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Telehealth interventions on pain in postoperative orthopedic surgery patients: A systematic review

Azka Qothrunnadaa[1], Aqmarina Abidah[2], Yulmira Maria Tisel[3], Albertina Dete Tabik[4], Yulis Setiya Dewi[5], Herdina Mariyanti[6]

[1,2,3,4,5,6]Faculty of Nursing, Universitas Airlangga, Surabaya, Indonesia

ARTICLE INFO

Article history:

Received Jul 9, 2025
Revised Jul 13, 2025
Accepted Jul 20, 2025

Keywords:

Orthopedic Surgery
Pain Management
Postoperative Care
Telehealth

ABSTRACT

This systematic review evaluates the effectiveness of telehealth interventions in managing pain among postoperative orthopedic surgery patients. The introduction highlights the transformative potential of digital health technologies, such as telemedicine and mobile health applications, in improving access, quality, and efficiency of healthcare, particularly for pain management and patient adherence. The methods section outlines a structured literature search across Scopus, PubMed, and Proquest databases, adhering to PRISMA guidelines, with inclusion criteria focusing on randomized controlled trials (RCTs) and quasi-experimental studies involving adult orthopedic patients aged 18–60 years. Ten studies met the criteria, demonstrating varied telehealth approaches, including mobile apps, video consultations, and remote monitoring. Results indicate significant pain reduction and improved clinical outcomes in telehealth groups compared to standard care, with enhanced patient adherence, functional recovery, and reduced opioid use. However, variability in intervention duration and pain measurement tools underscores the need for standardization. The conclusion affirms telehealth as a valuable tool for postoperative pain management, emphasizing its role in education, monitoring, and psychosocial support. Future research should explore combined interventions and economic impacts to optimize implementation.

Corresponding Author:

Azka Qothrunnadaa,
Faculty of Nursing,
Universitas Airlangga,
Mulyorejo, Surabaya, 60115, Indonesia
Email: azka.qothrunnadaa-2024@fkp.unair.ac.id

INTRODUCTION

Digital transformation holds the potential to revolutionize healthcare delivery by enhancing access, quality, and efficiency of services (Limna, 2023). Through telemedicine, remote monitoring, and health information systems, digital technologies can improve disease prevention, diagnosis, treatment, and management. Digital health solutions may reduce geographical barriers, enable personalized care, and empower individuals to actively manage their health, as noted by Dal Mas et al. (2023) in Wang et al. (2023). Electronic health (e-Health) and mobile health (m-Health) offer powerful tools for active patient education and behavior change reinforcement (Timmers et al.,

2019). Current trends emphasize the use of information and communication technologies (ICT) and digital media to deliver home-based care. However, given that non-adherence remains a major challenge, digital physiotherapy applications should aim not only to improve clinical outcomes but also to enhance patient compliance (Blasco et al., 2023).

Among existing technologies, smart mobile devices currently present the greatest potential, with applications being a leading trend. As an alternative, this field proposes the use of virtual assistants, such as AI-driven chatbots, to deliver conversational healthcare services. The most advanced chatbots employ natural language processing (NLP) for sophisticated interactions (Blasco et al., 2023). These tools are increasingly adopted by medical and nursing staff to monitor postoperative recovery in orthopedic patients. As healthcare facilities advance, they offer more treatment options for orthopedic surgery patients, whether for pain management or aesthetic purposes. The adoption of technology in plastic surgery is expanding in hospitals, though further analysis is needed to evaluate the benefits, particularly in robotic-assisted arthroplasty (UNIVERSITI & ALI, n.d.)(MAULA, 2020)(Sitorus, 2024). Assumed advantages include improved precision, real-time intraoperative feedback, personalized alignment and stability, and comprehensive data collection. Conversely, perceived limitations involve costs, prolonged operative times, and potential complications, raising questions about whether these technologies truly deliver superior outcomes (Vanderstappen et al., 2025).

Telerehabilitation, a form of rehabilitation leveraging ICT, allows healthcare professionals to provide remote support for post-discharge recovery. For example, nurses, physiotherapists, and clinicians use phone or video consultations to conduct assessments, deliver training, provide physical therapy, and monitor adherence in patients after knee arthroplasty (Wang et al., 2023a). Orthopedic surgery addresses musculoskeletal dysfunction, including unstable fractures, deformities, joint dislocations, and necrotic or infected tissue. Orthopedic diagnoses are categorized into traumatic cases (e.g., contusions, fractures, dislocations) and non-traumatic conditions (e.g., bone infections, chronic pain disorders). Hip fractures due to osteoporosis are among the most common traumatic cases, requiring surgical intervention to improve patients' quality of life (Pamungkas et al., 2022).

Chronic postoperative pain remains an ongoing clinical challenge, affecting approximately 10% of surgical patients. Recent clinical data suggest that perioperative interventions could reduce the incidence and severity of chronic post-surgical pain. The fact that perioperative management can mitigate chronic pain is particularly significant for surgeons, as every incision risks nerve damage and potential chronic pain development. Effective postoperative pain management is especially critical in reconstructive surgery, given that procedures like breast and extremity reconstruction carry elevated risks of chronic pain (Carroll et al., 2013). This systematic review aims to evaluate the effectiveness of telehealth interventions for pain management in postoperative orthopedic patients. By analyzing data from credible databases, it seeks to provide insights and references on the application of telehealth advancements in medical and nursing interventions for monitoring postoperative orthopedic patients with pain complaints.

RESEARCH METHOD

To achieve this objective, the review follows a structured approach involving several key stages: conducting a systematic literature search, performing a critical appraisal of the identified articles, and synthesizing relevant research findings (Brink & Van der Walt, 2006). The review process adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure methodological transparency and rigor at each research stage (Haddaway et al., 2022). A comprehensive literature search is conducted across multiple databases, including Scopus, PubMed, and ProQuest. To retrieve the most relevant articles, the search strategy employs Boolean operators and keywords aligned with Medical Subject Headings (MeSH) published between 2016 and 2025, as detailed in Table 1.

Table 1. Keywords of search strategy

Database	Search strategy	Results
Scopus	(Telemedicine OR mobile health OR mHealth OR eHealth OR telehealth OR telecare OR Internet-Based Intervention OR Internet Based Intervention OR Internet Intervention OR Web-based Intervention OR Online Intervention OR Digital Media OR Electronic Media) AND (Orthopedics OR Orthopedic Procedures OR Orthopedic Surgery OR Orthopedic Surgeries OR Orthopedic Surgical Procedure) AND (Pain OR ache OR physical suffering)	134
Pubmed	((Telemedicine OR "mobile health" OR mHealth OR eHealth OR telehealth OR telecare OR "Internet-Based Intervention" OR "Internet Based Intervention" OR "Internet Intervention" OR "Web-based Intervention" OR "Online Intervention" OR "Digital Media" OR "Electronic Media") AND (Orthopedics OR "Orthopedic Procedures" OR "Orthopedic Surgery" OR "Orthopedic Surgeries" OR "Orthopedic Surgical Procedure")) AND (Pain OR ache OR "physical suffering")	304
ProQuest	Title (telemedicine OR telerehabilitation OR internet-based OR interned OR web-based OR videoconferencing OR mobile OR app OR digital OR health OR e health OR conference OR video OR virtual) AND Fulltext (orthopedic OR orthopedic surgery OR musculoskeletal) AND title (pain OR physical suffering)	1280

The scope of this research is aligned with and designed to achieve the study's objectives. The studies included in this review must meet the following criteria: Population (P): adult orthopedic surgery patients aged 18–60 years; Intervention (I): studies examining remote pain management; Comparison (C): standard in-person pain management interventions; Outcome (O): the expected result is a reduction in pain scale; Study Design (S): articles with quasi-experimental and randomized controlled trials (RCTs), prospective and retrospective studies, and limited to original primary research studies/articles. Studies that do not focus on orthopedic surgery patients utilizing telehealth for pain reduction are excluded from this review.

The screening and selection process is conducted systematically by four authors to ensure rigor and minimize bias. The first stage involves an initial screening of titles and abstracts, performed independently by all four reviewers to identify studies that meet the predefined eligibility criteria. Following this, the selected full-text articles undergo a second screening for in-depth content analysis, where each reviewer assesses the studies for relevance, methodological quality, and alignment with the research objectives. Any discrepancies or disagreements among the reviewers are resolved through discussion and consensus. This dual-phase screening approach, involving multiple independent assessors, enhances the reliability and validity of the study selection process.

In this literature review, we assessed the methodological quality of studies meeting the inclusion criteria, particularly Randomized Controlled Trials (RCTs) examining the effectiveness of Telehealth in reducing pain among post-orthopedic surgery patients. The methodological rigor of each included study was evaluated using the Critical Appraisal Checklist developed by the Joanna Briggs Institute (JBI) (Barker et al., 2023). This checklist is designed to assess both internal and external validity, as well as potential biases that may influence study outcomes.

To ensure systematic evaluation of the included studies, the research team developed a standardized data extraction form. Four independent researchers individually assessed and summarized each study. Following this, their findings were cross-compared, and consensus was reached through discussion between the reviewers. The collected research data were then analyzed in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to maintain methodological rigor and transparency.

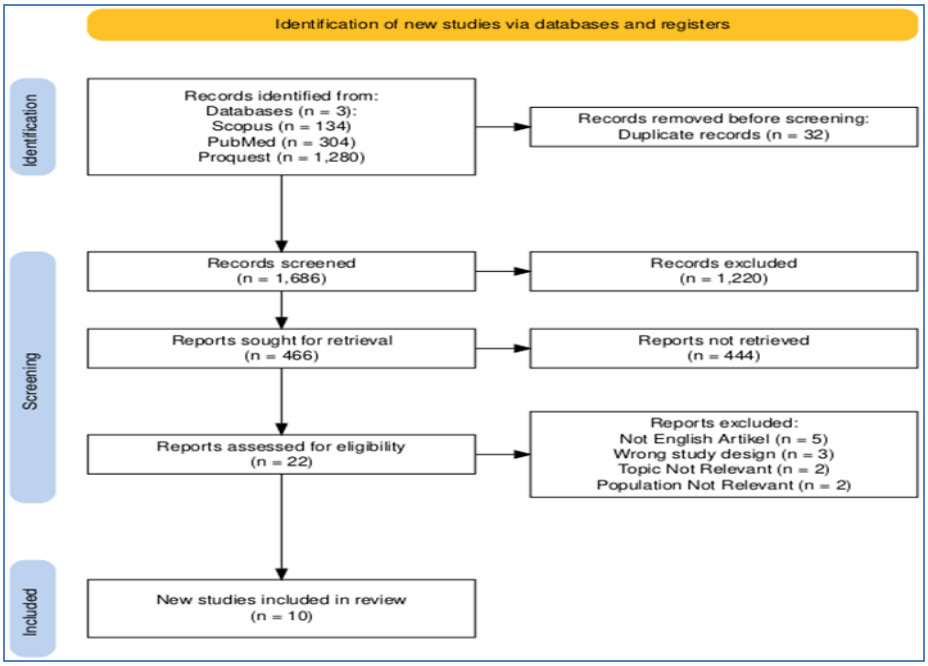

Figure 1. Study selection process

RESULTS AND DISCUSSIONS

Selection and characteristics of the study

The initial literature search across three databases yielded a total of 1,718 articles, distributed as follows: Scopus (n = 134), PubMed (n = 304), and ProQuest (n = 1,280). After removing 32 duplicate articles, 1,686 articles underwent screening, with 1,220 excluded for falling outside the specified publication range (2016–2025). From the remaining 466 articles identified for full-text retrieval, 22 were assessed for eligibility, while 444 were excluded based on title and abstract review. During the full-text assessment phase, five articles were excluded due to unavailability in English, three for mismatched study designs, two for being off-topic, and two for not focusing on orthopedic surgery patients. After applying the inclusion and exclusion criteria, 10 articles were ultimately included in this systematic review. Any discrepancies encountered during the screening process were resolved through discussion until consensus was reached.

This systematic review incorporates studies published between 2015 and 2025 from multiple countries, including the Netherlands, Germany, the United States, Spain, Norway, and China. The selected studies were limited to English-language articles with sample sizes exceeding 30 orthopedic surgery patients. All included articles represent original research studies that met our predefined inclusion criteria for methodological quality and relevance to telehealth applications in postoperative pain management. Table 2 lists the overall traits of the literature.

Quality Assessment

The JBI methodology for RCTs comprises 13 assessment indicators evaluating critical aspects including randomization processes, allocation concealment, blinding of participants and assessors, follow-up completeness, and validity of outcomes and statistical analyses. Among the 10 RCTs reviewed, methodological scores ranged from 75% to 92%, with the majority (7 out of 10 articles) achieving a score of 76.9%. The highest-scoring study, Wang et al. (2023) with 92%, demonstrated rigorous methodology, featuring clear randomization, robust bias-control strategies, and strong analytical approaches. Seven RCTs scored 76.9%, including studies by Timmers et al. (2019), Stuhlreyer et al. (2022), Anthony et al. (2020), Buvik et al. (2019), Kane et al. (2020), Hou et

al. (2019), and Zhao et al. (2024). These studies exhibited methodological limitations, such as inadequate allocation concealment, lack of participant/provider blinding, or incomplete follow-up, indicating areas for improvement.

The 92%-scored study (Wang et al., 2023) exemplified excellent methodological quality, fulfilling all critical design and execution criteria, thus yielding highly reliable results—though minor refinements may still be possible. Overall, while the reviewed studies demonstrated moderate-to-high methodological validity, some limitations persisted, including suboptimal handling of attrition bias (e.g., incomplete participant follow-up). Studies were evaluated using a "yes," "no," "unclear," or "not applicable" scale, where "yes" responses scored 1 point and other responses 0. Total scores were calculated by summing points across indicators, with studies scoring ≥50% deemed methodologically acceptable. The appraisal results indicate that most studies met good methodological standards (scoring >75%), with higher-scoring studies exhibiting tighter designs, better bias control, and clearer follow-up protocols, enhancing their reliability. Conversely, lower-scoring studies showed methodological weaknesses, necessitating cautious interpretation. This evaluation ensures that low-bias, high-quality studies are prioritized for deriving conclusions and recommendations in this systematic review. Table 3 presents the detailed appraisal results of the included studies.

Table 2. Keywords of search strategy

No.	Author, Year	Sample Size	Age (Years), Mean (SD)	Intervention Treatment	Control Treatment	Outcome
1.	(Timmers et al., 2019)	213	65.23	Education via "The Patient Journey" mobile application	Smartphone/tablet-based education once weekly	Significantly reduced pain levels within the first four weeks postoperatively
2.	(Stuhlreyer et al., 2022)	48	68 ± 10.2	Digital application with written and visual information on analgesics	Standard ward procedures	Reduced postoperative pain and decreased opioid consumption
3.	(Anthony et al., 2020)	82	47.06 ± 15.28	Mobile phone messages delivering Acceptance and Commitment Therapy (ACT)-based intervention twice daily	No messages received	Significant reduction in opioid use ($p < 0.05$); lower pain scores in the intervention group
4.	(Martinez-Rico et al., 2018)	70	27.7	Nursing phone assistance program, three times per week	Standard postoperative management	Improved pain and shoulder function; faster recovery time
5.	(Buvik et al., 2019)	389	-	Real-time video conference consultations	In-person specialist consultations	EQ-5D score was 0.77; 86% of patients preferred remote medical consultation (RMC) for subsequent visits
6.	(Wang et al., 2023b)	86	66.61 ± 7.23	Rehabilitation via WeChat platform	Standard care and rehabilitation	No significant difference in pain levels; significant improvement in self-efficacy ($p < 0.0001$)

No.	Author, Year	Sample Size	Age (Years), Mean (SD)	Intervention Treatment	Control Treatment	Outcome
7.	(Kane et al., 2020)	66	60.6 (range, 39-73)	Telehealth follow-up via video conferencing	In-person hospital follow-up	VAS score in telehealth group: 14.0; control group: 14.3; p = 0.951
8.	(Pronk et al., 2020)	71	63.6	PainCoach mobile application	Standard care	Faster pain reduction; lower opioid consumption
9.	(Hou et al., 2019)	168	18-64 thn, 9,54	Telerehabilitation with guided exercise videos	Standard rehabilitation with general medical advice	Significant reductions in ODI and pain VAS scores
10.	(Zhao et al., 2024)	100	66.55	Vital Health remote rehabilitation system application	Independent rehabilitation according to instructions	Significant reduction in VAS scores and lower WOMAC scores

Table 3. Keywords of search strategy

No	Author, Year	Study Design	1	2	3	4	5	6	7	8	9	10	11	12	13	Result
1	(Timmers et al., 2019)	RCT	√	X	√	X	X	√	√	√	√	√	√	√	√	76,9%
2	(Stuhlreyer et al., 2022)	RCT	√	X	√	X	X	V	√	√	√	√	√	√	√	76,9%
3	(Anthony et al., 2020)	RCT	√	0	√	X	0	√	√	√	√	√	√	√	√	76,9%
4	(Martinez-Rico et al., 2018)	RCT	√	0	√	X	√	√	√	√	√	√	√	√	√	84%
5	(Buvik et al., 2019)	RCT	√	0	√	X	X	√	√	√	√	√	√	√	√	76,9%
6	(Wang et al., 2023a)	RCT	√	√	√	√	√	X	√	√	√	√	√	√	√	92%
7	(Kane et al., 2020)	RCT	√	√	√	X	X	X	√	√	√	√	√	√	√	76,9%
8	(Pronk et al., 2020)	RCT	√	√	√	X	X	√	√	√	√	√	√	√	√	84%
9	(Hou et al., 2019)	RCT Prospective	√	√	√	X	X	X	√	√	√	√	√	√	√	76,9%
10	(Zhao et al., 2024)	RCT Prospective	√	0	√	X	X	√	√	√	√	√	√	√	√	76,9%

*√=Yes; X=No; 0=unclear

Types of Orthopedic Surgery Patients

The population characteristics in the included studies demonstrate diversity in the types of orthopedic surgeries undergone by patients. The study population was predominantly composed of patients with knee joint issues, specifically those who underwent Total Knee Replacement (TKR) surgery (Timmers et al., 2019; Stuhlreyer et al., 2022; Hou et al., 2019). Additionally, other enrolled patients included those with conditions such as Total Hip Arthroplasty (THA), Arthroscopic Bankart Repair, Arthroscopic Rotator Cuff Surgery, and Lumbar Spinal Surgery. Furthermore, some studies examined patients with postoperative fixation of traumatic upper or lower extremity fractures, as well as orthopedic patients referred for consultation. The variation in surgical types and investigated conditions indicates the relevance of this systematic review to diverse orthopedic surgery patient populations. However, generalizing findings should be done cautiously due to differences in population characteristics across the included studies.

Telehealth-Based Pain Management Rehabilitation Programs

The implementation of telehealth-based pain management rehabilitation programs for orthopedic surgery patients can be delivered through various modalities. Fundamentally, these programs utilize technologies such as smartphones or tablets, implemented in formats like the Pain Coach application, which includes features for pain medication usage, exercise and rest guidance, and indicators for when patients should contact the clinic (Pronk et al., 2020). Additionally, real-time video conferencing enables remote consultations, while some programs employ specialized rehabilitation applications to facilitate monitoring and support (Kane et al., 2020).

Total Duration of the Intervention Program

The duration of telehealth-based intervention programs exhibits a considerable range, depending on the specific type of intervention implemented and varying participant characteristics. Shorter interventions such as the delivery of written and visual information regarding pain-relief medication through a digital application, lasted for 4 days (Stuhlreyer et al., 2022). On the other hand, mobile phone-based rehabilitation programs (telerehabilitation) incorporating guided exercise videos were conducted over 24 months with periodic evaluations (Hou et al., 2019). Intermediate-duration interventions included mobile phone-delivered Acceptance and Commitment Therapy (ACT)-based interventions spanning 2 weeks, nurse-assisted telephone programs lasting 1 month, WeChat-based rehabilitation over 6 weeks, the Pain Coach application for 2 weeks, among others.

Pain Assessment Instruments

The pain assessment instruments utilized across the studies varied, tailored to differences in study populations and the types of interventions evaluated. Seven out of ten studies employed the Visual Analog Scale (VAS) to assess pain, either as the primary instrument or in conjunction with other pain assessment tools. Additionally, other instruments used included the Patient-Reported Outcomes Measurement Information System (PROMIS), the EuroQol-Visual Analogue Scale (EQ-VAS), the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), and the Oswestry Disability Index (ODI), each providing more comprehensive insights into the impact of pain on patients' functional capacity and quality of life. Furthermore, the Numerical Pain Rating Scale (NPRS) was utilized to quantify pain intensity numerically, commonly applied in post-total knee replacement (TKR) patients (Pronk et al., 2020).

Discussions

Telehealth interventions demonstrated significant benefits in reducing postoperative pain in orthopedic patients. The studies employed varied approaches, including daily care education via smartphone applications, video consultations, telephone follow-ups, and automated messaging. Most studies (Studies 1, 2, 3, 8, and 10) reported greater pain reduction in the intervention groups compared to controls. Key mechanisms supporting these outcomes included interactive app-based education and self-management (Studies 1, 6, and 10) and Acceptance and Commitment Therapy (ACT)-based text messaging (Study 3). These approaches improved patients' understanding of postoperative care, adherence to physiotherapy, and self-managed pain control.

Nurses played a critical role in these interventions, particularly in patient education and support. For instance, in Study 1, nurses utilized interactive apps to provide daily postoperative care instructions, enhancing patient compliance with physiotherapy and self-care. This highlights nurses' expanded role not only as direct caregivers but also as educators and facilitators in patient recovery. Similarly, in Study 4, telephone follow-ups by nurses improved adherence to home-based exercises and accelerated recovery in post-shoulder surgery patients. These findings suggest that nurses can actively contribute to remote rehabilitation, reducing reliance on conventional physical therapy and improving patient outcomes.

Additionally, telehealth interventions contributed to reduced opioid use. For example, the Pain Coach app (Study 8) and augmented reality application (Study 2) decreased opioid dependence by 23.2%, demonstrating how nurses can leverage such tools to educate patients on non-pharmacological pain management, promoting safer and more autonomous pain control. Real-time monitoring via app-based tele-rehabilitation (Studies 6 and 10) allowed for periodic progress assessments and tailored interventions. Another advantage of telehealth was its efficiency and accessibility. Video consultations (Study 5) and telephone follow-ups (Study 4) reduced wait times and travel costs, increasing patient engagement in recovery. However, some studies comparing telehealth to in-person visits found no significant differences in pain scores, suggesting that telehealth efficacy may depend on factors such as surgery type, intervention intensity, and patient population characteristics.

Despite these benefits, the reviewed studies had notable strengths and limitations. A key strength was their robust design, with all studies employing Randomized Controlled Trials (RCTs), enhancing internal validity. The integration of advanced technologies—mobile apps, augmented reality, and automated messaging (Studies 2, 3, and 8)—highlighted innovation in clinical practice. Some studies also used sophisticated statistical methods, such as Generalized Estimating Equations (GEE), to control for confounders (Studies 3 and 6). However, limitations included variability in pain measurement tools. For instance, Study 7 used the Visual Analog Scale (VAS) but found no significant differences, whereas Study 10, using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), reported significant pain reduction. This inconsistency complicates cross-study comparisons and underscores the need for standardized pain assessment tools in nursing practice. Nurses should ensure that measurement instruments align with patient needs and clinical contexts.

Another challenge was inconsistent intervention durations, ranging from 4 days (Study 2) to 24 months (Study 9). Short-term studies may underestimate sustained effects, whereas long-term studies (e.g., Study 9) showed significant improvements in pain and disability. Population heterogeneity, including diverse surgery types (e.g., total knee replacement, spinal surgery, rotator cuff repair), also limited generalizability. Nurses must tailor intervention durations to individual patient needs; intermediate-term interventions (6–12 weeks, as in Studies 6 and 10) appeared optimal for balancing efficacy and sustainability.

Overall, the intervention groups outperformed controls in several aspects. First, patient adherence improved significantly with daily app-based education (Study 1) and telephone follow-ups (Study 4), increasing physiotherapy compliance to 86%. Second, functional outcomes—such as Range of Motion (ROM, Study 4) and Self-Efficacy Scores (Study 6)—were higher in telehealth groups. Third, patient satisfaction was greater with telehealth (Study 5) due to ease of access and personalized interaction. However, two studies (Studies 5 and 7) found no significant differences in pain or satisfaction between groups. In Study 5, this may stem from passive video consultations lacking active education components, while Study 7's telehealth-only approach, without structured exercises, yielded limited effects. Nevertheless, patients preferred telehealth over conventional methods.

Telehealth interventions for postoperative pain management in orthopedic patients is further supported by recent scientific literature. Tsang et al. (2024) demonstrated that telerehabilitation significantly improved functional outcomes and reduced pain in total knee arthroplasty patients, aligning with findings on enhanced physiotherapy adherence and self-management. Kneuertz et al. (2020), in a systematic review of mobile health applications, highlighted that app-based interventions increased patient engagement and adherence to postoperative protocols, corroborating the efficacy of interactive tools. Campbell et al. (2025) emphasized the role of telehealth-delivered psychological interventions, such as Acceptance and Commitment Therapy (ACT), in reducing chronic pain, which supports Study 3's text messaging approach. These studies collectively underscore the versatility of telehealth in optimizing pain

management, adherence, and resource efficiency, while emphasizing the need for standardized protocols and tailored interventions to address variability in outcomes.

The findings underscore the need to integrate telehealth into nursing practice. Telehealth applications can enhance education, monitor adherence, and reduce the burden of conventional care. These interventions may also lower patient costs and time commitments by minimizing in-person visits,. The observed reduction in opioid use highlights telehealth's dual role in pain management and mitigating opioid-related risks. Intermediate-term interventions (6–12 weeks) appear most effective. Standardizing pain measurement tools (e.g., VAS or Numeric Pain Rating Scale (NPRS) is essential for future meta-analyses. Additionally, technological training for healthcare providers and patients is crucial for successful implementation.

CONCLUSION

This review supports the integration of telehealth as an essential component of postoperative care. Further studies should explore combined interventions, such as telehealth paired with physical therapy, as well as the economic impact of implementing this technology. Intermediate-term interventions (6–12 weeks) appear most effective. Standardized program designs and additional research with larger sample sizes and extended follow-up periods are required to optimize the clinical application of these interventions. Thus, telehealth has the potential to serve as a sustainable and effective solution for enhancing the quality of postoperative care in orthopedic patients.

ACKNOWLEDGEMENTS

The authors declare no conflicts of interest in conducting this research.

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