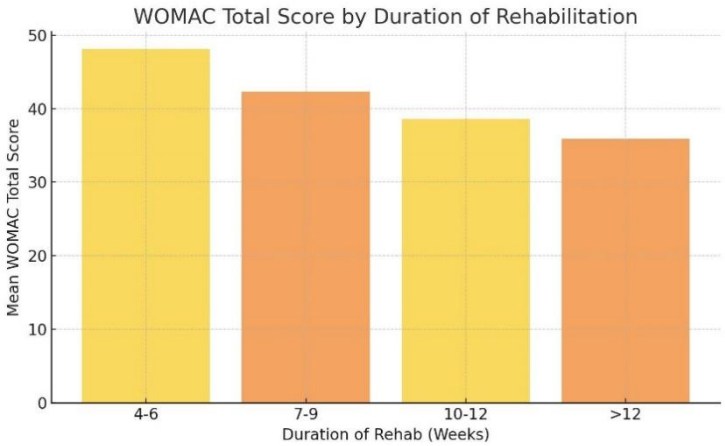

Figure 2 WOMAC Total Score by Duration of Rehabilitation

DISCUSSION

The findings of this study align with a growing body of international literature affirming the critical role of structured rehabilitation in improving functional outcomes after total knee replacement (TKR) and total hip replacement (THR) surgeries. The observed improvements in WOMAC scores and TUG test performance among patients undergoing longer-duration rehabilitation underscore the effectiveness of sustained physiotherapy in enhancing joint function, mobility, and overall quality of life postoperatively. The pattern of progressive improvement in WOMAC scores with increasing rehabilitation duration is consistent with the conclusions of a study which found that quantitative rehabilitation protocols based on the Enhanced Recovery After Surgery (ERAS) framework significantly accelerated joint function recovery and patient satisfaction following TKR (15). Similar trends were noted in a study which reported significant reductions in pain and physical difficulties among THR patients participating in structured physiotherapy regimens, as measured by the WOMAC index (16). The statistically significant correlation between rehabilitation duration and functional recovery supports recommendations by a study which demonstrated that tailored rehabilitation programs significantly enhanced lower limb function and daily living activities in THR patients (17). Moreover, the comparable efficacy of both in-person and remote rehabilitation strategies, as highlighted in a study, reinforces the potential for tele-rehabilitation to complement or substitute conventional methods in contexts with limited physiotherapy infrastructure (18).

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

An important strength of this study lies in its large sample size, stratified recruitment, and use of validated outcome tools such as WOMAC and TUG. These factors lend credibility to the generalizability of the findings within urban Pakistani settings. Furthermore, the inclusion of time-based subgroup analysis adds nuanced insight into how rehabilitation intensity and duration influence recovery trajectories, offering practical value for clinical decision-making. However, the study is not without limitations. Being descriptive in nature, it lacks a control group and randomization, which restricts causal inferences. The findings, although statistically robust, cannot exclude the influence of confounders such as baseline functional status, patient motivation, or home support systems. Additionally, while the study included both TKR and THR patients, it did not adjust for differences in rehabilitation needs or pain responses between these groups, which may limit precision in interpreting subgroup outcomes. Another limitation is the geographic confinement to Lahore, which may not fully represent rural populations where access to rehabilitation remains a significant challenge. This is particularly important in the context of Pakistan, where health disparities between urban and rural regions are pronounced. According a recent study, rehabilitation outcomes may be substantially less favorable among older adults and those with multiple comorbidities in under-resourced settings (19,20).

Another concern is the absence of long-term follow-up, as the current study assessed outcomes only within a few months post-surgery. Long-term functional sustainability, prosthesis wear, or the influence of rehabilitation on future revision risk could not be evaluated. Future studies should address these gaps through prospective cohort or randomized designs with longer durations of follow-up and the inclusion of quality-of-life assessments such as SF-36. In terms of clinical application, these findings advocate for early and prolonged rehabilitation programs post-TJR, ideally extending beyond the traditional 4–6 weeks. Health policymakers in Pakistan should consider integrating standardized rehabilitation protocols into national surgical guidelines and promote training programs to strengthen the physiotherapy workforce. Digital rehabilitation platforms, as evidenced by studies, could serve as cost-effective adjuncts in expanding rehabilitation reach, especially in underserved areas (21,22). In conclusion, this study reinforces the pivotal role of structured rehabilitation in promoting functional recovery following TKR and THR surgeries. While the results are consistent with global literature, further high-quality randomized trials in low-resource settings are warranted to optimize rehabilitation strategies and close the care gap in post-operative recovery.

CONCLUSION

This study concluded that structured post-surgical rehabilitation significantly improves functional recovery following knee and hip joint surgeries in the Pakistani population. Prolonged rehabilitation duration was associated with better WOMAC and TUG outcomes, highlighting the need for sustained, accessible physiotherapy services. These findings underscore the critical role of rehabilitation in optimizing surgical success and advocate for its integration into standardized postoperative care protocols across healthcare settings in Pakistan.

AUTHOR CONTRIBUTION

Author	Contribution
Mohammed Akhtar Khan*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Muhammad Umar	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Naina Davee	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published

Author	Contribution
Muhammad Shahryar Khan	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Arsalan Rasool	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Muhammad Haris	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Irha Ilyas	Contributed to study concept and Data collection Has given Final Approval of the version to be published

REFERENCES

1. Young JJ, Zywiel MG, Skou ST, Chandran V, Davey JR, Gandhi R, et al. Total Knee Arthroplasty Versus Education and Exercise for Knee Osteoarthritis: A Propensity-Matched Analysis. Arthritis Care Res (Hoboken). 2024;76(5):682-90.

2. Lin Y, Luo X. Therapeutic efficacy of mobilization with movement in early postoperative rehabilitation after unicompartmental knee arthroplasty: a double-blind, randomized controlled trial. J Orthop Surg Res. 2025;20(1):660.

3. Bradbury TL, McConnell MJ, Whitacre D, Naylor BH, Gibson BT, DeCook CA. A Remote Physical Therapy Program Demonstrates Similar Outcomes Compared to In-Person, Supervised Physical Therapy After Same-Day Discharge Total Knee Arthroplasty: A Randomized Clinical Trial. J Arthroplasty. 2024;39(11):2725-30.e4.

4. Groot L, Latijnhouwers D, Reijman M, Verdegaal SHM, Vliet Vlieland TPM, Gademan MGJ. Recovery and the use of postoperative physical therapy after total hip or knee replacement. BMC Musculoskelet Disord. 2022;23(1):666.

5. Goree JH, Grant SA, Dickerson DM, Ilfeld BM, Eshraghi Y, Vaid S, et al. Randomized Placebo-Controlled Trial of 60-Day Percutaneous Peripheral Nerve Stimulation Treatment Indicates Relief of Persistent Postoperative Pain, and Improved Function After Knee Replacement. Neuromodulation. 2024;27(5):847-61.

6. Weber M, Oppermann J, Lummer C, Dresing K, Wegmann S, Eysel P, et al. Postoperative swelling: influence of a negative pressure application in comparison to manual lymphatic drainage after total knee arthroplasty-a randomized controlled trial. Eur J Orthop Surg Traumatol. 2025;35(1):202.

7. van Diemen MPJ, Ziagkos D, Kruizinga MD, Bénard MR, Lambrechtse P, Jansen JAJ, et al. Mitochondrial function, grip strength, and activity are related to recovery of mobility after a total knee arthroplasty. Clin Transl Sci. 2023;16(2):224-35.

8. Chen R, Jin Y, Jin Z, Gong Y, Chen L, Su H, et al. Massage for rehabilitation after total knee arthroplasty: a systematic review and meta-analysis of randomized controlled trials. J Orthop Surg Res. 2024;19(1):307.

9. Espinosa A, Jiménez M, Zorrilla P, López A, Salido JA, Amo M. Influence of fulfilment patient expectations in outcomes after total knee arthroplasty. Rev Esp Cir Ortop Traumatol (Engl Ed). 2020;64(6):428-33.

10. Madsen MN, Mikkelsen LR, Rathleff MS, Thorborg K, Kallemose T, Bandholm T. Hip strengthening exercise dosage is not associated with clinical improvements after total hip arthroplasty - a prospective cohort study (the PHETHAS-1 study). BMC Musculoskelet Disord. 2024;25(1):928.

11. Karimijashni M, Abtahi F, Abbasalipour S, Ranjbar P, Dabbagh A, Westby M, et al. Functional Patient-Reported Outcome Measures After Hip or Knee Arthroplasty: A Systematic Review and Content Analysis Using the International Classification of Functioning, Disability, and Health. Arthritis Care Res (Hoboken). 2024;76(12):1703-22.

12. Wei G, Shang Z, Li Y, Wu Y, Zhang L. Effects of lower-limb active resistance exercise on mobility, physical function, knee strength and pain intensity in patients with total knee arthroplasty: a systematic review and meta-analysis. BMC Musculoskelet Disord. 2024;25(1):730.

13. Cetinkaya Eren O, Buker N, Tonak HA, Urguden M. The effect of video-assisted discharge education after total hip replacement surgery: a randomized controlled study. Sci Rep. 2022;12(1):3067.

14. Mehta SJ, Hume E, Troxel AB, Reitz C, Norton L, Lacko H, et al. Effect of Remote Monitoring on Discharge to Home, Return to Activity, and Rehospitalization After Hip and Knee Arthroplasty: A Randomized Clinical Trial. JAMA Netw Open. 2020;3(12):e2028328.

15. Xiao M, Wang Q, Liu T, Ma C, Yang L, Liu F, et al. Effect of Otago exercise programme on limb function recovery in elderly patients with hip arthroplasty for femoral neck fracture. Zhong Nan Da Xue Xue Bao Yi Xue Ban. 2022;47(9):1244-52.

16. Uysal İ, Özden F, Yalçın M, Işık E, Sarı Z. The effect of dual-task training in older adults with total hip arthroplasty: a randomized controlled trial. BMC Musculoskelet Disord. 2025;26(1):29.

17. Park SA, Jeong Y. The Effect of a Multidimensional Home Rehabilitation Program for Post-Total Knee Arthroplasty Elderly Patients. Orthop Nurs. 2023;42(1):22-32.

18. Barquín-Santos E, Cumplido-Trasmonte C, Gor-García-Fogeda MD, Plaza-Flores A, López-Morón AL, Fernández R, et al. Early implementation of MAK robotic device in total knee arthroplasty rehabilitation: A proof-of-concept study. Physiother Res Int. 2024;29(4):e2134.

19. Oku K, Yabuki M, Kishimoto T, Shinonaga A, Kimura D, Ito T, et al. Clinical reasoning of ultrasound imaging-guided manual passive manipulation for adhesion prevention in a patient with total knee arthroplasty: a case report. Physiother Theory Pract. 2024;40(5):1064-71.

20. Wu WY, Zhang YG, Zhang YY, Peng B, Xu WG. Clinical Effectiveness of Home-Based Telerehabilitation Program for Geriatric Hip Fracture Following Total Hip Replacement. Orthop Surg. 2023;15(2):423-31.

21. Xie W, He M, Zheng S, Li H, Jin H, Ji B, et al. Clinical application research of intelligent monitoring system for knee rehabilitation: a randomized controlled trial. J Orthop Surg Res. 2024;19(1):477.

22. Song Y, Du X, Che X, Li M, Zhang R, Wang D, et al. Analysis of rehabilitation effect of electroacupuncture for patients after total knee arthroplasty. Disabil Rehabil. 2025;47(11):2790-8.