LINK MEDICAL JOURNAL
of Health and Community Research | LMJHCR
Volume 4, Issue 1 | June 2026 | ISSN 3007-3448

DOI: 10.61919/d8xkar10

Original Article

Beyond the Step Count: A Qualitative Study of Patient and Clinician Experiences with Wearable-Supported Rehabilitation After Major Orthopedic Surgery

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"Cite this Article" | **Received**: 10 March 2026; **Accepted**: 08 June 2026; **Published**: 30 June 2026.

ABSTRACT

Background: Wearable technologies can make recovery after major lower-limb orthopedic surgery more visible, but their clinical value depends on how patients and clinicians interpret and act on the data they produce. Qualitative inquiry is needed to understand motivation, reassurance, anxiety, clinical meaning, workload, and digital exclusion. Objective: To explore patient and clinician experiences of wearable-supported rehabilitation and identify conditions under which wearable data are perceived as supportive, clinically meaningful, and feasible. Methods: An interpretive qualitative descriptive interview study included 14 purposively selected participants: nine postoperative patients and five clinicians involved in orthopedic rehabilitation. Semi-structured interviews were analyzed using reflexive thematic analysis. Results: Four themes were developed: numbers as reassurance and momentum; quantified recovery as pressure; data requiring clinical context; and remote visibility creating new work and inequities. Personal trends could make progress tangible, whereas inflexible targets could be experienced as judgment. Clinicians interpreted longitudinal patterns alongside symptoms, function, and circumstances. Remote monitoring was perceived as useful only when review responsibilities, escalation pathways, technical support, and non-digital alternatives were clear. Conclusion: Participants perceived wearables as most acceptable when they supported conversation rather than replaced it. Personalized goals, contextualized feedback, defined monitoring responsibilities, and equitable access are important sustainability conditions. Keywords: wearable technology; orthopedic rehabilitation; total knee arthroplasty; total hip arthroplasty; qualitative research; remote monitoring.

EDITORIAL INFORMATION

Author Contributions: Concept: DHA, NA; Design: DHA, YAL, MLA; Data Collection: AP, RMM, QAS, IA; Analysis: DHA, YAL, NA; Drafting: DHA, YAL, MLA, AP, RMM, QAS, IA, NA

Ethical Approval: Universitas Prima Indonesia, Medan, Indonesia

Informed Consent: Written informed consent was obtained from all participants

Conflict of Interest: The authors declare no conflict of interest; **Funding**: No external funding; **Data Availability**: Available from the corresponding author on reasonable request; **Acknowledgments**: N/A.

INTRODUCTION

Recovery after major lower-limb orthopedic surgery requires patients to translate clinical advice into repeated activity, exercise, pacing, and self-management at home. Total knee and hip arthroplasty illustrate this challenge: surgery may reduce pain and improve function, yet recovery trajectories vary and conventional follow-up provides only intermittent views of what happens between appointments. Smartphone applications, activity trackers, inertial sensors, and sensor-enabled exercise systems have therefore been introduced to make postoperative activity and functional change more visible. A systematic review of randomized studies found potential benefits across adherence, mobility, pain management, and satisfaction, but also substantial heterogeneity in technologies, outcomes, and delivery models (1).

Trials suggest that digitally supported rehabilitation can be feasible in selected arthroplasty populations. Smartwatch-linked self-directed rehabilitation produced short-term outcomes comparable with conventional pathways in one randomized trial, activity-tracker feedback increased daily step counts after hip or knee arthroplasty, and remote physical therapy achieved similar outcomes to supervised outpatient therapy after same-day discharge total knee arthroplasty in another selected cohort (2-4). These findings describe clinical outcomes but do not determine how patients interpret fluctuating numbers or how clinicians decide whether a pattern requires reassurance, treatment modification, or escalation.

Experience and acceptability evidence indicates that technology is often valued when it strengthens access, feedback, and continuity rather than replacing professional contact. Patients using remote-monitoring and app-based programs have generally reported ease of use and motivation, while many continue to prefer hybrid rehabilitation. Studies of patients considering wearable monitoring, qualitative syntheses of telerehabilitation experiences, and user-centered work with patients and physiotherapists similarly emphasize personalization, usability, timely communication, progress feedback, and therapist oversight (5-8). Qualitative methods are therefore necessary to examine meanings that outcome trials cannot capture, including when numerical targets reassure, become moralized as success or failure, alter patient-clinician communication, or create uncertainty about who is monitoring the data.

Wearable measures may complement rather than replicate patient-reported outcomes. Sensor-based studies have detected postoperative gait and mobility dimensions that are not consistently represented by standard clinical measures, and objective trajectories may diverge from patients' reports of pain or function (9-11). This additional information creates an interpretive problem because device placement, algorithms, adherence, symptoms, and daily circumstances can all influence a recorded pattern, while methodological inconsistency continues across clinical applications of wearable motion sensors (12). Expectations also shape how recovery is judged; patients may anticipate pain relief, mobility, and return to valued activities along a more linear path than their actual recovery follows (13). A plateau or low daily score can therefore become psychologically consequential even when it reflects appropriate pacing rather than clinical deterioration.

Access and implementation further determine whether monitoring is supportive. Digital-literacy research demonstrates substantial variation among older adults in device skills, confidence, and appraisal of digital health information (14,15). Wearable-supported rehabilitation may consequently redistribute work to patients, family members, and clinicians while excluding people who lack compatible devices, connectivity, vision, dexterity, language support, or confidence. Using a SPIDER-informed qualitative focus, this study examined postoperative patients and rehabilitation clinicians, wearable-supported recovery as the phenomenon of interest, semi-structured interviews as the design, perceived meaning and acceptability as the evaluation, and qualitative analysis as the research type. The objectives were to explore how patients and clinicians interpreted recovery metrics, identify barriers and facilitators affecting motivation and communication, assess perceived acceptability and burden, and define conditions considered necessary for clinically meaningful and sustainable use.

MATERIALS AND METHODS

An interpretive qualitative descriptive design was used to explore experiences of wearable-supported rehabilitation after major lower-limb orthopedic surgery. The design was selected to examine how participants understood recovery data and how those interpretations shaped reassurance, motivation, communication, and perceived responsibility. The final sample comprised 14 participants: nine postoperative patients recovering from total knee arthroplasty, total hip arthroplasty, or lower-limb fracture repair, and five clinicians working in physiotherapy, orthopedic practice, or rehabilitation nursing. Purposive sampling sought variation in operation type, rehabilitation experience, digital confidence, and professional role. The purpose was conceptual breadth rather than statistical representativeness.

A semi-structured interview guide addressed five areas: experiences of wearing and maintaining the device; interpretation of step counts, movement measures, or exercise-completion data; responses to goals, reminders, and alerts; use of wearable information in patient-clinician communication; and decisions about seeking reassurance, adjusting activity, or escalating concerns. Patients were assigned anonymous identifiers P1-P9 and clinicians C1-C5 in the analytic report and supporting quotations.

Data were analyzed using Braun and Clarke's reflexive thematic analysis (16,17). Analysis began with repeated reading to develop familiarity with the participant accounts. Semantic content concerning motivation, usability, and reassurance was coded alongside interpretive concepts including self-surveillance, responsibility, uncertainty, and redistribution of clinical work. Codes were compared within and across patient and clinician accounts and organized into candidate themes. Candidate themes were reviewed for internal coherence, distinction from one another, and their capacity to explain tensions in wearable-supported rehabilitation rather than merely summarize opinions. Divergent and disconfirming accounts were retained so that technology acceptance was not represented as homogeneous. The final thematic structure captured how wearable data shaped meaning, communication, responsibility, and access.

Trustworthiness was supported through an explicit coding trail, repeated comparison of candidate themes with participant accounts, attention to divergent cases, and reflexive consideration of how assumptions about digital innovation could privilege favorable interpretations. Comparing patient and clinician accounts provided source triangulation across experiential and professional perspectives. The revised report was prepared with reference to the Consolidated Criteria for Reporting Qualitative Research and the Standards for Reporting Qualitative Research (18,19). Ethical approval was obtained from Universitas Prima Indonesia.

RESULTS

The analysis included accounts from nine postoperative patients and five rehabilitation clinicians. Four themes described how wearable metrics could support recovery while also creating psychological, interpretive, organizational, and access-related tensions. Table 1 reports explicit representation by participant group; frequency intensity was not estimated.

Table 1. Theme matrix by participant group

Theme	Patient accounts	Clinician accounts	Cross-group interpretation	IDs
Numbers as reassurance and momentum	Present: weekly trends and small step gains made progress visible.	Present: longitudinal change summarized accumulated effort.	Personal trajectories were more meaningful than generic targets.	P1, P2, C1
Quantified recovery can become pressure	Present: low scores could be experienced as failure or device inconsistency.	Present: numbers could become judgments without explanation of normal fluctuation.	The same metric could motivate or moralize recovery.	P4, C2
Data requires clinical context	Present: patients sought help reconciling rising activity with persistent symptoms.	Present: clinicians interpreted trends alongside pain, sleep, confidence, and circumstances.	Wearable output functioned as a prompt for inquiry, not a standalone conclusion.	C3, C4
Remote visibility creates new work and new inequities	Present: device linkage and digital support affected continued use.	Present: dashboards created expectations about review, response, and out-of-hours monitoring.	Continuity depended on clear responsibility and inclusive support.	P9, C5

Presence is based on explicit representation in the thematic narrative and excerpts; it is not a frequency estimate.

Theme 1: Numbers as reassurance and momentum

Patients described postoperative progress as difficult to judge when pain, stiffness, and fatigue varied from day to day. Weekly graphs and small gains made change tangible when subjective improvement remained uncertain. Clinicians described a similar function but emphasized patterns over isolated readings. Across groups, comparison with a patient's own baseline was perceived as more useful than applying a generalized activity threshold. Wearable data therefore appeared to support motivation most clearly when it documented personal momentum without prescribing a rigid pace.

Theme 2: Quantified recovery can become pressure

Visibility also created pressure. Patients could interpret a low activity score as evidence that they had failed, even when they had been active in ways the device did not capture or had paced activity in response to symptoms. Clinicians similarly recognized that numbers could become judgments when normal fluctuation was not explained. Technical inconsistency intensified this problem by weakening confidence in the metric while leaving its emotional authority intact. The tension concerned not monitoring alone but uncertainty about how strictly targets should be followed and whether rest would be interpreted as non-adherence.

Theme 3: Data requires clinical context

Clinicians resisted treating wearable output as self-explanatory. A decline in activity was perceived as a prompt to ask about pain, sleep, confidence, home circumstances, and device use, while persistent decline accompanied by worsening symptoms was considered more concerning than a single low reading. Patients also wanted help reconciling objective improvement with continuing stiffness or uncertainty. These accounts supported a complementary model in which sensor trends, symptoms, function, and clinical judgment were interpreted together rather than treated as competing sources of truth.

Theme 4: Remote visibility creates new work and new inequities

Remote monitoring was perceived to extend care beyond scheduled appointments, but visibility created expectations that someone would review the dashboard and respond when recovery deviated from expectations. This generated questions about review frequency, alert thresholds, documentation, and out-of-hours responsibility.

Table 2. Representative quotations supporting themes and subthemes

Subtheme	Verbatim quotation	Participant
Progress over time	"I could not feel improvement each day, but the weekly graph offered me proof that I was making progress, rather than telling me what to do."	P1, patient after knee surgery
Small gains as momentum	"Adding two hundred steps felt insignificant, but after the surgery they got something I could measure and see that I am moving forward."	P2, patient after knee arthroplasty
Trends summarize effort	"Quantification was effective when patients observed the progression, as they could prompt improvement when their pain scale score was not significantly altered, but instead displayed the summation of effort."	C1, physiotherapist
Low scores as failure	"When the number was low, then I felt unsuccessful in the day, though I was actually quite active doing something, too bad about the tech inconsistent with the result."	P4, postoperative patient
Numbers as judgment	"A number can be motivational, however, it can also become a judgement when nobody tells why a recovery has ups and downs."	C2, rehabilitation nurse
Contextual inquiry	"When there was a drop in action I would have wanted to know about pain and sleep and confidence and what occurred at home and so forth."	C3, physiotherapist
Concerning patterns	"Data patterns of continuous decline with worsening symptoms are what make me concern myself."	C4, orthopedic clinician
Monitoring expectations	"When patients become aware that the dashboard is part of the system, they would rightly think that someone will take notice when their recovery is not going as expected."	C5, physiotherapist

Participation also depended on digital resources. One patient relied on a daughter to link the device and might otherwise have stopped using it. Connectivity, charging, language, vision, dexterity, and confidence were therefore linked to continuity and safety rather than convenience alone. Across the four themes, wearables were perceived as most useful when data remained secondary to clinical conversation.

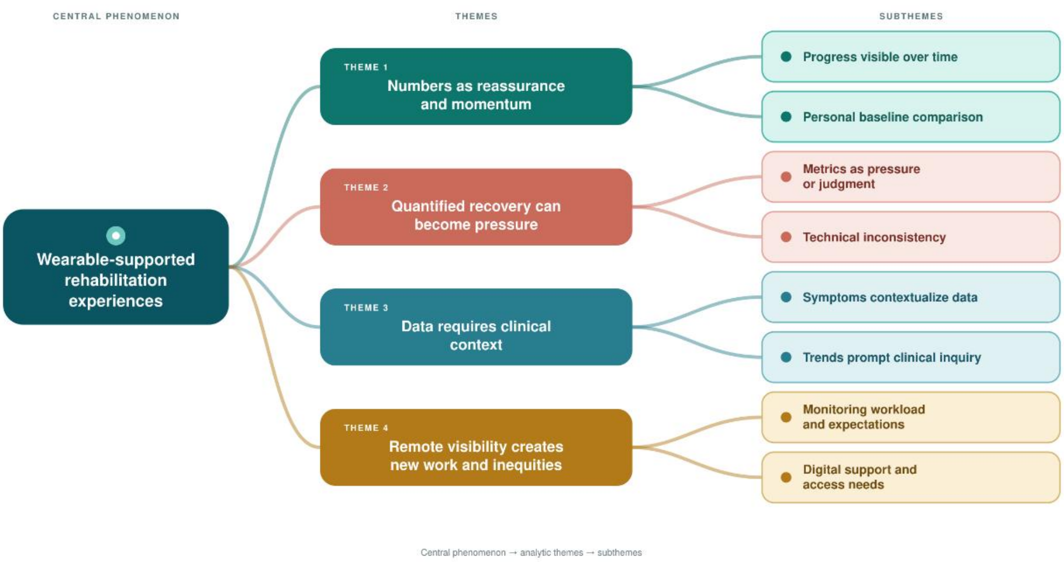

Figure 1. Presence map of qualitative subthemes by participant group

The figure shows shared patient-clinician representation for visible progress, personal baseline comparison, metric-related pressure, and the need to contextualize data. Patient accounts contributed the clearest evidence about technical inconsistency and digital support, whereas clinician accounts contributed the clearest evidence about trend-based inquiry and monitoring workload. These contrasts reinforce that wearable-supported rehabilitation was perceived simultaneously as a patient-facing feedback system and a clinical service requiring interpretation and governance.

DISCUSSION

This study suggests that wearable-supported orthopedic rehabilitation is best understood as a relational intervention in which technology changes feedback, expectations, and responsibility. Participants did not describe wearables as uniformly acceptable or unacceptable. The same metric could reassure, motivate, create pressure, or confuse depending on whether it was personalized, contextualized, and discussed. The four themes therefore locate clinical value not in data volume alone but in the interaction among numerical trends, symptoms, expectations, professional interpretation, and service design.

The perceived motivational value of visible progress is consistent with trials showing that wearable feedback can support activity and self-directed rehabilitation after arthroplasty (2,3). It also accords with patient-experience research in which remote monitoring was valued for usability, feedback, and connection with the clinical team, while professional contact remained important (5-8). The present findings qualify those benefits. Motivation appeared most credible when patients compared progress with their own baseline and understood that daily variability could reflect pain, fatigue, or appropriate pacing. Static targets, by contrast, could transform rehabilitation from support into a perceived test of effort. Programs should therefore negotiate adaptive goals and explain that temporary reductions in activity are not automatically evidence of poor adherence.

The findings also challenge the assumption that objective data are inherently more truthful than patient reports. Wearable sensors can capture gait and activity dimensions that patient-reported outcomes may miss, and objective and subjective recovery trajectories can diverge (9-11). However, device placement, algorithms, non-wear, symptoms, and daily circumstances affect the meaning of a recorded value, while clinical applications remain methodologically inconsistent (12). Clinicians in this study consequently treated trends as prompts for questions rather than diagnostic endpoints. Emerging thresholds for meaningful change in objective gait metrics may assist interpretation, but they cannot replace the patient's account of why activity changed (20).

Remote visibility also has implementation consequences. Monitoring can reduce uncertainty between appointments only if data are reviewed, interpreted, communicated, and documented. Without defined governance, technology redistributes rather than removes clinical work. Services should specify who reviews dashboards, at what interval, which patterns trigger contact, how actions are recorded, and what patients should expect outside working hours. Dashboard design should prioritize actionable trajectories instead of maximizing the number of displayed variables.

Equity requires comparable attention. Variation in older adults' digital skills and confidence is well established (14,15), and the patient account of relying on a family member demonstrates how technical support can become part of continuity and safety. Accessible onboarding, plain language, device and connectivity support, optional caregiver involvement, and non-digital pathways may reduce exclusion. Patients should not be characterized as non-adherent when the underlying barrier is an inaccessible interface, inadequate support, or a monitoring model that assumes resources they do not possess.

Several limitations shape interpretation. The purposive sample was small and limited to major lower-limb surgery, reducing transferability to upper-limb, spinal, or pediatric rehabilitation. Inclusion of arthroplasty and fracture repair increased conceptual breadth but may have obscured procedure-specific expectations and activity trajectories. Device-specific comparisons were not available, so the findings cannot identify which sensor, interface, or algorithm was most acceptable. The cross-sectional design captured perceptions at one stage of recovery and could not show how the meaning of data changed over time. Social-desirability influences also cannot be excluded when participants discuss technology connected with clinical care. Comparison across patient and clinician accounts, attention to divergent cases, and a coding trail supported trustworthiness, but the small and heterogeneous sample limits the breadth of perspectives represented. Longitudinal interviews linked to sensor traces could examine how participants interpret episodes of progress, plateau, overactivity, non-wear, and alerts while also evaluating workload, false alerts, digital exclusion, and adaptive versus static goals.

CONCLUSION

Patients and clinicians perceived wearable-supported rehabilitation as most acceptable when it made personal progress visible without turning recovery into a rigid performance target. Its perceived mechanisms included reassurance through longitudinal trends, support for self-management, and earlier clinical inquiry, while its conditions included personalized goals, contextual interpretation, clear monitoring and escalation responsibilities, technical support, and non-digital alternatives. Wearables should therefore complement clinical conversation rather than substitute for it, with implementation focused on adaptive feedback, equitable access, and governance that makes remote visibility actionable and sustainable.

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