The role of digital health interventions to improve health literacy in surgical patients: a narrative review in arthroplasty

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Published

2022

Journal Title

ANZ Journal of Surgery

Version

Accepted Manuscript (AM)

DOI

10.1111/ans.17931

Full Title: The role of digital health interventions to improve health literacy in surgical patients: A narrative review in arthroplasty.

Running Title: Digital health interventions in arthroplasty: a narrative review.

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Ethics approval: N/A

Word Count (main body): 2948 (excluding cover page, abstract, subheadings, figure, captions, tables, acknowledgements, superscript citations)

Key words: health literacy, digital health, digital health intervention, arthroplasty

ABSTRACT:

Objective:
Arthroplasty is a high-volume but costly treatment option for advanced osteoarthritis. Health literacy and patient education are modifiable factors that can improve patient outcomes in arthroplasty. Digital technologies show potential as an instrument for providing patients with reliable information. This narrative review aimed to identify the current evidence for how effective digital health interventions (DHIs) are in targeting health literacy and related constructs (including knowledge, decision-making and self-efficacy) in arthroplasty.

Methodology:

Six databases were searched for published studies comprising health literacy and related constructs, arthroplasty, and DHIs. The main outcome measure was health literacy. Two reviewer-authors independently screened studies according to predefined inclusion criteria and performed data extraction. Data was analysed and summarised in tabular and narrative form.

Results:
2764 titles and abstracts were screened. 167 papers underwent full-text analysis. No studies used health literacy as an outcome measure; therefore, the outcome measure was broadened to include its constructs, and the full-text analysis was repeated. Thirteen studies were included. No study following a structured design for their DHI. 11 studies demonstrated participant improvement in constructs of health literacy, including knowledge, decision-making and self-management.

Discussion:
Current evidence suggests that DHIs have a positive impact on constructs of health literacy. Insufficient information exists to conclude this due to a lack of studies and a structured approach to DHI design and evaluation.

Conclusion:
Further research with validated design frameworks for DHIs, end-user co-design, and standardized measures to assess effectiveness is warranted. Well-designed DHIs could become a key adjunct to future patient care.

Word count: 250

Introduction
Approximately 100,000 arthroplasty operations are performed yearly in Australia, contributing to direct healthcare costs currently exceeding $5.5 billion, estimated to increase to $7.6 billion by the year 2030[1]. Research suggests that approximately 25,000 patients may be dissatisfied[2-4] and 5,000 experience surgery-related complications following arthroplasty[5, 6]. There is an ever-present challenge to identify and prepare suitable patient candidates for a successful arthroplasty[7], necessitating new strategies to reduce complications and dissatisfaction. Enhancing patient education, especially prior to specialist referral, may be an important strategy.

Health education is a critical part of patient management. Health literacy is a multifaceted, complex network of knowledge and skills enabling patients to educate themselves and also be educated[8, 9]. Related constructs of health literacy include knowledge, decision-making and self-efficacy. Poor health literacy is associated with poor expectations in arthroplasty, such as of their walking capability postoperatively[10]. In contrast, improving health literacy can help to rationalize expectations, and improve outcomes such as reducing dissatisfaction and length of stay[11].

Sixty percent of patients have low health literacy in Australia[12], and this is comparable to other western countries[13, 14]. This highlights the imperative that health information be clear, simple and accessible for consumers. Conventional dissemination of patient

educational materials, such as in verbal or paper format, have historically shown varied results, highlighting that new ways are required to educate patients[15]. Numerous barriers exist in primary care to improve patient health literacy, revealing the need for greater innovation in educating and empowering patients[16].

Digital technology in healthcare is growing exponentially. Digital technology shows potential to readily provide health information to consumers, regardless of access to healthcare[17]. Hence, the rapidly growing arthroplasty demographic could benefit from digital technology providing educational content that improves their health literacy for their surgical journey. With prolonged waitlist times, this educative experience to empower patients could begin as early as the primary care level. Physicians may prescribe a digital health intervention (DHI) personalised to their patient's condition, which can help to educate and prepare them for future treatment, such as surgery[18].

This narrative review aimed to: (1) identify the current evidence for DHIs targeting health literacy and related constructs in the field of arthroplasty, and (2) assess how effective they are in educating patients and improving their health literacy. The purpose of this study was to summarise key characteristics in DHIs that are improving health literacy and education in patients undergoing arthroplasty.

Methods

This study was initially planned as a systematic review and the protocol and search strategy were registered with Research Registry (Review Registry Unique Identifying Number: reviewregistry888). However, there was insufficient data following screening pertaining to studies meeting the inclusion criteria of the search strategy for a systematic review. Following extensive discussion and evaluation by the authors, a narrative review was considered a more appropriate design. This review followed a structured narrative review methodology[19].

Search strategy

MEDLINE, Embase, CINAHL, PsychINFO, Web of Science and Scopus, were searched, modifying keywords, database-specific vocabulary and relevant Boolean operators for each database, from inception to April 2021. The search strategy comprised the following the concepts: (1) health literacy/education; (2) arthroplasty; and (3) DHIs. Forward and backward citation tracking of relevant studies and published literature reviews was conducted. A librarian was consulted to assist with the search strategy. See MEDLINE search strategy.

Inclusion and Exclusion Criteria

The inclusion criteria were ascertained a priori and applied to study selection. As many possible forms of technology as a means for education were included. Therefore, the inclusion criteria for the population/intervention/exposure comprised of: (1) all adult patients (18 years or older) who were undergoing or had undergone elective arthroplasty; (2) exposure to DHIs, including websites, mobile or tablet applications that educates patients preoperatively and/or postoperatively, compared to the conventional dissemination of educational material.

Studies pertaining to the primary outcome, health literacy, as measured by validated scales, were considered. Understanding that health literacy as an outcome measure may not be common, studies that measured health literacy and also its related constructs were included

for the full-text screening to ensure that the scope of this review was comprehensive while retaining a focus on health literacy.

A variety of study designs, including randomized and non-randomized controlled trials, pilot studies, and qualitative studies were evaluated. Editorials, commentaries, literature reviews, grey literature, and non-English language publications were excluded.

Study Selection and Post-Hoc re-evaluation

EndNote X9© was used to manage references. After implementing the search strategy across databases, two review authors (MTD and JT) independently screened titles and abstracts, excluding irrelevant articles. The same authors independently performed full-text screening, with eligible articles included after discussion and consensus (Figure 1). No studies required arbitration by a third review author.

Importantly, there were no studies that specifically measured health literacy as an outcome. However, full-text screening yielded numerous papers that measured related constructs of health literacy previously described in the literature, including knowledge, decision-making and self-efficacy, which are conceptually linked[9]. Thus, the decision was made to broaden the definition of health literacy, using these as a proxy for the intended health literacy outcome measure. The original search strategy was broadened to accept studies with these outcome measures and full-text screening was repeated (Figure 1).

Data Extraction

A data template was developed in Microsoft Excel, with the following data extracted: (1) study design/type, (2) participant demographic information, (3) description of DHI (platform, content, provider, delivery, duration of exposure, and timing) (4) outcome measures (5) participant feedback about the technology itself.

Data analysis

The DHIs and the main findings were compared between studies. Data were extracted, analysed and summarised in tabular and narrative form. The heterogeneity of studies and outcome measures meant that no meta-analysis was undertaken. Given the hybrid nature of this review, data reporting was completed utilising a narrative review synthesis methodology[19].

Risk of bias assessment

Two review authors (MTD and JT) independently completed risk of bias evaluation for each study. For the randomized controlled trials, the Risk of Bias 2 Tool (ROB2) was used. For the non-randomized controlled trials, the Risk of Bias In Non-randomised Studies 1 tool (ROBINS-1) was used. One study[20] was not assessed as it was a single-arm descriptive study and there were no subgroups to compare within the study design. Disagreements were resolved by discussion and consensus. There were no disagreements requiring arbitration by a third review author.

Results

Search strategy

The search strategy identified 5113 studies; 2349 duplicates were removed, and 2764 studies underwent title and abstract screening, with 167 proceeding to full text analysis. No studies were found that met the original inclusion criteria as no study specifically used health literacy as an outcome measure. After broadening the primary outcome measure to include related constructs of health literacy, 13 studies were included for final analysis (Figure 1).

Risk of bias

The main source of potential bias was due to patients and clinicians or assessors, who delivered the interventions or measured the outcome, being aware of the assigned intervention to participants. There was also moderate risk of bias for outcome measurements due to patients self-selecting for screening. All 12 studies assessed had a moderate risk of bias (Table 3). As one study[20] was a descriptive single arm study, a risk of bias assessment was not performed.

Study and patient characteristics

Seven studies[21-27] were randomized controlled trials, three[28-30] were quasi-experimental, two were prospective[31, 32], and one[20] was a descriptive single arm study. There were a total of 1802 participants. Eight studies[24-29, 31, 32] declared they received no funding, while five studies[20-23, 30] received funding from professional healthcare bodies, insurance companies, or research bodies (Table 1).

Digital Health Intervention characteristics

Platform

Eight studies[21, 23, 25-29, 32] used a videotape or DVD component as their DHI (Table 1). Four studies[21, 23, 26, 32] used a video made by Informed Medical Decisions Foundation. The four other studies[25, 27-29] either developed their own visual material or used a third-party company to create it. Four studies[20, 22, 24, 30] used a website, with one study developing an e-learning platform with educational videos[22]. One study used a text messaging system[31]. No study reported using any theoretical framework to guide DHI development.

Content

Content varied across the 13 studies (Table 2). Content included anatomy, pathology, pathogenesis of osteoarthritis, treatment options for osteoarthritis, preparation for surgery, the surgical procedure, expectations of outcomes, in-hospital activities, analgesia, expectations, postoperative recovery and exercises, limitations and restrictions, prevention of complications and signs and symptoms of infection, as well as guidance for when to seek help. Seven studies[21-23, 25, 26, 30, 32] utilised interviews with patients, allied health professionals or surgeons.

Delivery and provider

Five studies were designed as self-directed learning: one study[28] provided participants with a videodisc to play on DVD/VCD players. Another[31] used an automated interactive text messaging system to disseminate information. Two studies[22, 30] emailed a link to their e-learning platform or website, respectively. The fifth study[26]provided participants with educational material and a decision aid DVD to use at home. The other eight studies[20, 21, 23-25, 27, 29, 32] utilised staff, researchers, or nurses to supervise access to videos or assist with websites at hospital, or performed home visits to facilitate participation.

Timing, duration and frequency of exposure

Eleven studies provided their DHIs to participants preoperatively: participants from four studies[23, 24, 28, 32] were preoperative without a surgery date; five studies[22, 26, 29-31] exposed patients to their DHI preoperatively and postoperatively; and two studies[21, 25] only exposed their participants to their DHI preoperatively. Two studies only showed their DHI postoperatively: one[27] showed their videotape to patients on day 5-6 postoperatively, while the other[20]interviewed participants and provided their DHI after they were discharged home.

Duration and frequency of exposure varied across studies. No study provided reasoning behind their decisions about DHI exposure timeframes. Seven studies[20, 23-25, 28, 29, 32] exposed their participants to the DHI only once, while one study[27] showed their DHI twice (on Day 5-6 postoperatively and on the day before discharge). The DHI of the remaining five studies were provided on an ongoing basis: one study[22] provided 32 videos on their website to be accessed at any time, with frequent reminders sent out prior to and after surgery. Another study[31] allowed interaction with their text messaging system for three weeks. Participants from another study[30] accessed their website over a 12-month period. Two studies[21, 26] gave participants access to their decisional aid DVD at home for at least one week, with one of these also providing an audio recording of their surgical consultation[21].

Participant feedback about technology

Four studies sought participant feedback for their DHI (Table 2): Patients using the videodisc[28] found it very effective regarding their preparation for and recovery from surgery. The majority of patients believed the video they viewed[32] was educational, assisting their decision about whether or not to have surgery. Of the patients receiving and interacting with text messages[31], 87% believed they were more prepared for surgery, 100% were more informed, and 97% would use it again, stating that the messages provided great advice and reassurance, were not too burdensome, and gave the sense of social support. Patient feedback about the website pictographs[20] said it helped to convey the necessary information. The website's language was accessible except for complex wording of legal statements. The website layout was accessible and straightforward with no distractions, though navigation of hyperlinks was difficult.

One study[22] monitored usage of their e-learning platform, finding that user traffic was highest on the e-learning platform during the preoperative phase, but reduced over 12 months. Eight studies[21, 23-27, 29, 30] did not ask for participant feedback.

Outcome characteristics

Across the 13 studies, outcome measures were validated but varied widely (Table 1). Of the 13 studies, only two studies[22, 32] used the same outcome measure, namely the WOMAC. Despite not measuring health literacy, eleven studies demonstrated patient improvement for their validated outcome measures. The following significant findings in these studies were as follows: Four studies improved decision-making capacity[21], decision-making readiness[32], and decision-making quality[26], or reduced decisional conflict[21, 23]. Four studies improved knowledge of participants' procedure, preparation for or recovery from surgery[24, 26, 29, 31]. Three studies improved functional status[28], exercise performance[29], or skill technique acquisition, physical activity and weight reduction[30]. Three studies improved self-care cognition[28], self-efficacy[21], or self-management of health and lifestyle, actively engaging with life, and self-reflection[30]. Three studies improved satisfaction of the service provided[24], surgeon consultation[21], or overall satisfaction[31]. Two studies demonstrated that their DHI was easy to understand and use[20], or highlighted that informed patients were more compliant with treatment prescriptions[27]. One study found their DHI had no effect on expectations or satisfaction after 12 months[22]. Another study demonstrated non-significant improvement in expectations of range of motion or stair use following their DHI[25].

Discussion

This narrative review explored how effective DHIs were in improving patient health literacy and related constructs in arthroplasty. The systematic search yielded no study that specifically used health literacy as an outcome measure. This is an important finding as it illustrates that the educational process for patients is not being developed or conducted from a health literacy perspective, which has the potential to improve patient outcomes following surgery. On expansion of the criteria to include related constructs of health literacy, 13 studies were found. The findings of this review suggest that DHIs have a positive impact on these related constructs, whether at the initial consultation, during preparation for or recovery from surgery. Patients may theoretically benefit from these DHIs if designed effectively and provided as early as possible in their care. While DHIs in orthopaedics are still in their infancy, new research initiatives, such as virtual reality and sensor wearables, are catalysing uptake of DHIs in management for both clinicians and patients alike[33]. This trend may create a paradigm shift in the management of arthroplasty, and indeed other surgical fields, in the future.

Despite differences in study design, platform, and outcome measures, health literacy related constructs still improved in participants across eleven studies. However, there was no significant change in the two studies using videos[22, 25] to measure expectations. As poor health literacy is associated with unrealistic expectations about surgical outcomes[34], perhaps these videos did not specifically address expectations or health literacy during design, and therefore did not sufficiently educate participants. Alternatively, as one study[22] suggested, perhaps these DHIs were unable to maintain patient engagement to effect a significant change. Future research may consider more targeted videos or a different method altogether to address expectations. This may include using gamification elements in

DHIs, which are rising in prominence[35], to improve patients engaging with their long term health management[36]. If this is successful, DHIs may improve health literacy, rationalize expectations, and ultimately lead to better outcomes.

In contrast, studies using DVD[28], website[30] and phone[31] for self-directed learning demonstrated improved self-care cognition, preparation for surgery, health-directed activity, self-monitoring, social integration and self-management lifestyle. This reflects how engaging and accessible DHIs can empower and improve autonomy in patients. The interactive text messaging[31] or immersive website[30] seemed to have enough interaction within their program to engage and maintain user participation. The addition of gamified elements[35], such as points or leaderboards, may further enhance engagement and interaction with these DHIs. Future designs should build on this research.

Studies that only provided their DHI once[20, 23-25, 28, 29, 32] or twice[27] to participants still yielded an improvement in self-care cognition, knowledge, exercise performance and satisfaction. Similarly, DHIs provided on an ongoing basis[21, 22, 26, 30, 31] also led to better knowledge, decision-making, self-efficacy and satisfaction. It is unclear whether content permanently accessible to participants or consumed only once has a greater impact on outcomes. Future studies must explore whether frequency of DHI exposure influences outcomes as this could have clinical and financial implications.

The burgeoning nature of DHIs in arthroplasty was the main limitation of this review. First, these studies were heterogenous in design, method, and outcome measure. Future studies must minimize bias by blinding patients, clinicians and assessors to trial hypotheses when delivering and evaluating DHIs.

Second, these DHIs were developed and tested based only on what those involved in their design believed would be most useful to patients. While some studies sought participant feedback about their DHI, studies did not use a co-design approach involving clinicians and consumers[37], nor did they utilise an existing validated framework[38] to design and evaluate them. This is a similar finding to other surgical fields[39]. It would be difficult to assign success to these DHIs without using a framework to further refine their design, iterating content based on user feedback and reassessing efficacy.

Furthermore, no study explicitly measured health literacy through a validated scale – of which many exist based on health literacy constructs and frameworks[40] – nor did any study ascribe their own outcome measure as a constituent of health literacy. As such, it remains unclear whether these DHIs could improve health literacy. Health literacy interventions are known to improve health markers over time, such as morbidity and mortality, albeit these are often traditionally formatted didactic seminars and paper-based resources, with a relative paucity of technologically enabled interventions[41]. To reach a wider consumer audience, more concerted research and development of health literacy interventions on digital media should be considered. In turn, future studies should be designed to test these DHIs that specifically target the improvement of health literacy, using validated health literacy outcomes measures.

Based on these results, several suggestions can be made to facilitate creating a successful DHI for patients undergoing arthroplasty. DHIs should be co-designed with input from clinicians and consumers, following a validated design and evaluation framework. Regardless of platform, DHIs should be available to users in and out of the hospital, to be used as long and frequently as needed. DHI interfaces should be simple, accessible and self-directed without requiring ongoing input by staff or clinicians. Content should educate and empower users, comprehensively covering preoperative clinical, logistical and administrative preparation, postoperative recovery and how to monitor for complications. Patients should be free to learn as much as they want. Patients would also benefit from learning about past experiences from former patients, allied health staff or clinicians.

Furthermore, gamification elements in DHI design and progress tracking, as alluded to in one study[30], may also extend patient-DHI engagement to increase the chances of lasting positive effects. DHIs appear to be an accepted part of treatment across other surgical fields[42], with timing, delivery and the future addition of peer support networks seeming important in promoting positive health behaviour change[42]. Thus, potential exists for self-management of health and psychosocial support via visual-based DHI material, as seen in cancer patients[39].

One could imagine a general practitioner, physiotherapist, or surgeon 'prescribing' a DHI to their patient to support them in managing their condition and facilitating better understanding and decision-making for the next steps of their management. If provided earlier in their diagnosis, patients would receive reliable information that empowered them to better access the care they need in a timely manner.

Conclusion

The rise of digital technologies creates new opportunities to improve patient health literacy. Despite the paucity of published literature, this review has found that DHIs may be useful in improving constructs related to health literacy in patients undergoing arthroplasty. Further research is required to develop effective DHIs targeting health literacy, which could in turn play an important role in the patient care pathway. If embedded as early as possible, this could lead to better patient outcomes in arthroplasty, and may serve as an exemplar for other fields of surgery. In doing so, DHIs could be an important adjunct to patient care in the future.

AUTHOR CONTRIBUTIONS

MTD: conception, data collection, data extraction, data analysis, interpretation, drafting; SB: conception, supervision, direction, interpretation, drafting; JT: data collection, data extraction, interpretation, drafting; MMD: conception, supervision, direction, interpretation, drafting; PFC: conception, supervision, direction, interpretation, drafting.

ACKNOWLEDGEMENTS:

We thank Patrick Condron, Senior Librarian, University of Melbourne, for his assistance with the development of the search strategy.

FUNDING:

This research is supported by an NHMRC Centre's for Research Excellence Grant (APP1116325). MTD is supported by the Melville Hughes Trust Scholarship 2020 through the

University of Melbourne. MMD holds a NHMRC Career Development Fellowship (APP1122526) and University of Melbourne Dame Kate Campbell Fellowship. PFC holds a NHMRC Practitioner Fellowship (APP1154203).

COMPETING INTERESTS STATEMENT:
Competing interest: No relevant disclosures.

References

1. Schofield D, et al. The long-term economic impacts of arthritis through lost productive life years: results from an Australian microsimulation model. BMC Public Health. 2018;18(1):654.
2. Dunbar MJ, et al. I can't get no satisfaction after my total knee replacement: rhymes and reasons. Bone Joint J. 2013;95(11 Supple A):148-52.
3. Hamilton D, et al. What determines patient satisfaction with surgery? A prospective cohort study of 4709 patients following total joint replacement. BMJ open. 2013;3(4):e002525.
4. Scott C, et al. Predicting dissatisfaction following total knee replacement: a prospective study of 1217 patients. Bone & Joint Journal. 2010;92(9):1253-8.
5. Jain NB, et al. Comorbidities increase complication rates in patients having arthroplasty. Clinical Orthopaedics and Related Research®. 2005;435:232-8.
6. Phillips CB, et al. Incidence rates of dislocation, pulmonary embolism, and deep infection during the first six months after elective total hip replacement. JBJS. 2003;85(1):20-6.
7. Dowsey MM, et al. Using discrete choice experiments as a decision aid in total knee arthroplasty: study protocol for a randomised controlled trial. Trials. 2016;17(1):416.
8. Nutbeam D. The evolving concept of health literacy. Social science & medicine. 2008;67(12):2072-8.
9. Sørensen K, et al. Health literacy and public health: a systematic review and integration of definitions and models. BMC public health. 2012;12(1):80.
10. Hadden KB, et al. Health literacy and surgery expectations in total hip and knee arthroplasty patients. Patient Educ Couns. 2018;101(10):1823-7.
11. McDonald S, et al. Pre-operative education for hip or knee replacement. The Cochrane database of systematic reviews. 2004;1(1).
12. Health AIo, et al. Australia's health 2018. Canberra: AIHW; 2018.
13. Cutilli CC, et al. Understanding the health literacy of America: results of the National Assessment of Adult Literacy. Orthopedic nursing. 2009;28(1):27-32; quiz 3-4.
14. Sorensen K, et al. Health literacy in Europe: Comparative results of the European health literacy survey (HLS-EU). European journal of public health. 2015;25.
15. Marcus C. Strategies for improving the quality of verbal patient and family education: a review of the literature and creation of the EDUCATE model. Health Psychol Behav Med. 2014;2(1):482-95.
16. Hedelund Lausen L, et al. How is health literacy addressed in primary care? Strategies that general practitioners use to support patients. Journal of Communication in Healthcare. 2018;11(4):278-87.
17. Murray E, et al. Evaluating digital health interventions: key questions and approaches. Elsevier; 2016.
18. Sverdlov O, et al. Digital Therapeutics: An Integral Component of Digital Innovation in Drug Development. Clinical Pharmacology & Therapeutics. 2018;104(1):72-80.
19. Ferrari R. Writing narrative style literature reviews. Medical Writing. 2015;24(4):230-5.
20. Choi J, et al. Web-Based, Pictograph-Formatted Discharge Instructions for Low-Literacy Older Adults After Hip Replacement Surgery: Findings of End-User Evaluation of the Website. Rehabilitation Nursing Journal. 2017;42(5).
21. Bozic KJ, et al. Shared decision making in patients with osteoarthritis of the hip and knee: results of a randomized controlled trial. The Journal of bone and joint surgery American volume. 2013;95(18):1633-9.

22. Culliton SE, et al. Effect of an e-Learning Tool on Expectations and Satisfaction Following Total Knee Arthroplasty: A Randomized Controlled Trial. The Journal of arthroplasty. 2018;33(7):2153-8.
23. de Achaval S, et al. Impact of educational and patient decision aids on decisional conflict associated with total knee arthroplasty. Arthritis care & research. 2012;64(2):229-37.
24. Fraval A, et al. Internet based patient education improves informed consent for elective orthopaedic surgery: a randomized controlled trial. BMC musculoskeletal disorders. 2015;16:14.
25. Leal-Blanquet J, et al. Effects of an educational audiovisual videodisc on patients' pre-operative expectations with total knee arthroplasty: a prospective randomized comparative study. Knee surgery, sports traumatology, arthroscopy : official journal of the ESSKA. 2013;21(11):2595-602.
26. Stacey D, et al. Decision aid for patients considering total knee arthroplasty with preference report for surgeons: a pilot randomized controlled trial. BMC musculoskeletal disorders. 2014;15:54.
27. Wong J, et al. Effects of an experimental program on post-hospital adjustment of early discharged patients. Int J Nurs Stud. 1990;27(1):7-20.
28. Chen H-H, et al. A new multimedia-based instruction for hip arthroplasty in clinical practice. Computer Methods and Programs in Biomedicine. 2005;80(2):181-6.
29. Lin PC, et al. Comparing the effectiveness of different educational programs for patients with total knee arthroplasty. Orthopedic nursing. 1997;16(5):43-9.
30. Umapathy H, et al. The Web-Based Osteoarthritis Management Resource My Joint Pain Improves Quality of Care: A Quasi-Experimental Study. J Med Internet Res. 2015;17(7):e167.
31. Day MA, et al. Increasing Perioperative Communication With Automated Mobile Phone Messaging in Total Joint Arthroplasty. The Journal of arthroplasty. 2018;33(1):19-24.
32. Weng HH, et al. Development of a decision aid to address racial disparities in utilization of knee replacement surgery. Arthritis and rheumatism. 2007;57(4):568-75.
33. Bini SA, et al. Digital Orthopaedics: A Glimpse Into the Future in the Midst of a Pandemic. The Journal of arthroplasty. 2020;35(7S):S68-S73.
34. De Oliveira GS, Jr., et al. The impact of health literacy in the care of surgical patients: a qualitative systematic review. BMC surgery. 2015;15:86.
35. Johnson D, et al. Gamification for health and wellbeing: A systematic review of the literature. Internet interventions. 2016;6:89-106 PubMed .
36. Deterding S, et al., editors. Gamification: Toward a definition. CHI 2011 gamification workshop proceedings; 2011: Vancouver BC, Canada.
37. Gunatillake T, et al. Embedding consumer and community involvement within an established research centre: moving from general recommendations to an actionable framework. Res Involv Engagem. 2020;6:64.
38. Kowatsch T, et al. A design and evaluation framework for digital health interventions. it - Information Technology. 2019;61(5-6):253-63.
39. Boulley Escriva G, et al. Digital Health Interventions to Help Living with Cancer: A Systematic Review of Participants' Engagement and Psychosocial Effects. Psycho-Oncology. 2018;27.
40. Liu H, et al. Assessment Tools for Health Literacy among the General Population: A Systematic Review. International journal of environmental research and public health. 2018;15(8):1711.
41. Meherali S, et al. Health Literacy Interventions to Improve Health Outcomes in Low- and Middle-Income Countries. Health literacy research and practice. 2020;4(4):e251-e66.
42. Robinson A, et al. Digital technology to support lifestyle and health behaviour changes in surgical patients: systematic review. BJS Open. 2020;5(2).
43. Moher D, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. BMJ. 2009;339:b2535.

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram of systematic search[43].

Study	Design	Funding	Population	Number of particip-ants	Age	Setting	Digital intervention	Main meas

Chen et al, 2005	Quasi-experimental	Nil	THR patients	66	50 years and older	Teaching hospital	Videodisc	Resea Self-c Scale and S Funct Index funct
Weng et al, 2007	Prospective	Nil	African American and Caucasian male veterans with moderate-severe knee OA	64	55-85 years of age	Hospital	Educational video	Short West McM Univ Osteo (WO (valic chang expec pain a Decis Scale decis
Day et al 2017	Prospective	Nil	Patients scheduled for total joint arthroplasty	64	23 patients 51-75 years of age; 2 were older than 75; 5 were younger than 50.	Hospital	Text messaging software	Press Hosp Asses Healt and S (HCA (valic quest text m softw
Choi et al 2017	Descriptive single arm	American Nurses Foundation, Association of Rehabilitation Nurses	Post THA patients with low literacy	15	65 years and older	Rehabilitation hospital	Web-based pictographs	Resea interv (unva clarit of we picto
Culliton et al, 2018	RCT	Canadian Orthopaedic Association	Patients undergoing TKA	416	20 years and older	Hospital	Online educational videos	WOM for m expec Patie Symp (valic satisf

Achaval et al 2012	RCT	Agency for Healthcare Research	Patients with knee OA	210	Mean age 63 years	Hospital	DVD and ACA	Decis Scale decis
Fraval et al, 2015	RCT	Nil	Waitlisted for TKA, THA, knee scope, shoulder scope, ACLR	211	Mean age 54 years	Hospital	Website	Opera quest from Infor Comp (valic know
Leal-Blanquet et al, 2013	RCT	N/A	Patients with knee OA awaiting TKA	92	Mean age 72 years	Hospital	DVD	Knee Expe (valic expec surge
Lin et al, 1997	Quasi-experimen-tal	N/A	Patients scheduled for TKA	60	45 years and older	Metropolitan medical centre	Videotape	State (valic anxie Ques (valic know Perfo Chec perfo posto recov recov
Umapathy et al, 2015	Quasi-experimen-tal	BUPA, AstraZeneca, Pfizer, Google, Anchor Housing	Patients with hip or knee OA	195	50 years and older	Nationwide sample	Website	Healt Impa (valic of he educa mana Osteo Indic for ap care r partic

Stacey et al, 2014	RCT	N/A	Patients with knee OA	140	mean age 67 years	Tertiary hospital	DVD with 50-minute video	Hip-K Ostec Decis Instru for know deriv Decis Scale quali
Wong et al, 1990	RCT	N/A	Patients waitlisted for THA	146	Mean age: Exp 1: 63 years Exp 2: 72 years Control: 65 years	Academic medical centres	Videotape component	Objec Capa (valic Subje Capa (valic hospi Patie Scale comp perfo home
Bozic et al, 2013	RCT	Grant – Robert Wood Johnson Foundation	Patients with hip or knee OA	123	Mean age 63 years	Academic medical centres	DVD and information booklet; health coach phone discussion to formulate questions	Know (valic infor Decis instru for w reach consu

Table 1. Study Characteristics.

Study	**Digital intervention**	**Duration/ frequency of exposure**	**Timing**	**Delivery**	**Provider**	**Key attributes**

Chen et al, 2005	Videodisc	Unclear duration. Once off	Preoperative	Provided to patient to use at home	Self-directed	Anatomy, pathology, THR p preparation, practical guide hospital stay and limitations postoperative care, long-ter protect THR.
Weng et al, 2007	Educational video	2 hours. Once off	Preoperative	Race-specific group meeting at hospital	Staff	Treatment options for knee TKR. Explained pathogenes data illustrations. Patient int treatment choice
Day et al 2017	Text messaging (software algorithm bot)	Three weeks (one week before surgery to two weeks after surgery. Once off	Before surgery: 1 week, 4 days, 2 days, 1 day After surgery: Daily from day 1 to 14 postoperatively	Provided to patient via mobile phone	Self-directed	Preoperative text messages: Lifestyle advice (continue e smoking), preparation for su plan to get help from family skin, fasting times), reminde medication correctly. Postoperative text messages Advice about in-hospital act analgesia, expectations, gen suggestions, encouragement level, looking for signs of in phone number in case of nee request follow up text for ea received for more detail
Choi et al 2017	Web based pictographs	Unclear duration. Once off	After discharge from hospital following THR.	Participant's home, community room in public library or town hall	Researcher	45 web-based pictographs c content including hip pathol procedure, advice about self prevention of complications symptoms of infection, instr medication prescribed, guid to seek help.
Culliton et al, 2018	Online educational videos	1-2minute videos x32. Ongoing.	24 hours after preadmission clinic visit; 6 weeks, 12 weeks and 52 weeks postoperatively	Via website at clinic and home	Self-directed	E-learning platform informe allied health and previous T Didactic videos presented b groups regarding expectatio function, limitations/restrict videos about ADLs/exercise videos about TKR procedur
Achaval et al 2012	DVD and ACA	DVD 45 minutes ACA 15 minutes. Once off.	Preoperative	Hospital site	Staff	Videobooklet decision aid c "shared decision-making" D booklet) about treatment cho osteoarthritis. Patients recei training from staff about co adaptive conjoint analysis (A which used visual pictograp
Fraval et al, 2015	Website	Unclear duration. Once off.	Following surgeon appointment and discussion of surgery	Hospital outpatient clinic	Clerical staff	Website is freely accessible, written and with no financia provides information for a n conditions and procedures. replacement, it provides a th overview using words and d treatment options, indicatio

						expectations, complications, preparation for and recovery the procedure itself, in-hosp frequently asked questions, term outlook.
Leal-Blanquet et al, 2013	DVD + education session	DVD 10 minutes 45-minute education session. Once off.	4 weeks prior to date of surgery	Hospital outpatient clinic	Nurse	DVD content included proc admission to surgery, recov immediate post-op care, out 2/6/12 months. Patient expe pain and function and ADLs
Lin et al, 1997	Videotape	17 minutes for videotape. Once off.	Perioperative days prior to surgery until 6 days postoperatively	Following admission/ during inpatient stay for arthroplasty	Researcher	Videotape content included about surgery, postoperative postoperative exercises.
Umapathyet al, 2015	Website	12 months. Ongoing.	Undefined	Provided to patient to use via email at home	Self-directed	Website was freely accessib included evidence-based inf self-management support re and Knee OA related inform about treatment and manage (including conservative eg v exercise, and surgical eg TJ arthroscopy), fact sheets, he providers, and videos with p narratives and information a Website included OA risk as visual analogue scale for joi cardiovascular risk assessme bleeding risk assessment, m treatment history and prior c HCP. OA management algo customised Mx plan. Memb website included tailored m prompts to encourage users their OA, with self-tracking weekly/monthly/ biannual a about pain and weight. Web experience after patients co HOOS/KOOS/DASS
Stacey et al, 2014	DVD	50-minute video. Ongoing.	Prior to consultation and one year after study recruitment	Provided to patient to use at home	Self-directed	Various treatment options fo lifestyle changes, non-drug pain medication, injections, complementary therapies an Description of options, prob benefits and harms, video-c experiences
Wong et al, 1990	Videotape component	Unclear duration. Once off.	Day 5-6 postoperatively; 1 week, 3 months and 6 months postoperatively	Community health nurse visits	Community health nurse visits	Videotape content details no stated. Pamphlet and videota included safe methods of ca ADLs, post-discharge exerc signs and symptoms of com (eginfection), safe and prop walking/bathing/dressing/to expected stage of progress o months, potential impact of psychosocial welfare (to pre

						unrealistic expectations), av community resources.
Bozic et al, 2013	DVD and information booklet; health coach phone discussion to formulate questions	Unclear duration. Ongoing	Prior to initial consultation with orthopaedic surgeon	Clinic	Staff	Natural history and treatmer for hip/knee OA (surgical ar surgical).

Table 2. Summary of findings.

Study	ROB2/ ROBINS-1	Confounding	Selection of participants	Classification of interventions	Deviation from intended interventions	Missing data
Chen et al, 2005	ROBINS-1					
Weng et al, 2007	ROBINS-1					
Day et al 2017	ROBINS-1					
Lin et al, 1997	ROBINS-1					
Umapathy et al, 2015	ROBINS-1					
			Randomization	Deviation from intended interventions (assignment)	Deviation from intended interventions (adhering)	Missing data
Culliton et al, 2018	ROB2					
Achaval et al 2012	ROB2					
Fraval et al, 2015	ROB2					
Leal-Blanquetet al, 2013	ROB2					
Stacey et al, 2014	ROB2					
Wong et al, 1990	ROB2					
Bozic et al, 2013	ROB2					
Choi et al 2017	N/A	N/A	N/A	N/A	N/A	N/A

Table 3. Risk of bias assessment.