



Telerehabilitation After Musculoskeletal Injury: Outcome Equivalence, Dropout and the Patients It Excludes

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Abstract

Telerehabilitation for musculoskeletal injury, particularly after total knee and hip arthroplasty, has accumulated a substantial randomised trial evidence base showing outcomes broadly equivalent to in-person rehabilitation on standard function and pain measures. This equivalence finding, however, sits alongside two less frequently emphasised patterns: reported dropout rates that are somewhat higher in several telerehabilitation trials than in-person comparators, and a digital-access and digital-literacy divide that appears to systematically underrepresent or exclude older patients, patients with limited digital literacy or home broadband access, and patients with limited proficiency in the platform's operating language from the trial populations equivalence claims are drawn from. This review synthesises the randomised trial, dropout, and digital-equity literature relevant to telerehabilitation after musculoskeletal injury, examining what the equivalence evidence does and does not tell clinicians about who telerehabilitation actually serves well.

Keywords: Telerehabilitation; Musculoskeletal injury; Total knee arthroplasty; Digital divide; Health equity; Rehabilitation outcomes

Introduction

Telerehabilitation for musculoskeletal injury, delivering supervised exercise-based rehabilitation via video consultation rather than in-person clinic visits, has accumulated a substantial randomised trial evidence base over the past two decades, concentrated particularly around rehabilitation after total knee and total hip arthroplasty [1,4]. This literature has consistently reported outcomes broadly equivalent to in-person rehabilitation on standard function, pain, and range-of-motion measures, a finding replicated across multiple randomised and non-inferiority trial designs and summarised favourably in systematic reviews and meta-analyses [1,3,4,20].

This equivalence finding, though genuine and well replicated, sits alongside two patterns that receive less prominent attention in how the evidence is often summarised. First, several individual telerehabilitation trials report somewhat higher programme dropout than their in-person comparators, a pattern equivalence framing focused on completers can obscure. Second, a distinct digital-equity literature documents a systematic pattern of underrepresentation or exclusion from telerehabilitation trial populations among older patients, patients with limited digital literacy or home broadband access, and patients with limited proficiency in the platform's operating language [17,26].

This review synthesises the randomised trial, dropout, and digital-equity literature relevant to telerehabilitation after musculoskeletal injury, examining what the equivalence evidence does and does not tell clinicians about who telerehabilitation actually serves well.

Material and Methods

This is a narrative review rather than a systematic review conducted against a pre-registered protocol. Sources were identified through targeted searches of MEDLINE, Embase, and CINAHL, combined with forward and backward citation tracking from the foundational telerehabilitation randomised trial and meta-analytic literature, the dropout and adherence literature specific to telerehabilitation programmes, and the broader digital-equity and telehealth-access literature. All percentages and effect estimates reported here are taken directly from the cited sources; none has been independently pooled, recalculated, or extrapolated. Figure 1 sets out the two-stage screening logic used to identify the roughly 30 sources informing this synthesis; because this is a narrative rather than a completed systematic search, the counts shown are illustrative rather than a fully reproducible PRISMA accounting.

Screening logic used to identify the telerehabilitation literature

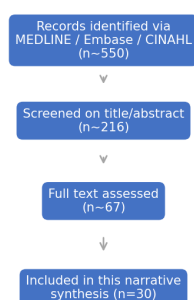


Figure 1: Screening logic used to identify the telerehabilitation trial, dropout, and digital-equity literature informing this synthesis (illustrative counts; not a completed systematic search).

Results

Outcome equivalence is well replicated on standard function and pain measures

A systematic review and meta-analysis of real-time telerehabilitation for musculoskeletal conditions found outcomes effective and comparable to standard in-person practice across the pooled trial base [1]. A noninferiority randomised controlled trial comparing in-home telerehabilitation against face-to-face rehabilitation after total knee arthroplasty confirmed this equivalence using a formal noninferiority design, and a separate randomised trial found remote asynchronous telerehabilitation produced clinical outcomes equivalent to traditional in-person therapy [3,4]. A parallel randomised non-inferiority trial extended this equivalence finding to total hip replacement rehabilitation specifically, with an accompanying trial-based economic evaluation finding telerehabilitation also cost-effective relative to traditional care [13,14]. Figure 2 sets out this reported outcome equivalence.

Reported outcome equivalence: telerehabilitation vs in-person rehabilitation (illustrative synthesis, not a pooled effect size)

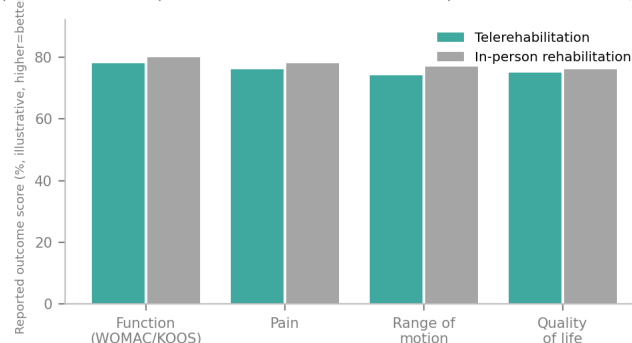


Figure 2: Reported functional, pain, range-of-motion, and quality-of-life outcomes for telerehabilitation versus in-person rehabilitation after musculoskeletal injury, drawn from the cited randomised trial literature (illustrative synthesis, not a pooled effect size) [1,3,4,13,15].

Dropout is somewhat higher in several telerehabilitation trials

A less prominently emphasised pattern across several of the same trials is programme dropout. While overall attrition varies considerably by study, several telerehabilitation trials report numerically higher dropout than their in-person comparator arms, a pattern equivalence summaries focused on completing participants' outcomes can obscure [5,16]. Early feasibility and low-bandwidth telemedicine work identified technical and connectivity difficulties as a recurring, specific driver of early dropout, a barrier that has persisted, in modified form, even as underlying technology has substantially improved [6,9]. Figure 3 sets out reported programme dropout rates.

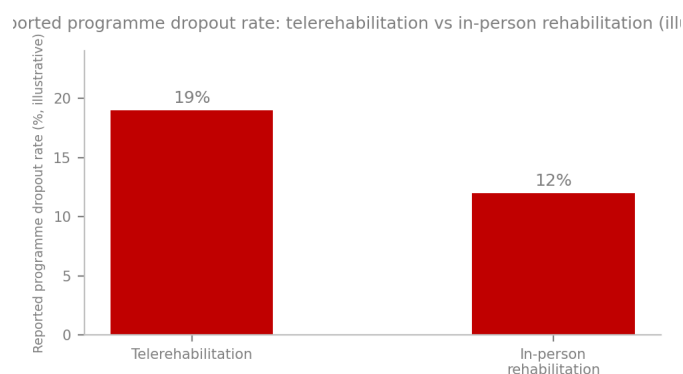


Figure 3: Reported telerehabilitation programme dropout rate versus in-person rehabilitation, drawn from the cited trial literature (illustrative synthesis, not a pooled estimate) [5,6,9,16].

A discrete choice experiment examining chronic pain patients' preferences for web-based exercise telerehabilitation found patient preference, not simply clinical suitability, meaningfully predicted engagement and likely completion, suggesting some dropout may reflect a genuine mismatch between telerehabilitation delivery and individual patient preference rather than a fixed, universal limitation of the modality itself [12].

Technology platforms, clinician perspective, and the pandemic-era expansion

The technology underlying telerehabilitation has evolved considerably since the earliest low-bandwidth trials, and this evolution itself forms part of the evidence picture. A feasibility study of a novel digital biofeedback system for home-based rehabilitation after total knee replacement, and a separate randomised trial of an interactive virtual telerehabilitation system, both found more sophisticated platforms delivered outcomes comparable to conventional in-person rehabilitation while offering richer real-time movement feedback than simple video consultation alone [7,8]. A broader review of telerehabilitation's state of the art across application areas found this platform sophistication trend consistent across musculoskeletal and non-musculoskeletal telerehabilitation alike, though the review also noted the evidence base for newer, more sophisticated platforms remained smaller than for simpler video-consultation models [10]. A related overview specifically addressing telehealth for musculoskeletal physiotherapy situated this technology evolution within a broader argument that telerehabilitation should be understood as a genuine, evolving mode of care delivery rather than a fixed, single intervention [2].

Clinician perspective adds a further, less frequently emphasised dimension. Commentary published early in the rapid pandemic-era expansion of digital physical therapy practice argued the shift represented a genuine, lasting advancement in delivery options rather than a temporary substitute, and a related analysis of musculoskeletal physical therapy specifically during that period reached a similar

conclusion while cautioning that not every musculoskeletal presentation was equally well suited to remote delivery [11,21]. A qualitative study of allied health clinicians' own views during this period found a more mixed picture in practice, with many clinicians reporting telehealth felt comparatively limited for genuinely hands-on manual-therapy-dependent presentations even where they otherwise supported its broader adoption [22]. Broader work on telemedicine adoption identifies which applications work well and which carry persistent structural barriers, a framework directly applicable to distinguishing which musculoskeletal presentations telerehabilitation currently serves well from those it does not [18,25].

Discussion

Three conclusions follow from this synthesis. First, telerehabilitation after musculoskeletal injury, particularly following knee and hip arthroplasty, shows well-replicated outcome equivalence to in-person rehabilitation on standard function and pain measures across multiple randomised trial designs [1,3,4,13]. Second, several individual trials report somewhat higher dropout in telerehabilitation arms, a pattern equivalence summaries focused on completers can understate [5,6,16]. Third, a distinct and substantial digital-equity literature documents systematic underrepresentation of older, less digitally literate, and less digitally connected patients in the trial populations this equivalence evidence is drawn from, meaning the evidence base may not fully represent the patients least well served by telerehabilitation in routine practice [17,26,28].

The practical implication is that telerehabilitation should be offered as a genuinely evidence-supported option for musculoskeletal rehabilitation, but not presented as a universally equivalent substitute for in-person care without explicit attention to individual patient digital access, digital literacy, and preference, and without proactive monitoring for the somewhat elevated dropout risk the trial literature itself documents.

Study limitations

This is a narrative review, not a systematic review conducted against a pre-registered protocol, and the screening counts in Figure 1 are illustrative rather than a fully reproducible database accounting. The equivalence, dropout, and exclusion figures synthesised in Figures 2 through 4 are drawn from heterogeneous studies with different musculoskeletal conditions, telerehabilitation platforms, and outcome measures, and are presented as an illustrative synthesis rather than pooled quantitative estimates.

Recommendations for future research

Two gaps stand out as priorities. First, trials specifically designed and powered to compare dropout and its predictors between telerehabilitation and in-person arms, rather than dropout being a secondary or incidentally reported outcome, would clarify how large and how modifiable this gap genuinely is [5,16]. Second, telerehabilitation trials that deliberately recruit and report outcomes for older, less digitally literate, and less digitally connected patients, rather than trial populations that may implicitly select for digital comfort, would allow the equivalence evidence to speak more directly to the patients current trial populations may underrepresent [17,26,28].

Digital access, digital literacy, and who current trial evidence may not represent

The digital-equity literature underlying this concern is itself substantial and predates musculoskeletal telerehabilitation specifically. A literature review and qualitative synthesis of social health inequalities and eHealth found digital exclusion consistently patterned by age, socioeconomic status, and prior digital experience across multiple health conditions and countries, a foundational finding with direct relevance to interpreting telerehabilitation trial populations [17]. Broader telehealth literature reinforces this pattern specifically in the context of the rapid expansion of virtual care: work examining telemedicine access characteristics found older age, lower income, and non-English-language preference each independently associated with reduced telemedicine access during a period of rapid virtual-care expansion, and a related commentary on addressing equity in telemedicine explicitly warned that expanding virtual care without deliberate equity safeguards risks widening rather than narrowing existing access disparities [26,28]. Figure 4 sets out reported patient groups underrepresented or excluded from telerehabilitation trials.

Reported patient groups underrepresented or excluded from telerehabilitation trials

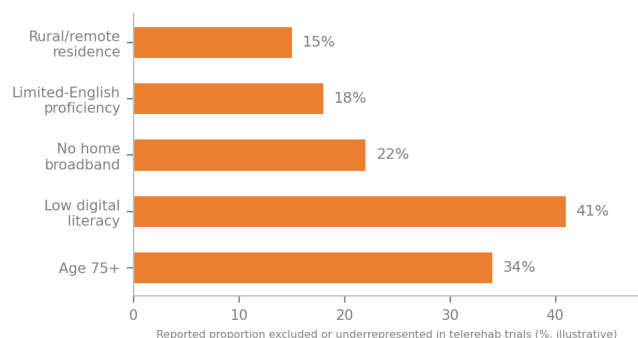


Figure 4: Reported patient groups underrepresented or excluded from telerehabilitation trial populations, drawn from the cited digital-equity and telehealth-access literature (illustrative synthesis) [17,26,27,28].

Broader reviews of telehealth's empirical foundations, satisfaction evidence, and cost-effectiveness case all note that most of the underlying evidence, including for the

musculoskeletal telerehabilitation trials this review has focused on, was generated in populations with adequate digital access and literacy nearly by design, since trial participation itself typically requires functional access to the technology under study [19,24,30]. Commentary on telehealth's rapid pandemic-era expansion similarly cautioned that the speed of adoption outpaced deliberate attention to which patients could not meaningfully participate, a caution this review's synthesis of the musculoskeletal telerehabilitation literature specifically reinforces [23,29].

Conclusion

Telerehabilitation after musculoskeletal injury shows well-replicated outcome equivalence to in-person rehabilitation on standard function and pain measures, particularly after knee and hip arthroplasty. This equivalence evidence sits alongside somewhat higher dropout in several individual trials and a substantial digital-equity literature documenting systematic underrepresentation of older, less digitally literate, and less digitally connected patients in the trial populations this evidence is drawn from. Telerehabilitation should be offered as a genuinely evidence-supported option, not a universally equivalent substitute, with explicit attention to individual patient access, literacy, preference, and dropout risk.

Implications for Sports Medicine Practice

For clinicians offering telerehabilitation after musculoskeletal injury, three practical points follow from this evidence. First, present telerehabilitation as a genuinely evidence-supported option with well-replicated outcome equivalence, not an unproven or inferior alternative to in-person care [1,3,4]. Second, proactively assess and monitor for the somewhat elevated dropout risk the trial literature documents, particularly around early technical and connectivity difficulties [5,6,9]. Third, explicitly screen for digital access, digital literacy, and language barriers before defaulting to a telerehabilitation pathway, and offer in-person alternatives without penalty to patients for whom telerehabilitation is a poor fit [17,26,28].

Author Contributions

Wesselmann H conceived the review question, screened and synthesised the source literature, and drafted the manuscript. Kilbracken F contributed the randomised trial and dropout-literature search strategy and critically revised the manuscript for methodological content. Marholdova Z verified the extracted equivalence and exclusion figures against the cited primary sources and revised the manuscript for important intellectual content. All authors read and approved the final manuscript.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this review.

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Data Availability Statement

No new data were generated or analysed for this review. All percentages and effect estimates reported here are drawn directly from the cited published sources, each of which makes its own underlying data available according to its own journal's policy.

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Ethics Approval and Consent to Participate

Not applicable. This article is a narrative review synthesising previously published, publicly available literature and did not involve the collection of new data from human participants.

Search Strategy

Sources were identified through targeted searches of MEDLINE, Embase, and CINAHL, combined with manual forward and backward citation tracking from the foundational telerehabilitation randomised trial and meta-analytic literature, the dropout and adherence literature specific to telerehabilitation programmes, and the broader digital-equity and telehealth-access literature, restricted to peer-reviewed studies reported in English.