Digital health for quality healthcare: A systematic mapping of review studies

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Abstract

Objective: To systematically catalogue review studies on digital health to establish extent of evidence on quality healthcare and illuminate gaps for new understanding, perspectives and insights for evidence-informed policies and practices.

Methods: We systematically searched PubMed database using sensitive search strings. Two reviewers independently conducted two-phase selection via title and abstract, followed by full-text appraisal. Consensuses were derived for any discrepancies. A standardized data extraction tool was used for reliable data mining.

Results: A total of 54 reviews from year 2014 to 2021 were included with notable increase in trend of publications. Systematic reviews constituted the majority (61.1%, (37.0% with meta-analyses)) followed by scoping reviews (38.9%). Domains of quality being reviewed include effectiveness (75.9%), accessibility (33.3%), patient safety (31.5%), efficiency (25.9%), patient-centred care (20.4%) and equity (16.7%). Mobile apps and computer-based were the commonest (79.6%) modalities. Strategies for effective intervention via digital health included engineering improved health behaviour (50.0%), better clinical assessment (35.1%), treatment compliance (33.3%) and enhanced coordination of care (24.1%). Psychiatry was the discipline with the most topics being reviewed for digital health (20.3%).

Conclusion: Digital health reviews reported findings that were skewed towards improving the effectiveness of intervention via mHealth applications, and predominantly related to mental health and behavioural therapies. There were considerable gaps on review of evidence on digital health for cost efficiency, equitable healthcare and patient-centred care. Future empirical and review studies may investigate the association between fields of practice and tendency to adopt and research the use of digital health to improve care.

Keywords

Digital health, systematic mapping, quality healthcare, mHealth, technology-enhanced

Introduction

Digital health has shifted the paradigm of quality medical care. In the literature, digital health is diversely defined. From a review of 1527 papers, the seminal study by Fatehi et al.[1] finds 95 unique definitions of digital health, yet common to these definitions is digital intervention that examines the provision of healthcare rather than the use of the technology itself. Empowered by the industrial revolution 4.0, digital health invigorates applications of digital technology that changes the landscape of conventional medical practice. As a result, there is an increasing interest to capitalize digital health to improve the quality of healthcare.

To understand how digital health may improve healthcare quality, this study adopts six domains of quality as

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being defined by the consensus of experts;[2] patient safety, access to healthcare, effective treatment, efficient use of resources, equity of care across subgroups of populations and patient-centred care. The judgement among these experts were in coherence with the following descriptions of quality care from the World Health Organization (WHO).[3(pp. 9–10)] Patient safety relates to the delivery of care which minimizes risks and harms. Effective treatment denotes improved health outcomes to patients and community. Efficiency indicates optimum use of resources that avoid waste. Equitable healthcare concerns on consistent care quality across different subgroup of patient population. Quality of access refers to the delivery of care that is timely, geographically reasonable and appropriate to the medical need. Lastly, patient-centred approach emphasizes care that considers individual patient's preferences, aspirations and the cultures of the community. Therefore, reviewing the notion of quality from these domains provides a multi-faceted approach to understand digital health and its roles to improve quality healthcare.

This understanding is important because the literature has reported innovative digital technology contributes towards quality healthcare in various ways. For example, Rahman et al.[4] reported the use of Vis-Screen mobile application to widen population-based screening for visual impairment and blindness. They raised concern that there was a lack of awareness among certain group of population, especially those who were disadvantaged in terms of economy, education and remote areas of residence. In these population, late presentation of ophthalmologic conditions hindered timely intervention, resulting in dire consequences to the quality of life.[4] Similarly, Yang et al.[5] innovated digital neuroradiology imaging database to enhance retrospective research and prospective clinical trials in the field of radiology, neurosurgery, neurology, rehabilitation and others, for patients with brain tumour. The likely contribution on clinical care from application of this technology is reflected by Othman et al.[6] who reported 386 new cases of primary brain tumour were registered within the period of 2013 to 2018 in a neurosurgery department of a tertiary hospital in Malaysia. The gravity of impact on quality care is further magnified by the potential similar findings among tertiary medical centres around the world. Thus, this variety of contributions indicate the rising interest, research and adoption of digital health for quality healthcare.

Paradoxically, the exponential rise of digital health adoption over the last two decades may have created a challenge to establish the extent of impact from digital health on quality healthcare.[7] Challenges associated with digital health include ethical concern on information security, acceptability on new practice, and whether the technology really is practical and feasible to be implemented in real practice.[8] In 13 November 2018, these challenges had prompted the European Union to sanction a public

hearing, followed by an official report by expert panel on effective ways of investing in health (EXPH) to assess the impact of digital transformation on health service.[9] In their summary finding, the 14-member expert panel highlighted broad perspectives should be taken in making the decision to adopt, employ or invest new digital health services.[9] Therefore, aligning the evidence with the need of practice, policy and research may depart from eliciting the extent of evidence with the broader aspects of healthcare.

In response, we are conducting this systematic mapping of review studies to gain a wide-ranging perspective on evidence related to the digital health and quality medical care. A systematic mapping is also known as a scoping review as described by Arksey and O'Malley.[10,11(pp. 48–49)] However, systematic mapping does not appraise the quality of the selected study and consequently does not analyze the results of the selected studies. Instead, a mapping review focuses on systematic cataloguing of selected studies to derive new insight and understanding on the breadth, purpose and trend of research activities on the topic of interest.[12] The importance of systematic mapping is increasingly recognized in the context of providing multi-faceted aspects of evidence including the literature descriptions of an intervention at different places, contexts, time and fields of practice.[13] These broad perspectives of evidence may prove useful and important for complicated evidence-informed policy decision because every institution is unique in its experience, expertise and resources for healthcare quality improvement.

Therefore, this study adopts systematic mapping design as a robust methodological approach to establish the extent of review evidence on digital health for quality healthcare. The following sections of this study will outline the objective, methodology and results of this review. We will then narratively discuss the findings before concluding with the key findings for policies and practices.

Objective

To our knowledge, there is yet a study that reviews the evidence of review studies on digital health and aspects of quality medical care. The objective of this study is to systematically map these review studies to establish six end-points: (1) general characteristics of review studies on digital health; (2) trend of research activities by year publication; (3) the aim and objective of digital health for quality medical care; (4) approaches to improve the effectiveness of intervention via digital health; (5) type and frequency of digital health interventions; and (6) predominant disciplines of medical practice and their topics for digital health.

Engaging with users of review study

Engaging key stakeholders allows a review study to gain users' perspectives to help navigate clearer aims and

goals that are relevant and meaningful to inform policy and practice.[14] However, this approach was not adopted due to practical challenges related to the COVID-19 lockdown period during the conduct of this study. Alternatively, the objectives of this review were derived through informal engagement with local key stakeholders. This informal engagement was achieved through one reviewer (HMY) who is currently a member of board of director of Universiti Sultan Zainal Abidin (UniSZA) teaching hospital, and another reviewer (RAM) who was a member of UniSZA centre of academic quality. Objectives (4), (5) and (6) were added following both authors' experience as policymakers and regular engagement with various stakeholders.

Methods

Search strategy

We began by performing rapid synthesis of evidence with data mining via few keywords in PubMed databases such as 'digital health' and 'medicine'.[15] This exercise served as preliminary measures of exploring research activities in the fields of interest, thus guided a more targeted search by indicating arbitrary boundaries of review that was within the time and practical constraints of this study.[16]

Consequently, we derived three conceptual frameworks to guide structured searching for studies on digital health on quality medical care: digital health, medicine and review study.

Conducted in the PubMed database, we designed search strings for each conceptual framework to be based on title/abstract and MeSH term. The final Boolean search strings for this study were conducted on 2 June 2021.

Study selection criteria

Following rapid review of evidence, we developed criteria to define the focus and boundaries of this mapping review. The selection criteria were summarized in Table 1.

Selecting studies

Selections were conducted by two independent reviewers (MSI and YIAB). Reviewers initially rejected irrelevant studies based on title and abstract. If there was any doubt for exclusion, studies were accepted for the full text screening. All discrepancies between reviewers were resolved by consensus.

Table 1. Criteria for study selection.

	Inclusion criteria	Exclusion criteria
Population	Studies of quality healthcare that include medical professionals were accepted.	
Language	Studies were conducted in English	
Study design	Studies were either systematic review, systematic mapping, or scoping review	Original studies, review protocols, literature reviews, and review of review studies (overview, meta-review or umbrella review)
Intervention	Studies were researching the use of digital technology to improve patient care.	Reviews that were mainly focusing on: - Education of health practitioners on the use of digital technology - Evaluation or application of technology rather than directly on patient care
Comparison	Studies with or without comparison of interventions were accepted	
Outcome	Studies reported results that feature any domain of quality care as its main finding or as one of the main findings.	
Timeframe	All publication dates were accepted	Duplicates of the same study

Extracting studies

All title and abstract of included studies were imported into reference manager Endnote 20. Then all details of the final included studies were extracted into a standardized data mining template in Microsoft Excel with structure as shown in Supplemental Appendix 1.

Quality appraisal and search for grey literature

Both quality appraisal and search for grey literature were not applicable for this study which aimed to systematically catalogue the research activities to achieve broad perspectives on the evidence in this field.[17] Consequently, the results of the selected reviews were presented in the appendix section (Supplemental Appendix 2). This approach was adopted as a measure of good practice to avoid misleading the readers that the included reviews had been critically appraised.[18]

Data analysis

PRISMA flowchart[19] for the selection process and systematic mapping of all included reviews based on standardized data extraction tool were constructed. Data were analyzed and narratively summarized using descriptive statistics in tables or graphs for each objective of the study. Descriptive statistics were computed using Microsoft Excel[20] while Microsoft Power BI[21] was used for visualization of spatial data.

Results

Search and selection

The structured searching via search strings based on conceptual frameworks returned 4545 studies regarding digital health, 2,709,890 articles concerning medicine, and 199,138 publications on review study. The final Boolean search operation revealed a total of 155 studies that were relevant for all three conceptual frameworks. Table 2 provides summary of the structured search strategy used in this study.

From these 155 studies, no duplications were found. Subsequently, 64 studies were removed during first stage of selection via title and abstract. Further 37 studies were excluded following second stage selection by full text appraisal. Figure 1 summarizes the PRISMA flow diagram[19] for the final 54 reviews for data extraction.

Data mapping of included reviews

Mapping of data by standardized data extraction tool for all 54 reviews established the extent of review evidence to answer all six endpoints of this study. Table 3 provides results of data mapping conducted in this study.

Endpoints

Characteristics of review studies on digital health. This study identified 13 scoping reviews, 20 systematic reviews with meta-analyses and 21 systematic reviews without meta-analyses. From the 54 reviews, institutions of the main author for the reviews were reported from 15 countries; United Kingdom (16), United States (7), Australia (7), Canada (5), Switzerland (4), China (4), Ireland (2), Netherlands (2), and one each for Brazil, Singapore, France, Turkey, Finland, Greece, Ethiopia (Figure 2).

Publication year. There was an increasing number of reviews from one publication in the year 2014 to 26 articles for the year 2020. Figure 3 displays the number of reviewed articles by year of publication.

Domains of quality care. Digital health had been reviewed to deliver all six domains of quality healthcare. From the 54

Table 2. Results of the structured searching.

| No.	Conceptual framework	Search string	Number of returned publications
#1	Digital health	(digital health[Title/Abstract]) OR (digital health[MeSH Terms])	4545
#2	Medicine	((((((medicine[Title/Abstract])) OR (medical[Title/Abstract])) OR (doctor[Title/Abstract])) OR (medicine[MeSH Terms])) OR (medical[MeSH Terms])) OR (doctor[MeSH Terms])	2,709,890
#3	Review study	(((((systematic review[Title/Abstract]) OR (scoping review[Title/Abstract])) OR (systematic mapping[Title/Abstract])) OR (systematic review[MeSH Terms])) OR (scoping review[MeSH Terms])) OR (systematic mapping[MeSH Terms])	199,138
#4	Final search	((#1) AND (#2)) AND (#3)	155
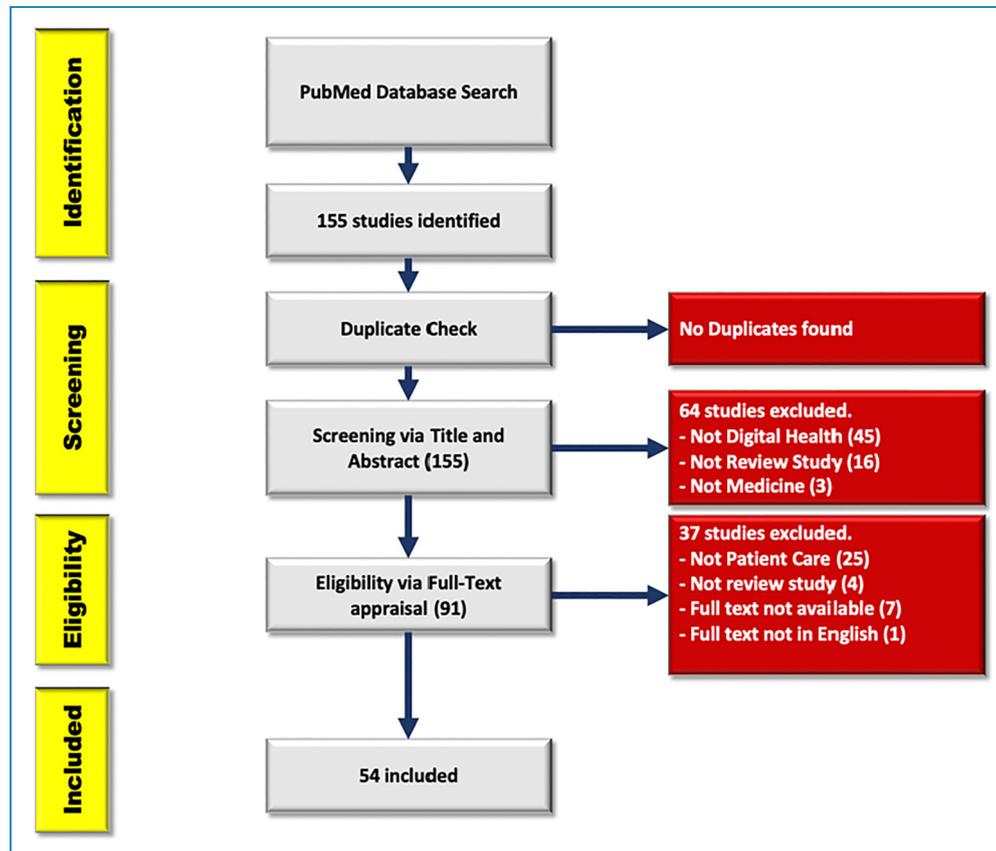
Figure 1. PRISMA flow diagram[19] of the selection process.

reviews, evidence was mostly prevalent on the aspect of effective intervention (75.9%). Additionally, there were comparable extent of evidence on digital health for accessibility (33.3%), patient safety (31.5%) and efficiency (25.9%). However, there were considerably less number of reviews on digital health for patient-centred care (20.4%) and equitable healthcare (16.7%). Figure 4 summarizes the number of reviews on digital health by domains of quality of care.

Approaches for effective intervention. Digital health had been reviewed to deliver a more effective intervention via four distinct approaches. The targets of intervention included improving health behaviour (50.0%), enhancing clinical assessment (35.1%), supporting medication compliance or treatment engagement (33.3%) and strengthening coordination of care (24.1%) (Figure 5).

Types of digital health interventions. The data mapping also revealed 15 unique categories of digital health for quality healthcare. Mobile apps and computer-based programs were the most reported digital health intervention. Videocassette, electronic medication container, endoscope-equipped smartphone and IoT each were least

applied. Figure 6 presents 15 distinct digital applications used for health interventions reported in the 54 reviews.

Predominant disciplines of medical practice and their topics. Most topic of reviews on digital health for quality healthcare were multidisciplinary in nature (32). However, for single main field of discipline, topics related to psychiatric care emerged as the commonest (11). Table 4 shows predominant disciplines being addressed by the digital health reviews and their topics.

Discussion

To the best of our knowledge, this is the first study to systematically search, select and map review studies on digital health for quality healthcare. A total of 54 reviews are included, ranged from the year 2014 to 2021 with increasing trend till the end of 2020 (Graph 1). From these reviews, a total of 15 distinct digital health interventions are identified (Graph 4) with findings which encapsulate all six domains of quality healthcare (Graph 2), 12 identified group of practices (graph 5), with 51 unique topics of healthcare (Table 3). Therefore, the systematic mapping of compilations of review studies on digital health create new evidence, insight and understanding on quality

Table 3. Data mapping for 54 reviews on digital health for quality healthcare.

No	Author	Type of review*	Topic of review	No. of studies	Main field of discipline	Digital health identified in the review															Domain of quality medical care					Effective intervention			
						Mobile apps*	Computer-based*	Sensor-based technology	Electronic-Record-based	A.I.*	Telemedicine*	Wearable device	SMS	Game Consoles	Internet of Thing (IoT)	AR / VR*	Endoscope-equipped smartphone	Electronic Medication Container	Videocassette	Telephone Consult	Patient Safety	Efficient use of resources	Access to healthcare	Patient-centred Care	Equity	Improving Health Behaviour	Treatment compliance	Enhanced Clinical Assessment	Better Care Coordination
1	Aapro et al.[22]	Sys.R	Supportive care in Oncology	52	Oncology	X	X				X	X	X								X	X	X	X				X	X
2	Robbins et al.[23]	Sys.R	Healthy Aging	51	Multidisciplinary	X	X	X	X		X	X				X					X								
3	Slattery et al.[24]	Sys.R + MA	Chronic Pain	30	Multidisciplinary	X	X	X	X		X					X				X									
4	El Morr & Layal,[25]	Sys.R	Intimate Partner Violence	25	Multidisciplinary	X	X														X		X	X	X			X	X
5	Beleigoli et al.[26]	Sys.R + MA	Obesity	11	Multidisciplinary	X	X						X													X			
6	Davies et al.[27]	Sys.R + MA	Depression, Anxiety, and psychological well-being	17	Psychiatry		X																						
7	Biagianti et al.[28]	Sys.R	Psychosis	8	Psychiatry	X	X				X																X		
8	Rose et al.[29]	Sys.R + MA	Adolescent health -	27	Psychiatry	X	X						X			X						X				X			

Table 3. Continued.

No	Author	Type of review*	Topic of review	No. of studies	Main field of discipline	Mobile apps*	Computer-based*	Sensor-based technology	Electronic-Record-based	A.I.*	Telemedicine*	Wearable device	SMS	Game Consoles	Internet of Thing (IoT)	AR / VR*	Endoscope-equipped smartphone	Electronic Medication Container	Videocassette	Telephone Consult	Patient Safety	Efficient use of resources	Access to healthcare	Patient-centred Care	Equity	Improving Health Behaviour	Treatment compliance	Enhanced Clinical Assessment	Better Care Coordination
			Diet and healthy behaviour																										
9	Lau et al.[30]	Sys.R + MA	Youth with chronic illness	16	Psychiatry	X	X						X																
10	Gandrup et al.[31]	Sys.R	Remote symptom monitoring	12	Multidisciplinary	X	X		X														X	X		X		X	X
11	Rollin et al.[32]	Sys.R	Melanoma	5	Multidisciplinary	X	X				X		X										X		X	X			X
12	Sharma et al.[33]	Sys.R + MA	Renal transplantation	18	Renal medicine	X	X															X					X		X
13	Farnood et al.[34]	Sys.R	Online self-diagnosing	25	Multidisciplinary	X	X																X			X			X
14	Escriva Boulley et al.[35]	Sys.R	Care for patients with cancer	23	Multidisciplinary	X	X				X		X											X					
15	Zhou & Parmanto,[36]	Sys.R	Rehabilitation in underserved areas	10	Rehabilitation medicine	X	X				X											X	X		X	X	X	X	X
16	Yadav et al.[37]	Sys.R + MA	Fragility fracture recovery	15	Multidisciplinary	X	X				X										X X X		X	X		X	X	X	X

(continued)

Table 3. Continued.

No	Author	Type of review*	Topic of review	No. of studies	Main field of discipline	Mobile apps*	Computer-based*	Sensor-based technology	Electronic-Record-based	A.I.*	Telemedicine*	Wearable device	SMS	Game Consoles	Internet of Thing (IoT)	AR / VR*	Endoscope-equipped smartphone	Electronic Medication Container	Videocassette	Telephone Consult	Patient Safety	Efficient use of resources	Access to healthcare	Patient-centred Care	Equity	Improving Health Behaviour	Treatment compliance	Enhanced Clinical Assessment	Better Care Coordination
17	Robinson et al.[38]	Sys.R	Health Behavior and support for patients undergoing elective surgery	18	Multidisciplinary	X	X				X	X				X	X						X	X	X	X			
18	Gunasekeran et al.[39]	Sc.R	COVID-19 public health responses	247	Public Health	X	X			X	X	X			X	X					X	X	X	X	X			X	X
19	Milne-Ives et al.[40]	Sys.R + MA	Physical Activity, Diet, Drug and Alcohol use. Mental Health	52	Psychological medicine	X										X										X			
20	Stogios et al.[41]	Sys.R + MA	Hypertension	17	Multidisciplinary	X	X				X															X	X		
21	Wang et al.[42]	Sys.R + MA	Rehabilitation after Total Knee or Hip Replacement	19	Rehabilitation medicine	X	X	X			X	X		X		X					X		X	X		X	X	X	
22	Choukou et al.[43]	Sc.R	Remote care during COVID-19	6	Multidisciplinary	X	X	X			X	X								X	X		X						
23	Kemp et al.[44]	Sc.R	Mental health	37	Psychological Medicine	X			X	X	X		X											X		X			

(continued)

Table 3. Continued.

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																					Domain								
24	Forbes et al.[45]	Sys.R	Supportive care for prostate cancer survivor	16	Multidisciplinary	X	X		X	X	X											X		X				X	X
25	Lee et al.[46]	Sc.R	Tuberculosis	145	Multidisciplinary	X	X			X	X		X								X						X	X	X
26	Liu et al.[47]	Sys.R + MA	Stroke	13	Neurology	X																				X			
27	Cao et al.[48]	Sc.R	STI and HIV	21	Multidisciplinary	X	X			X	X		X								X		X			X	X	X	X
28	Widmer et al.[49]	Sys.R + MA	Cardiovascular disease (general)	51	Multidisciplinary	X	X		X		X		X																
29	Rhodes et al.[50]	Sys.R + MA	Diet, Physical Activity and Weigh Gain in Pregnancy	11	Multidisciplinary	X	X						X													X	X		
30	Bergin et al.[51]	Sc.R	Mental health for children and young people	30	Psychiatry	X	X							X							X		X		X				
31	Nanah & Bayoumi;[52]	Sys.R	effective communication in neurosurgical care	13	Neurosurgery	X	X			X	X					X	X				X	X						X	X

Table 3. Continued.

No	Author	Type of review*	Topic of review	No. of studies	Main field of discipline	Mobile apps*	Computer-based*	Sensor-based technology	Electronic-Record-based	A.I.*	Telemedicine*	Wearable device	SMS	Game Consoles	Internet of Thing (IoT)	AR / VR*	Endoscope-equipped smartphone	Electronic Medication Container	Videocassette	Telephone Consult	Patient Safety	Efficient use of resources	Access to healthcare	Patient-centred Care	Equity	Improving Health Behaviour	Treatment compliance	Enhanced Clinical Assessment	Better Care Coordination
32	Tornivuori et al.[53]	Sys.R+MA	Transition of care among adolescent with chronic illness	12	Multidisciplinary	X	X					X	X							X	X					X		X	X
33	Tully et al.[54]	Sc.R	Paediatric Weight Management	42	Paediatric	X						X														X			
34	Hewitt et al.[55]	Sys.R+MA	Musculoskeletal conditions	19	Multidisciplinary	X	X																						
35	Bempong et al.[56]	Sc.R	Infectious disease control	82	Multidisciplinary	X	X			X		X										X				X			
36	Robotham et al.[57]	Sys.R+MA	Clinic Attendance	25	Multidisciplinary	X	X					X											X						
37	Seppen et al.[58]	Sc.R	Rheumatoid arthritis	10	Rheumatology	X	X					X											X			X	X	X	
38	Wang et al.[59]	Sys.R+MA	mental health and quality of life among cancer patients	7	Psychiatry	X	X																	X		X	X	X	

(continued)

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Table 3. Continued.

No	Author	Type of review*	Topic of review	No. of studies	Main field of discipline	Mobile apps*	Computer-based*	Sensor-based technology	Electronic-Record-based	A.I.*	Telemedicine*	Wearable device	SMS	Game Consoles	Internet of Thing (IoT)	AR / VR*	Endoscope-equipped smartphone	Electronic Medication Container	Videocassette	Telephone Consult	Patient Safety	Efficient use of resources	Access to healthcare	Patient-centred Care	Equity	Improving Health Behaviour	Treatment compliance	Enhanced Clinical Assessment	Better Care Coordination
						Digital health identified in the review															Domain of quality medical care						Effective intervention		
39	Nwolise et al.[60]	Sys.R	Preconception care women with diabetes	12	Multidisciplinary	X	X																X	X		X			
40	Triantafyllidis et al.[61]	Sys.R	Childhood obesity	17	Multidisciplinary	X	X		X	X	X	X														X	X	X	
41	Brigden et al.[62]	Sys.R	Children with chronic condition	17	Multidisciplinary	X	X		X	X	X		X								X					X	X	X	
42	Li et al.[63]	Sys.R + MA	adverse drug reaction reporting	13	Multidisciplinary	X			X		X		X							X	X								
43	Taj et al.[64]	Sc.R	Health Behaviour	631	Psychological Medicine	X	X				X	X	X			X										X			
44	Tilahun et al.[65]	Sc.R	Neglected tropical diseases	6	Infectious Disease	X	X		X		X		X									X	X		X			X	X
45	Ngwatu et al.[66]	Sys.R	Tuberculosis	6	Multidisciplinary						X		X					X									X		
46	Patel et al.[67]	Sys.R + MA	Obesity	15	Multidisciplinary	X	X		X				X							X						X			
47	Jones et al.[68]	Sc.R	PTSD	38	Psychiatry	X					X					X					X		X		X	X		X	X

(continued)

Table 3. Continued.

No	Author	Type of review*	Topic of review	No. of studies	Main field of discipline	Mobile apps*	Computer-based*	Sensor-based technology	Electronic-Record-based	A.I.*	Telemedicine*	Wearable device	SMS	Game Consoles	Internet of Thing (IoT)	AR / VR*	Endoscope-equipped smartphone	Electronic Medication Container	Videocassette	Telephone Consult	Patient Safety	Efficient use of resources	Access to healthcare	Patient-centred Care	Equity	Improving Health Behaviour	Treatment compliance	Enhanced Clinical Assessment	Better Care Coordination
48	Batra et al.[69]	Sys.R	Mental Health	18	Psychiatry	X	X	X	X	X		X										X	X				X	X	X
49	Nicholl et al.[70]	Sys.R + MA	Low Back Pain	6	Multidisciplinary	X	X					X										X				X			
50	Austin et al.[71]	Sys.R	Anticoagulation therapy	27	Multidisciplinary		X		X	X			X								X	X							
51	Godinho et al.[72]	Sys.R	Patient-centred care service delivery	39	Multidisciplinary	X	X				X		X								X	X	X	X		X	X		
52	Jiang et al.[73]	Sys.R	Cardiovascular diseases	14	Multidisciplinary	X					X	X	X							X		X	X						
53	Yin et al.[74]	Sc.R	Inflammatory Bowel Disease	68	Gastroenterology	X															X						X	X	X
54	Tighe et al.[75]	Sys.R	Noncommunicable disease	7	Multidisciplinary	X	X	X																X		X	X	X	

Figure 2. Review studies on digital health by the countries and regions.
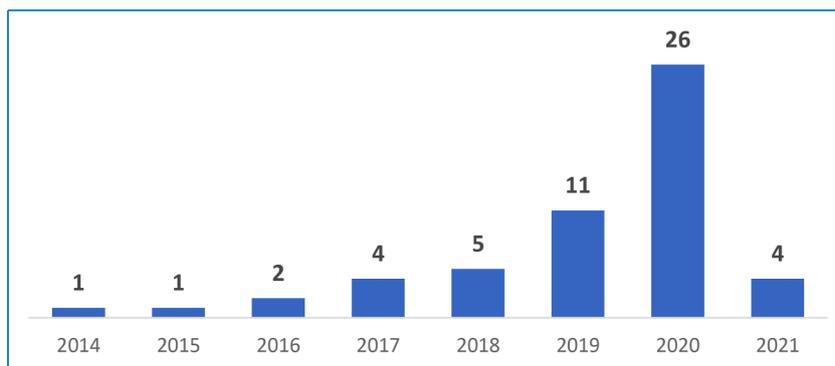
Figure 3. Simple bar chart displaying the number of included reviews by year of publication ($n = 54$).

healthcare which otherwise would have been impossible to derive from individual review.

Effective intervention

The new perspective is evident on the use of digital health primarily to deliver more effective intervention especially via improved health behaviour. For example, to improve diet and physical activities among adolescents, Rose, Barker[29] reported 15 studies were employing web-based program, four were using short messaging system (SMS), three were using gaming approach, and one each was adopting email and other digital platform. All these technologies were primarily used as a medium to deliver educational intervention by providing information and step-by-step guide on how to achieve and maintain healthy diet and physical activities. Similarly, Milne-Ives et al.[40] found a total of 52 randomized controlled trials (RCTs) which targeted the use of mobile apps to drive changes in health behaviour related to diet, physical activities, alcohol and

mental health. In a slightly different context, Stogios et al.[41] identified 17 RCTs which investigate the use of digital-based counselling for behaviour change to reduce systolic blood pressure (SBP). Although each review focuses on unique topic of care, all 21 reviews share similar findings of consistent strategy which capitalized the intimate digital technology engagement among mass population to engineer behaviour change for favourable clinical outcomes.

Similar strategy for effective intervention has been extended for technology-enhanced clinical assessment with heightened treatment compliance and engagement. For example, to determine how digital health aids the screening, diagnosis and management of intimate partner violence (IPV), El Morr and Layal[25] have researched 16 RCTs and nine non-RCTs; four pre-post design studies, two cross-sectional studies, two prospective studies and one diagnostic case-control study. The research interest was centred on elucidating the evidence on how the use of desktop computer, laptop, tablet and phone could assist
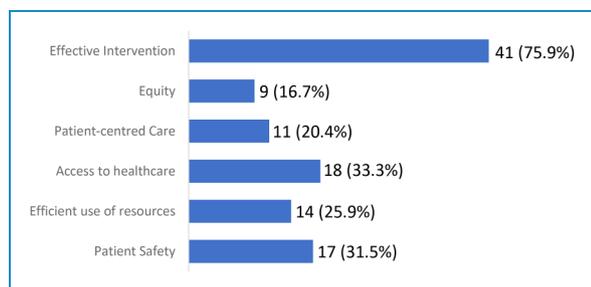
Figure 4. Bar chart presenting the number of articles reporting the different domains of quality medical care ($n = 54$).

women with IPV to initiate contact and subsequent access to help and care.[25] In comparison, the scoping review on tuberculosis control by Lee et al.[46] identified a total of 43 primary studies which employ various adherence-technologies such as video-observed therapy to encourage patients' compliance on medication. Likewise, Batra et al.[69] investigated 18 studies which report the use of smart electronic pill container and personal digital record which can provide cues and alerts to improve treatment compliance in hospital setting among patients with serious mental health illness. Thus, the varying intricacy and practices denote how dynamic application of digital health could push the boundaries of conventional approach to improve assessment and treatment compliance.

Setting a new height of more effective intervention is further exemplified in the coordination of complex care. An insightful review by Yadav et al.[37] had compiled evidence from 15 studies from the year 2003 to 2016 on the use of digital health to enhance care on patients with fragility fracture. They reported digital health has been employed at various aspects of care including assisting recovery, education and compliance, treatment engagement, risk reduction for secondary prevention, and communication with the treating team. Yet, common to these aspects of care was the use of digital technology to systematically stage, organize and execute varying duty of care.[37] The tasks include the delivery of digital-based educational package, scheduled phone call by registered nurses, electronic reminder to the treating physician, and systematic collection of clinical history, test results, progress, previous and current treatment regimen for osteoporosis including bisphosphonates and alternatives such as calcitonin and hormone replacement raloxifene.[37] In a more recent context, the scoping review by Gunasekeren et al.[39] has analyzed 247 studies to understand the use of digital health to coordinate the COVID-19 public health responses. Artificial intelligence, telemedicine and big data constitute the main technology being employed. Interestingly, the surge of technology-enhanced coordinated response was justified by the unprecedented scale of impact from the pandemic. Despite the 247 studies were only being conducted since the time of the pandemic in late 2019,[76] the volume of

publication of the primary studies in a short period of time highlighted strong commitment for new strategies to address the evolving challenges of care. Therefore, the emerging needs of practice appeared had invigorated the adoption of digital health for effective care coordination and potentially more efficient health intervention.

Other domains of quality healthcare

Unfortunately, complicated aspects of care may have hindered reviews from concluding the use of digital health for cost efficiency. For example, in reviewing the use of digital health for anticoagulation therapy, Austin, Barras[71] reported one study on the use of computerized physician order entry (CPOE) for enoxaparin injection. Yet, deducing cost-effectiveness of digital health for anticoagulation therapy such as CPOE was limited due to scarce availability of primary studies.[71] For similar reason, most reviews which explicitly reported results on cost-effectiveness was reporting this aspect of quality care only as peripheral findings with limited depth to derive a concrete aggregation of results.[22,29,36,39,45,52,65] In comparison, Jiang et al.[73] was focusing on the cost effectiveness of employing digital health for cardiovascular diseases (CVDs). All 15 studies identified in the review reported predominant use of telemedicine and wearable devices to achieve cost-efficiency. Yet, heterogeneity of the included studies had limited their conclusion on these digital health to deliver higher quality-adjusted lifeyears or improved clinical outcomes at a lower cost than the standard care.[73] Therefore, despite a huge volume of empirical research and review studies on digital health, the multifaceted aspects of cost-effectiveness may have incurred complex challenges resulting in the gaps of evidence to establish the magnitude of impact, the mechanism and the fidelity of implementation on digital health for cost-efficient healthcare.

Nonetheless, the lack of concrete evidence on cost-efficiency does not negate the strong research interest on accessible, safe and patient-centred care through digital health. For example, Rollin et al.[32] have reviewed five studies on the use of digital health for melanoma care in rural areas and remote communities of Australia. The use of telemedicine has been attributed to improve early detection of skin lesion, facilitate patients' decision-making, reduced their stress, and empower communication and education. This is in addition of being convenient and save the time for travel. The use of telemedicine has brought fundamental access to quality melanoma care, in addition to reduce the disparity between care in rural and urban areas.[32] Likewise, Godinho et al.[72] have reviewed 39 studies on the use of mHealth to deliver multiple aspects of patient-oriented care including accessibility, equitable care and timely intervention which minimizes risks and harms. The comprehensive review found the use of mHealth such as text messages, mobile apps, phone call
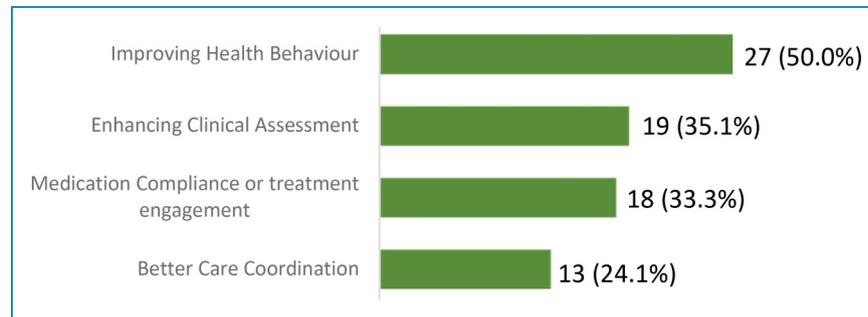
Figure 5. Bar chart illustrating the frequency of reviews by reported approaches to improve the effectiveness of health intervention (*n* = 54).
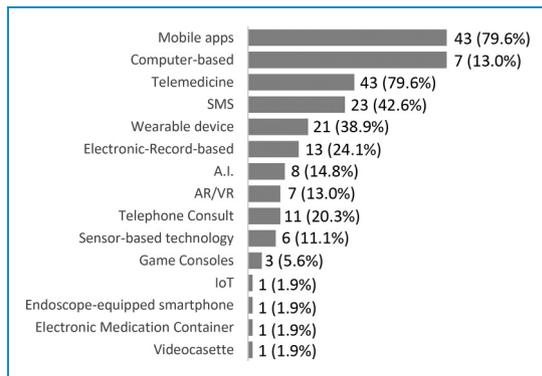

Figure 6. Bar chart providing the information of 15 distinct digital health interventions and the number of reviews reporting their use to improve quality healthcare (*n* = 54).

and video communication for people-centred care have primarily been used for community-based health issues. These issues include medication compliance, lifestyle activities, diabetes, CVDs and smoking cessation.[72] In these studies, mHealth enhances quality care by enabling patients to bypass gatekeepers for a direct access to healthcare, increasing affordability, empower governance of care, more robust evaluation on safety and strengthening the scheduling and navigation of services.[72] Thus, adoption of digital health for quality healthcare may not only be reactively motivated by the emerging needs of care, but also proactively committed via ongoing determination to set a new benchmark of quality on existing practice.

Trend of review activities on digital health

This motivation is reflected by the large number in each type of reviews. The 13 scoping reviews and 21 systematic reviews without meta-analyses provide meaningful shortcut evidence to the literature.[11(p. 22)] Under the same theme or topic of interest, these reviews illuminate the breadth, purpose and extent of research activities while establish what is known and gaps of evidence.[12] In contrast, the 20 systematic reviews with meta-analyses vigorously search,

select, appraise research quality and aggregate evidence from varying contexts and fields of practice to deduce with statistical certainty on the effectiveness of the digital health intervention of interest.[77] Therefore, the increasing number of review studies reflects an escalating motivation to harvest new understanding from these cluster of research to attain deeper insight, broader perspectives and more robust information for decision making.

As a result, the increasing volume of reviews and their diversity in objectives, context, types and topics of interest reflect the heightened interests to establish evidence-informed policies and practices. This trend of reviews is consistent with the increasing trend in the original studies related to the digital health. Compiling digital health research from 2000 until 2018, the review by Taj et al.[64] reported an exponential growth of publications since 2009 attributable to the revolution in smartphone innovation. Supporting this evidence is the result of this study which shows smartphone-based intervention is the most prominent digital health being employed for quality care. Mobile apps, phone calls, video conference and telemedicine and web-based intervention are categories of digital health which can all be delivered via smartphones. Interestingly, smartphones have been available for mostly corporate users since 1993.[78] It is likely the transition of technology users from a niche market to mass population may have served as the key factor that explains the impact and motivation to aggregate research for evidence in this field.

Consequently, the popular smartphone-based digital health to improve health behaviour may elucidate psychiatry as the single field of medical practice most featured in this study. The intrinsic association between favourable change of behaviour and mental health issues may have influenced many aspects of psychiatric care. These aspects include depression, dietary issue, adolescent mental health, substance abuse disorder, psychotic disorder, anxiety and general mental health conditions which made multiple appearance as the focus of reviews on digital health.[27–30,40,44,51,64] Cognitive behavioural therapy, mental health examination, timely risk assessment, regular consultations and many other managements of psychiatric

Table 4. Predominant disciplines being addressed by the digital health reviews and their topics ($n = 54$).

No.	Main discipline	Number of reviews	Topic of review		

1	Multidisciplinary	32	Healthy aging
			  Chronic pain
			  Intimate partner violence
			  Obesity (2 reviews)
			  Remote symptom monitoring
			  Melanoma
			  Online self-diagnosing
			  Care for patients with cancer
			  Fragility fracture recovery
			  Health behaviour and support for patients undergoing elective surgery
				Hypertension
				  Remote care during COVID-19
				  Supportive care for prostate cancer survivor
				  STI and HIV
				  Diet, physical activity and weigh gain in pregnancy
				  Transition of care among adolescent with chronic illness
				  Musculoskeletal conditions
				  Infectious disease control
				  Clinic Attendance
				  Noncommunicable disease
					Preconception care women with diabetes
					  Childhood obesity
					  Children with chronic condition
					  Adverse drug reaction reporting
					  Tuberculosis (2 reviews)
					  Low back pain
					  Anticoagulation therapy
					  Patient-centred care service delivery
					  Cardiovascular diseases (2 reviews)

2	Psychiatry	11	Depression, anxiety, and psychological well-being Psychosis Adolescent health - Diet and healthy behaviour Youth with chronic illness	Mental health for children and young people Mental health and quality of life among cancer patients PTSD	Physical Activity, Diet, Drug and alcohol use and mental health Mental health – General (2 reviews) Health behaviour
3	Rehabilitation care	2	Rehabilitation in underserved areas	Rehabilitation after total knee or hip replacement	
4	Oncology	1	Supportive care in oncology		
5	Nephrology	1	Renal transplantation care		
6	Public Health	1	COVID-19 public health responses		
7	Neurology	1	Stroke		
8	Neurosurgery	1	Effective communication in neurosurgical care		
9	Paediatric	1	Paediatric weight management		
10	Rheumatology	1	Rheumatoid arthritis		
11	Infectious disease	1	Neglected tropical diseases		
12	Gastroenterology	1	Inflammatory bowel disease		

patient can directly be enhanced via digital health. Hence, it is likely this association has driven strong advocacy to review digital health to improve clinical outcomes among patients in psychiatric care. This connection also suggests a strong association between research on digital technology, health behaviour and the nature of field of practice.

Table 5. Summary of considerations for policy and practice.

1	Smartphone-based intervention is the commonest digital health for quality healthcare.
2	Digital health is mainly researched to attain more effective health intervention through improved health behaviour, better medication compliance or treatment engagement, more comprehensive clinical assessment, and enhanced coordination of care.
3	More empirical and review of evidence is necessary to better-inform the use of digital health for cost-efficient and equitable healthcare.
4	Most review of evidence on the use of digital health focus on topics related to psychiatric care.
5	Technology-enhanced quality healthcare may be benefited from research on the association between fields of health practices and the tendency to adopt or research digital health to improve care.
6	Complex policy decision-making for technology-enhanced quality healthcare may be benefited from the wide-ranging perspectives of evidence via methodologically robust and transparent mapping of digital health interventions at various time, contexts, fields of practice, categories of technology and types of evidence for all six domains of quality healthcare.

Suggestion for future direction of reviews on digital health studies

There are notable gaps of evidence on the use of digital health for equitable healthcare, which is the least domain of quality being reviewed (Figure 4). Equitable healthcare addresses reliable services against varying sociodemographic factors such as ethnicity, religion, gender, income and geographic location.[79] Hence, improving equitable care transgress beyond mere improving accessibility. These concerns were highlighted by Bergin et al.[51] whose review reported studies among children on mental health commonly did not include ethnicity and socio-economic status when investigating issue of access to care. Furthermore, improving access and equitable care may be achieved without any change to the routine treatment protocol. Unlike introducing a new strategy, there is less burden of proof to substantiate the effectiveness and safety profile of existing treatments. In contrast, digital health may eliminate or minimize various factors which have disadvantaged certain subgroup of population from otherwise receive a quality healthcare. This is in addition to the surge of technology-users over the last few decades. Therefore, expanding the aggregative and configurative review evidence of digital health for equitable and accessible healthcare, from this aspect, would prove meaningful and impactful due to the scale of target population.

Limitations

There are several limitations of this study. Firstly, the notion of quality is hugely debated, and it is possible that some aspects of quality is not adequately represented in this study. For example, Bate et al.[80] proposed that quality improvement needs to be viewed from social movement approach which comprise both programmatic 'top-down' and internally driven 'bottom-up' approaches. Grol,[81] in contrast, emphasized the change of culture as a precursor to initiate the culture of change. Tenets of these change of culture include the promotion of reflective practitioners, the power of peers, and patients as partners instead of mere client.[81] Loffler[82] meanwhile insightfully articulated the notion of quality that are essentially evolutionary, rather than static and fragmented in domains. The arguments rewind back to the history of quality from the public sector that transitioned from quality being understood as meeting the expected norms and routines, into effective in meeting the purpose, and finally in fulfilling and exceeding clients' satisfaction. Understanding the notion of quality from these lenses of perspectives may illuminate unique insight on the roles and evidence of digital health to improve quality care. Nonetheless, expanding the philosophical context of quality and evidence of reviews on digital health require more resources that is beyond the scope of this study.

Secondly, categories of interest are inherently overlap. For example, telemedicine has been referred as remote communication either via voice, or video or both.[36] Yet, these features have also been reported as mobile apps in other reviews.[40,43] To be transparent, whenever there is an overlap between descriptions of digital health intervention, this mapping study consistently catalogue based on how the intervention was described by the review. Therefore, the systematic mapping remains robust and transparent despite possible slight variations due to inherent overlapping spectrum of types of digital health and practices.

Conclusion

This study has systematically searched, selected and catalogued review studies on digital health and quality care. Table 5 summarizes key considerations from this study for policy and practice. Majority of reviews describe improved health behaviour, enhanced assessment, treatment compliance and better coordination as the main approach of quality improvement via digital health. Topics related to psychiatry and smartphone-based intervention are the most featured field of practice and the type of digital health respectively. Future studies may investigate the association between field of practice and tendency to adopt and research the use of digital health to improve care. Further reviews may also aggregate evidence

on how digital health exerts broader impact on quality care especially in the domain of cost effectiveness and equitable healthcare.

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References

1. Fatehi F, Samadbeik M and Kazemi A. What is digital health? Review of definitions. *Stud Health Technol Inform* 2020; 375: 67–71. DOI: 10.3233/SHTI200696

2. Dorning H. Consensus on quality, http://www.qualitywatch.org.uk/consensus-quality (2015, accessed 16 January 2017).

3. WHO. Quality of care: a process for making strategic choices in health systems, http://www.who.int/management/quality/assurance/QualityCare_B.Def.pdf (2006, accessed 16 January 2017).

4. Rahman S, Mutalib A, Baig A, et al. A pilot study on the validation of vis-screen mobile application for vision test *J ASIAN Behav Stud* 2020; 5: 1.

5. Yang GL, Tan YF, Loh SC, et al. Neuroradiology imaging database: using picture archive and communication systems for brain tumour research. *Singapore Med J* 2007; 48: 342–346.

6. Othman AK, Udin N, Shab MS, et al. Demographic study of brain tumour in a neurosurgical department in Terengganu, Malaysia. *Med J Malaysia* 2020; 75: 705–709.

7. Mohd Faeiz P and Siti Norazlina J. Digital transformation of healthcare and medical education, within, and beyond pandemic COVID-19. *Asian J Med Biomed* 2020; 4. DOI: 10.37231/ajmb.2020.4.2.363.

8. Abu Bakar YI, Hassan A, Yusoff MSB, et al. A scoping review of effective teaching strategies in surface anatomy. *Anat Sci Educ* 2022; 15: 166–177. DOI: 10.1002/ase.2067.

9. European Commission. Assessing the impact of digital transformation of health services, https://ec.europa.eu/health/sites/default/files/expert_panel/docs/022_digitaltransformation_en.pdf (2019, accessed 20 June 2021).

10. Arksey H and O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol* 2005; 8: 19–32.

11. Gough D. *An introduction to systematic reviews*. Edited by David Gough, Sandy Oliver, James Thomas [Kindle Version]. London: Sage, 2012.

12. Gough D and Thomas J. Commonality and diversity in reviews. In: David Gough SO and Thomas J (eds) *An Introduction to systematic reviews*. London: Sage, 2012, pp. 43–70.

13. James KL, Randall NP and Haddaway NR. A methodology for systematic mapping in environmental sciences. *Environ Evidence* 2016; 5: 7.

14. Rees R and Oliver S. Stakeholder perspectives and participation in reviews. In: David Gough SO and Thomas J (eds) *An introduction to systematic reviews*. London: Sage, 2012, pp. 19–41.

15. Booth A, Sutton A and Papaioannou D. *Systematic approaches to a successful literature review*. 2nd ed. Los Angeles: Sage, 2016.

16. Oliver S and Sutcliffe K. Describing and analysing studies. In: David Gough SO and Thomas James (ed) *An introduction to systematic reviews*. London: Sage, 2012, pp. 123–142.

17. Gough D, Oliver S and Thomas J. Learning from research: systematic reviews for informing policy decisions. *Alliance Useful Evidence* 2013; 1: 38.

18. Rees R. *Systematic review: diversity, design and debate: workshop 2 - activity 5&6*. UK: UCL, 2017.

19. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *Br Med J* 2021; 372: 71.

20. Microsoft Coorporation. Microsoft Excel, https://office.microsoft.com/excel (2018).

21. Microsoft Coorporation. Microsoft Power BI, https://powerbi.microsoft.com/en-us/desktop/ (2018).

22. Aapro M, Bossi P, Dasari A, et al. Digital health for optimal supportive care in oncology: benefits, limits, and future perspectives. *Support Care Cancer* 2020; 28: 4589–4612.

23. Robbins TD, Lim Choi Keung SN and Arvanitis TN. E-health for active ageing; A systematic review. *Maturitas* 2018; 114: 34–40.

24. Slattery BW, Haugh S, O'Connor L, et al. An evaluation of the effectiveness of the modalities used to deliver electronic health interventions for chronic pain: systematic review with network meta-analysis. *J Med Internet Res* 2019; 21: e11086.

25. El Morr C and Layal M. Effectiveness of ICT-based intimate partner violence interventions: a systematic review. *BMC Public Health* 2020; 20: 1372. DOI: 10.1186/s12889-020-09408-8

26. Beleigoli AM, Andrade AQ, Cançado AG, et al. Web-based digital health interventions for weight loss and lifestyle habit changes in overweight and obese adults: systematic review and meta-analysis. *J Med Internet Res* 2019; 21: e298.

27. Davies EB, Morriss R and Glazebrook C. Computer-delivered and web-based interventions to improve depression, anxiety, and psychological well-being of university students: a systematic review and meta-analysis. *J Med Internet Res* 2014; 16: e130.

28. Biagianti B, Quraishi SH and Schlosser DA. Potential benefits of incorporating peer-to-peer interactions into digital interventions for psychotic disorders: a systematic review. *Psychiatr Serv* 2018; 69: 377–388.

29. Rose T, Barker M, Maria Jacob C, et al. A systematic review of digital interventions for improving the diet and physical activity behaviors of adolescents. *J Adolesc Health: Off Publ Soc Adolesc Med* 2017; 61: 669–677.

30. Lau N, Waldbaum S, Parigoris R, et al. Ehealth and mHealth psychosocial interventions for youths with chronic illnesses: systematic review. *JMIR Pediatr Parent* 2020; 3: e22329.

31. Gandrup J, Ali SM, McBeth J, et al. Remote symptom monitoring integrated into electronic health records: a systematic review. *J Am Med Inf Assoc: JAMIA* 2020; 27: 1752–1763.

32. Rollin A, Ridout B and Campbell A. Digital health in melanoma posttreatment care in rural and remote Australia: systematic review. *J Med Internet Res* 2018; 20: e11547.

33. Sharma V, Piscoran O, Summers A, et al. The use of health information technology in renal transplantation: a systematic review. *Transplant Rev (Orlando)* 2021; 35: 100607.

34. Farnood A, Johnston B and Mair FS. A mixed methods systematic review of the effects of patient online self-diagnosing in the 'smart-phone society' on the healthcare professional-patient relationship and medical authority. *BMC Med Inform Decis Mak* 2020; 20: 53.

35. Escriva Boulley G, Leroy T, Bernetière C, et al. Digital health interventions to help living with cancer: a systematic review of participants' engagement and psychosocial effects. *Psychooncology* 2018; 27: 2677–2686.

36. Zhou L and Parmanto B. Reaching people with disabilities in underserved areas through digital interventions: systematic review. *J Med Internet Res* 2019; 21: e12981.

37. Yadav L, Haldar A, Jasper U, et al. Utilising digital health technology to support patient-healthcare provider communication in fragility fracture recovery: systematic review and meta-analysis. *Int J Environ Res Public Health* 2019; 16: 1–22. DOI: 10.3390/ijerph16204047

38. Robinson A, Oksuz U, Slight R, et al. Digital and mobile technologies to promote physical health behavior change and provide psychological support for patients undergoing elective surgery: meta-ethnography and systematic review. *JMIR Mhealth Uhealth* 2020; 8: e19237.

39. Gunasekeran DV, Tseng R, Tham YC, et al. Applications of digital health for public health responses to COVID-19: a systematic scoping review of artificial intelligence, telehealth and related technologies. *NPJ Digit Med* 2021; 4: 40.

40. Milne-Ives M, Lam C, De Cock C, et al. Mobile apps for health behavior change in physical activity, diet, drug and alcohol use, and mental health: systematic review. *JMIR Mhealth Uhealth* 2020; 8: e17046.

41. Stogios N, Kaur B, Huszti E, et al. Advancing digital health interventions as a clinically applied science for blood pressure reduction: a systematic review and meta-analysis. *Can J Cardiol* 2020; 36: 764–774.

42. Wang X, Hunter DJ, Vesentini G, et al. Technology-assisted rehabilitation following total knee or hip replacement for people with osteoarthritis: a systematic review and meta-analysis. *BMC Musculoskelet Disord* 2019; 20: 06.

43. Choukou MA, Taha A, Qadeer A, et al. Digital health technology for remote care in response to the COVID-19 pandemic: a scoping review. *Eur Rev Med Pharmacol Sci* 2021; 25: 3386–3394.

44. Kemp J, Zhang T, Inglis F, et al. Delivery of compassionate mental health care in a digital technology-driven age: scoping review. *J Med Internet Res* 2020; 22: e16263.

45. Forbes CC, Finlay A, McIntosh M, et al. A systematic review of the feasibility, acceptability, and efficacy of online supportive care interventions targeting men with a history of prostate cancer. *J Cancer Surviv* 2019; 13: 75–96.

46. Lee Y, Raviglione MC and Flahault A. Use of digital technology to enhance tuberculosis control: scoping review. *J Med Internet Res* 2020; 22: e15727.

47. Liu S, Feng W, Chhatbar PY, et al. Mobile health as a viable strategy to enhance stroke risk factor control: a systematic review and meta-analysis. *J Neurol Sci* 2017; 378: 140–145.

48. Cao B, Bao H, Oppong E, et al. Digital health for sexually transmitted infection and HIV services: a global scoping review. *Curr Opin Infect Dis* 2020; 33: 44–50.

49. Widmer RJ, Collins NM, Collins CS, et al. Digital health interventions for the prevention of cardiovascular disease: a systematic review and meta-analysis. *Mayo Clin Proc* 2015; 90: 469–480.

50. Rhodes A, Smith AD, Chadwick P, et al. Exclusively digital health interventions targeting diet, physical activity, and weight gain in pregnant women: systematic review and meta-analysis. *JMIR Mhealth Uhealth* 2020; 8: e18255.

51. Bergin AD, Vallejos EP, Davies EB, et al. Preventive digital mental health interventions for children and young people: a review of the design and reporting of research. *NPJ Digit Med* 2020; 3: 33.

52. Nanah A and Bayoumi AB. The pros and cons of digital health communication tools in neurosurgery: a systematic review of literature. *Neurosurg Rev* 2020; 43: 835–846.

53. Tornivuori A, Tuominen O, Salanterä S, et al. A systematic review on randomized controlled trials: coaching elements of digital services to support chronically ill adolescents during transition of care. *J Adv Nurs* 2020; 76: 1293–1306.

54. Tully L, Burls A, Sorensen J, et al. Mobile health for pediatric weight management: systematic scoping review. *JMIR Mhealth Uhealth* 2020; 8: e16214.

55. Hewitt S, Sephton R and Yeowell G. The effectiveness of digital health interventions in the management of musculoskeletal conditions: systematic literature review. *J Med Internet Res* 2020; 22: e15617.

56. Bempong NE, Ruiz De Castañeda R, Schütte S, et al. Precision global health - the case of Ebola: a scoping review. *J Glob Health* 2019; 9: 010404.

57. Robotham D, Satkunanathan S, Reynolds J, et al. Using digital notifications to improve attendance in clinic: systematic review and meta-analysis. *BMJ Open* 2016; 6: e012116.

58. Seppen BF, den Boer P, Wiegel J, et al. Asynchronous mHealth interventions in rheumatoid arthritis: systematic scoping review. *JMIR Mhealth Uhealth* 2020; 8: e19260.

59. Wang Y, Lin Y, Chen J, et al. Effects of Internet-based psycho-educational interventions on mental health and quality of life among cancer patients: a systematic review and meta-analysis. *Support Care Cancer* 2020; 28: 2541–2552.

60. Nwolise CH, Carey N and Shawe J. Preconception care education for women with diabetes: a systematic review of conventional and digital health interventions. *J Med Internet Res* 2016; 18: e291.

61. Triantafyllidis A, Polychronidou E, Alexiadis A, et al. Computerized decision support and machine learning applications for the prevention and treatment of childhood obesity: a systematic review of the literature. *Artif Intell Med* 2020; 104: 101844.

62. Brigden A, Anderson E, Linney C, et al. Digital behavior change interventions for younger children with chronic health conditions: systematic review. *J Med Internet Res* 2020; 22: e16924.

63. Li R, Zaidi STR, Chen T, et al. Effectiveness of interventions to improve adverse drug reaction reporting by healthcare professionals over the last decade: a systematic review. *Pharmacoepidemiol Drug Saf* 2020; 29: –8.

64. Taj F, Klein MCA and van Halteren A. Digital health behavior change technology: bibliometric and scoping review of two decades of research. *JMIR Mhealth Uhealth* 2019; 7: e13311.

65. Tilahun B, Gashu KD, Mekonnen ZA, et al. Mapping the role of digital health technologies in the case detection, management, and treatment outcomes of neglected tropical diseases: a scoping review. *Trop Med Health* 2021; 49: 17.

66. Ngwatu BK, Nsengiyumva NP, Oxlade O, et al. The impact of digital health technologies on tuberculosis treatment: a systematic review. *Eur Respir J* 2018; 51: 1–11. DOI: 10.1183/13993003.01596-2017

67. Patel ML, Wakayama LN, Bass MB, et al. Motivational interviewing in eHealth and telehealth interventions for weight loss: a systematic review. *Prev Med* 2019; 126: 105738.

68. Jones C, Miguel-Cruz A, Smith-MacDonald L, et al. Virtual trauma-focused therapy for military members, veterans, and public safety personnel with posttraumatic stress injury: systematic scoping review. *JMIR Mhealth Uhealth* 2020; 8: e22079.

69. Batra S, Baker RA, Wang T, et al. Digital health technology for use in patients with serious mental illness: a systematic review of the literature. *Med Devices (Auckl)* 2017; 10: 237–251.

70. Nicholl BI, Sandal LF, Stochkendahl MJ, et al. Digital support interventions for the self-management of low back pain: a systematic review. *J Med Internet Res* 2017; 19: e179.

71. Austin J, Barras M and Sullivan C. Interventions designed to improve the safety and quality of therapeutic anticoagulation in an inpatient electronic medical record. *Int J Med Inform* 2020; 135: 104066.

72. Godinho MA, Jonnagaddala J, Gudi N, et al. Mhealth for integrated people-centred health services in the western pacific: a systematic review. *Int J Med Inform* 2020; 142: 104259.

73. Jiang X, Ming WK and You JH. The cost-effectiveness of digital health interventions on the management of cardiovascular diseases: systematic review. *J Med Internet Res* 2019; 21: e13166.

74. Yin AL, Hachuel D, Pollak JP, et al. Digital health apps in the clinical care of inflammatory bowel disease: scoping review. *J Med Internet Res* 2019; 21: e14630.

75. Tighe SA, Ball K, Kensing F, et al. Toward a digital platform for the self-management of noncommunicable disease: systematic review of platform-like interventions. *J Med Internet Res* 2020; 22: e16774.

76. WHO and China. Report of the WHO-China joint mission on coronavirus disease 2019 (COVID-19) official report, World Health Organization, Geneva, Switzerland, 16–24 February 2020.

77. Thomas J, Harden A and Newman M. Synthesis: combining results systematically and appropriately. In: Gough D, Oliver S and Thomas J (eds) *An introduction to systematic reviews*. London: Sage, 2012, pp. 179–226.

78. Sarwar M and Soomro T. Impact of smartphone's on society. *Eur J Sci Res* 2013; 98: 216–226.

79. Mayberry RM, Nicewander DA, Qin H, et al. Improving quality and reducing inequities: a challenge in achieving best care. *Proc (Baylor Univ Med Cent)* 2006; 19: 103–118.

80. Bate SP, Robert G and Bevan H. The next phase of healthcare improvement: what can we learn from social movements? *Qual Saf Health Care* 2004; 13: 62–66.

81. Richard PTM Gro. Quality improvement in primary care: A change of culture, towards a culture of change. *Eur J Gen Pract* 2004; 10(2): 43–44. DOI: 10.3109/13814780409094230.

82. Loffler E. Defining quality in public administration. In: NISPAcee conference, Riga, Latvia: Working Group on Better Quality Administration for the Public, 2013.