

Digital and Connected Health Technologies for Remote Orthopaedic Follow-up: Acceptance, Effectiveness, and Implementation Barriers- A Preliminary Scoping Review of 235 Studies*

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Abstract

Orthopaedic care produces a large and growing demand for post-operative and rehabilitative follow-up, and digital tools are increasingly used to deliver this follow-up at a distance. What remains unclear is how well these tools are accepted, what they achieve and what stops them from being used in routine care. This preliminary scoping review maps the evidence on digital and connected health technologies for remote follow-up in orthopaedics along three dimensions: acceptance, effectiveness and implementation barriers. The review follows the Arksey and O'Malley framework and is reported using PRISMA-ScR. Scopus and PubMed were searched in June 2026, returning 972 records. After deduplication and title, abstract and full-text assessment, 235 primary studies were included; full-text retrieval is ongoing, so the findings represent an interim map. Most addressed knee osteoarthritis, arthroplasty and fractures, using telerehabilitation, mobile applications, wearable sensors or virtual consultations. Acceptance was generally high but tied closely to usability, feedback quality and ongoing support. Effectiveness was often comparable or non-inferior to in-person care, especially for telerehabilitation after surgery. Barriers clustered around digital literacy, workflow integration, reimbursement and data protection, and were described far more often than they were tested. The findings support a cautious, targeted scaling of digital follow-up, framed as a health information systems challenge as much as a clinical one, with implementation as the priority for future research.

Keywords: digital health; remote follow-up; orthopaedics; implementation

Introduction

Musculoskeletal conditions are among the largest contributors to disability worldwide and account for a substantial share of the global need for rehabilitation (Cieza et al., 2020), and the demand they place on orthopaedic services keeps rising. Ageing populations, higher rates of joint replacement and a shortage of clinical staff all push in the same direction. Each surgical or conservative episode is followed by a period of monitoring and rehabilitation, and this follow-up phase is where much of the workload sits. Routine in-person review after joint replacement consumes clinic capacity even when most patients recover without complications. Digital technologies have been proposed as a way to ease this pressure. Telemedicine, telerehabilitation, remote monitoring, wearable sensors and mobile applications can extend, partly replace or complement face-to-face follow-up. From an information systems perspective, these tools reconfigure follow-up as a data flow in which the patient generates information at home, a system processes it and the clinician acts on it when required.

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Connected devices and Internet-of-Things frameworks for healthcare make this flow technically feasible, and the COVID-19 pandemic accelerated its adoption out of necessity rather than design. Technical feasibility, however, does not guarantee uptake, and uptake does not guarantee benefit. An intervention that performs well in a pilot may not transfer to routine clinical practice, and engagement observed in a trial often declines once the study ends. The evidence on these questions is dispersed across surgical subspecialties, technology types and outcome measures, which makes the overall picture difficult to assess. A scoping review is well suited to this situation, since the aim is to map the breadth of the field and identify gaps rather than to pool effect sizes. This review asks one broad question and three specific ones. The broad question is what the literature covers on digital remote follow-up in orthopaedics. The specific questions concern acceptance among patients and providers, the effectiveness reported across clinical and process outcomes and the barriers that shape implementation. Throughout, the public health management angle is kept in view, since the value of these tools ultimately depends on whether health systems can steer, fund and scale them fairly.

Methods

Design

The review uses the scoping review methodology of Arksey and O'Malley (2005), with the refinements proposed by Levac et al. (2010) and the guidance of the JBI approach (Peters et al., 2020). Reporting follows the PRISMA Extension for Scoping Reviews (Tricco et al., 2018). In line with scoping review conventions, no formal risk-of-bias appraisal was performed, and effectiveness is treated as a mapping of reported findings rather than a pooled judgement. Because full-text retrieval was still in progress at the time of writing, this article reports a preliminary, interim scoping review, and the included set should be regarded as provisional.

Eligibility criteria

Eligibility was structured with the Population–Concept–Context scheme. The population was patients receiving orthopaedic or musculoskeletal care, or their treating clinicians. The concept was any digital technology used for follow-up or aftercare, addressing acceptance, effectiveness or implementation. The context was post-operative, rehabilitative or longitudinal outpatient follow-up in any setting or country. Primary studies and empirical reports in English or German, published from 2015 onwards, were included. Study protocols without results, editorials and secondary literature such as systematic reviews and meta-analyses were excluded, the last so that the map reflects primary evidence.

Information Sources and Search

Scopus and PubMed were searched on 5 June 2026. The strategy combined four concept blocks: digital health technologies, follow-up or aftercare, orthopaedics and the outcome dimensions. The broad term “rehabilitation” was dropped from the follow-up block to reduce noise from generic rehabilitation literature, while “telerehabilitation” was kept among the technology terms. The Scopus search returned 675 records and the PubMed search 297.

Selection and Charting

Records were deduplicated and screened against the eligibility criteria at title, abstract and full-text level. Screening was carried out independently by several reviewers, with disagreements resolved by discussion or by a further reviewer, and a structured criterion-based form with documented evidence supported each decision. Full texts were obtained from the reference library; where a full text could not be retrieved, the record was retained as awaiting retrieval rather than excluded. Data were charted on study origin, orthopaedic indication, technology, follow-up function and the three outcome dimensions, with implementation findings organised around established determinant frameworks.

Results

Search and Selection

The two databases yielded 972 records, reduced to 856 after 116 duplicates were removed. Title and abstract assessment carried 806 records forward. Full texts were available and assessed for 470 of these; 336 could not be retrieved and remain to be sourced. At full-text level, 235 primary studies met the criteria. The most frequent reasons for exclusion were study protocols without results (92), secondary literature such as reviews and meta-analyses (61), and a non-orthopaedic population (60), with smaller numbers excluded for the absence of a digital intervention (10) or an ineligible publication type (7). The full selection process, from identification through to the included studies, is shown in Figure 1.

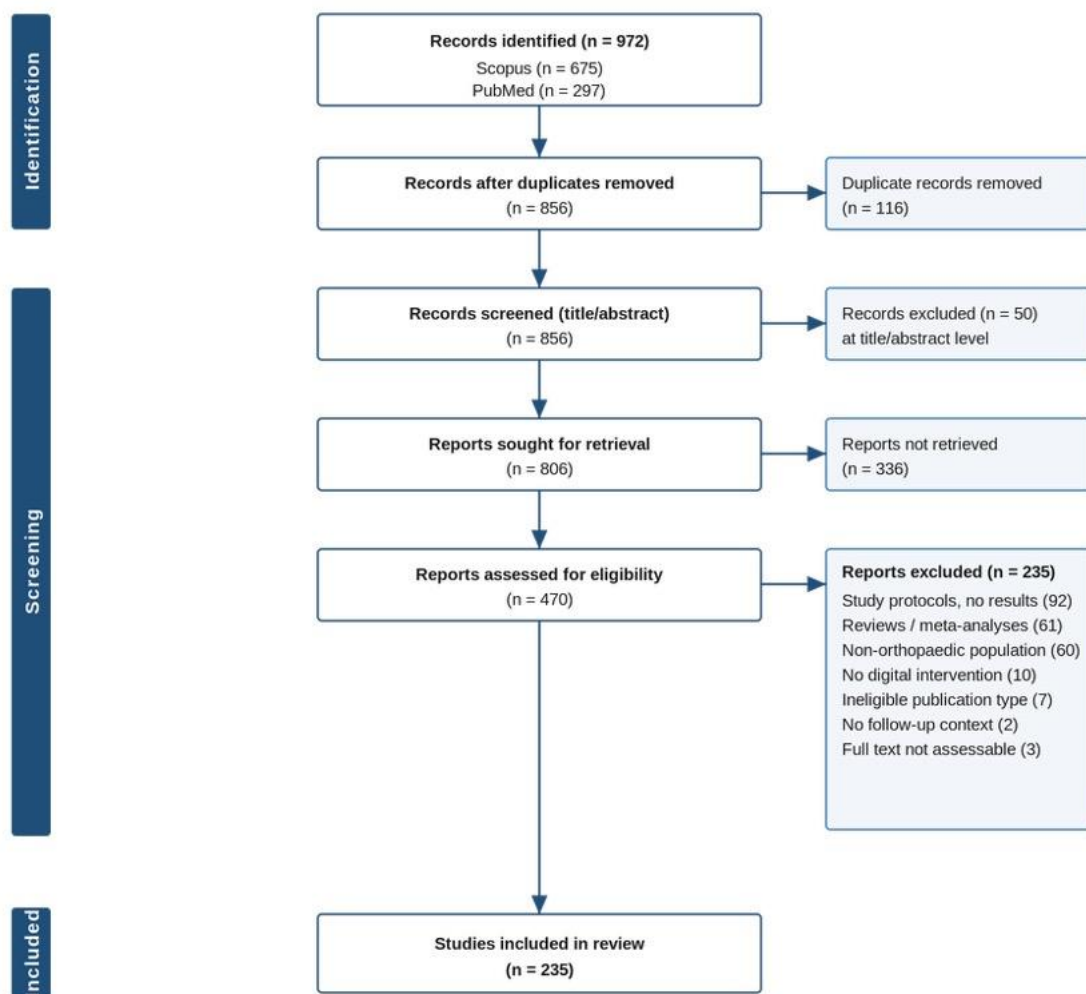


Figure 1. PRISMA-ScR flow diagram of the study selection process.

Characteristics of Included Studies

Because 235 studies cannot all be discussed in a conference paper, the narrative below cites representative studies for each theme rather than every record. The complete set of included studies, with their indication, technology and outcome focus, is listed in the supplementary charting table (Appendix S1); the studies named in the text were chosen to illustrate the range of indications, technologies and findings, not to single them out as the strongest evidence. The included studies covered the main orthopaedic indications (Table 1). Arthroplasty and joint replacement were the most frequent ($n = 70$), followed by fracture and trauma ($n = 51$) and spine or back conditions ($n = 41$), with osteoarthritis ($n = 28$) and general musculoskeletal conditions ($n = 22$) also well represented.

Randomised controlled trials were the most common design (n = 90), alongside a large body of pilot and feasibility work (n = 52). Output increased over time, with 102 studies published in 2021–2023 and 84 in 2024–2026. Where a country could be identified, European studies were the most common, ahead of North America and Asia

Table 1. Characteristics of the included studies (n = 235).

Characteristic	Category	n
Indication	Arthroplasty / joint replacement	70
	Fracture / trauma	51
	Spine / back	41
	Osteoarthritis	28
	General musculoskeletal	22
	Sports / shoulder	9
	Other / unspecified	14
Technology	Mobile application	45
	Wearable / sensor	43
	Telemedicine / virtual consultation	37
	Telerehabilitation	33
	Remote monitoring	8
	Digital therapeutic	1
	Other / multiple modalities	68
Study design	Randomised controlled trial	90
	Pilot / feasibility	52
	Cohort / observational	20
	Qualitative / mixed methods	20
	Case report	6
	Other / unclear	47
	Publication year	2015–2017
2018–2020		39
2021–2023		102
2024–2026		84

Categories were derived from titles and abstracts; the technology categories are not mutually exclusive, and counts should be read as approximate. One record had no clear publication year.

The technologies (Table 1) fell into a few overlapping groups: telerehabilitation and home exercise programmes delivered through mobile applications; wearable sensors and connected devices used to guide exercise and monitor recovery; virtual consultations and telemedicine clinics replacing routine review; and self-management apps and digital therapeutics. Many studies combined several elements, such as an app paired with a wearable sensor, which makes a clean typology difficult and indicates convergence between tools. The follow-up function also varied: some tools delivered structured rehabilitation, others monitored a physiological signal such as range of motion, activity or lung function, and a third set supported review and triage. This distinction matters, because a telerehabilitation trial and a virtual clinic study answer different questions even when both are labelled digital follow-up.

Acceptance

Acceptance among patients was reported as high in most studies, although it was closely tied to usability and the quality of feedback. A sensor-augmented telerehabilitation system for knee osteoarthritis combined electromyographic and inertial sensing to provide personalised feedback and remote tracking, addressing a recognised limitation of platforms that lack objective monitoring (Plavoukou et al., 2025). A qualitative study

accompanying a self-directed mobile health programme for knee osteoarthritis reported that patients valued the structure and convenience but identified usability problems that affected their willingness to continue (Dieter et al., 2025b). Adherence, which reflects acceptance over time, was more variable. A secondary analysis comparing in-person and app-based exercise for hip and knee osteoarthritis noted that adherence to exercise tends to be poor regardless of delivery format (Martinsen et al., 2025). A randomised trial evaluated whether a mobile app added to a home strength programme improved adherence and function (Hinman et al., 2026), and a further trial examined whether exergaming with sensor-based visual feedback sustained engagement better than a conventional home programme (Jarungvittayakon et al., 2025).

Provider acceptance surfaced mostly in the telemedicine literature. A study of telemedicine in spine care compared patient and surgeon perspectives directly and found that the willingness to keep using telehealth beyond the pandemic depended on the clinical question at hand (Srinivasan et al., 2025). Attitudes among trauma surgery professionals were examined more broadly in a study that asked whether eHealth had become “the new digital normal”, linking adoption to system pressure and constrained resources (Spierings et al., 2024). Patient satisfaction with virtual upper-limb orthopaedic clinics was high in a retrospective review of consultations set up to manage elective waiting lists (Van Heerden et al., 2025). A mobile health app used around hand surgery was judged easy to use and was linked to better satisfaction in a perioperative pilot (Xiao et al., 2025). Acceptance is also an equity question, since a tool that only suits confident users widens rather than narrows gaps. A multilingual chatbot was designed to engage arthroplasty patients with limited English proficiency, treating language as a social determinant of health rather than an afterthought (Rainey et al., 2023). Virtual follow-up after distal radius fracture surgery was studied in a mostly elderly group with low digital literacy, where video calls replaced routine review during the pandemic, and the patient experience reflected that tension between convenience and confidence (Arvidsson et al., 2023).

Effectiveness

A recurring finding across the included studies is that digital follow-up was comparable to in-person care rather than superior to it. For a scalable intervention, equivalence is itself a clinically relevant result. Telerehabilitation after open reduction and internal fixation for ankle fracture was evaluated in a non-inferiority trial of 468 patients for both efficacy and cost-effectiveness (Wu et al., 2026). Telerehabilitation after arthroscopic subacromial decompression had reported a comparable result earlier, with effectiveness not inferior to standard practice in a feasibility study (Pastora-Bernal et al., 2018). A randomised trial directly compared digital and conventional physical therapy for chronic shoulder pain (Pak et al., 2023). Telehealth extended to assessment as well as exercise delivery. A case report described self-performed orthopaedic examination in the telehealth management of a youth athlete with an acute rotator cuff strain, illustrating both the potential and the constraints of remote physical assessment (Wang et al., 2023). Improving access was the stated motivation for using telerehabilitation to deliver a home exercise programme to young people with arthrogryposis, for whom specialised care is often geographically distant (Gagnon et al., 2021).

For osteoarthritis and anterior knee pain, several trials reported clinical benefit. A self-directed mobile health exercise intervention for knee osteoarthritis was evaluated for pain reduction and functional improvement when added to usual care (Dieter et al., 2025a). A digital therapeutic for anterior knee pain reported outcomes superior to German standard care in a multicentre randomised trial across nine centres (Ferner et al., 2025). A wearable transcutaneous electrical nerve stimulation device was tested as a way to lower the barriers to exercise therapy and raise physical activity in patients with chronic knee pain (Yamada et al., 2025).

Several studies reported service-level rather than purely clinical outcomes. A remote patient monitoring platform after total hip or knee arthroplasty was evaluated against length of stay, hospital readmissions and emergency department visits (Chahal et al., 2024). An adapted arthroplasty pathway that shifted care towards shorter hospitalisation, home discharge and post-discharge telemedicine and telerehabilitation was reported as safe and effective in a cohort of more than five hundred patients (Ong et al., 2023). Monitoring and prevention formed a distinct strand. A telemonitored ankle pump system for patients with tibial plateau fractures was used for venous thromboembolism prevention, motivated by insufficient monitoring capacity and nursing shortages (Ge et al., 2025). A remote spirometry system paired with a mobile app was used to monitor lung function during rehabilitation after rib fractures (Liao et al., 2025). Virtual arthroplasty follow-up for total hip replacement was evaluated for clinical outcomes together with patient satisfaction, economic impact and environmental benefit, outcomes that align with a system-level, public health management perspective (Platt and Bolland, 2025).

Two German studies on rehabilitation aftercare are directly relevant, since they address the follow-up phase specifically. A longitudinal study of more than a thousand orthopaedic rehabilitation patients compared digital aftercare with conventional aftercare and a control group on work ability (Schmidt et al., 2026). A related study compared the same digital and conventional aftercare on physical and mental health outcomes (Schmidt et al., 2024). At population scale, a Danish cohort of 12,842 users of a musculoskeletal self-management app examined which users went on to use secondary healthcare, linking app use to downstream service demand (Simonsen et al., 2025).

Implementation barriers

Barriers recurred across very different technologies and settings, which suggests they are structural rather than tool-specific. They tend to sit at three levels. Closest to the patient are digital literacy, access to devices and the confidence to self-manage, all of which shape whether a tool reaches the people who could benefit. The osteoarthritis adherence studies make this point indirectly, since poor adherence is partly a barrier of capability and motivation rather than technology (Martinsen et al., 2025; Hinman et al., 2026). Barriers also live in the clinic, in the form of workflow and clinician buy-in. A tool that does not fit the working day rarely survives. The spine telemedicine study framed its findings as guidance for when telehealth fits and when it does not, which is a workflow judgement (Srinivasan et al., 2025). Mobile self-care for low-complex orthopaedic injuries was studied within a direct discharge pathway, where the app, an information leaflet and a telephone helpline together replaced routine follow-up appointments; the barrier here is redesigning the pathway, not the app alone (Spierings et al., 2025). Further up, the obstacles turn systemic, involving reimbursement, infrastructure, data protection and equity. Online prehabilitation before total knee replacement was implemented using pandemic data and evaluated as an implementation pilot, which surfaced the practical work of embedding a new service (Garland et al., 2025). Telemedicine for musculoskeletal conditions in a Medicare Advantage population was studied within a specific payment context, a reminder that financing shapes what is feasible (O'Connor et al., 2025). The self-management support trial for low-back pain among workers with high physical demands points to equity, since the benefit of a tool can depend on the user's working conditions (Rasmussen et al., 2024).

Discussion

Taken together, the evidence is reasonably consistent. The field is large but uneven, with a concentration of work on knee osteoarthritis and telerehabilitation and much thinner coverage of other indications and technologies. Acceptance and effectiveness are reasonably well studied, whereas implementation is described more often than it is investigated, and many studies report barriers without testing how to address them. The most consistent finding concerns equivalence: digital follow-up was generally comparable to usual care rather than superior to it. This shifts the rationale for adoption towards access, convenience and cost, with improvements in clinical outcomes rarely the central argument. This has a direct implication for public health management. If digital follow-up largely matches in-person care, the rationale for adoption rests on system-level value: freeing clinic capacity, reaching patients in remote areas, reducing travel and lowering cost and carbon emissions. The virtual arthroplasty follow-up study is relevant here, as it measured these outcomes alongside clinical ones (Platt and Bolland, 2025). The German aftercare studies are relevant for the same reason, since work ability and mental health are outcomes of interest to health systems and payers (Schmidt et al., 2024; Schmidt et al., 2026).

Framing the field as a health information systems problem helps to explain the barriers. The technologies are, in effect, connected data systems, and their weak points are familiar: usability at the human-machine interface, integration with clinical workflows, secure data handling and the infrastructure required for continuous monitoring. The healthcare Internet-of-Things framing fits the wearable and remote-monitoring studies (Plavoukou et al., 2025; Ge et al., 2025; Liao et al., 2025) and indicates that scaling these tools requires engineering and governance work alongside clinical evidence. The data these systems generate are beginning to be analysed in their own right, as in a study that applied machine learning clustering to motion data from a home-based digital physiotherapy device to identify rehabilitation patterns (Twumasi et al., 2025), which raises further analytics and governance questions. Acceptance frameworks from information systems research, such as the technology acceptance model (Davis, 1989) and its unified successor (Venkatesh et al., 2003), provide a vocabulary for the acceptance findings, while the NASSS framework (Greenhalgh et al., 2017) and CFIR (Damschroder et al., 2009) offer structure for the implementation side.

The development of the field also carries a methodological implication. Pilot and feasibility studies predominate (Table 1), and many trials are designed to demonstrate equivalence. This was appropriate while the open question was whether digital follow-up could work at all. The relevant questions now are different: under what conditions

it works, for whom and at what cost to the system. Addressing them requires implementation studies, pragmatic trials and economic evaluations, and outcomes that payers and managers recognise. The practical implication is not that digital follow-up should replace in-person care entirely, but that it can be targeted. Low-complexity, stable cases after surgery, routine review appointments and structured rehabilitation are the most plausible candidates, consistent with the direct discharge and virtual clinic studies (Spierings et al., 2025; Van Heerden et al., 2025). Higher-risk or unstable patients continue to require closer contact. Designing this division of care deliberately, and funding it appropriately, is where public health management can contribute most.

Limitations

This review has clear limits. The search covered two databases and two languages, so some evidence will have been missed, and the language restriction may bias the map towards certain regions. A substantial number of full texts had not been retrieved at the time of analysis and incorporating them may change the balance of indications and technologies; retrieval is ongoing. The study characteristics in Table 1 were charted from titles and abstracts, so the category counts are approximate and the technology groups overlap. As a scoping review, the work maps the evidence without appraising study quality, so the effectiveness findings reported here should be read as claims made by the primary studies rather than as verified conclusions, particularly where they rest on abstract-level information. Newer tools, including AI-driven systems, are also only beginning to appear in the literature and are likely under-represented.

Conclusion

Digital and connected health technologies for remote follow-up in orthopaedics have progressed beyond the proof-of-concept stage. The evidence base is substantial, concentrated on telerehabilitation, mobile applications and wearable monitoring, and most developed in knee osteoarthritis, arthroplasty and fractures. Acceptance is generally good but conditional on usability and support, and effectiveness is most often comparable to in-person care. The principal obstacles are no longer technical feasibility but implementation: digital literacy, workflow integration, reimbursement and data protection. Treating digital follow-up as a health information systems challenge, and steering its adoption through deliberate public health management, offers the most plausible route from pilot studies to reliable routine care. The priority for future research is to study implementation directly rather than to conduct further equivalence trials.

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