Digital technologies in management of chronic pain — a systematic review

Afshan Hussain,[1] Husna Haroon,[2] Ashfaq Ahmed,[3] Syed Amir Gilani[4]

Abstract

Objective: To determine the effectiveness of digital health technologies in the management of chronic pain.

Methods: The systematic review comprised search for randomised controlled trials and controlled clinical trials involving patients with chronic pain published between 2010 and 2020. The search was conducted on PubMed, Google Scholar, MEDLINE, National Centre for Biotechnology Information, and National Library of Medicine databases. Risk bias tool was used to evaluate the biasness in the studies and Pedro scale was used to assess the quality of the included articles.

Results: Of the 33 articles fully assessed, 14(42.42%) were analysed. All the studies analysed were randomised controlled trials and scored 6-10 on the Pedro scale which showed high quality of methodology. The studies typically reported statistically significant benefits of digital health technologies in the management of chronic pain. One of the main benefits was enhanced pain coping skills of the patients. Additionally, majority of the studies included increased adherence to exercise as an essential advantage.

Conclusion: All the studies analysed reported favourable conclusions regarding the use of digital intervention for chronic pain management.

Keywords: Chronic pain, Digital intervention, Health technologies, Pain management, Randomised controlled trial.

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Introduction

Increasingly, the internet has been used to provide healthcare interventions as a time-efficient and convenient method, particularly in cases with chronic pain. The internet is believed to be used by about 34% of the world's population; roughly 2.4 billion people.

Interestingly, the age group with the fastest increasing internet usage is the older adults. The internet is, therefore, a viable mode of communication to allow initiatives to reach a large number of people, particularly older adults living in remote areas.[1]

Individuals who are likely to use the internet on a daily basis via cell phones, tablets or computers are gaining acceptance towards this mode of interaction. A creative online support resource can also provide an interactive means of following the rehabilitation of patients in a way that is readily accessible.[2]

While telehealth provides modern conveniences and possibly expanded access to care, especially for patients with limited mobility, for the continuity of treatment, the patient remains heavily reliant on a therapist. For acute and chronic pain, remote therapeutics provide independent, home-based and on-demand access to care.

Digital multi-session therapies have been shown to be successful for chronic pain. Despite these accomplishments, any one procedure will not fulfil everyone's needs; even web-based pain treatments available have engagement rates of <60%, indicating the need to give a wide variety of affordable services for chronic pain management.[3] In the acute-care environment, efficient and secure pain control is an important task. Pain affects about half of hospitalised patients, with one-quarter of those experiencing "unbearable" pain. Pain care, including opioids, is typically pharmacological management, which can lead to contradictions and suboptimal results. Data from the United States Centres for Disease Control and Prevention (CDC) indicates that one year later, even a single-day use of opioid treatment anticipates a 6% chance of dependence. Thus, in hospitalised patients, there is an urgent prerequisite for protected, well-founded, drug-related alternatives for pain management.[4]

Service delivery interventions for telemedicine and eHealth are being attempted and found to be innovative in many cases. Technology for communication is comparatively inexpensive to use. Connection with patients is essentially possible if the staff and facilities are available.[5]

[1]Department of Physical Therapy, [3]Department of Physiotherapy, [2]University Institute of Physical Therapy, University of Lahore, Lahore, [4]Department of Radiology, University of Lahore, Lahore, Pakistan.

Correspondence: Afshan Hussain. Email: afshanhussain.k@gmail.com

The current systematic review was planned to determine the effectiveness of digital health technologies in the management of chronic pain.

Materials and Methods

The systematic review comprised search for randomised controlled trials (RCTs) and controlled clinical trials involving patients with chronic pain published between 2010 and 2020. The search was conducted on PubMed, Google Scholar, MEDLINE, National Centre for Biotechnology Information (NCBI), and National Library of Medicine (NLM) databases.

Studies were included if the study participants had access to any form of digital source, had participants of either gender regardless of age, had been peer-reviewed, published in professional and scientific journals, contained any standardised assessment tool of the intervention's outcome, were RCTs or controlled clinical trials, and were published in English language between 2010 and 2020.

Studies were excluded if the patients in the study suffered from any other traumatic injury that required regular hospital visits or hospital admissions, any form of editorials, commentaries, case series, textbook articles, studies written in languages other than English, presence of health condition that affected the rehabilitation programme, if the participants did not have access to any form of digital source, and studies that did not have any protocol to ensure or validate if the participants attended the treatment.

The key words used for the search were: 'telehealth', 'telemedicine', 'web-based exercise', 'internet delivered exercise', 'chronic pain', 'osteoarthritis', 'SMS service', 'low back pain', 'VR', 'pain coping skills', 'persistent pain', 'musculoskeletal conditions', 'digital activity', and 'digital health'. There was also a manual check of references from the retrieved journals. Boolean terms included digital intervention AND chronic pain management OR pain coping skills.

Comparison groups were considered.

Primary outcome of interest was overall adherence to exercise, adherence to number of exercise sessions, pain intensity, level of activity, and disability.

Secondary outcomes included movement activity, cognitive predictors of behavioural change and health-related variables, and satisfaction with digital intervention experiences.

Risk bias tool was used to evaluate the biasness in the studies, and Pedro scale[6] was used to assess the quality of the included studies.

Results

Of the 33 articles fully assessed, 14(42.42%) were analysed in detail (Figure). All the studies analysed scored 6-10 on the Pedro scale which showed high quality of methodology (Table-1). All the studies analysed were RCTs, reporting statistically significant benefits of digital health technologies in the management of chronic pain. One of the main benefits was enhanced pain coping skills of the patients. Additionally, majority of the studies included increased adherence to exercise as another essential advantage (Table-2). Risk bias of each study was also evaluated (Table-3).

Table-1: Quality assessment using Pedro scale of the studies analysed.

Author Name	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Total Score
(Lambert et al.)[2]	Y	Y	Y	Y	N	Y	N	Y	Y	Y	Y	8
(Bennell et al.)[7]	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	8
(Kim L. Bennell et al.)[8]	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	9
(Harmelink et al.)[9]	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	8
(Chen et al.)[10]	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	6
(Nelligan et al.)[11]	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	9
(B.F. Dear et al.)[12]	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	6
(Eaton et al.)[13]	N	Y	Y	Y	N	N	N	Y	Y	Y	Y	6
(B.F. Dear et al.)[14]	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	6
(Rini et al.)[15]	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	8
(Palermo et al.)[16]	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	8
(Connelly et al.)[17]	Y	Y	N	Y	N	Y	Y	Y	Y	Y	Y	8
(Spiegel B et al.)[4]	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	6
(Rutledge et al.)[18]	Y	Y	N	Y	N	N	Y	Y	Y	Y	Y	7

Table-2: Characteristics of the studies included.

No.	Study Author	Method	Dropouts	Participants	Interventions	Outcomes	Conclusion	Quality of life
1	(Lambert et al,2017)[2]	RCT computer-generated, concealed, fixed block randomization procedure	3	80 EG: 40 CG: 40	EG: HEPs via an app with remote support CG: HEPs via paper handouts	• PSFS • WHODAS 2.0	Participants who received their HEPs on an app with remote support reported greater adherence and greater improvements in function and pain management	N/A
2	(Kim L. Bennell et al,2017)[8]	RCT Computer-generated randomization by random permuted blocks of size 2 to 8 stratified by sex and residence (metropolitan or regional/ rural)	0	148 IG: 74 CG: 74	IG: online educational material+ PCST programme+ Skype sessions with a physiotherapist CG: online educational material only	• NRS • WOMAC • ASES • CSQ • PCS • AQoL-2	For persons with chronic knee pain, Internet delivered, physiotherapist-prescribed exercise and PCST provide clinically meaningful improvements in pain and function that are sustained for at least 6 months.	Both groups had similar improvements in functional status, and quality of life.
3	(Bennell et al,2019)[7]	RCT stratification by physical therapists and patient-affected body region	0	305 IG: 153 CG: 152	IG: individualized home exercise program using a commercially available web-based exercise programming system (Physitrack, https://www.physitrack. com). CG: usual physical therapy care as determined by the physical therapist.	• NRS	A commercially available web-based exercise programming system resulted in greater adherence to a physical therapist-prescribed home exercise programme for 3 wks when compared with usual methods physical therapists use to deliver exercise in people with musculoskeletal conditions.	N/A
4	(Harmelink et al.)[9]	RCT block randomization with a block size of 6.	0	110 IG:55 CG:55	IG: a two-week home-based exercise programme+ activity coaching system CG: a two-week home-based exercise programme.	• TUG • 2MWT • KOOS • SF-36	Participants with additional activity coaching system showed greater improvement in function	IG had better improvements in functional status, and quality of life.

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No.	Study Author	Method	Dropouts	Participants	Interventions	Outcomes	Conclusion	Quality of life
5	(Chen et al,2017)[10]	RCT participants were assigned a number based on the order of the time when they agreed to participate in the study	6	66 IG: 33 CG: 33	CG: shoulder exercises +printed pamphlet about shoulder exercises. IG: shoulder exercises +printed pamphlet about shoulder exercises+ reminders, encouragement and educational messages by mobile phone daily	• SST • VAS	The text messages significantly increased patient compliance with shoulder exercises and thus improved patients' shoulder range of motion.	N/A
6	(Nelligan et al,2019)[11]	RCT Computer generated randomization by study biostatistician in permuted blocks of sizes 6 to 12	3	62 TG: 31 CG: 31	TG: My Knee Exercise website and SMS support CG: URL to access 'My Knee Education' website.	• NRS • WOMAC • KOOS • AQoL-2 • EARS • PASE • ASES • SEE	Both groups showed significant improvement in the first 3 weeks but TG showed greater improvement towards the end of the trial.	Both groups had similar improvements in functional status, and quality of life.
7	(Rutledge et al,2018)[18]	RCT	0	66 CG:33 EG:33	EG: telehealth adaptation of cognitive behavioural therapy (CBT) for chronic back pain CG: supportive care for chronic back pain.	• RMDQ • NRS • CGI-11	EG: showed patterns of treatment participation, treatment satisfaction, and patient self-reported improvements that were generally comparable to patients receiving a parallel SC treatment.	Significant pre to post-treatment reductions in back pain disability and pain severity were observed in both conditions.
8	(B.F. Dear et al,2013)[12]	The design comprised a Consolidated Standards of Reporting Trials-revised compliant RCT	3	62 TG: 31 CG: 31	TG: (iCBT) programme CG: waitlist	• PSEQ • TSK • PRSS	TG: participants report significant improvements on measures of disability, depression, anxiety, and average pain ratings.	N/A
9	(Eaton et al,2018)[13]	Cluster randomized controlled trial	6	41 IG:23 CG:18	EG: PCPs presented each study patient at a TelePain session CG: PCPs were asked to refrain from attending TelePain sessions during the study period.	• KASRP • Know Pain-12 • Perceived Competence Scale	No significant improvement between the groups in the management of chronic pain	N/A

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No.	Study Author	Method	Dropouts	Participants	Interventions	Outcomes	Conclusion	Quality of life
10	(B.F. Dear et al,2015)[14]	A 4-arm CONSORT-revised compliant randomized controlled trial	0	471 G1:139 G2: 135 G3:123 CG:74	The Pain Course, when provided with different levels of clinician support G1: regular contact G2: optional contact G3: no contact CG: treatment as usual waitlist CG	• RMDQ • PHQ-9 • GAD-7 • WBPQ • PSEQ • TSK • CPAQ-8	All 3 treatment groups reported significance improvement as compared to the CG	N/A
11	(Rini et al,2015)[15]	RCT multi-center, balanced (1:1) randomization.	4	113 EG: 58 CG: 55	EG: Internet-based PCST (PainCOACH) CG: assessment only	• AIMS2 • ASES • Pain Anxiety Symptoms Scale • Positive and Negative Affect Scale	PainCOACH users' self-efficacy for pain management increased from baseline to post-intervention compared to the control group	N/A
12	(Palermo et al,2016)[16]	Multicenter, balanced (1:1) randomized parallel-group design	8	273 EG: 138 CG: 135	EG: Internet cognitive-behavioral therapy condition CG: Internet-delivered pain education	• CECR • CALI • NRS • BAPQ • ASWS • ARCS • HHI-Pain	Results demonstrated significantly greater reduction in activity limitations from baseline to 6-month follow-up for Internet CBT compared with Internet education	N/A
13	(Connelly et al,2018)[17]	RCT Web-based randomization service was used to equally (1:1) randomize participants	0	289 TG: 144 CG: 145	TG: online self-management program (teens taking charge) CG: online disease education program	• CASE • NRS • PCQ • PedsQL	Self-directed online self-management training and online disease education comparably and modestly improve pain and HRQOL in youth with JIA.	Participants in both study groups had improvements in pain and HRQOL
14	(Spiegel B et al,2019)[4]	RCT using the Microsoft Excel random number generator.	20	140 CG:70 EG:70	EG: Virtual reality pain distraction experience CG: Control pain distraction experience.	• NRS • HCAHPS	EG: VR group achieved improved pain scores	N/A

EG: Experimental group, TG: Treatment group, IG: Intervention group, CG: Control group, VR: Virtual reality, NRS: Numeric rating scale, VAS: Visual analogue scale, PSFS: Patient-specific functional scale, WHODAS2.0: World Health Organisation disability assessment schedule, WOMAC: Western Ontario and McMaster universities osteoarthritis index, AQoL-2: Assessment of quality of life,

ASES: Arthritis self-efficacy scale, CSQ; Coping strategies questionnaire, PCS: Pain catastrophizing scale, TUG: Time up and go, 2MWT: 2-minute walk test, KOOS: Knee osteoarthritis outcome score, SF-36: Short form 36, SST: Simple shoulder test, EARS: Exercise adherence rating scale, PASE: Physical activity scale for the elderly, SEE: Self-efficacy for exercise, RMDQ: Roland-Morris disability questionnaire, CGI-11: Clinical global impressions scale, PSEQ: Pain self-efficacy questionnaire, TSK: Tampa scale of kinesiophobia, PRSS: Pain responses self-statements, KASRP: Knowledge and attitudes survey regarding pain, PHQ: Patient health questionnaire, GAD: Generalised anxiety disorder, WBPQ: Wisconsin brief pain questionnaire, CPAQ: Chronic pain acceptance questionnaire,

AIMS: Arthritis impact measurement scale, CECR: Computer equipment comfort rating, CALI: Child activity limitations interview, ASWS: Adolescent sleep wake scale, ARCS: Adult responses to children's symptoms, CASE: Children's arthritis self-efficacy scale, PCQ: Pain coping questionnaire, PedsQL: Paediatric quality of life scale, HCAHPS: Hospital consumer assessment of healthcare providers and systems.

Table-3: Risk of bias for each study.

No.	Study Author	Random sequence generation (Selection bias)	Allocation concealment (Selection Bias)	Blinding of outcome assessment (Detection bias)
1	(Lambert et al, 2017)[2]	+	+	+
2	(Kim L. Bennell et al, 2017)[8]	+	+	+
3	(Bennell et al, 2019)[7]	+	+	+
4	(Harmelink et al.)[9]	?	+	+
5	(Chen et al, 2017)[10]	+	?	?
6	(Nelligan et al, 2019)[11]	+	+	+
7	(Rutledge et al, 2018)[18]	+	?	+
8	(B.F. Dear et al, 2013)[12]	?	?	-
9	(Eaton et al, 2018)[13]	+	+	?
10	(B.F. Dear et al, 2015)[14]	+	?	+
11	(Palermo et al, 2016)[16]	+	?	?
12	(Rini et al, 2015)[15]	+	+	+
13	(Connelly et al, 2018)[17]	+	-	+
14	(Spiegel B et al, 2019)[4]	+	-	?

Unclear? Low Risk +, High Risk -

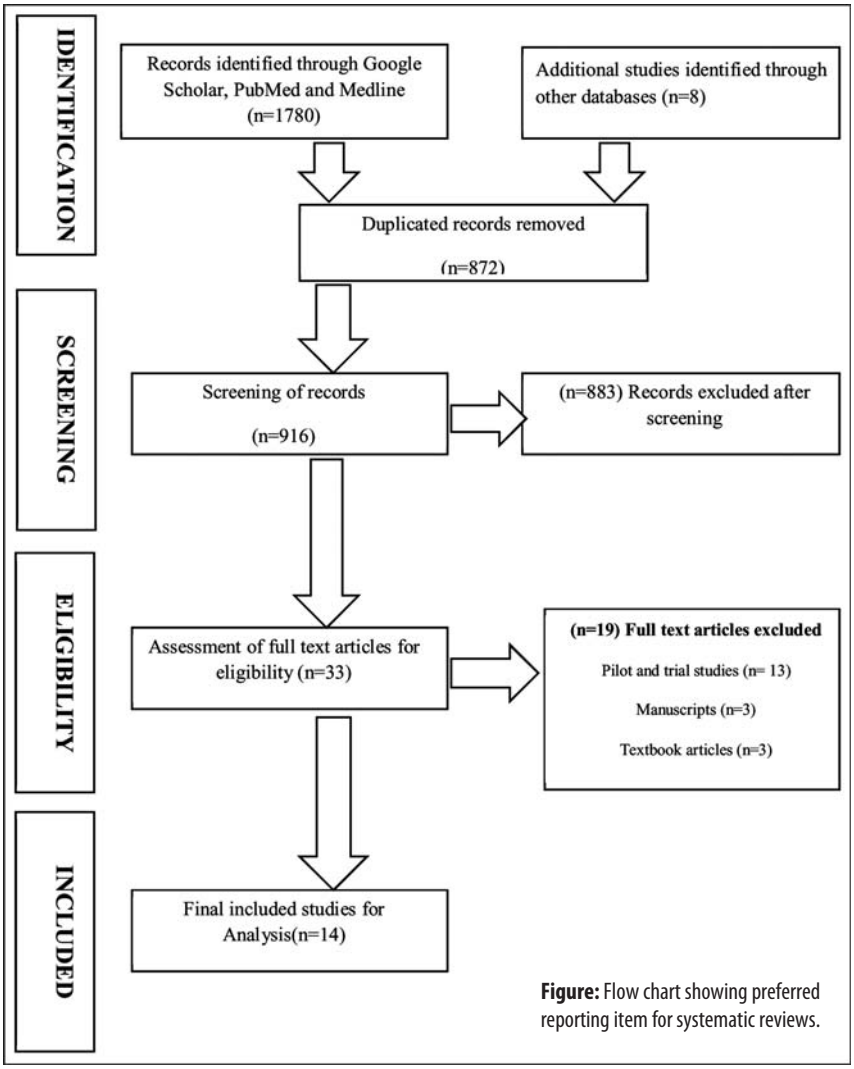

Figure: Flow chart showing preferred reporting item for systematic reviews.

Discussion

The systematic review analysed 14 studies that met the inclusion criteria.[2,4,6-17] Despite a rapid uptake of technology in the health community, there has been little high-quality research to determine the efficacy of such technology in the field of physiotherapy. The studies included in the current review provide positive evidence in that digital technologies can indeed improve patients' ability to manage pain and also conditions that cause chronic pain. All the 14 studies included used different types of digital interventions with different strategies. It is very important as it can be added to the generalisation capacity of the current review. Even though there is very little difference of opinion in the studies, all of them support the view that digital interventions do help patients manage their pain better.

A study by Lambert et al[2] 2017 discussed how efficient it was to provide HEPs (home exercise programmes) using an app in conjunction with text messages and phone calls in order to address a practical question about the efficacy of a "set" of interventions delivered via technology versus paper handouts.

Kim et al[7] in 2017 compared the effects of traditionally prescribed home workouts

with that of an online intervention which combined physiotherapist-prescribed home workout, Skype sessions with a physiotherapist and an immersive PCST (Pain-coping skills training) software.

Another study[6] by Bennell et al. stated that traditional approaches used by physical therapists to administer exercise to patients with musculoskeletal disorders when compared with a publicly accessible web-based exercise programming framework resulted in better symptom control.

Harmelink et al.[8] evaluated how successful an activity coaching system was when combined with a home-based fitness routine.

Nelligan et al.[10] compared the effects of a digitally distributed intervention combining "My Knee Workout," a website with knee osteoarthritis (OA) and exercise instruction advice with that of only an education guidance.

Rutledge et al.[17] compared the effects of telephone delivered CBT (Cognitive behavioural therapy) for pain management with that of supportive care condition that basically involves education using standard textbooks, active listening and maintaining current medications and treatment practice.

The efficacy of a new programme, the pain course in reducing disability and anxiety, was explored by B.F. Dear et al.[11]

Eaton et al.[12] evaluated the effects of tele-mentoring and the impact it had on pain management on patient outcomes.

Another study by B.F. Dear et al.[13] explored the efficacy of an internet pain course programme in combination with video conferences with the clinician compared with no clinician support at all.

Rini et al.[14] evaluated an internet-delivered automated PainCOACH (An Internet-based interactive PCST programme) PCST intervention compared to an assessment-only group.

Palermo et al.[15] demonstrated the effectiveness of an internet-based CBT programme for paediatric pain and disability. The intervention was compared to a waitlist group.

Connelly et al.[16] sought to determine the effect of an online self-management programme which included multimedia-based modules on pain and health-related quality of life in adolescents with juvenile idiopathic arthritis.

Spiegel B et al.[4] evaluated the effectiveness of therapeutic Virtual Reality (VR) compared with yoga and meditation sessions, poetry readings and discussions on health and wellness topics.

Conclusion

All the 14 studies supported the use of digital technologies in pain management as it increased compliance and confidence of using the given intervention while improving participants' sleep quality. The studies suggested that there is a potential for sustained benefits.

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