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DIGITAL-BASED AND TELEREHABILITATION INTERVENTIONS IN ORTHOPAEDIC POSTOPERATIVE RECOVERY: LITERATURE REVIEW

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ABSTRACT

Orthopedic surgery aims to treat musculoskeletal disorders; however, postoperative recovery often presents functional limitations. Digital interventions and telerehabilitation are increasingly being applied in nursing, although evidence of their effectiveness remains limited. This systematic review evaluated the effectiveness of these technologies in supporting postoperative orthopedic recovery and identified their contributions to evidence-based nursing practice. A systematic review following the PRISMA guidelines was conducted using Scopus, PubMed, Web of Science, ScienceDirect, and SAGE databases. Randomized controlled trials and quasi-experimental studies published between 2015 and 2025 involving adult postoperative orthopedic patients were included. The interventions were compared with conventional rehabilitation. Six outcome domains were evaluated: physical function, quality of life, pain, psychosocial aspects, self-efficacy, patient compliance and satisfaction. A total of 1,508 articles were identified, of which 16 studies met the inclusion criteria. Digital-based interventions and telerehabilitation consistently improved physical function (e.g., Timed Up and Go, Functional Independence Measure), increased quality of life (EQ-5D, SF-36), and reduced postoperative pain more rapidly than conventional rehabilitation did. Improvements were also observed in anxiety, depression, self-efficacy, health literacy, patient satisfaction, and adherence to the rehabilitation program. Digital and telerehabilitation interventions effectively support orthopedic postoperative recovery, positively affecting physical, psychosocial, and behavioral outcomes. A multimodal model integrating education, exercise, occupational therapy, and psychosocial support based on self-efficacy and biopsychosocial approaches yielded optimal results. Integration into surgical nursing practice is recommended, with attention to technological infrastructure and clinician training.

Keywords: digital rehabilitation; intervention; orthopedic patients; postoperative; telerehabilitation

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INTRODUCTION

Orthopedic surgery as a medical procedure that aims to improve the patient's musculoskeletal condition. However, the postoperative recovery process is often followed by various impacts on the patient's functional abilities. Orthopedic postoperative patients experience a lot of decreased daily living activities, disturbances in balance and gait, and pain to infection. This condition can slow the recovery process and reduce the patient's quality of life. Nurses have a strategic role in providing ongoing nursing care, from the acute phase in the hospital to the postoperative rehabilitation stage . Along with the development of technology, nurses began to implement digital-based interventions and telerehabilitation in providing nursing care. Systematic research related to the review of technology-based rehabilitation interventions in postoperative orthopedic patients in evidence-based nursing practice is still lacking. Therefore, a comprehensive literature review is needed on digital-based interventions and telerehabilitation in patients with postoperative fractures (Skou et al.,

2022); (Amanda, 2024); (Marina et al., 2025; Zamroni, 2022) (D. Zhang et al., 2025); (Anderson, 2022).

In 2019, the global prevalence of fractures was 178 million new cases, a 33.4% increase since 1990, partly due to population growth and aging. In addition, this figure also contributes to 25.8 million incidents of Years Lived with Disability (YLDs) as of 2019. Meanwhile, the prevalence of fractures in Indonesia according to Basic Health Research has always increased until 2018 and the highest prevalence of injuries in the lower extremities is 67.9% and the upper extremity reaches 32.7% (WHO, 2024) (Nurjanah, et al, 2023)

Postoperative rehabilitation is essential to restore optimal movement function . Improving the quality of care is considered important to provide efficient and quality handling of complex fracture cases . However, physical limitations, geographical distance, and the burden of health facility services often interfere with the postoperative rehabilitation process. These barriers can result in delays in therapy, low patient adherence, and suboptimal recovery outcomes. One of the efforts to overcome the limitations of large-scale physical interaction in the postoperative rehabilitation process is by utilizing the development of health information technology (Amanda, 2024) (Ramdhani,et al, 2024) (Suharyono, et al., 2021).

The form of technology utilization is digital-based rehabilitation interventions, including telerehabilitation, mobile applications, and wearable technology (Pepper Et Al. , 2023) . Digital rehabilitation allows patients to continue to receive physical therapy, health education, and psychosocial support remotely, without relying on physical presence in healthcare facilities so as to improve patient independence and recovery . Therefore, an in-depth understanding of the effectiveness of digital rehabilitation and telerehabilitation is required through an evidence-based review of the literature. This review aimed to evaluate the effectiveness of digital rehabilitation and telerehabilitation interventions in the recovery of orthopedic postoperative patients and to identify the contribution of these interventions to nursing practice. (Donohoe et al., 2020)

METHOD

This systematic review was conducted out based on the PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analyses) guidelines to ensure transparency, replication, and accuracy at every stage of the review . This process was carried out using an Evidence-Based Nursing approach, including a systematic literature search, quality assessment of methodological studies, and synthesis of findings from articles that met the criteria. Literature searches were conducted in five major electronic databases: Scopus, PubMed, Web of Science, ScienceDirect, and SAGE. The search strategy was designed using a combination of keywords and Boolean operators based on the term MeSH, namely: (Bolan et al., 2021) (Bolan et al., 2021) ("telerehabilitation" OR "telemedicine" OR "teletherapy" OR "remote therapy" OR "virtual rehabilitation" OR "Telehealth") AND ("occupational therapy" OR "rehabilitation" OR "therapy" OR "occupational health") AND ("fracture" OR "hip surgery" OR "hip injury" OR "hip replacement" OR "Orthopedic Surgery"). The included studies were limited to publications in English or Indonesian, published between 2015 and 2025.

The selection study was conducted using the following PICOS criteria: Patient population (P) included adults aged ≥18 years who underwent orthopedic surgery; Interventions (I) in the form of digital-based rehabilitation and telerehabilitation interventions, including mobile applications, web-based programs, video telemonitoring, virtual reality-based rehabilitation, and wearable sensors; Comparison (C) is patients who do not receive specialized interventions or are only undergoing conventional rehabilitation; Outcomes (O) included physical function (range of motion/ROM, muscle strength, daily activity/ADL), pain reduction, quality of life (QoL), patient adherence to the program, and patient satisfaction level; and Research design (S) is limited to quantitative studies,

namely Randomized Controlled Trials (RCTs) and quasi-experiments. From the initial search results of 1,508 articles, after removing duplicates (n = 36), there were 1,472 articles filtered by title and abstract. A total of 800 articles were removed for irrelevance, and of the remaining 672 articles, 634 were eliminated after full-text review. A total of 38 articles entered the full feasibility assessment stage, and 22 articles were excluded because the population was not suitable (n = 10), the intervention was irrelevant (n = 5), or the study design was not suitable (n = 7). Finally, 16 studies were included in this systematic review (Figure 1).

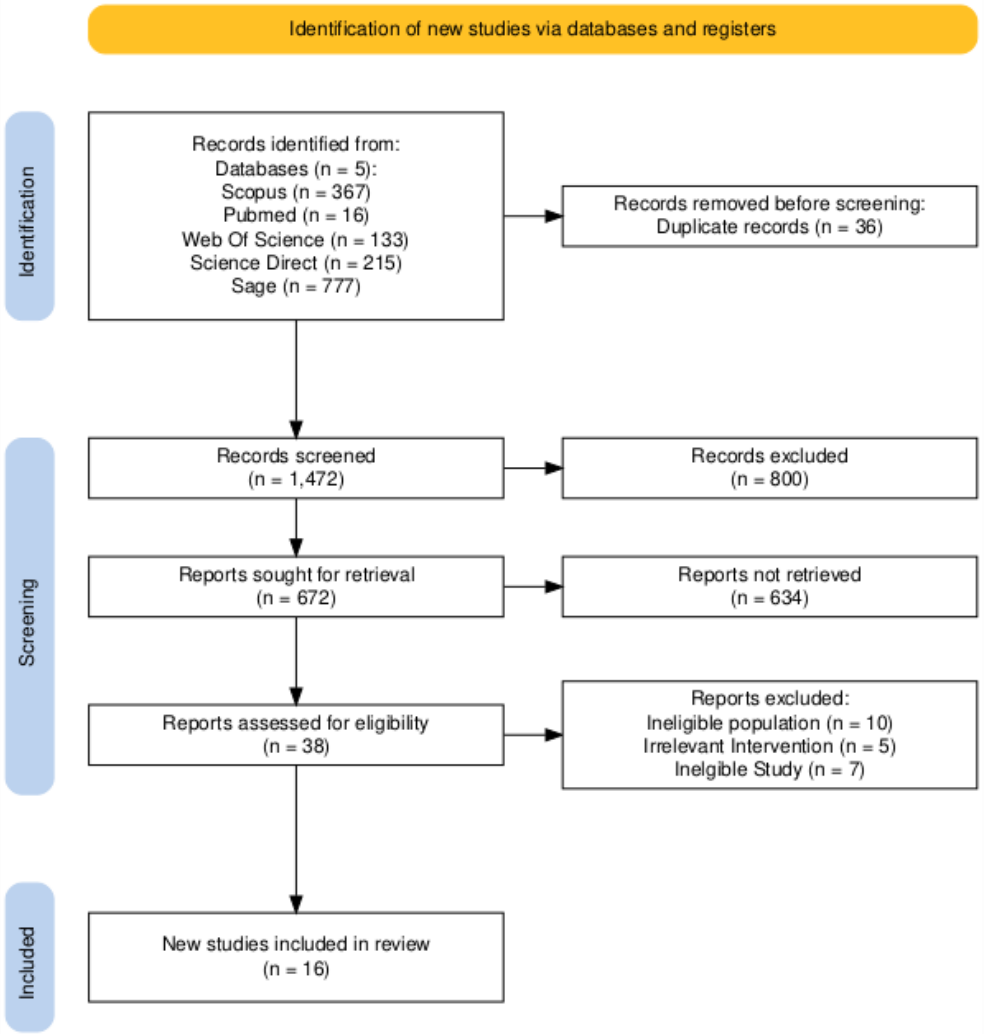

Figure 1. Diagram Flow PRISMA (Haddaway et al., 2022)

RESULT

Based on the results of the article selection, the author found 16 relevant articles to be analyzed in more depth through systematic review. The results of this review are shown in Table 2.

Table 1.
Summary of Included Studies

No	Title/ Author	Study Design	Intervention	Clinical Outcome
1	Effects of a home-based occupational therapy telerehabilitation via smartphone for outpatients after hip fracture surgery. (Li et al., 2022)	RCT	Home-based telerehabilitation using the Caspar Health app via smartphone, with exercise videos and feedback from therapists	Increased IADL independence & efficacy fell in the intervention group; no significant improvement in balance, walking speed, pain, ADL

No	Title/ Author	Study Design	Intervention	Clinical Outcome
2	Can Tele-Health Support Self-Care and Empowerment? A Qualitative Study of Hip Fracture Patients' Experiences With Testing an App. (Jensen et al., 2019)	Qualitative (Observation and interview)	The 'My Hip Fracture Journey' tablet app is given during hospital treatment and is used at home for 3-4 weeks after discharge	Improving patients' self-care, sense of autonomy, and health literacy; The app is thought to support rehabilitation, but not all patients use it independently
3	Effect of short-form video health education on health knowledge and satisfaction in patients with lower extremity fractures, (Zheng & Yan, 2023)	Quasi-experimental	Short WeChat-based health education videos (14 videos, 1–3 minutes long) + conventional education	Significant improvements in health knowledge (95.1% vs. 82%) and nursing satisfaction (80.9 vs. 78.1); $p<0.05$
4	An m-Health telerehabilitation and health education program on physical performance in patients with hip fracture and their family caregivers: Study protocol for the ActiveHip+ randomized controlled trial, (Mora-Traverso et al., 2022)	RCT	Smartphone-based ActiveHip+ program (12 weeks) that includes: 24 physical exercise sessions, 12 occupational therapy sessions, 7 patient and caregiver education modules, and ADL recommendation videos	Primary outcomes: physical performance, secondary: quality of life, functional status, pain, anxiety/depression, caregiving burden
5	Face-to-face Exercises Are Not Superior to Tele-rehabilitation in Post-operative Total Hip Arthroplasty, (Brazeiro et al., 2025)	RCT	Home-based exercise (tele-rehab) using booklet + weekly call monitoring for 6 weeks	Both groups experienced significant improvements in HHS and muscle strength; only tele-rehab showed a significant improvement in TUG. There were no significant differences between groups on all outcomes
6	Effects of the @ctivehip Telerehabilitation Program on QoL, Psychological Factors, and Fitness Level (Mora-Traverso et al., 2024)	RCT Clinical Trials	12-week home-based telerehabilitation via @ctivehip platform: 2 occupational therapy sessions + 3 physical exercise sessions/week, with online content according to ability level	Significant improvements in quality of life (EQ-5D), decreased anxiety and depression (HADS), and improved fitness level (IFIS) in the telerehabilitation group compared to controls ($p<0.05$; moderate effect size)
7	Effects of Tele-Rehabilitation Compared with Home-Based In-Person Rehabilitation for Older Adults after Hip Fracture, (Ortiz-Piña et al., 2021)	RCT Clinical Trials	Video-based @ctivehip telerehabilitation program and online platform: 12 weeks, 3 physical exercise sessions + 2 occupational therapy sessions/week, accompanied by a caregiver	The telerehab group showed a significant improvement in FIM ($p<0.001$) and TUG ($p=0.025$), not significantly in SPPB. Large size effects for FIM (Cohen's $d=0.98$) and medium for TUG ($d=0.63$)

No	Title/ Author	Study Design	Intervention	Clinical Outcome
8	Early Virtual-Reality-Based Home Rehabilitation after Total Hip Arthroplasty, (Fascio et al., 2022)	RCT	Virtual Reality Rehabilitation System (VRRS): tablet + wearable sensor, self-paced exercise program with real-time monitoring by therapist	There were no significant differences between the groups in the HOOS JR, FIM, or Barthel Index; however, GPE was higher in the VRRS group ($p < 0.001$), indicating a positive perception of the telerehab program
9	Effectiveness of Physical Therapy after Total Hip Arthroplasty at the Third Stage of Rehabilitation Using a Telemedicine Program, (Strukov et al. 2022)	RCT	Telemedicine-based physical therapy for 3 months: 3x/week online exercise sessions (30 minutes) with instructor post-discharge	The telemedicine group showed significant improvements in quality of life (EQ-5D, SF-36), reduced anxiety, and improved mobility (6MWT, 10MWT) compared to the control group ($p<0.05$)
10	Effectiveness of In-Home Augmented Reality–Based Telerehabilitation After ACL Reconstruction, (Lim et al., 2024)	RCT	8–10 weeks of augmented reality (AR)-based telerehabilitation using UINCARE Home 1, real-time training with a Kinect camera	There is no significant difference in IKDC; quadriceps strength increases faster in the AR group ($p<0.05$); similar results on ROM, pain, quality of life, and hop tests
11	Telerehabilitation is non-inferior to usual care following total hip replacement, (Nelson et al., 2020)	RCT	6-week telerehabilitation via iPad using the Wellpepper (HEP) app and eHAB (teleconsultation), 3 training reminders/day, video call sessions in week 2 and optional week 4	There were no significant differences between groups in HOOS QOL, muscle strength, TUG, and satisfaction. The intervention group was more adherent in exercising (86% vs. 74%) and had an easier time attending rehabilitation sessions
12	Effect of Home-based Telerehabilitation on Postoperative Outcome of Hip Fracture in the Elderly, (Y. Y. Zhang et al., 2022)	RCT	Telerehabilitation is based on an internet-based rehabilitation management system, including video programs, vital sign monitoring, remote assessment, personalized education	The telerehabilitation group showed significant improvements in pelvic function (HHS), independence (FIM), somatic integration (TUG & SPPB) compared to controls ($P<0.05$); lower risk of falling
13	The Effectiveness of Telerehabilitation as a Supplement After Total Knee or Hip Replacement, (Eichler et al., 2019)	RCT	Telerehabilitation for 3 months using the MeineReha system (Kinect-based, real-time visual feedback, demonstration avatar, exercise monitoring, voice and text communication)	Significant improvements in 6 MWT and physical function in both groups, no meaningful differences; higher return-to-work in the intervention group (64.6% vs. 46.2%; $p=0.01$); TUQ shows high levels of satisfaction and convenience
14	Effectiveness of a Tele-rehabilitation Intervention to Improve Performance and Reduce Morbidity Post Hip Fracture,	RCT	10 CO-OP-based telerehabilitation sessions via Skype, facilitated by occupational therapists with caregivers, focusing on goal–plan–	ADL outcomes (FIM), quality of life (SF-12), depression reduction (GDS) & caregiver burden (ZBI)

No	Title/ Author	Study Design	Intervention	Clinical Outcome
	(Gilboa et al., 2019)		do–check	
15	Effect of Short-Form Video Health Education on Knowledge and Satisfaction in Patients with Lower Extremity Fractures, (Zheng & Yan, 2023)	Quasi-Experimental	Health education videos (14 videos of 1–3 minutes, aired through the official WeChat forum of the orthopaedic treatment unit)	Health knowledge scores were higher in the video group (95.1% vs. 82.0%) and NSNS satisfaction scores were higher (80.90 vs. 78.13); Statistically significant difference ($p<0.05$)
16	Effectiveness of a Mobile Application-Based Programme for Rehabilitation After THA/TKA, (Wang et al., 2023)	RCT	6 weeks of rehabilitation based on the WeChat application, containing educational videos, discussion forums, relaxation techniques, exercise reminders, based on Self-Efficacy Theory and the Illeris Model	Significant improvements in self-efficacy ($p<0.001$), physical function ($p=0.007$), quality of life ($p=0.018$); Decreased anxiety and depression were also recorded although not clinically significant

Based on the results of the analysis of the 16 studies above, the author classified the results into six main domains that are the focus of the evaluation of the effectiveness of the intervention: physical function, quality of life, pain, psychosocial aspects, self-efficacy, and patient satisfaction or compliance with the rehabilitation program. The studies covered a wide range of orthopedic postoperative conditions, such as pelvic fractures, total hip arthroplasty (THA), and other lower extremity fractures.

Physical Function

Most studies have shown that telerehabilitation can produce significant improvements in physical function, equivalent to or even exceeding the effectiveness of conventional rehabilitation. Frequently used outcomes include the Timed Up and Go (TUG), Six-Minute Walk Test (6 MWT), Short Physical Performance Battery (SPPB), and Range of Motion (ROM). The largest effect was seen in the increase in the value of the Functional Independence Measure (FIM) and TUG as a mobility indicator . (Li et al., 2022; Lim et al., 2024; Mora-Traverso et al., 2024; Ortiz-Piña et al., 2021; Strukov et al., 2022)

Quality of Life

Digital interventions have also been shown to improve patients' quality of life. Instruments such as the EQ-5D and SF-36 were used to assess these changes, with most studies showing significant improvements and medium-sized effects . (Gilboa et al., 2019; Mora-Traverso et al., 2024; Nelson et al., 2020; Strukov et al., 2022; Wang et al., 2023)

Pain

Some studies measured pain perception using the Visual Analog Scale (VAS) and numerical rating scale (NRS). and showed that although not always statistically significant, the intervention group showed a faster reduction in pain. However, other studies did not find significant differences in pain perception between the groups . (Lim et al., 2024) (Strukov et al., 2022) (Li et al., 2022)

Psychosocial Aspects (Anxiety, Depression, Caregiver Burden)

Several studies have evaluated the effects of telerehabilitation on the psychological conditions of patients and their caregivers. The results showed that this intervention was effective in lowering anxiety, depression, and caregiver burden. Instruments such as the Hospital Anxiety and Depression

Scale (HADS) and the Geriatric Depression Scale (GDS) are used to measure this effect (Gilboa et al., 2019; Mora-Traverso et al., 2024; Wang et al., 2023) .

Self-Efficacy and Health Literacy

Increased self-efficacy and health literacy were reported in studies using a theory-based approach. Digital interventions designed with the support of self-efficacy theory have been shown to increase patients' confidence in undergoing rehabilitation independently and understanding their recovery process . (Jensen et al., 2019; Wang et al., 2023)

Satisfaction and Compliance

Telerehabilitation also positively contributes to patient satisfaction and ease of access to services. Patients feel more autonomous, actively involved in the healing process, and find it easier to schedule and follow exercise sessions . Additionally, adherence to rehabilitation programs increased significantly in the telerehabilitation group. Patients tended to be more consistent in following the exercise and maintaining program retention over a longer period of time than the control group (Eichler et al., 2019; Nelson et al., 2020) (Brazeiro et al., 2025; Nelson et al., 2020).

DISCUSSION

A review of 16 studies found that digital rehabilitation and telerehabilitation interventions were significantly effective in supporting the recovery of patients after orthopedic surgery in the physical, psychosocial, and behavioral health domains. Most studies noted improvements in physical function through instruments such as Timed Up and Go (TUG), Functional Independence Measure (FIM), and Short Physical Performance Battery (SPPB), indicating that digital interventions are able to provide adequate therapeutic stimulus, even equivalent to face-to-face approaches . The findings of several of these studies confirmed that telerehabilitation resulted in significant improvements in the mobility and functional activity abilities of older adult patients. This is in line with the theory of neuroplasticity, which explains that repetition and meaningful exercise are able to reshape neural connections, even in the context of advanced or post-injury limitations . (Li et al., 2022; Lim et al., 2024; Mora-Traverso et al., 2024; Ortiz-Piña et al., 2021; Strukov et al., 2022) (Marzola et al., 2023; Poljaković, 2019)

The quality of life assessed through the EQ-5D and SF-36 instruments also experienced a significant improvement in the digital intervention group . This effect arises not only from an improvement in physical status but also from the perception of autonomy and active participation of the patient in the recovery process. This view is in line with the biopsychosocial approach, which emphasizes the interaction between biological, psychological, and social aspects in determining the quality of life and well-being of individuals holistically. When patients feel supported by a responsive digital environment, they will experience increased self-control and meaning towards the recovery process . (Gilboa et al., 2019; Mora-Traverso et al., 2024; Nelson et al., 2020; Strukov et al., 2022; Wang et al., 2023) (Made et al., 2025; Mahapatra & Sharma, 2024; Makivić Klemenc- Ketiš , 2022; Savarimalai et al., 2021).

In terms of pain management, some studies show that although pain scores do not necessarily differ significantly between groups, the group that underwent telerehabilitation interventions showed a faster decreasing trend of pain . This mechanism can be explained through the gate control theory of pain, which states that cognitive activities, including attention and education can modulate the perception of pain . This suggests that digital interventions, including education on pain management, breathing exercises, or relaxation techniques, contribute to improved coping mechanisms for postoperative pain. (Lim et al., 2024; Strukov et al., 2022) (Braz et al., 2014; Kwok & Trang, 2024)

Another interesting finding is the decrease in levels of anxiety, depression, and caregiver burden recorded in several studies . The presence of psychological support modules, caregiver engagement, and a two-way educational approach through the app is proven to strengthen the emotional aspects of patients . This reinforces the understanding that rehabilitation interventions must not only restore physical function but also consider the psychological condition and social relations of the patient, especially in older groups, who are more vulnerable to social isolation. (Gilboa et al., 2019; Mora-Traverso et al., 2024; Wang et al., 2023) (Cutilli , 2020)

In addition to the clinical aspect, the effectiveness of telerehabilitation is also reflected in the improvement of self-efficacy and health literacy. The study of and , underlines that interventions designed with a self-efficacy theory approach and adult learning models such as Illeris, improve patients' ability to understand, organize, and undergo the rehabilitation process independently. According to Bandura, self-confidence in one's ability to complete tasks affects an individual's motivation and persistence in achieving health goals. In this context, digital interventions act as an empowering medium that not only informs, but also encourages sustainable behavioural change . (Jensen et al., 2019) Wang et al (2023) (Bandura, 1978, 1994)

Telerehabilitation improves adherence to rehabilitation programs and positive patient experiences during recovery. Studies show that patients in the digital group are more compliant with daily exercise and more likely to attend scheduled sessions . While other studies reported high levels of satisfaction with the convenience, flexibility, and personalization of programs offered through digital applications . This concept is in line with the theory of self-determination, which emphasizes the importance of autonomy, competence, and social connectedness in maintaining long-term health behaviors . (Eichler et al., 2019; Nelson et al., 2020) (Brazeiro et al., 2025; Nelson et al., 2020). (Deci & Ryan, 2015; Hagger et al., 2020)

Overall, the integration of digital rehabilitation interventions in orthopaedic postoperative services provides a new direction for surgical medical nursing practice. Nurses play a central role in designing, facilitating, and evaluating the success of telerehabilitation programs based on patients' needs. Considering the multidimensional benefits offered, this approach is not only clinically relevant but also adaptable to future changes in the healthcare systems. However, it is also necessary to anticipate implementation challenges, such as access to technology, digital readiness of older adult patients, and the need for training for health workers, so that these interventions can be implemented sustainably and equitably.

CONCLUSION

This literature review shows that digital rehabilitation and telerehabilitation interventions are effective in accelerating and optimizing postoperative orthopedic recovery, particularly in patients with pelvic fractures, total hip arthroplasty (THA), and other lower-extremity fractures. The six main domains that were positively affected included improved physical function, quality of life, reduction of pain symptoms, improvement of psychosocial aspects, improvement of self-efficacy and health literacy, and patient adherence to and satisfaction with the rehabilitation programs. Multimodal interventions that combine education, physical exercise, occupational therapy, and psychosocial support have been shown to produce meaningful clinical and behavioral outcomes.

The effectiveness of interventions is higher when programs are designed based on theories such as self-efficacy theory, self-determination theory, and biopsychosocial approaches. In addition, digital features such as real-time monitoring, personalized feedback, short video-based education, and caregiver involvement contributed to the successful implementation of the intervention. These findings indicate that digital rehabilitation can be an alternative and complement to conventional rehabilitation services, especially in the context of a health system that demands high efficiency, sustainability, and accessibility.

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