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Review Article

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Digital home-based rehabilitation and functional independence after orthopedic surgery interpreted through Orem's self-care lens: a systematic review

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Abstract

Digital home-based rehabilitation may support functional recovery after orthopedic surgery, although its effectiveness and alignment with Orem's Self-Care Deficit Nursing Theory remain unclear. This systematic review aimed to synthesize the effects of digital home-based rehabilitation on functional independence by comparator type and evaluate its alignment with Orem's theoretical constructs. Comparative studies published between 2015 and 2026 were reviewed following PRISMA 2020 guidelines. Risk of bias was assessed using RoB 2 and ROBINS-I, evidence certainty was evaluated using GRADE, and findings were synthesized narratively following SWiM principles. Sixteen studies involving 1,900 participants, including 14 randomized trials, were included. Compared with usual or minimal care, six of 12 comparisons favored digital rehabilitation, although improvements were generally below clinically important thresholds. Compared with active professional rehabilitation, four randomized comparisons showed no difference, while two non-randomized studies favored digital interventions. None of the interventions explicitly applied Orem's theory or assessed self-care deficits. Digital home-based rehabilitation probably provides little or no additional functional benefit compared with active professional care (moderate-certainty evidence) but may slightly improve short-term function compared with usual or minimal care (low-certainty evidence). Future nursing interventions should explicitly incorporate Orem's theoretical constructs and evaluate self-care agency alongside functional outcomes.

INTRODUCTION

After knee or hip arthroplasty or hip fracture surgery, most recovery takes place at home, where patients must regain independence in activities of daily living (ADL). Functional independence, an outcome measured with instruments such as the Barthel Index, differs from self-care agency. In Orem's theory, self-care agency is the capacity to know, judge and act on one's self-care requirements [1].

In Orem's Self-Care Deficit Nursing Theory, the *therapeutic self-care demand* after orthopedic surgery includes exercise, mobilization, pain and wound care and fall prevention; a *self-care deficit* exists when

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demand exceeds *self-care agency* and determines the *nursing system* required, including the supportive-educative system [1]. Orem-based programs have been synthesized in chronic illness [2] and studied after hip fracture and arthroplasty, but were delivered face to face [3,4]. Previous reviews reported small benefits of home-based or digital rehabilitation over usual care [5–7], no clear difference from conventional physiotherapy [8,9], and mapped telerehabilitation after hip fracture [10].

None of these reviews used a nursing theory, reported self-care agency or analyzed passive and active comparators separately (Supplementary Table S2).

This review therefore aimed to synthesize the effects of digital home-based rehabilitation on functional independence, self-care agency and related outcomes after orthopedic surgery, separately by comparator type, and to appraise how far program components and outcome measures correspond to Orem's constructs. The second aim did not influence eligibility or the effectiveness synthesis.

METHODS

Study Design

This systematic review is reported according to PRISMA 2020 [11], with narrative synthesis following SWiM [12]. No protocol was registered; all departures from planned methods are listed in Supplementary Table S6.

Setting and Period

An initial search (28 September 2026) of PubMed, SINTA and ten nursing and rehabilitation journals yielded 22 records. Because it could not be fully reconstructed, a structured PubMed search covering 1 January 2015 to 28 September 2026 (English or Indonesian) was run on 22 October 2026 (54 records; strings in Supplementary Table S1). Other major databases were not accessible.

Population, Sample, and Sampling

Eligible studies enrolled adults recovering at home after knee or hip arthroplasty or surgically treated hip fracture, with a concurrent control group and a validated function or ADL measure (other criteria in Supplementary Table S5). Because requiring studies to cite Orem's theory yielded no eligible study, this rule was replaced before data extraction by an outcome-based criterion and re-applied to all records. Two reviewers independently screened records, resolving disagreements by discussion (Supplementary File S3).

Variables, Instruments, and Measurements

The primary outcome was functional independence, ADL or physical function (e.g., FIM, Barthel Index, KOOS/HOOS-ADL, WOMAC); secondary outcomes were self-care agency, self-efficacy, quality of life and adverse events. Program components and measures were coded against Orem's constructs (self-care agency, dependent-care agency, therapeutic self-care demand, self-care deficit and nursing system) [1] as direct, indirect or speculative links (definitions in Table 2); functional outcomes were never counted as evidence of theory fidelity.

Intervention or Procedure

Eligible interventions were digital programs (application, website, videoconference or wearable sensors with remote monitoring) delivered at home after discharge. Comparators were classified a priori as *passive* (usual care, discharge education, printed programs, no rehabilitation) or *active professional* (face-to-face physiotherapy, home visits, scheduled telephone guidance).

Data Collection

Two reviewers independently extracted design, population, intervention, comparator, professional contact, outcomes, effect estimates, adverse events and theoretical basis, and assessed risk of bias with RoB 2 [13] or ROBINS-I [14] (Supplementary Tables S4 and S9).

Data Analysis

Results were grouped by comparator and outcome; mean differences (MD, digital minus control) with 95% confidence intervals (CI) were taken as reported or computed. Meta-analysis was not feasible because instruments, score types and comparators differed. Certainty was rated with GRADE [15,16], separately for randomized and non-randomized evidence [17], judging imprecision against the minimal clinically important difference (MCID) (Supplementary Table S10).

Ethical Considerations

This review used only published data and involved no human participants; ethical approval and informed consent were therefore not required.

RESULTS

Study Selection and Characteristics

The searches identified 76 records; after two duplicates were removed, 74 were screened and 41 excluded. Of 33 reports sought, eight full texts could not be obtained (awaiting classification; Supplementary Table S8), nine were excluded after assessment (Supplementary Table S7), and 16 studies were included [18–33] (Figure 1).

The studies (2015–2026; 1,900 participants analyzed) comprised 14 randomized trials, one quasi-randomized study [20] and one non-randomized study with allocation by patient choice [25] (Table 1). Seven enrolled patients after knee arthroplasty, five after hip or mixed arthroplasty and four after hip fracture. Programs lasted 3 weeks to 6 months; two were nurse-delivered [27,28]. Ten studies had passive, four active and two both comparator types [19,33].

Risk of Bias

No study had low overall risk of bias (Table 1). Eleven trials raised some concerns, mainly because participants were unblinded and function was self-reported. Three were at high risk because of attrition with completer analysis [21,31] or unblinded outcome collection by intervention nurses [28]. Both non-randomized studies were at serious risk of confounding [20,25].

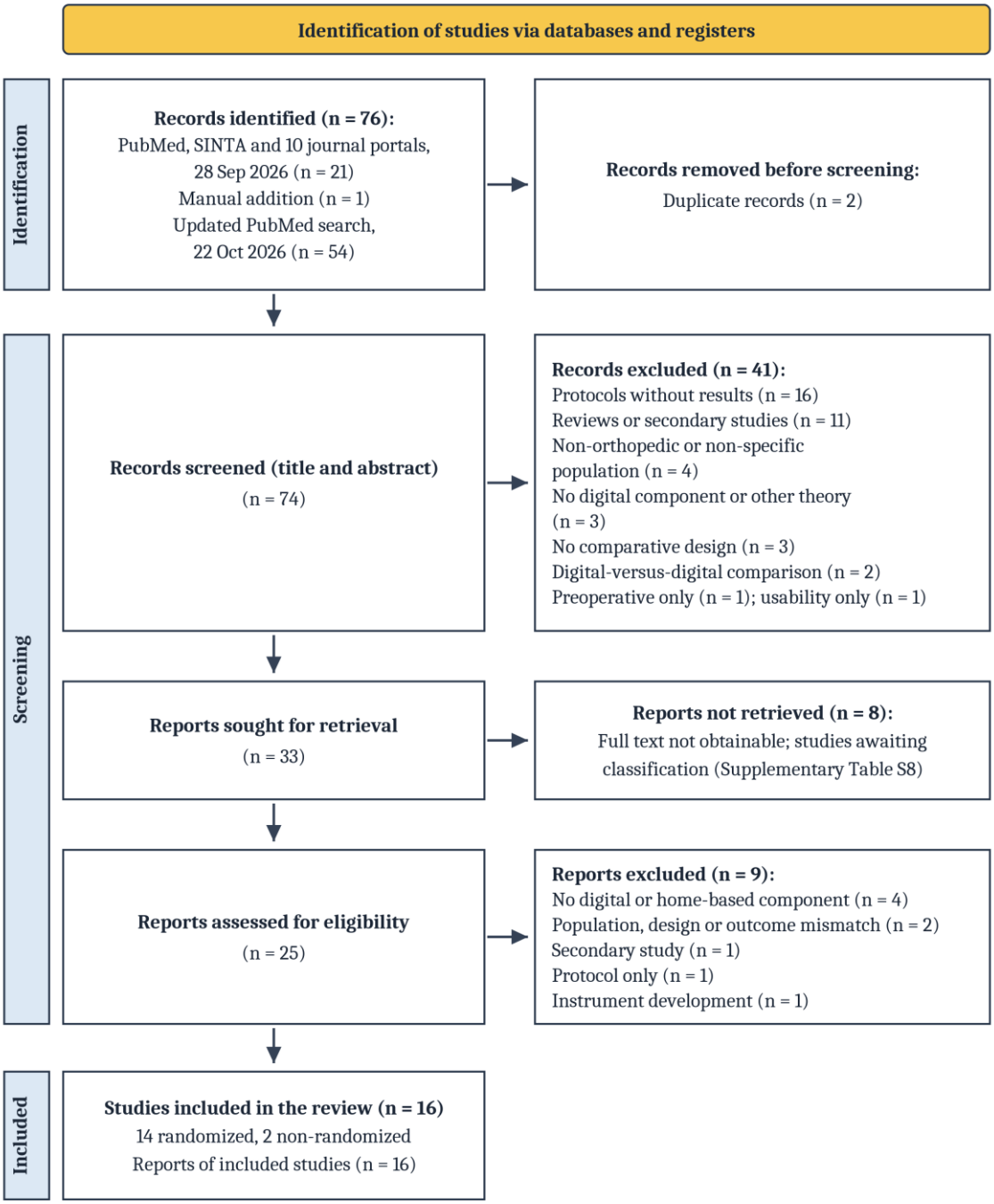


Figure 1
PRISMA 2020 flow diagram of study selection.

Table 1
Characteristics, function results and overall risk of bias of the included (n = 16)

Study (country); design, n	Digital intervention (delivered by; duration)	Comparator [type]	Outcome; follow-up	Result, digital vs control (95% CI)	RoB
Knee arthroplasty					
Boztaş 2026 (Turkey) [18]; RCT, 67	Web/app education with reminders (researchers; 1 mo)	Discharge education [P]	SF-36 PF; 4 wk	↑ Change 36.1 vs 21.0; P<0.05	SC
Xie 2024 (China) [19]; 3-arm RCT, 120	Smart brace sensors + app, physician-adjusted plan (physicians; 1 mo)	(a) WeChat plan [P]; (b) plan + 6 calls [A]	WOMAC; 1 mo	(a) ↑ P<0.05; (b) ↔ no significant difference	SC
Correia 2019 (Portugal) [20]; quasi-randomized, 59	AI motion-tracker biofeedback + app (PT; 8 wk)	Face-to-face home PT [A]	KOOS-ADL; 6 mo	↑ Median difference 7.0 (4.0 to 13.0)	Serious
Sadiq 2025 (Pakistan) [22]; RCT, 44	Web lifestyle program added to supervised training (PT; 12 wk)	Same training + handouts [P]	KOOS-ADL; 22 wk	↔ MD 3.30 (−3.00 to 9.60)	SC
Jung 2025 (Korea) [26]; RCT, 49	Wearable tracker + app feedback (self-directed; 12 wk)	Self-directed rehabilitation [P]	WOMAC function; 12 wk	↑ Group effect −3.8 (lower = better); P=0.001	SC
Moffet 2015 (Canada) [29]; non-inferiority RCT, 198	16 in-home videoconference sessions (PT; 2 mo)	Face-to-face home visits [A]	WOMAC function; 4 mo	↔ MD 0.4 (−3.4 to 4.3); non-inferior	SC
Fleischman 2019 (USA) [33]; 3-arm RCT, 290	Interactive web platform with videos (unsupervised; 8 wk)	(a) Printed manual [P]; (b) outpatient PT [A]	KOOS change; 6 mo	(a) ↔ 32 vs 33; (b) ↔ 32 vs 34 points	SC
Hip or mixed arthroplasty					
Nelson 2020 (Australia) [30]; non-inferiority RCT, 69	iPad exercise app + videoconference (PT; 6 wk)	In-person outpatient PT [A]	HOOS-ADL change; 6 wk	↔ Difference 2 (−6 to 11)	SC
Wang Q 2023 (China) [27]; RCT, 86	WeChat program based on self-efficacy theory (nurse; 6 wk)	Usual care + pamphlet [P]	HOOS/KOOS-PS change; 6 wk	↑ MD 4.57 (1.24 to 7.90); below MCID	SC
DRAW1 2024 (Denmark) [23]; 3-arm RCT, 168	Sensor-based app with remote supervision (PT; 6 wk)	(a) Written home program [P]; (b) no rehabilitation [P]	HOOS/KOOS-ADL; 6 wk / 12 mo	↔ vs no rehabilitation: MD 4.4 (−1.6 to 10.4) / 3.5 (−4.4 to 11.5)	SC
DRAW2 2026 (Denmark) [24]; 3-arm RCT, 169	As DRAW1 (replication)	As DRAW1 [P]	HOOS/KOOS-ADL; 6 wk / 12 mo	↔ MD 0.7 (−2.4 to 3.8) / −0.4 (−3.6 to 2.7)	SC
Wang J 2018 (China) [28]; RCT, 389	Internet home-care platform with online nursing clinic (nurse specialists; 6 mo)	Routine nursing care [P]	Barthel Index; 6 mo	↑ MD 5.02 (3.97 to 6.07)	High
Hip fracture					
Zhang 2022 (China) [21]; RCT, 51	Internet-based rehabilitation with remote monitoring (team; 3 mo)	Telephone follow-up + outpatient visits [P]	FIM; 3 mo	↑ MD 7.35 (3.03 to 11.67)	High
Cheng 2022 (Hong Kong) [31]; RCT, 39	App with exercise and caregiver videos, reminders (PT; 2 mo)	Same program + pamphlet [P]	LEFS (median); 2 mo	↔ 52 vs 47.5; P>0.05	High
Li 2022 (Hong Kong) [32]; feasibility RCT, 31	OT home program via app with feedback (OT; 3 wk)	Weekly paper program [P]	Modified Barthel; 6 wk	↔ MD 3.60 (−2.70 to 9.90)	SC
Ortiz-Piña 2021 (Spain) [25]; non-randomized, 71	Web telerehabilitation, caregiver-supervised	In-person home rehabilitation [A]	FIM; 3 mo	↑ MD 10.73 (5.20 to 16.26)	Serious

Effects on Outcomes

Versus passive comparators, six of 12 contrasts favored the digital program and six showed no difference (Table 1). Physical function improved by 4.6 points with the WeChat program, below the MCID of 8–10 points [27]. The largest differences came from trials at high risk of bias [21,28], whereas the trials at lowest risk found no

difference from no rehabilitation [23,24] or from a printed manual [33] (low certainty). *Versus active professional comparators,* all four randomized contrasts showed no difference [19,29,30,33] (moderate certainty). The two non-randomized studies favored the digital program [20,25], with groups that differed at baseline in function, age or treatment time (very low certainty).

Self-care agency improved after web-based education (Self-Care Agency Scale MD 63.5, 95% CI 52.3 to 74.8) [18], and self-efficacy improved after the nurse-delivered WeChat program (MD 0.72, 95% CI 0.31 to 1.14) [27]. Quality of life favored digital programs in five trials against passive comparators [18,19,22,27,28] but not against active comparators [29,30]. Adverse events were similar between arms in the four trials that collected them systematically [23,24,29,33] and were unreported in six [19,22,26,28,30,32]. Certainty for these outcomes was low (Supplementary Table S10).

Mapping to Orem's Constructs

No study cited Orem's theory; one used Bandura's self-efficacy theory [27]. The only direct link was the Self-Care Agency Scale [18]; other links were indirect (Table 2). No study assessed a self-care deficit; several admitted only patients who could use a smartphone or had a caregiver with internet access [22,25,27,28].

Table 2
Mapping of program features and measures to Orem's constructs

Orem construct	Program feature or measure (studies)	Link
Self-care agency	Self-Care Agency Scale [18]	Direct
Development of self-care agency; supportive-educative system	Education, goals, feedback, reminders, professional replies, online nursing clinic; self-efficacy scales [18,27,28]	Indirect
Regulation of therapeutic self-care demand	Sensor data reviewed by professionals with plan adjustment [19,20,23,24,26]; real-time videoconference physiotherapy [29,30]	Indirect
Universal and health-deviation self-care requisites	Video programs, self-monitoring checklists, ADL and home-safety training [21,22,25,32,33]; remote vital-sign monitoring [21]	Indirect / speculative
Dependent-care agency; partly compensatory system	Caregiver assistance, training videos and caregiver-supervised sessions [20,25,31]	Indirect
Self-care deficit	Assessment of the gap between capacity and demand (all studies)	Absent

DISCUSSION

The main finding depends on the comparator: digital delivery achieved functional outcomes similar to professional rehabilitation, whereas its benefit over minimal care was small. These findings agree with previous reviews [6–9]; separating comparators explains conflicting results: where the control arm received equivalent professional contact, differences vanished [19,29,30,33], whereas where the digital arm received more contact or treatment time, results favored it [20,27,28].

The DRAW trials suggest that structured rehabilitation of any kind may add little to natural recovery of self-reported ADL after arthroplasty [23,24], and the large self-care agency effect may be inflated by self-report in an unblinded trial [18]. Because no program assessed a self-care deficit, the programs are compatible with, but not built on, Orem's theory.

For nursing practice, digital delivery appears a reasonable alternative where in-person services are hard to reach. Before offering it, nurses could assess the patient's ability to use the device and caregiver

support [20], that is, self-care deficit and dependent-care agency, keep a feedback channel open [27,28], involve caregivers [25,31] and retain scheduled professional contact.

Strengths include separation of comparators and explicit mapping rules. Limitations include eight unobtainable full texts, a reproducible search of PubMed only, an Orem criterion revised without a registered protocol, self-reported outcomes in unblinded trials and an interpretive mapping.

CONCLUSION

Digital home-based rehabilitation after arthroplasty or hip fracture surgery probably results in little or no difference in function compared with professional rehabilitation (moderate certainty) and may slightly improve short-term function, self-efficacy and quality of life compared with usual care or printed programs, mostly by less than clinically important amounts (low certainty). No program operationalized Orem's theory or assessed self-care deficit.

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