

## Patient Satisfaction with Online Education and Rehabilitation Delivery for Primary Hip Joint Arthroplasty

James Fryar (MD, BSc)<sup>1</sup>, Sharon Kermeci (MNur)<sup>2</sup>, Rachel Vickery (MHsc)<sup>3</sup>, Patrick Weinrauch (PhD)<sup>2</sup>

1 The Prince Charles Hospital, Internal Medicine Department, Queensland Health, Rode Rd, 4032, Queensland, Australia;

2 Brisbane Hip Clinic, 141 Warry Street, Fortitude Valley, 4006, Queensland, Australia;

3 Human Care Solutions, Queensland, Australia.

**Conflict-of-interest statement:** The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper.

**Open-Access:** This article is an open-access article which was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

**Correspondence to:** James Fryar, The Prince Charles Hospital, Internal Medicine Department, Queensland Health, Rode Rd, 4032, Queensland, Australia.

**Email:** james.fryar@health.qld.gov.au

**Telephone:** +61-437-442-527

**Fax:** +61-07-3831 9771

**Received:** May 21, 2022

**Revised:** June 5, 2022

**Accepted:** June 9 2022

**Published online:** June 28, 2022

### ABSTRACT

**AIM:** Hip arthroplasty involves a complex perioperative period, with both preparation and rehabilitation playing key roles in the overall outcome of the operation. New technologies must be investigated to improve patient experiences in the perioperative period. HealthLnx is a web-based program designed as an adjunct to regular perioperative care, with preoperative education and postoperative rehabilitation components. The study aimed to assess whether patients have positive experiences with a web-based perioperative education

and rehabilitation delivery program while undergoing elective hip arthroplasty.

**MATERIALS AND METHODS:** One hundred and fifty-six participants undergoing primary hip joint arthroplasty procedures were enrolled in an online web-based education and rehabilitation program three weeks prior to surgery, ending six weeks post-surgery. Patients opted-in to the program and were able to participate as frequently as desired. Patient-reported experience measures were then completed, with primary outcomes of satisfaction and engagement. Satisfaction was measured using a single 10-point scale, while engagement was defined as accessing the program twice or more times.

**RESULTS:** Engagement was high, with a rate of 86.1%. Satisfaction rates among participants were high, with a mean satisfaction rate of 8.1, with a median value of 9/10. No significant differences in satisfaction and engagement existed between patient demographics.

**CONCLUSION:** Overall, patient engagement and satisfaction for the web-based perioperative program were high when used as an adjunct to regular care. Further study should be undertaken to determine whether online programs improve clinical outcomes for patients undertaking hip arthroplasty procedures.

**Key words:** Arthroplasty; Replacement; Hip; Internet-Based Intervention

© 2022 The Author(s). Published by ACT Publishing Group Ltd. All rights reserved.

Fryar J, Kermeci S, Vickery R, Weinrauch P. Patient Satisfaction with Online Education and Rehabilitation Delivery for Primary Hip Joint Arthroplasty. *International Journal of Orthopaedics* 2022; 9(3): 1688-1693 Available from: URL: <http://www.ghrnet.org/index.php/ijo/article/view/3297>

### INTRODUCTION

Hip arthroplasty in Australia is a common procedure<sup>[1]</sup>, despite reductions in procedures due to hospital restrictions on elective procedures to prevent the spread of COVID-19<sup>[2]</sup>.

Hip arthroplasty involves a complex perioperative period, with

both preparation and rehabilitation playing key roles in the overall outcome of the operation. Typically, a large volume of educational material is delivered to each patient through the process of their preparation and recovery.

Preoperative information provision has been ranked as one of the most important factors to patients undergoing hip arthroplasty, and can result in reduced levels of anxiety, and better physical and psychological outcomes for patients<sup>[3,4]</sup>. However, patients have expressed concerns including inadequate written information, and inconsistent information<sup>[5]</sup>. Further, patient satisfaction has been directly correlated with consultation times<sup>[6]</sup>. With anaesthetists and surgeons being time-poor, scalable methods of delivering high quality perioperative care without increasing time demands must be investigated. Patients also express concern when information provision regarding topics such as pain management and side effects, surgical procedures, wound management and rehabilitation does not meet their expectation<sup>[5,7]</sup>. In preparation for surgery, patients potentially are overwhelmed by large volumes of information, and report forgetting information such as exercise techniques and the proper use of crutches<sup>[5]</sup>. Patients have expressed desire for multimodal and easily accessible information provision to overcome these challenges<sup>[7]</sup>. These issues culminate in patients feeling anxious, uninformed, and unsafe during their peri-surgical care period.

Postoperative rehabilitation plays a significant role in patient outcomes after hip arthroplasty and is widely utilised for patients around the world<sup>[8]</sup>. A Cochrane review conducted in 2008 concluded that early multidisciplinary rehabilitation improves clinical outcomes, including functional gain, shorter hospital stays and fewer post-operative complications<sup>[9]</sup>.

Health information technology is a rapidly growing area of medicine, and is used throughout many areas of healthcare, including orthopaedics<sup>[10-12]</sup>. Attitudes to digital healthcare are generally positive<sup>[5,12,13]</sup>. Digital and internet-based technologies are becoming increasingly viable as more of the population becomes connected to the internet through electronic devices<sup>[10]</sup>. Although digital health technologies have been shown to be effective in improving health outcomes in some settings, one major limitation is a lack of patient engagement<sup>[11]</sup>. It is therefore important to explore patient attitudes and experiences with health technologies, to attempt to increase the effectiveness of these interventions.

Previous papers have attempted to assess the effectiveness of digital interventions for preoperative education or postoperative rehabilitation in hip arthroplasty. Wang *et al.* conducted a systematic review and meta-analysis to assess the effectiveness of technology-assisted rehabilitation following total hip or knee arthroplasty<sup>[14]</sup>. Only four studies were identified for total hip replacement, with the authors of the review concluding that the available evidence was low quality, with major limitations. Other papers have provided some evidence that home-based rehabilitation programs with digital technology can result in superior functional gain and have positive experiences with patients<sup>[13,15]</sup>, however the literature is still lacking. Many of these technologies address either preoperative education or postoperative rehabilitation, but not both.

This study aimed to assess whether patients have positive experiences with a web-based perioperative education and rehabilitation delivery program while undergoing hip arthroplasty.

It was hypothesised that there would be high rates of engagement, and high rates of satisfaction among those who engaged with the program. It was hypothesised that elderly patients would have lower engagement and satisfaction than younger patients.

## METHODS

### Technology-based Intervention Design

HealthLnx (GoWellHealth; SHI Global Ltd; New Zealand) is a flexible web-based program allowing clinicians to develop care packages centred about target health conditions or interventions. In the current study, the care package used was developed as an adjunct to assist with regular perioperative care, with the aim of improving patient experiences through two main components: pre-operative education, and post-operative rehabilitation. The program ran from three weeks prior to surgery, to six weeks post-surgery. Patient education was released online daily, with the aim of providing the most relevant information appropriate to the patient's stage of preparation or recovery, instead of large volumes of information provided at a single time point. The aim of the pre-operative phase of the program was to decrease anxiety about the procedure, and to allow patients to feel safe, well-informed, and prepared for their surgery.

The post-operative rehabilitation phase of the program was designed as an adjunct to physiotherapy-led exercise programs. The online program allowed for tailored rehabilitation plans, where physiotherapists could access and alter content as required, including types of exercises and number of repetitions. The program included videos and descriptions of exercises and served as a daily reminder for patients to complete their exercises.

### Study Design

This was a single-centre trial, designed to assess patient satisfaction and engagement for an online education and rehabilitation program. All participants were managed by primary hip arthroplasty or resurfacing operations between 24 June 2014 and 22 December 2015. Cases were elective only. All patients were enrolled to the program at the time of their initial consultation, at least 3 weeks prior to their surgery date. Patients were sent an email allowing them to voluntarily enter into using the HealthLnx program. No follow-up occurred for those patients who did not self-enrol. Use of the program was not mandated, and there was no additional cost incurred to the patient. Pre-operative education ran for three weeks, and post-operative rehabilitation ran for six weeks. After six weeks, patient-reported experience measures (PREMs) were obtained regarding engagement and satisfaction. The PREM was administered online, sent via direct email to the patients. Participants who did not complete the PREM after the initial request were followed up one further time, before being deemed lost to follow up. The primary outcome measure of this study was patient satisfaction level. Satisfaction was measured on a scale of 1-10. The PREM was designed by author S. Kermeci.

PREMs were de-identified before analysis by a single researcher. Analysis was then conducted by a separate researcher. Engagement was defined as accessing the online program two or more times throughout the duration. The PREM also contained a qualitative section, asking for written feedback about the program. These responses were not formally analysed, but recurring themes were noted by the authors. Ethics approval was obtained from the St Andrews War Memorial Hospital Ethics Committee for the conduct of this study.

### Exclusion Criteria

Exclusion criteria were (1) No access to internet, email or computer; (2) patients without basic computer skills; (3) patients booked for surgery fewer than 3 weeks before surgery date.

**Data Selection**

156 patients were enrolled in the online delivery program with 137 completing the patient-reported experience measure (PREM), providing a participation rate of 87.82%. 13 of these patients were lost to follow up after multiple attempts to contact, and six opted out. 128 of the remaining 137 responses were complete responses, with nine partially complete (93.43%). Patients with partially complete PREMs were included if the primary outcome measure (satisfaction) was completed (seven patients) and excluded if this was blank (two patients). This left a final sample of 135 patients. The majority of patients completed the PREM at the six-week mark (109), while the remaining patients had completed the PREM at the seven-week mark post-surgery.

There are several potential causes for participants opting out and being lost to follow up. These include being too busy to complete the PREM, missing enrolment emails, or changing email addresses, being dissatisfied with either the program or specific aspects of their healthcare.

**Statistical Analysis**

Statistical analysis was conducted using Microsoft Excel (Version 2203) to determine whether differences exist in demographics between groups. Two-sample F tests were used to determine whether variance existed between groups. T tests were performed according to whether variance was equal or unequal. To determine whether age was statistically significantly different between groups, T tests were used ( $p < 0.05$ ). Chi square tests were used to determine whether gender was different between groups.

**RESULTS**

**Patient Demographics**

There were 156 participants in total with 172 hip arthroplasty procedures performed. Of the 156 participants, 59 were female and 97 male, with an average age of 57.69 years (range 16.4-81.1) at the time of surgery. Of these participants 16 underwent bilateral procedures (4 simultaneous, 12 staged). The majority of participants (52.6%) were under the age of 60, with 34.6% of participants living greater than 100km from the clinic location.

There were no significant differences in demographics between those who engaged vs those who did not engage, as displayed in Table 2. Males (8.5) had a significantly higher satisfaction level than females (7.55), shown in Table 3. There was no significant relationship between age and satisfaction, shown in Table 4.

Engagement was defined as accessing two or more times throughout the program, and implied that these patients were able to provide a reasonable assessment of the program. Table 5 details engagement and satisfaction levels. Engagement was calculated as 118/137, providing a rate of 86.1%. Overall, satisfaction rates among participants were high. Mean satisfaction rate was 8.14, with a median value of 9. 85.3% of respondents reported scores of 7 or greater.

Table 6 shows PREMs based on the online health delivery program, measured from 1-5 points. Patients were, on balance, very satisfied with their experiences of the technology-based health delivery program. Patients were most satisfied with the preoperative information videos and content, with a rating of 4.6/5. The postoperative videos were also well received, with a rating of 4.52. Ratings of above 4 were observed for content related to anaesthetics information, reduction in anxiety, discharge instructions, wound care, and convenience. A lower rating of 3.92 was seen in the final

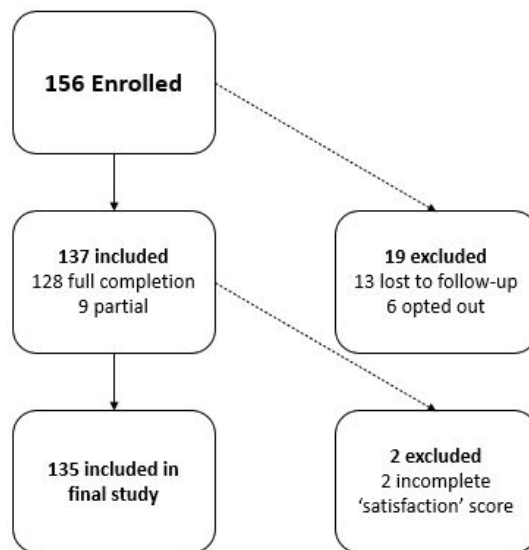


Figure 1 Flowchart of patient selection in study.

Table 1 Patient Demographics.

Gender	
Male	97 (62.2%)
Female	59 (37.8%)
Age at time of surgery (years)	
Mean	57.69
Range	16.4-81.1
Age 60 years or over	
Patients	74 (47.4%)
Procedures	76 (43.9%)
Locality % (km radius from hospital)	
0-50km	78 (50%)
51-100km	24 (15.4%)
101-200km	25 (16.0%)
201-500km	7 (4.5%)
500+kms	22 (14.1%)
Procedure Total Hip Arthroplasty	
Anterior 76 (43.9%)	Male 20 (11.6%)
	Female 56 (32.4%)
Posterior 20 (11.6%)	Male 12 (6.9%)
	Female 8 (4.6%)
Procedure Resurfacing	
Posterior 77 (44.5%)	Male 76 (43.9%)
	Female 1 (0.6%)

Table 2 Statistical Analysis of Demographics vs Engagement.

	Engaged	Not Engaged	P value
Male	72	12	
Female	44	9	0.67
Mean age (years ± SEM)	56.53 (±0.96)	62.72 (±2.87)	0.056

Table 3 Statistical Analysis of Gender vs Satisfaction.

	Male	Female	P value
Satisfaction (mean ±SEM)	8.5 (±0.22)	7.55 (±0.37)	0.03*

\*P < 0.05

question, related to the importance of HealthLnx in achieving the patient’s desired outcomes.

The qualitative section of the survey yielded several recurring themes from patient comments. Patients reported two major reasons for non-engagement; technical issues or lack of skills with technology, and that there was too much effort involved with the process. Patients were especially satisfied with the preoperative information videos, and the ability to refer back to this information at their own convenience. Patients in remote areas commented on the benefits of being able to access information and exercises via the program, instead of needing to travel for physiotherapy. Patients expressed their desire for a mobile phone compatible version of the program. Access to computers in the hospital was limited, and mobile phone compatibility would allow information access during the first few days postoperatively. In addition, some patients reported that accessing their computers at home was difficult given their lack of mobility and would have preferred a mobile phone-based program.

## DISCUSSION

Overall, engagement rates were high, however, there were several reasons for non-engagement identified. As patients were enrolled at their first visit and had no further prompting, and participation in the online program was voluntary, it was expected that a proportion of patients would be unwilling to engage in use of new technology. Technical issues included that their passwords did not work, or the

online program was not working. These two reasons may be linked, as those lacking skills in technology may have also found that using the online program required too much effort. This rate of engagement is similar to other digital perioperative medicine programs<sup>[16]</sup>.

Overall, satisfaction rates among those who engaged with the program were high, as predicted. Mean satisfaction rate was 8.14, with a median value of 9. 85.3% of respondents reported scores of 7 or greater. These rates are supported in the literature with other digital perioperative medicine programs<sup>[5,13]</sup>.

The highest ratings were seen in the preoperative information, postoperative information, and postoperative exercise videos. Patients enjoyed the audio-visual mode of information delivery. When compared to paper-based information sheets and exercises, the videos are more personalised and are easier to follow, which could explain the higher ratings.

Potential reasons for patients rating HealthLnx 3.92/5 for importance in achieving desired outcomes are that the survey was conducted at 6-7 weeks post-operation. Recovery from hip arthroplasty requires sufficient time to be completely achieved and patients may not achieved their desired outcomes within the short duration of time when the program was running. Patients may also have viewed HealthLnx as a useful adjunct to their regular care, but not a vital component – this is in keeping with the design of the program, as it was intended for use in conjunction with, but not supplanting, advice from surgeons, hospital staff and physiotherapists.

Overall, patients reported excellent experiences with the online

**Table 4** Statistical Analysis of Age vs Satisfaction.

	Age (mean years ±SEM)	P value
Satisfaction (≥ 7)	56.72 (±0.9)	
Satisfaction (< 7)	55.54 (±3.4)	0.65

**Table 5** Patient Engagement and Satisfaction of Technology-Assisted Health Delivery Program.

Mean Satisfaction (±SEM)	8.14 (±0.20)
Median Satisfaction	9
Satisfaction (% scores ≥7)	85.34%
Engagement	118/137 (86.1%)

**Table 6** Patient Reported Experience Measures of Technology-Assisted Health Delivery Program With 5-Point Likert Scale Responses.

Measure	Score (±SEM)
Once my account was activated and I had logged in the first time I found HealthLnx easy to use	4.44 (±0.06)
I found the online/web-based design of the program convenient with my lifestyle and/or work commitments.	4.26 (±0.07)
I found the HealthLnx pre-surgery information content and videos helpful and easy to follow	4.61 (±0.05)
I found the HealthLnx post-surgery information content and videos helpful and easy to follow	4.52 (±0.06)
I found the HealthLnx exercise videos helpful and easy to follow.	4.49 (±0.06)
The content on HealthLnx gave me a good understanding of my surgery pathway and how to maximize my recovery.	4.41 (±0.07)
I feel that the HealthLnx package that was supplied to me was comprehensive and that it assisted me in my recovery	4.40 (±0.07)
After viewing the pre-operative education information, I felt less anxious about my surgery than before I had viewed it all.	4.09 (±0.08)
After viewing the pre-operative education information, I felt prepared for my surgery.	4.24 (±0.06)
After viewing the pre-operative information, I felt more confident that I was prepared for the post-discharge phase than if I had not viewed this information.	4.22 (±0.08)
After viewing the pre-operative video from the anesthetist, I felt less anxious about the anesthetic process than before I had viewed it.	4.09 (±0.08)
I understood my post-discharge exercise program better by using HealthLnx combination with the physiotherapy sessions, than I would if I had received physiotherapy alone.	4.19 (±0.09)
The discharge instructions and hip precautions videos were helpful.	4.44 (±0.06)
It was helpful to be able to refer back to previous instructions provided within the HealthLnx package when necessary.	4.19 (±0.06)
After viewing the post-operative education information, I felt prepared for the recovery process	4.22 (±0.07)
I felt the progression of the post-operative exercise program was challenging but able to be achieved.	4.02 (±0.08)
I found the Post-operative information made it easier to work within my hip restrictions whilst continuing my rehabilitation.	4.21 (±0.07)
I felt confident I knew how to look after my wound and spot any issues once I was discharged.	4.19 (±0.06)
Completing the pre-operative exercise program helped me feel physically ready for my surgery	4.18 (±0.07)
The post-operative exercise videos helped me feel confident that I was doing my post op exercises correctly.	4.05 (±0.07)
I feel I did my exercise more effectively because I had videos to refer to rather than just trying to remember what I was taught OR following a paper handout.	4.12 (±0.09)
The information and guidance provided on the HealthLnx program played an important role in me achieving the outcome that I wanted.	3.92 (±0.07)



health delivery program. Patients reported improved preparation and understanding about their surgery and had reduced anxiety on the day of surgery. With surgeons and anaesthetists being time-poor, the ability to build relationships with patients by using personalised videos, without additional time spent face-to-face, was important. Of particular note, we highlight the number of elderly patients who were able to engage with the online program, and who were very satisfied with their experience. No significant relationship was found between age and engagement/satisfaction. This was contrary to the hypothesis that elder patients would have lower engagement and satisfaction than younger patients. Another key benefit is that the information contained within the program is scalable. After creating the content and videos, these can be reused and provided to thousands of patients, while still retaining a personalised aspect. Providing the perioperative information in a timely manner has also reduced the volume of patients contacting the surgeon's offices with questions and concerns.

The authors acknowledge several limitations of this study. The PREMs used in this study are subjective experiences reported by patients. These do not necessarily correlate with other clinical outcomes such as length of stay, resource utilisation or complication rates. As the technology was relatively new in 2014 when data were collected, the authors anticipated some negative experiences due to issues with ease of use and technical issues. These were also experienced in several other similar studies<sup>[12,13]</sup>. This may artificially lower the average satisfaction experienced by patients. It is anticipated that improvements in the software and design of online perioperative medicine programs will reduce the number of patients dissatisfied due to technical issues. There is potential for positive or negative PREMs to be based on the patient's overall patient experiences with the surgeon, surgery, and the perioperative period, rather than just HealthLnx.

## CONCLUSIONS

Overall, patient experiences with HealthLnx were positive, with high engagement and satisfaction. The authors acknowledge the limitations of this study. Further study is required with newer perioperative medicine technologies to confirm the beliefs of the authors. Further studies with more detailed information on engagement would be beneficial to be able to target online interventions towards those who are more likely to engage. Interventional studies with hard clinical endpoints instead of PREMs could be used to investigate whether perioperative medicine programs have benefits on clinical outcomes for patients. The current study was a small, single-centre trial in a private clinic. As such, it is difficult to generalise the results to all populations. However, in the current population, the authors can suggest that patients report benefit and high satisfaction with online health programs when used as an adjunct to their regular care. Other studies have reported similar benefits in the literature, however more research must be performed before concluding with certainty that patients have high rates of satisfaction with web-based perioperative programs in arthroplasty. It is possible that this high rate of satisfaction may translate into other areas of orthopaedics or the wider medical community, however further studies are required before arriving at this conclusion.

## ACKNOWLEDGEMENTS

Author RV has financial interest in an online health care delivery company unrelated to the current manuscript. No funding was provided for the production of this manuscript; however Author PW will be funding any article processing charges.

## REFERENCES

1. Johnson VL, Hunter DJ. The epidemiology of osteoarthritis. *Best Pract Res Clin Rheumatol.* 2014; **28(1)**: 5-15. [DOI: 10.1016/j.berh.2014.01.004; 24792942]
2. Bonano JC, Huddleston JI. Perioperative Medical and Surgical Coronavirus Disease 2019 Issues: Keeping Surgeons, Operating Room Teams, and Patients Safe. *The Journal of Arthroplasty.* 2021; **36(7, Supplement)**: S46-S8. [DOI: 10.1016/j.arth.2021.01.047]; [PMCID: PMC7826132]
3. Zwijnenberg NC, Damman OC, Spreeuwenberg P, Hendriks M, Rademakers JJ. Different patient subgroup, different ranking? Which quality indicators do patients find important when choosing a hospital for hip- or knee arthroplasty? *BMC Health Serv Res.* 2011; **11**: 299. [DOI: 10.1186/1472-6963-11-299]; [PMCID: PMC3268112]
4. Cooke M, Walker R, Aitken LM, Freeman A, Pavey S, Cantrill R. Pre-operative self-efficacy education vs. usual care for patients undergoing joint replacement surgery: a pilot randomised controlled trial. *Scand J Caring Sci.* 2016; **30(1)**: 74-82. [DOI: 10.1111/scs.12223]
5. Jansson MM, Harjumaa M, Puhto AP, Pikkarainen M. Patients' satisfaction and experiences during elective primary fast-track total hip and knee arthroplasty journey: A qualitative study. *J Clin Nurs.* 2020; **29(3-4)**: 567-82. [DOI: 10.1111/jocn.15121; 31769559]
6. Alarcon-Ruiz CA, Heredia P, Taype-Rondan A. Association of waiting and consultation time with patient satisfaction: secondary-data analysis of a national survey in Peruvian ambulatory care facilities. *BMC Health Serv Res.* 2019; **19(1)**: 439. [DOI: 10.1186/s12913-019-4288-6]; [PMCID: PMC6604432]
7. Kennedy D, Wainwright A, Pereira L, Robarts S, Dickson P, Christian J, Webster F. A qualitative study of patient education needs for hip and knee replacement. *BMC Musculoskelet Disord.* 2017; **18(1)**: 413. [DOI: 10.1186/s12891-017-1769-9]; [PMCID: PMC5639777]
8. Wainwright TW, Gill M, McDonald DA, Middleton RG, Reed M, Sahota O, Yates P, Ljungqvist O. Consensus statement for perioperative care in total hip replacement and total knee replacement surgery: Enhanced Recovery After Surgery (ERAS®) Society recommendations. *Acta Orthop.* 2020; **91(1)**: 3-19. [DOI: 10.1080/17453674.2019.1683790]; [PMCID: PMC7006728]
9. Khan F, Ng L, Gonzalez S, Hale T, Turner-Stokes L. Multidisciplinary rehabilitation programmes following joint replacement at the hip and knee in chronic arthropathy. *Cochrane Database Syst Rev.* 2008(2). [DOI: 10.1002/14651858.CD004957.pub3]; [PMCID: PMC8859927]
10. Bossen D, Veenhof C, Van Beek KE, Spreeuwenberg PM, Dekker J, De Bakker DH. Effectiveness of a web-based physical activity intervention in patients with knee and/or hip osteoarthritis: randomized controlled trial. *J Med Internet Res.* 2013; **15(11)**: e257. [DOI: 10.2196/jmir.2662]; [PMCID: PMC3841352]
11. Alkhaldi G, Hamilton FL, Lau R, Webster R, Michie S, Murray E. The Effectiveness of Prompts to Promote Engagement With Digital Interventions: A Systematic Review. *J Med Internet Res.* 2016; **18(1)**: e6. [DOI: 10.2196/jmir.4790]; [PMCID: PMC4723726]
12. Dunphy E, Hamilton FL, Spasić I, Button K. Acceptability of a digital health intervention alongside physiotherapy to support patients following anterior cruciate ligament reconstruction. *BMC Musculoskelet Disord.* 2017; **18(1)**: 471. [DOI: 10.1186/s12891-017-1846-0]; [PMCID: PMC5697059]
13. Hoogland J, Wijnen A, Munsterman T, Gerritsma CL, Dijkstra B, Zijlstra WP, Annegarn J, Ibarra F, Zijlstra W, Stevens M. Feasibility and Patient Experience of a Home-Based Rehabilitation Program Driven by a Tablet App and Mobility Monitoring for

- Patients After a Total Hip Arthroplasty. *JMIR mHealth and uHealth*. 2019; **7(1)**: e10342. [DOI: 10.2196/10342]; [PMCID: PMC6374724]
14. Wang X, Hunter DJ, Vesentini G, Pozzobon D, Ferreira ML. Technology-assisted rehabilitation following total knee or hip replacement for people with osteoarthritis: a systematic review and meta-analysis. *BMC Musculoskelet Disord*. 2019; **20(1)**: 506. [DOI: 10.1186/s12891-019-2900-x]; [PMCID: PMC6825714]
  15. Wijnen A, Hoogland J, Munsterman T, Gerritsma CL, Dijkstra B, Zijlstra WP, Dekker JS, Annegarn J, Ibarra F, Slager GE, Zijlstra W, Stevens M. Effectiveness of a Home-Based Rehabilitation Program After Total Hip Arthroplasty Driven by a Tablet App and Remote Coaching: Nonrandomized Controlled Trial Combining a Single-Arm Intervention Cohort With Historical Controls. *JMIR Rehabil Assist Technol*. 2020; **7(1)**: e14139. [DOI: 10.2196/14139]; [PMCID: PMC7215512]
  16. Dias Correia F, Nogueira A, Magalhães I, Guimarães J, Moreira M, Barradas I, Molinos M, Teixeira L, Pires J, Seabra R, Lains J, Bento V. Digital Versus Conventional Rehabilitation After Total Hip Arthroplasty: A Single-Center, Parallel-Group Pilot Study. *JMIR Rehabil Assist Technol*. 2019; **6(1)**: e14523. [DOI: 10.2196/14523]; [PMCID: PMC6611148]