Comparative Analysis of Real-World Recovery After Total Hip vs. Total Knee Replacement: Insights from 25,248 Days of iPhone Activity Data

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INTRODUCTION: Patient recovery is variable and not always easy to track. Many previous studies on orthopedic procedures rely on patient surveys or clinical tests, which may not fully represent a patient's real-life, daily activity. iPhone-based activity tracking provides a novel, low-burden solution that continuously captures patient activity (step count, distance, exercise minutes, and more) throughout daily life. This study compares the real-world recovery times of 14 total hip and 15 total knee replacement patients, as measured by smartphone-based activity data.

METHODS: A custom iOS app enabled patients to upload four years of historical iPhone activity data in under five minutes. Encrypted data was stored in a secure, cloud-hosted AWS database. Data were tracked retrospectively for 14 total hip and 15 total knee patients (ages 30–90, mixed racial/ethnic distribution) from two years pre-procedure up to two years post-procedure or present day, totaling 25,248 days of activity. Data processing used Python, Pandas, Matplotlib, and AWS (DynamoDB, Lambda & GraphQL). Step counts and activity metrics were normalized to pre-surgery medians; paired t-tests assessed post-operative changes.

RESULTS: A significant ($p < 0.05$) decline in step counts was observed immediately after surgery for both groups: 14 days for hip and 28 days for knee patients. Both cohorts ultimately recovered to meet or exceed pre-procedure activity levels, with hip patients recovering in 15 weeks and knee patients in 12 weeks. Knee recovery trajectories were more variable, with evidence of temporary pullbacks in activity between 3–4 months post-procedure [Figure 3]. Individual recovery patterns were influenced by factors like seasonality and pre-procedure events [Figures 4 & 5]. Figure 1 shows median weekly step count trajectories: hip patients starting at ~20% of baseline, reaching 100% by week 15, and plateauing around 120%; knee patients starting at ~10%, reaching 100% by 12 weeks, and plateauing at 120–150% of baseline after an initial temporary decline. Figure 2 mitigated seasonal impacts by plotting year-over-year knee patient activity changes, confirming similar patterns. Figures 3a & 3b present recovery percentages: 100% of hip patients ultimately met pre-procedure step counts, while 20% of knee patients still had down weeks at 7 months. Figure 4 suggests that recovery may continue beyond 7 months. Figures 5a–5c highlight sample patient data, demonstrating seasonal and individual variation in activity patterns.

DISCUSSION AND CONCLUSION: This study demonstrates the feasibility and value of smartphone-based activity data to capture real-world recovery in total hip and knee replacement patients. While both groups showed significant early declines, most patients recovered to or exceeded pre-surgery levels by 15 weeks (hip) and 12 weeks (knee). The more variable recovery in knee patients – characterized by temporary activity reductions – emphasizes the need for personalized care plans and continuous monitoring. The app-based approach reduces patient burden and enables secure, automated, and ongoing data uploads every three months for up to two years post-procedure. This framework also facilitates future expansion, including additional patients and Apple Watch data for sleep and balance analysis. Overall, these findings highlight how real-world activity data can transform orthopedic recovery tracking, supporting tailored, data-driven care for THR and TKR patients.