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Impact of digital services on healthcare and social welfare: An umbrella review

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ABSTRACT

Background: Digital services can be effective and cost-efficient options for treating non-communicable diseases, but generalizability is limited due to heterogeneous treatment effects. This umbrella review aims to evaluate the impact of digital services on population health, costs, and patient and healthcare professional satisfaction, and to identify facilitators and barriers to using digital services in healthcare and social welfare.
Methods: The protocol of the study was registered on the 4th of September 2022 to the International Prospective Register of Systematic Reviews, PROSPERO (CRD42022355635). The review was performed using the Centre for Reviews and Dissemination, Cochrane, Ovid Medline, Scopus, and Web of Science in June 2022. The methodological quality of the included reviews was assessed. The impact of digital services was categorized as no evidence, no dominance, and mixed and positive effect. Inductive content analysis was used to identify facilitators and barriers.
Results: A total of 66 studies were included in the review, 64 % of which were evaluated as high quality. Studies on the impact of digital services in social welfare were not identified. Sixty-five percent of reviews evaluated the impact of digital services on population health with mixed effects; 21 % were on costs with mixed effects; 27 % were on patient satisfaction with positive effects; and 7.6 % were on healthcare professionals' satisfaction with mixed effects. Various features, allocation, end-user support, organized services, and service development facilitated the use of digital services. Correspondingly, barriers were related to service limitations, digital competency, funding- and service strategies, resources and change management.
Conclusions: Compared to usual care, digital services had a mixed impact on population health and costs with high satisfaction in patients. Mixed healthcare professionals' satisfaction was associated with the use of digital services, and it was less studied. To ensure successful implementation and sustainability of digital services, attention must be paid to address barriers and supporting facilitators at all levels.

What is already known

- Digital services have been rapidly developed in recent years to address global healthcare and social welfare challenges.
- The implementation of digital services is hindered due to the lack of knowledge of their impact and of the facilitators and barriers affecting usage.

What this paper adds

- Digital services have a mixed impact on population health and costs with high patient satisfaction and mixed healthcare professional satisfaction.
- Various facilitators and barriers affect the use of digital services which need to be considered.
- Further diverse and long-term research utilizing the quadruple aim framework is needed to evaluate the impact of digital services on healthcare and especially in social welfare services.

1. Introduction

Global spending on health is estimated to increase from USD 21 trillion to 24 trillion by 2040, which will largely be driven by increases in

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government health spending (Dieleman et al., 2017), due to aging and multimorbidity (Garin et al., 2016; Mcphail, 2016; Skou et al., 2022). Private health financing through out-of-pocket payments and prepaid mechanisms is anticipated to expand, although at a slower rate than the growth observed in government spending (Dieleman et al., 2017). Non-communicable diseases (e.g., ischemic heart disease, stroke) are the leading cause of death globally (74 % of all deaths), although preventable by modifying key lifestyle risk factors, and they continue to be a significant challenge to public health (World Health Organization, 2022). The impact of aging and multimorbid conditions varies across health systems, regions, disease combinations, and with different population factors (e.g., social disadvantage and age) requiring economic evaluations to support planning and decision-making regarding safe and cost-effective healthcare and social welfare (Mcphail, 2016).

Digital services, such as telemedicine interventions, mobile health applications and remote monitoring devices, have been proposed as one solution to address problems in terms of accessibility, availability, and costs in healthcare (Petracca et al., 2020; Golinelli et al., 2020). According to previous literature, digital services may offer equal or better results than usual care in the treatment of medical specialties (Snoswell et al., 2021) including chronic non-communicable (Zanaboni et al., 2018; Eze et al., 2020; Timpel et al., 2020; Farwati et al., 2021) and mental health conditions (Barnett et al., 2021). In addition to effectiveness, digital services can be a cost-effective option, and can affect the utilization of services, but the generalizability of the results is limited due to heterogeneous treatment effects and inconsistent reporting methods (Eze et al., 2020; Shigekawa et al., 2018). However, as digital services may not routinely reduce costs, other benefits must also be considered (Snoswell et al., 2020), such as user acceptance and satisfaction (Abimbola et al., 2019). Digital services can add value to the patient–provider relationship by increasing the professionals (Konttila et al., 2019) and patients' sense of control, providing better access to care and development of a partnership (Nordesjö et al., 2021). On the other, digital services can cause the relationship to become technology-driven rather than patient-focused (Konttila et al., 2019; Nordesjö et al., 2021) or break professional boundaries (Nordesjö et al., 2021). Implementation and following sustainable delivery and use of digital services can therefore be problematic, requiring information on facilitating and hindering factors on technology, patient and professional end-users, and contextual and organizational factors (Petracca et al., 2020; Cresswell and Sheikh, 2012).

Due to the COVID-19 pandemic, people had more limitations on seeking treatment in person for their chronic, non-communicable diseases (Singh et al., 2020). As such, there was an increased demand for services as the pandemic eased, placing additional burden on workers in healthcare and social welfare sectors (Dubey et al., 2020; Chan and Horne, 2021). The previous umbrella review (Eze et al., 2020) was conducted before the COVID-19 pandemic, after which digital services have been developed and deployed rapidly. Therefore, a comprehensive and up-to-date overview of the impact of digital services is needed in different segments of healthcare and social welfare.

In this umbrella review, the impact of digital services is evaluated by using the Quadrable aim framework, which focuses on development of healthcare system performance through four key objectives: population health improvement, cost reduction, and enhancement of patients' and health care professionals' satisfaction (Bodenheimer and Sinsky, 2014; Berwick et al., 2008). The digital services were identified using a predefined definition based on the World Health Organization (2018) classification of digital health interventions of various digital and mobile technologies and their functionalities used to achieve healthcare objectives.

2. Material and methods

An umbrella review was conducted according to the methodology of a systematic review, including use of a formal review protocol, an appraisal of the quality of selected reviews, and synthesis of the findings (Aromataris et al., 2015). The protocol was registered in the International Prospective Register of Systematic Reviews, PROSPERO (CRD42022355635).

2.1. Objectives

The aim of this umbrella review was to provide a comprehensive and up-to-date overview of the impact of digital services in healthcare and social welfare. The secondary aim was to summarize the factors that affect the use of digital services. Research questions for this umbrella review were as follows:

- What kind of digital services are available in healthcare and social welfare?
- What is the impact of digital services on population health, costs, and patient and healthcare professional satisfaction?
- What are the facilitators and barriers to using digital services?

2.2. Eligibility criteria

Using the PICOS (participants, interventions, context/consequence, outcomes, and study design) strategy (Speckman and Friedly, 2019), inclusion and exclusion criteria alongside the research questions and related terminology were developed (Appendix A). The umbrella review aimed to scope the impact of digital services in all different domains of healthcare and social welfare; therefore, no restrictions were set for participants. The digital services had to fit the pre-defined definition based on WHO classification of digital health interventions (World Health Organization, 2018) including interactive two-way patient-provider communication. Therefore, an automated (e.g., predesigned text messages, prompts, reminders) and one-way client communication systems were excluded. In the interest of acquiring information on new and advanced digital services, reviews focusing solely or mainly (over 50 % of studies) on telephone consultation were excluded. Digital services for health system managers and data services were also excluded.

Studies were excluded if they were not written in English or Finnish or published before 2012. Reviews with a majority of included studies (over 50 %) conducted in high-income countries were selected. China is an upper-middle income country, but due to advancements in digital infrastructure, industry, and subsequent digital economy (Zhang et al., 2021), Chinese studies were included in the umbrella review. Gray literature was excluded as the umbrella review focused on reviews of peer-reviewed, original studies.

2.3. Search methods

The search strategy was designed and conducted in close cooperation with a university information specialist (Appendix B). An initial search was made using PROSPERO, Cochrane, and Center for Open Science to determine whether studies were available on the digital services of interest and to develop search strategy. Database-specific keywords and phrases were formulated based on terms related to or describing the nature of research questions (Appendix A). The final search was conducted in June 2022 using five digital databases: Centre for Reviews and Dissemination (CRD), Cochrane, Ovid Medline, Scopus, and Web of Science. The CRD database search was divided into two final searches based on the three different databases within the CRD database. The DARE and Economic evaluation databases were searched via Ovid Medline. The international HTA database was searched directly.

The search and selection process of the included reviews is reported using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement for systematic reviews (Moher et al., 2010) and is illustrated in the PRISMA diagram (Fig. 1). The initial search yielded 538 articles, and 222 articles were selected for full-text review after duplicate removal, and title and abstract screening. In the

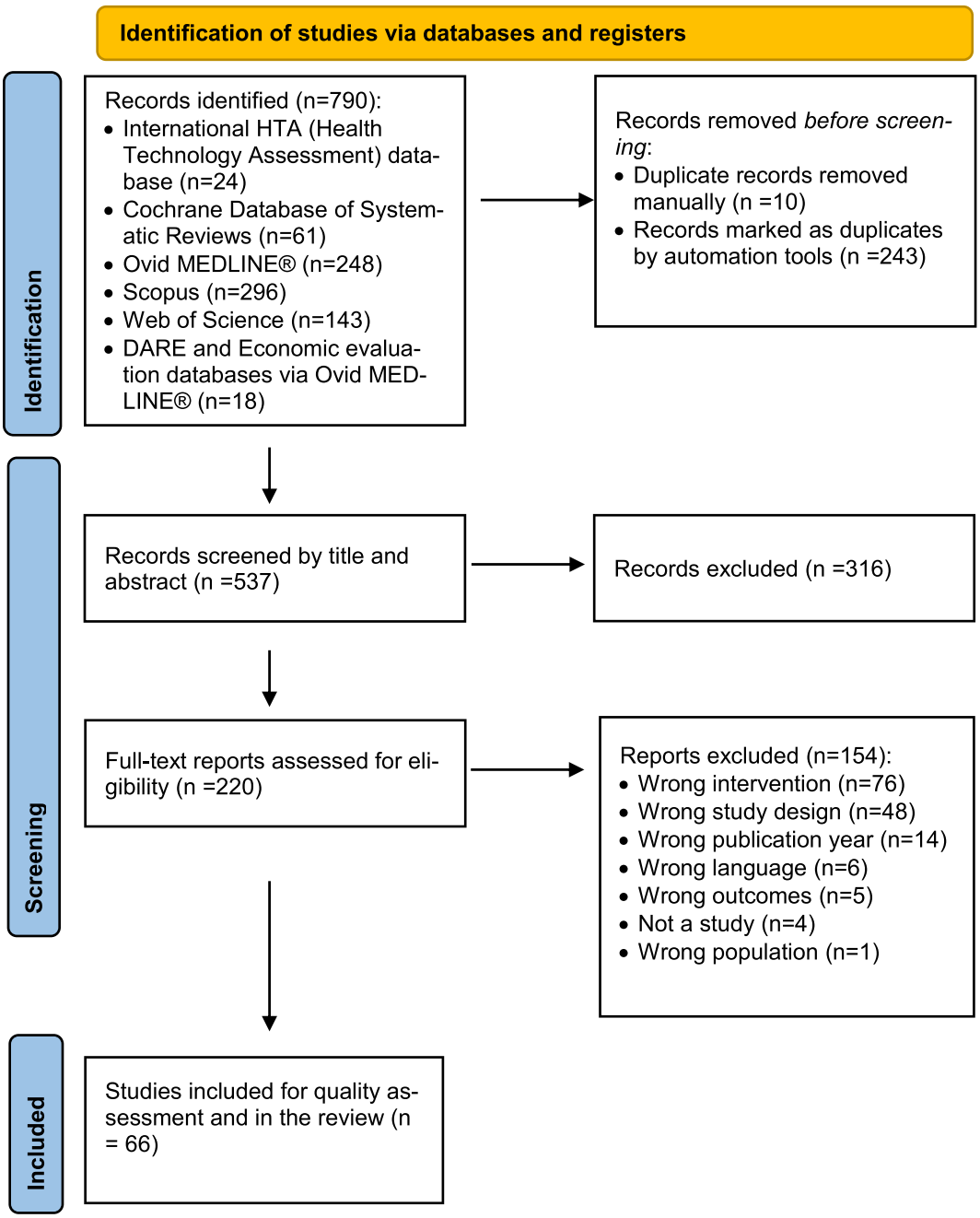

Fig. 1. PRISMA diagram.
From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi:10.1136/bmj.n71.

full-text phase, 154 reviews were excluded based on language and country restrictions, publication year, study design (e.g., lack of quality appraisal), interventions (e.g., unmeasured effects of defined digital services), or the type of article (Fig. 1). Data screening was completed independently by three reviewers (S.L., H.H., and A.V).

2.4. Assessment of methodological quality

The methodological quality of all the included reviews was assessed using the JBI critical appraisal tool for systematic reviews, consisting of 11 questions to assess study quality and the extent to which potential bias has been addressed (Aromataris et al., 2015). The assessment was conducted independently by two researchers (S.L. and H.H.) and final consensus was reached through discussion (Appendix C). Regardless of the methodological quality, all reviews were accepted for data extraction.

2.5. Data extraction and synthesis

Data was extracted by two researchers (S.L and H.H) using a preformed extraction template made using Covidence software. The extracted data consisted of study characteristics, object/aim, study design (e.g., qualitative/quantitative/mixed methods), setting/context, digital service(s) of interest, and research findings based on the quadruple aim framework (population health, costs, patient satisfaction, HCP satisfaction). Digital services were extracted using the predefined definition based on the WHO categorization (World Health Organization, 2018) from which three categories were formed: 1) synchronous

communication (e.g., real-time videoconferences and calls); 2) asynchronous communication (e.g., messaging, exchange of images, videos, audio); and 3) remote monitoring (e.g., video monitoring, remote tracking with wearable technology). The condition or domain, where the impact of digital services was evaluated, was classified based on medical specialties (e.g., cardiology) or healthcare context (e.g., primary care). Impact (lack of evidence, no dominance, mixed and positive effect) was classified as follows: positive, when digital services were more effective than usual care; mixed, when digital services were both positive and/or as effective as usual care; no dominance, when digital services were as effective as usual care; and lack of evidence, when the effect of digital services could not be determined in the review.

Due to the heterogeneity of the included reviews, a narrative description with supportive tabulations of the results was formed. The principle of inductive content analysis was used to identify and categorize facilitators and barriers to use digital services, with the unit of analysis being content-specific wording (Kyngäs, 2019). The initial content analysis was conducted by one reviewer (H.H), and further abstracted and verified by three reviewers (H.H, E.L, M.J).

3. Results

3.1. Characteristics of included reviews

The umbrella review identified 66 systematic reviews that met the predefined inclusion criteria (Appendix A). The reviews were published between 2012 and 2022, and nearly half (n = 29) were published during the last three years (2020–2022). The reviews were conducted in Europe (49 %), North America (21 %), Australia (18 %), and Asia (12 %) and in healthcare.

The quality of the included reviews was mostly (64 %) high (scoring 9–11/11 total score). The overall risk of bias was viewed as low since no study scored less than half of the scores (<5/11 total score). High risk of bias was most often related to the inclusion criteria, use of sources and resources, and assessment of publication bias (Appendix C).

3.2. Digital services in healthcare and social welfare

Of the included reviews, 18 % focused solely on asynchronous communication, 18 % on synchronous communication, and 25.5 % on both synchronous and asynchronous communication (Table 1). Only one study (1.5 %) focused solely on remote monitoring. Usually, remote monitoring was used in conjunction with asynchronous communication in 12 % and synchronous communication in 10 % of the included reviews.

3.3. Population health

Forty-three (65 %) reviews evaluated the impact of digital services on population health (Table 2). Most of the reviews (91 %) compared the impact of digital services with usual care or another non-digital intervention.

3.3.1. Cardiology

Nine (13.6 %) reviews evaluated the impact of digital services in cardiology (Kirakalaprathapan and Oremus, 2022; Inglis et al., 2015;

Table 1
Digital services in healthcare and social welfare.

Digital service	Examples of digital services?	Studies
Remote monitoring	Remote monitoring using cameras or with automatic transmission of physiological data using wearables or implantable technologies such as fitness trackers, pedometers, accelerometers, vital monitoring devices (e.g., blood pressure, oxygen saturation, heart rate, asthma, cardiac, spirometry, uterus activity, electronic stethoscope) from patient to healthcare professional via landline or mobile telephone or broadband technology, to gather data of vital signs and health behavior readings in everyday life or during delivery of intervention (e.g., entertaining fitness and relaxation content) with alerts of abnormalities conveyed to HCP.	Aspry et al., 2013; Brainard et al., 2016; Dawes et al., 2021; Flodgren et al., 2015; Fortuna et al., 2020; Gee et al., 2016; Gunter et al., 2016; Inglis et al., 2015; Kew and Cates, 2016a; Kirakalaprathapan and Oremus, 2022; Kraef et al., 2020; Laver et al., 2020; McLean et al., 2012; Munro et al., 2013; Palmer et al., 2021; Pandor et al., 2013; Robson and Hosseinzadeh, 2021; So and Chung, 2018; Sul et al., 2020; Svendsen et al., 2020; Urquhart et al., 2017; Vázquez-De Sebastián et al., 2021; Wong et al., 2020; Yang et al., 2017; Zhang et al., 2022 (n = 25)
Asynchronous communication	Asynchronous communication using web-based or mobile applications and devices for text messaging (emails and SMS) and delivering audiovisual data in secure channels, electronic health records, digital discussion forums, bulletin boards, and graffiti walls, social media networks, and shared documents. Patients can upload data (e.g., health, wellness, and behavior tracking, health visit data, home-testing values), perform self-tests (e.g., risks), keep diaries, answer questionnaires/surveys, manage their own care (e.g., view test results, manage medication lists and administrative issues), have access to tailored and personalized multimedia material and individual feedback (e.g., graphic data and reports), alerts of abnormal readings, recommendations, and reminders (e.g., to measure values, upcoming appointments, lifestyle, self-care and treatment guidance), decision-support to contact and interact with healthcare professionals, peers, family, caregivers, other service users. Service providers (e.g., healthcare professionals, clinical educators, treatment specialists) can access and monitor patient transmitted data, receive reports of patient data, and alerts with abnormalities or emergencies and provide support, counseling, education, therapy, and rehabilitation, and moderate e-communities.	Ali et al., 2019; Arsenijevic et al., 2020; Aspry et al., 2013; Bradford et al., 2016; Dawes et al., 2021; de Jongh et al., 2012; Devi et al., 2015; Dol et al., 2017; Fortuna et al., 2020; Gee et al., 2016; Gunter et al., 2016; Haberlin et al., 2018; Han et al., 2020; Hand, 2022; Iribarren et al., 2017; Jansson et al., 2020; Kaner et al., 2017; Kew and Cates, 2016a, 2016b; Kirakalaprathapan and Oremus, 2022; Kuo and Dang, 2016; Laver et al., 2020; López-Liria et al., 2022; Ma et al., 2018; Mashhadi et al., 2021; Massoudi et al., 2018; Mold et al., 2015; Munro et al., 2013; Nguyen et al., 2021; Nordheim et al., 2014; Palmer et al., 2021; Pandor et al., 2013; Parker et al., 2018; Radhakrishnan et al., 2016; Rat et al., 2018; Robson and Hosseinzadeh, 2021; So and Chung, 2018; Stewart et al., 2022; Svendsen et al., 2020; Tan and Lai, 2012; Taylor et al., 2017; Tornivuori et al., 2020; Vázquez-De Sebastián et al., 2021; Versluis et al., 2022; Wong et al., 2020; Zhang et al., 2022 (n = 46)
Synchronous communication	Synchronous communication using telephones, smartphones, or devices at home or in provider locations (e.g., clinics, health kiosk) for telephone- or videoconferencing and real-time messaging in chats or instant communication software applications, interactive messaging modules on secure websites between patients, HCP, and caregivers (e.g., remote visits for family/parents). HCP can send tailored real-time advice and provide consultations, coaching (teach-back communication), rehabilitation, education, therapy, and preoperative and postoperative multidisciplinary evaluation.	Ali et al., 2019; Arsenijevic et al., 2020; Aspry et al., 2013; Bakhit et al., 2021; Berryhill et al., 2019; Bradford et al., 2016; Brainard et al., 2016; Carrillo De Albornoz et al., 2022; Devi et al., 2015; Dol et al., 2017; Flodgren et al., 2015; Fortuna et al., 2020; Greenwood et al., 2022; Gunter et al., 2016; Haberlin et al., 2018; Han et al., 2020; Hand, 2022; Inglis et al., 2015; James et al., 2021; Jansson et al., 2020; Jones et al., 2022; Kaner et al., 2017; Kraef et al., 2020; Laver et al., 2020; Lin et al., 2019; Ma et al., 2018; Mashhadi et al., 2021; Massoudi et al., 2018; McCleery et al., 2021; McLean et al., 2012; Nordheim et al., 2014; Oliver et al., 2012; Parker et al., 2018; Robson and Hosseinzadeh, 2021; Sartori et al., 2021; Scott et al., 2022; So and Chung, 2018; Sul et al., 2020; Svendsen et al., 2020; Tan and Lai, 2012; Tornivuori et al., 2020; Tzelepis et al., 2019; Vázquez-De Sebastián et al., 2021; Wong et al., 2020; Yang et al., 2017; Zhang et al., 2022 (n = 46)

Table 2
The impact of digital services on population health.

Specialty	Context/condition	Review	Intervention/comparator	Result	Impact			
					Lack of evidence	No dominance	Mixed effect	Positive
Cardiology	Heart failure	Flodgren et al., 2015	Remote monitoring and synchronous communications Usual care	Compared to usual care, telemedicine had equal impact on health outcomes.		x		
	Heart failure	Inglis et al., 2015	Remote monitoring and synchronous communications Usual care	Compared to usual care, structured telephone support and non-invasive home telemonitoring reduced the risk of all-cause mortality and heart failure-related hospitalizations, and improved health-related quality of life, heart failure knowledge, and self-care behaviors.				x
	Heart failure	Pandor et al., 2013	Remote monitoring and asynchronous communication Usual care	Compared to usual care, telemonitoring had no impact on all-cause hospitalizations. A sensitivity analysis showed greater beneficial effects for most outcomes, especially with telemonitoring during office hours. Remote monitoring was beneficial in reducing all-cause mortality but was reported in one low-quality study.			x	
	Heart failure	Kirakalaprathapan and Oremus, 2022	Remote monitoring and asynchronous communications Usual care/another intervention	Compared to usual care or another intervention, integrated telehealth reduced hospitalizations, rehospitalizations, and mortality. Significant discrepancies were, however, identified due to variations in telehealth modalities and the risk of bias.				x
	Coronary heart disease	Aspry et al., 2013	Remote monitoring, asynchronous and synchronous communications Usual care/another intervention	Compared to usual care or another intervention, 23 trials reported a positive impact on lipid control, but only 14 showed positive impact on clinical outcomes.			x	
	Hypertension	de Jongh et al., 2012	Asynchronous communication Usual care	Compared to usual care, digital services had no dominance on blood pressure, blood pressure control, and body weight with moderate quality evidence.		x		
	Hypertension	Flodgren et al., 2015	Remote monitoring and synchronous communications Usual care	Compared to usual care, monitoring via telemedicine had a positive impact on blood pressure control.				x
	Secondary prevention of cardiovascular disease	Devi et al., 2015	Asynchronous and synchronous communications Usual care	Compared to usual care, digital services had no dominance on all-cause mortality or total cholesterol.		x		
	Primary prevention of cardiovascular disease	Palmer et al., 2021	Remote monitoring and asynchronous communication Usual care/active controls	Compared to usual care, digital services had a positive impact on the use of medicines prescribed, but no impact on self-care.			x	
	Cardiovascular rehabilitation	Munro et al., 2013	Remote monitoring and asynchronous communication Usual care/another intervention	Compared to usual care, digital services had a positive impact on physical activity measures and clinical outcomes, but the impact was mixed on psychosocial measures. No interventions noted a negative effect on outcomes.			x	
Endocrinology	Diabetes	de Jongh et al., 2012	Asynchronous communication Usual care	Compared to usual care, text messaging interventions or email reminders had no dominance for blood sugar control (HbA1c), the frequency of diabetic complications, or body weight with moderate quality evidence.		x		
	Diabetes	Flodgren et al., 2015	Remote monitoring and synchronous communications Usual care	Compared to usual care, telemedicine had a positive impact on blood glucose, lipid, and blood pressure control.				x
	Diabetes	Kuo and Dang, 2016	Asynchronous communication Usual care/another intervention	Compared to usual care/another intervention, the impact of the secure messaging was positive on blood sugar control (HbA1c) but mixed on blood pressure and lipid control.			x	
	Diabetes	Robson and Hosseinzadeh, 2021	Remote monitoring, asynchronous and synchronous communications Usual care	Compared to usual care, telehealth interventions had a positive impact on blood sugar control (HbA1c).				x
	Diabetes	So and Chung, 2018	Remote monitoring, asynchronous and synchronous communications Usual care/no treatment	Compared to usual care/no treatment at all, telehealth interventions had a positive impact on blood sugar control (HbA1c, 2-h-post-meal glucose).				x
	Diabetes	Vázquez-de Sebastián et al., 2021	Remote monitoring, asynchronous and synchronous communication Usual care/no treatment	Compared to usual care or no treatment, digital services had a positive impact on blood sugar control (HbA1c), self-management, and medication adherence.				x
	Diabetes	Zhang et al., 2022	Remote monitoring, asynchronous and synchronous communications Usual care	Compared to usual care, digital services had a positive impact on glycated hemoglobin, fasting glucose, postprandial glucose, and blood pressure control and self-efficacy. There was no dominance over usual care in weight and lipid control or diabetes awareness.			x	

(continued on next page)

Table 2 (*continued*)

Specialty	Context/condition	Review	Intervention/comparator	Result	Impact			
					Lack of evidence	No dominance	Mixed effect	Positive
Psychiatry	Anxiety	Berryhill et al., 2019	Synchronous communication Usual care	Compared to usual care, digital services had a positive impact on anxiety measures (14/21 studies) and on clinical measures (11/21 studies). There was no dominance over usual care in videoconferencing.			x	
	Anxiety	Massoudi et al., 2018	Asynchronous and synchronous communications Usual care/another intervention (waiting list)	There was no dominance over usual care in the treatment of anxiety.		x		
	Anxiety and stress	Gee et al., 2016	Remote monitoring and asynchronous communication Usual care/another intervention (i.e.,waiting list)/no treatment	Compared to usual care, digital services had a positive impact on generalized anxiety, stress, and panic disorders. There was no impact in the treatment of social phobia.			x	
	Depression	Massoudi et al., 2018	Asynchronous and synchronous communications Usual care/another intervention (waiting list)	Compared to usual care, eHealth had a small positive impact on depression, and compared to a waiting list, eHealth had a moderate impact on depression.				X
	Schizophrenia spectrum disorder or bipolar disorder	Fortuna et al., 2020	Remote monitoring, asynchronous and synchronous communication Another intervention/no comparison	Compared to another intervention or with no comparison at all, digital peer support interventions had a preliminary positive impact on functioning, symptoms, and program utilization.				x
	Post-traumatic stress disorder	Scott et al., 2022	Synchronous communications Usual care	Digital services had no dominance over usual care in PTSD severity, depression severity, therapeutic alliance, or treatment satisfaction.		x		
	Various mental health conditions	Flodgren et al., 2015	Remote monitoring and synchronous communication Usual care	There was no dominance over usual care in the psychotherapeutic treatment of different mental health problems.		x		
	Less common mental health conditions	Greenwood et al., 2022	Synchronous communications Usual care	There was no dominance over usual care in patient outcomes (symptom severity, symptom improvement, or global function) in patients with less common mental health problems.		x		
Pulmonology	Asthma	de Jongh et al., 2012	Asynchronous communication Usual care	Compared to usual care, digital services had a positive impact on peak expiratory flow variability and the pooled symptom score. There was no dominance over usual care in forced vital capacity or forced expiratory flow in one second.			x	
	Asthma	Kew and Cates, 2016a	Remote monitoring and asynchronous communications Usual care	There was a lack of evidence of telemonitoring in increase of asthma attacks that would require a course of oral steroids, a visit to the emergency department or a hospital stay.	x			
	Asthma	Kew and Cates, 2016b	Asynchronous communication Usual care	There was lack of evidence on the impact of digital services in exacerbations, asthma control or quality of life in the treatment of asthma.	x			
	COPD	McLean et al., 2012	Remote monitoring and synchronous communications Usual care	Compared to usual care, digital services had a positive impact on emergency room visits and ward treatment in patients with COPD. There was no dominance over usual care in quality of life or mortality.			x	
	COPD	Sul et al., 2020	Remote monitoring and synchronous communication Usual care	There was no dominance over usual care in the treatment balance of COPD patients or total mortality. Compared to usual care, telemonitoring combined with lung function monitoring has a positive impact on exacerbations when this intervention was continued for six months.			x	
	COPD	Yang et al., 2017	Remote monitoring and synchronous communications Usual care or another intervention	Compared to usual care, telemonitoring had a positive impact on all-cause readmissions over 6–12 months in patients with COPD.				x
	Various respiratory conditions	Flodgren et al., 2015	Remote monitoring and synchronous communications Usual care	Compared to usual care digital services had a positive impact in patient with a respiratory condition.				x

Preventive medicine	Salt consumption	Ali et al., 2019	Asynchronous and synchronous communication Usual care/no comparison	There was a lack of evidence to evaluate the impact of digital services in salt reduction.	x		
	Substance abuse	Flodgren et al., 2015	Remote monitoring and synchronous communication Usual care	Compared to usual care, therapy delivered over videoconferencing had a mixed impact on substance abuse problems.			x
	Alcohol consumption	Kaner et al., 2017	Asynchronous and synchronous communication Usual care	Compared to usual care, the impact of digital services was mixed in lowering alcohol consumption.			x
	Smoking cessation	Tzelepis et al., 2019	Synchronous communications Another intervention	Digital services had no dominance over usual care in assisting people to quit smoking.		x	
	Smoking cessation	Taylor et al., 2017	Asynchronous communication No comparator, no treatment, or another intervention	Compared to no treatment at all, digital services had a positive impact on smoking cessation. There was no dominance over other interventions.		x	
	Smoking cessation	Taylor et al., 2017	Asynchronous communication No comparator, no treatment, or another intervention	There was a lack of evidence on the impact of digital service in smoking cessation in young people.	x		
Dermatology	Dermatological conditions	Flodgren et al., 2015	Remote monitoring and synchronous communications Usual care	There was no dominance of digital services over usual care in the treatment of dermatological conditions.		x	
	Dermatological conditions	Rat et al., 2018	Asynchronous communication Usual care or no comparison	There was a lack of evidence on the safety and efficacy of automated apps for identification of melanoma.	x		
	Foot and leg ulcers	Nordheim et al., 2014	Asynchronous and synchronous communications Usual care	There was a lack of evidence on the impact of telemedicine consultation compared to usual care of leg and foot ulcers.	x		
Infectiology	Small infections	Han et al., 2020	Asynchronous and synchronous communication Usual care	Compared to usual care, more antibiotic treatments were initiated for patients using digital services, but the results of the study were contradictory.	x		
	Small infections	Bakhit et al., 2021	Synchronous communication Usual care	Compared to usual care, more antibiotic treatments were initiated for patients using digital service, but the evidence is insufficient.	x		
	Infections	Nguyen et al., 2021	Asynchronous communication Usual care	Compared to usual care, mixed quality was observed in appropriate antibiotic prescribing with further study needed.	x		
Pediatrics	Neonatal care	Dol et al., 2017	Asynchronous and synchronous communication Usual care or no comparator	Compared to usual care or no comparator, there was lack of evidence to evaluate impact of digital services on neonatal outcomes (e.g., length of stay).	x		
	Neonatal care	Tan and Lai, 2012	Asynchronous and synchronous communications Usual care	There was a lack of evidence to evaluate the impact of telemedicine technology on supporting the parents of high-risk new-born infants receiving intensive care.	x		
	Prenatal care	Urquhart et al., 2017	Remote monitoring Usual care	There was no dominance of digital services over usual care on maternal and perinatal outcomes (e.g., mortality, incidence of preterm birth).		x	
Neurology	Stroke	Laver et al., 2020	Remote monitoring, asynchronous and synchronous communications Usual care	There was no dominance over usual care of short-term post-hospital discharge telerehabilitation programs on depressive symptoms, quality of life, or independence in activities of daily living in patients with stroke.		x	
	Dementia, cognitive impairment	McCleery et al., 2021	Synchronous communications Usual care	Telehealth had no dominance over usual care on sensitivity and specificity in diagnosing all-cause dementia.		x	

(continued on next page)

Table 2 (*continued*)

Specialty	Context/condition	Review	Intervention/comparator	Result	Impact			
					Lack of evidence	No dominance	Mixed effect	Positive
Oncology	Cancer survivors	Haberlin et al., 2018	Asynchronous and synchronous communication Usual care or no comparison	Compared to usual care eHealth interventions had a positive impact on PA and exercise in cancer survivors.				x
Orthopedy	Orthopedic conditions	Jansson et al., 2020	Asynchronous and synchronous communications Usual care	Compared to usual care, digital services had a mixed impact on clinical outcomes in orthopedic conditions.			x	
Surgery	Postoperative care	Dawes et al., 2021	Remote monitoring and asynchronous communication Usual care	Compared to usual care, mHealth had positive impact on emergency department visits, readmissions, and accelerated improvements in quality of life after surgery.				x
Palliative care	Palliative care	Oliver et al., 2012	Synchronous communications	There was a lack of evidence of the impact of digital services on patient anxiety, caregiver quality of life, communication anxiety. No study was large enough to find significance in these clinical measures, but all found the clinical tools appropriate for use in the setting.	x			
Multimorbidity	Multimorbidity	Kraef et al., 2020	Remote monitoring and synchronous communication Usual care	Compared to usual care, digital services had a positive impact on systolic blood pressure, HbA1c, and total cholesterol.				x
Various specialties	Various conditions	Nguyen et al., 2021	Asynchronous communication Usual care	Compared to usual care, e-visits had a mixed impact on clinical outcomes, especially for chronic disease management.			x	
	Chronic conditions in adolescents	Tornivuori et al., 2020	Asynchronous and synchronous communication Usual care/another intervention (not tailored digital intervention)	Compared to usual care, tailored digital health services had a positive impact on health and transition of care outcomes in chronically ill adolescents.				x
	Various conditions	Wong et al., 2020	Remote monitoring, asynchronous and synchronous communications Usual care	Compared to usual care, eHealth had a positive impact on medication adherence and quality of life in non-hospital settings (13/24 studies).				x

de Jongh et al., 2012; Palmer et al., 2021; Pandor et al., 2013; Aspry et al., 2013; Devi et al., 2015; Munro et al., 2013; Flodgren et al., 2015). Compared to usual care, digital services had a positive impact on mortality (Kirakalaprathapan and Oremus, 2022; Inglis et al., 2015; Pandor et al., 2013), quality of life and self-care (Inglis et al., 2015), and mixed impact on hospitalization in patients with heart failure, with positive impact in one review (Inglis et al., 2015) and no dominance in one (Pandor et al., 2013). Compared to usual care, the impact of digital services was mixed on lipid control in coronary heart disease patients with hypercholesterolemia (Aspry et al., 2013) and on blood pressure control in patients with hypertension (Flodgren et al., 2015). Compared to usual care, the impact of digital services was mixed on primary prevention (Palmer et al., 2021) and cardiovascular rehabilitation (Munro et al., 2013), with no dominance on secondary prevention in patients with coronary heart disease (Devi et al., 2015).

3.3.2. Endocrinology

Seven (10.6 %) reviews examined the impact of digital services in endocrinology, with all reviews on diabetes (de Jongh et al., 2012; Flodgren et al., 2015; Robson and Hosseinzadeh, 2021; So and Chung, 2018; Vázquez-De Sebastián et al., 2021; Zhang et al., 2022; Kuo and Dang, 2016). Compared to usual care, the overall impact of digital services was slightly positive on blood glucose, with positive impact in six reviews (Flodgren et al., 2015; Robson and Hosseinzadeh, 2021; So and Chung, 2018; Vázquez-De Sebastián et al., 2021; Zhang et al., 2022; Kuo and Dang, 2016) and no dominance in one (de Jongh et al., 2012). Digital services had an overall mixed impact on blood pressure with positive impact in two reviews (Flodgren et al., 2015; Zhang et al., 2022) and mixed in one review (Kuo and Dang, 2016). Digital services had a mixed impact on lipid control with one positive (Flodgren et al., 2015), one mixed (Kuo and Dang, 2016) and one review with no dominance over usual care (Zhang et al., 2022). Digital services had no dominance over usual care in metabolism (de Jongh et al., 2012; Zhang et al., 2022) and in diabetic complications (de Jongh et al., 2012).

3.3.3. Psychiatry

Seven (10.6 %) reviews examined the impact of digital services in psychiatry (Flodgren et al., 2015; Berryhill et al., 2019; Massoudi et al., 2018; Gee et al., 2016; Fortuna et al., 2020; Scott et al., 2022; Greenwood et al., 2022). Compared to usual care, digital services had a positive impact in patients with depression, schizophrenia spectrum disorder and bipolar disorder (Fortuna et al., 2020). Compared to usual care, the overall impact of digital services was mixed in anxiety patients with positive impact in two reviews (Berryhill et al., 2019; Gee et al., 2016) and no dominance over usual care in one (Massoudi et al., 2018). Digital services also had a positive impact in patients with stress and panic disorders (Gee et al., 2016). Digital services had no dominance over usual care on social phobia (Gee et al., 2016), post-traumatic stress disorder (Scott et al., 2022), mixed mental health conditions (Flodgren et al., 2015), less common mental health conditions, and chronic conditions (Greenwood et al., 2022).

3.3.4. Pulmonology

Seven (10.6 %) reviews evaluated the impact of digital services in pulmonology (de Jongh et al., 2012; Flodgren et al., 2015; Kew and Cates, 2016a, 2016b; McLean et al., 2012; Sul et al., 2020; Yang et al., 2017). Compared to usual care, digital services had a positive impact on patients with various respiratory conditions (Flodgren et al., 2015). Compared to usual care, digital services had a mixed impact on patients with asthma: the impact was positive on peak expiratory flow variability, with no dominance on forced vital capacity or forced expiratory flow (de Jongh et al., 2012). There was a lack of evidence related to asthma control, quality of life, and exacerbations (Kew and Cates, 2016a, 2016b). Compared to usual care, the impact of digital services was positive on hospitalizations (McLean et al., 2012), readmissions (Yang et al., 2017), and exacerbations (Sul et al., 2020) with no dominance on treatment balance, total mortality (Sul et al., 2020), or quality of life (McLean et al., 2012) in patients with chronic obstructive pulmonary disease.

3.3.5. Preventive medicine

Five (7.6 %) reviews evaluated the impact of digital services on salt consumption, smoking cessation, and alcohol consumption (Flodgren et al., 2015; Ali et al., 2019; Kaner et al., 2017; Tzelepis et al., 2019; Taylor et al., 2017). Compared to usual care, digital services had a mixed impact on harmful alcohol consumption (Kaner et al., 2017) and substance abuse (Flodgren et al., 2015) and no dominance over usual care or other interventions on smoking cessation (Tzelepis et al., 2019; Taylor et al., 2017), but when compared to no intervention at all, the impact of digital services was positive (Taylor et al., 2017). There was a lack of evidence of the impact of digital services on salt consumption (Ali et al., 2019), and smoking cessation in younger populations (Taylor et al., 2017).

3.3.6. Dermatology

Three (4.5 %) reviews evaluated the impact of digital services in dermatology (Flodgren et al., 2015; Rat et al., 2018; Nordheim et al., 2014). Compared to usual care, digital services had no dominance in patients with dermatological conditions (Flodgren et al., 2015). There was a lack of evidence of the impact of digital services on early identification of melanoma (Rat et al., 2018) and the treatment of foot and leg ulcers (Nordheim et al., 2014).

3.3.7. Infectiology

Three (4.5 %) reviews evaluated the impact of digital services in infectiology. Compared to usual care, the evidence on the impact of digital services in infectiology lacked evidence with more (Han et al., 2020; Bakhit et al., 2021) or varying (Nguyen et al., 2021) numbers of appropriate antibiotic treatments prescribed on infection patients when using digital services.

3.3.8. Pediatrics

Three (4.5 %) reviews evaluated the impact of digital services in pediatrics (Dol et al., 2017; Tan and Lai, 2012; Urquhart et al., 2017). Compared to usual care, digital services had no dominance on obstetric and perinatal outcomes such as perinatal mortality or incidence of preterm birth (Urquhart et al., 2017). In addition, there was a lack of evidence on the impact of digital services on supporting parents of infants receiving intensive care (Dol et al., 2017; Tan and Lai, 2012).

3.3.9. Neurology

Two (3 %) reviews evaluated the impact of digital services in neurology (Laver et al., 2020; McCleery et al., 2021). Compared to usual care, digital services had no dominance on post-discharge care in short-term hospitalized cerebrovascular disease patients (Laver et al., 2020) or on the assessment of dementia and mild cognitive impairment (McCleery et al., 2021).

3.3.10. Other specialties

Compared to usual care, digital services had a positive impact on the physical activity in oncology (Haberlin et al., 2018). Digital services had a positive impact on clinical outcomes in patients with multimorbidity (Kraef et al., 2020), quality of life, the number of emergency room visits, and readmissions in patients recovering from surgery (Dawes et al., 2021) and a mixed impact on clinical outcomes in orthopedy (Jansson et al., 2020). There was a lack of evidence of the impact of digital services on anxiety symptoms, and quality of life in palliative care patients (Oliver et al., 2012).

Three reviews (4,5 %) evaluated the impact of digital services across specialties with no direct indication of specialty specific impact (Nguyen et al., 2021; Tornivuori et al., 2020; Wong et al., 2020). Compared to usual care digital services had a positive impact on medication

Table 3
The impact of digital services on patient satisfaction.

Condition or domain	Review	Intervention/comparator	Result	Impact			
				Lack of effect	No dominance	Mixed effect	Positive effect
Healthcare	Flodgren et al., 2015	Remote monitoring and synchronous communications Usual care	There was a lack of evidence on the acceptance of patients for digital services.	X			
Surgery	Gunter et al., 2016	Remote monitoring, synchronous and asynchronous communication Usual care/no comparison	Compared to usual care, digital services had a positive impact on patient satisfaction. Patients experienced digital services as useful. Patients were interested in trying digital services.				X
Surgery	Sartori et al., 2021	Synchronous communications Usual care	Compared to usual care, digital services had a positive impact (1/2 studies) on patients with hemorrhoidal disease waiting for surgery.				X
Primary care, mental health, and allied health services	Carrillo De Albornoz et al., 2022	Synchronous communications Usual care	Compared to usual care, video receptions had positive impact on patient satisfaction, but lower continuity of care compared to usual care. Digital services have the potential to deliver interventions at a distance while improving access to healthcare.			X	
Primary care	Mold et al., 2015	Asynchronous communication Usual care	Compared to usual care, online access to electronic health records and related services improved patient satisfaction.				X
Home care	Radhakrishnan et al. (2016)	Asynchronous communication No comparison/usual care	Tele-homecare had a positive impact on patient satisfaction. Patients experienced that remote home care promoted daily self-monitoring.				X
PICC-catheter care	Ma et al., 2018	Synchronous, asynchronous communication Usual care	Compared to usual care, WeChat had positive impact on PICC catheter patient satisfaction.				X
Palliative care	Oliver et al., 2012	Synchronous communications usual care/no comparison	Digital services had a positive impact on patients and relative satisfaction with experiences of them being useful and easy.				X
Laboratory testing	Versluis et al., 2022	Asynchronous communication Usual care/no comparison	Digital services had positive impact on patient satisfaction. They were acceptable, with 81 % of participants preferring home-based testing over clinic-based testing.				X
Preventive medicine	Lin et al., 2019	Synchronous communications/ Usual care/another intervention/no comparison	Telemedicine had positive impact on patient satisfaction.				X
Preventive medicine	Tzelepis et al., 2019	Synchronous communications Another intervention	Smoking cessation guidance through video-mediated sessions had a positive impact on patient satisfaction. Patients would recommend digital services over telephone interventions to friends or family members.				X
Cardiology	Inglis et al. (2015)	Remote monitoring and synchronous communications Usual care	Compared to usual care, digital services had a positive impact on patient satisfaction.				X
Cardiology	Munro et al. (2013)	Remote monitoring and asynchronous communication Usual care/another intervention	Compared to usual care or another intervention, digital services had a positive impact on patient satisfaction.				X
Dermatology	López-Liria et al., 2022	Asynchronous communication Usual care	Compared to usual care, digital services had a positive impact on patient satisfaction.				X
Dermatology	Rat et al., 2018	Asynchronous communication Usual care/no comparison	Compared to usual care or with no comparison, the use of store and forward teledermatology had a positive impact on improved patient access to dermatology consultation by optimizing the care course.				X
Pulmonology	McLean et al., 2012	Remote monitoring and synchronous communications Usual care	Compared to usual care, digital services had a positive impact on patients with COPD with the possibility of a face-to-face appointment when requested.				X
Long term health conditions	de Jongh et al., 2012	Asynchronous communication Usual care	Compared to usual care, SMS-based based communication had a positive impact on patient satisfaction with varying levels of satisfaction.			X	
Endocrinology diabetes	Vázquez-de Sebastián et al., 2021	Remote monitoring, synchronous and asynchronous communication Usual care/no treatment	Compared to usual care, digital services had a positive on patient satisfaction. Satisfied patients had more decreased levels of Hba1c-levels than less satisfied patients.				X

adherence and quality of life on varied specialties in non-hospital settings (Wong et al., 2020), and on health-outcomes and chronic disease self-management in adolescent patients during transitioning of care (Tornivuori et al., 2020). The impact of digital services was mixed on varied specialties and especially chronic disease management in healthcare (Nguyen et al., 2021).

3.4. Patient satisfaction

Patient satisfaction on digital services was examined in 18 (27 %) reviews (Inglis et al., 2015; de Jongh et al., 2012; Munro et al., 2013; Flodgren et al., 2015; Vázquez-De Sebastián et al., 2021; McLean et al., 2012; Tzelepis et al., 2019; Rat et al., 2018; Oliver et al., 2012; Gunter et al., 2016; Sartori et al., 2021; Carrillo De Albornoz et al., 2022; Mold et al., 2015; Radhakrishnan et al., 2016; Ma et al., 2018; Versluis et al., 2022; Lin et al., 2019; López-Liria et al., 2022) (Table 3). The impact of digital services was positive on patient satisfaction in 78 % of the included reviews. Caregivers' experiences were evaluated in one review (Oliver et al., 2012) and the usability of digital services in three (Arsenijevic et al., 2020; Jones et al., 2022; Parker et al., 2018).

Compared to usual care, patients preferred digital services in home testing (Versluis et al., 2022) and in the treatment of dermatological conditions (López-Liria et al., 2022). In addition, patients preferred to view their personal health information online instead of coming to face-to-face appointments (Mold et al., 2015). The impact of digital services on patient satisfaction was positive when digital services were accessible (Oliver et al., 2012), easy to use (Gunter et al., 2016), improved patient–provider communication (Radhakrishnan et al., 2016) and included the option to usual care (McLean et al., 2012).

3.4.1. Access to care

Compared to usual care, digital services had a positive impact on access to care in patients with substance misuse problems when usual services were congested (Lin et al., 2019), by reducing the consultation delay and speeding up referrals for dermatological patients (Rat et al., 2018), and for patients in surgical care (Sartori et al., 2021). Compared to usual care, the impact of digital services was positive in primary health care, with high patient satisfaction and potential to deliver time-efficient care at a distance, although the continuity of care was not as robust as usual care (Carrillo De Albornoz et al., 2022).

3.4.2. Vulnerable groups

Three (4.6 %) reviews identified patient groups (i.e., vulnerable groups) who might have challenges in the use of digital services (Arsenijevic et al., 2020; Jones et al., 2022; Parker et al., 2018). Overall, the use of digital services was low in people on low incomes, elderly, minorities (Arsenijevic et al., 2020; Jones et al., 2022), and with long-term conditions (Arsenijevic et al., 2020; Parker et al., 2018). The willingness to utilize services was influenced by motivation and health literacy (Parker et al., 2018). Additionally, the use of digital services was low among non-English–speaking older people with low levels of education and lower household income (Jones et al., 2022). Digital services utilizing different modalities with patient–provider communication increased the use of digital services in vulnerable groups (Arsenijevic et al., 2020).

3.5. Healthcare professionals' satisfaction

Six (9 %) reviews evaluated the impact of digital services on HCP's satisfaction (Vázquez-De Sebastián et al., 2021; Oliver et al., 2012; Gunter et al., 2016; Mold et al., 2015; Radhakrishnan et al., 2016; López-Liria et al., 2022) (Table 4). Digital services had a positive impact on HCP satisfaction in endocrinology (Vázquez-De Sebastián et al., 2021), palliative care (Oliver et al., 2012), dermatology (López-Liria et al., 2022), and surgery (Gunter et al., 2016). Easy use and perceived usefulness of the digital services were related to HCPs satisfaction (Oliver et al., 2012).

The impact of digital services on HCP's satisfaction was mixed in primary care (Mold et al., 2015) and home care (Radhakrishnan et al., 2016). Although concerns were not realized, HCPs had concerns regarding the impact of digital services on the workload (Mold et al., 2015). The negative experiences of HCPs decreased the implementation success of digital services (Radhakrishnan et al., 2016).

3.6. Costs

Fourteen (21 %) reviews evaluated the impact of digital services on costs (Inglis et al., 2015; Palmer et al., 2021; Fortuna et al., 2020; de Jongh et al., 2012; Pandor et al., 2013; Massoudi et al., 2018; Sul et al., 2020; Nguyen et al., 2021; Urquhart et al., 2017; Jansson et al., 2020; Oliver et al., 2012; Sartori et al., 2021; Carrillo De Albornoz et al., 2022; López-Liria et al., 2022; Iribarren et al., 2017; Brainard et al., 2016; Mashhadi et al., 2021). Compared to usual care, digital services had a positive impact on costs in cardiology (Pandor et al., 2013), dermatology (López-Liria et al., 2022), and palliative care (Oliver et al., 2012), and in varied primary healthcare domains (Nguyen et al., 2021; Carrillo De Albornoz et al., 2022). The impact of digital services on costs was mixed in psychiatry (Massoudi et al., 2018) with no dominance over usual care on total costs in orthopedy (Jansson et al., 2020).

Table 4
The impact of digital services on healthcare professionals' satisfaction.

Condition or domain	Author	Intervention/comparator	Results	Impact			
				Lack of evidence	No dominance	Mixed Impact	Positive impact
Primary care	Mold et al. (2015)	Asynchronous communication Usual care	Compared to usual care, digital services had a mixed impact on HCP experiences of increased workload by practices.			x	
Homecare	Radhakrishnan et al. (2016)	Asynchronous communication No comparison or usual care	The impact of digital services was mixed on healthcare professional satisfaction, with HCP experiences of uncertainty with effectiveness affecting use of digital services.			x	
Surgery	Gunter et al. (2016)	Remote monitoring, asynchronous and synchronous communications Usual care/no comparison	The impact of digital services was positive on healthcare professional satisfaction in post-surgery discharge care.				x
Palliative care	Oliver et al. (2012)	Synchronous communications Usual care/no comparison	The impact of digital services was positive on attitudes and experiences of HCP. They perceived digital services to be useful and easy to use.				x
Endocrinolog	Vázquez-de Sebastián et al. (2021)	Remote monitoring, synchronous and asynchronous communication Usual care/no treatment	Compared to usual care, the impact of digital services was positive on healthcare professionals' satisfaction.				x
Dermatology	López-Liria et al. (2022)	Asynchronous communication Usual care	Compared to usual care, the impact of digital services was positive on HCP satisfaction in dermatological disease care.				x

Compared to usual care, digital services had a positive impact on surgeon volume in pre- and post-surgery visits in surgery patients with hemorrhoids (Sartori et al., 2021). Compared to usual care, the impact of digital services was mixed on the reduction of hospital readmissions of out-patients (Mashhadi et al., 2021) and obstetric health service utilization (Urquhart et al., 2017). The impact of digital services had no dominance over usual care in health service utilization in endocrinology (de Jongh et al., 2012) or pulmonology (Sul et al., 2020) (Table 5).

3.7. Facilitators and barriers to using digital services

Fourteen (21 %) reviews described facilitators and barriers to using digital services (Aspry et al., 2013; Munro et al., 2013; Fortuna et al., 2020; Tornivuori et al., 2020; Wong et al., 2020; Radhakrishnan et al., 2016; Versluis et al., 2022; Arsenijevic et al., 2020; Parker et al., 2018; Hand, 2022; Svendsen et al., 2020; James et al., 2021; Bradford et al., 2016; Stewart et al., 2022). Five main, 19 generic, and 83 sub-categories describing facilitators to use digital services were identified. In addition, six main, 17 generic, and 38 sub-categories describing barriers to the use of digital services were identified.

3.7.1. Facilitators

The identified facilitators to using digital services were inductively formed in five main categories: various features, allocation, end-user support, organized services, and service development (Fig. 2). Various features such as multimodality, high-quality health information, convenient user interface, process monitoring (e.g., goals, results, activities), enhanced communication (e.g., patient–provider, family, peers), privacy, accessibility, and tailoring (e.g., needs, literacies, skills, changing life circumstances) facilitated the use of digital services for the end-users, and especially patient users.

Identification of suitable end-users with supportive qualities (e.g., health literacy, self-efficacy, activeness, engagement, solution-orientation) is important for allocating digital services. Support personnel (e.g., IT staff, clinical champions, coordinators) and goal-directed quality education should be available to all end-users. Patient end-users should receive support for digital service use from family, professionals, and authorities, as appropriate. Organized services with multilevel administrative guidance (e.g., determined aims, goals, collaboration, responsibilities), organizational commitment, and supportive collaboration structures (e.g., interprofessionality, networking) with adequate resources (e.g., time, staff, funding, and technology) facilitated the use of digital services. Service development with multi-perspective impact assessment and applicable procedures (e.g., piloting, data sharing, co-creation, functional processes, and service design) supported the use of digital services.

3.7.2. Barriers

The identified barriers to using digital services were inductively formed in six main categories: service limitations, digital competency, service strategy, funding strategy, change management, and resources (Fig. 3). Service limitations such as technical issues (e.g., malfunctioning, and outdated solutions, weak audio-visual qualities, logging-in and data transfer difficulties), inapplicable solutions (e.g., inappropriate questionnaires, lack of possibilities for symptom identification), and access restrictions (e.g., lack of broadband connection, power sources, and technology) limited the use of digital services. The use of digital service was also hindered by a lack of digital competency of patients (e.g., literacy deficits, preferences of traditional human contact services, fears of privacy violations) and HCP end-users (e.g., lack of experience, resistance to change and digital services). Lack of digital competency was related to undefined roles of both patients and HCP in the use of digital services.

The use of digital services was not supported, due to a lack of national guidance (e.g., short political terms, lack of strategies, standards for the procuring and providing) and funding strategy (e.g., funders, funding models, reimbursement, financial pressure). An unstable baseline for change (e.g., deficient service structures, regional differences, readiness for change), lack of resources (e.g., staff, facilities, equipment) with uneasiness of redesigning processes due to lack of research data, and adaptable service models made change management for the use of digital services difficult.

4. Discussion

The umbrella review identified 66 systematic reviews. It shows the increasing deployment of various digital services in healthcare, especially after the onset of the COVID-19 pandemic and the impact of digital services on healthcare performance by using the Quadrable aim framework. A post-pandemic update was relevant and enabled a more comprehensive understanding of the rapidly evolving landscape of digitalizing healthcare (Eze et al., 2020; Timpel et al., 2020; Snoswell et al., 2020). Though new research has emerged, the impact of digital services is mixed, highlighting the need for further research especially understanding the impact mechanisms of digital services on population health.

4.1. Digital services in healthcare and social welfare

Synchronous and asynchronous communication were the most used digital services in healthcare. As wearable technology develops, it is possible that remote monitoring will increase and become a more common addition. It has potential health benefits but raises ethical and data management issues that need addressing (Cohen et al., 2020). The results of this review were similar to the pre-pandemic umbrella review, although remote monitoring was defined as the asynchronous transmission of data from devices, with separate store-and-forward services to define transmission of patient data (Eze et al., 2020). This review adds new information by describing the various functionalities for asynchronous communication between patients and healthcare professionals, and for the transmission of patient and health data.

4.2. Impact of digital services on population health

The impact of digital services on population health align with findings from the previous literature (Eze et al., 2020; Timpel et al., 2020; Snoswell et al., 2020; Koh et al., 2022). Digital services have demonstrated a mixed, but mostly positive impact on population health in various medical specialties including cardiology, endocrinology (i.e., diabetes), pulmonology, and psychiatry. However, there is limited evidence and a lack of reviews focusing on other specialties such as orthopedy, oncology, dermatology, and pediatrics, with either no dominance or limited evidence available. The scarcity of comprehensive and targeted research in these areas has also been highlighted in previous reviews (Eze et al., 2020; Snoswell et al., 2020), underscoring the need for additional studies of clinical effectiveness that encompass a broader healthcare context. The review also identified a possible negative impact of digital services on the treatment of infections. Three reviews reported that patients treated via digital services were prescribed more (Han et al., 2020; Bakhit et al., 2021) or varying numbers of antibiotic treatments (Nguyen et al., 2021) than in usual face-to-face care. This emphasizes that the utilization of digital services can lead to unintended consequences requiring researching the implementation, delivery, and use of digital services.

4.3. Impact of digital services on patient satisfaction

Predominantly positive patient satisfaction was reported. Compared to usual care, patients preferred digital services in home testing, for instance. According to previous literature, digital services can improve access to healthcare services (Leonardsen et al., 2020), which was also indicated by this review. Only one review specifically examined the satisfaction of patient caregivers, highlighting the need to explore their

Table 5
The impact of digital services on costs.

Condition or domain	Review	Intervention Comparator Type of cost-evaluation	Results	Impact No evidence	No dominance	Mixed effect	Positive
Healthcare	Iribarren et al., 2017	Asynchronous communication Usual care/other intervention Economic evaluation (25 CEA, 12 CUA, 1 CMA, 1 CBA)	Compared to usual care, mHealth interventions were cost-effective, economically beneficial, or resulted in cost savings (29/39 studies).			x	
Healthcare all domains	Nguyen et al., 2021	Asynchronous communication Usual care Cost analysis	Compared to usual care, e-visits reduced health care costs.				x
Primary care, mental health, and allied health services	Carrillo De Albornoz et al., 2022	Synchronous communications Usual care N/A	Compared to usual care, digital services e-visits reduced health care costs.				x
Healthcare domain	Brainard et al., 2016	Remote monitoring and synchronous communications Usual care Resource use and cost analysis	Compared to usual care, the impact of digital services was positive in reducing unplanned care use and emergency transport when facilitating access to specialist expertise in rural areas, but evidence was limited, and some studies showed significant increases in unplanned care.			x	
Psychiatry	Massoudi et al., 2018	Asynchronous and synchronous communications Usual care/another intervention (waiting list) Cost-effectiveness analysis	Compared to usual care, three studies out of four found eHealth interventions cost-effective in patients with depression/anxiety.			x	
Out-patient care	Mashhadi et al., 2021	Synchronous and asynchronous communication Usual care Resource use	Compared to usual care, digital services had a mixed impact with a significant reduction of hospital admission in seven studies and non-significant in four studies.			x	
Cardiology	Pandor et al., 2013	Remote monitoring and asynchronous communication Usual care/other intervention Cost-effectiveness analysis	Compared to usual care or other interventions, telemonitoring during office hours was a cost-effective in patients with heart failure.				x
Endocrinology	de Jongh et al., 2012	Asynchronous communication Usual care Resource use	Digital services (i.e., text messaging support) had no dominance over usual care in health service utilization in patients with diabetes.		x		
Pulmonology	Sul et al., 2020	Remote monitoring and synchronous communications Usual care Resource use	Digital services had no dominance over usual care in health service utilization (length of hospital stay, number of hospital admissions, number of emergency room visits) in patients with COPD.		x		
Dermatology	López-Liria et al., 2022	Asynchronous communication Usual care Cost-effectiveness analysis	Compared to usual care, teledermatology lowered costs.				x
Pediatrics	Urquhart et al., 2017	Remote monitoring Usual care Resource use	Compared to usual care, home uterine monitoring reduced admissions to neonatal intensive care unit but increased unscheduled antenatal visits and tocolytic treatment.			x	
Orthopaedy	Jansson et al., 2020	Asynchronous and synchronous communications No treatment/usual care/other intervention N/A	Computer and telephone-delivered interventions did not increase costs.		x		
Palliative care	Oliver et al., 2012	Synchronous communications Usual care (home visits) Cost analysis	Compared to usual care, telemedicine visits were less expensive.				x
Surgery	Sartori et al., 2021	Synchronous communications Usual care Resource use	Compared to usual care, digital services reduced the number of surgeons.				x

Abbreviations: CEA, Cost-effectiveness analysis; CUA, Cost utility analysis; CMA, Cost minimization analysis; CBA, Cost benefit analysis.

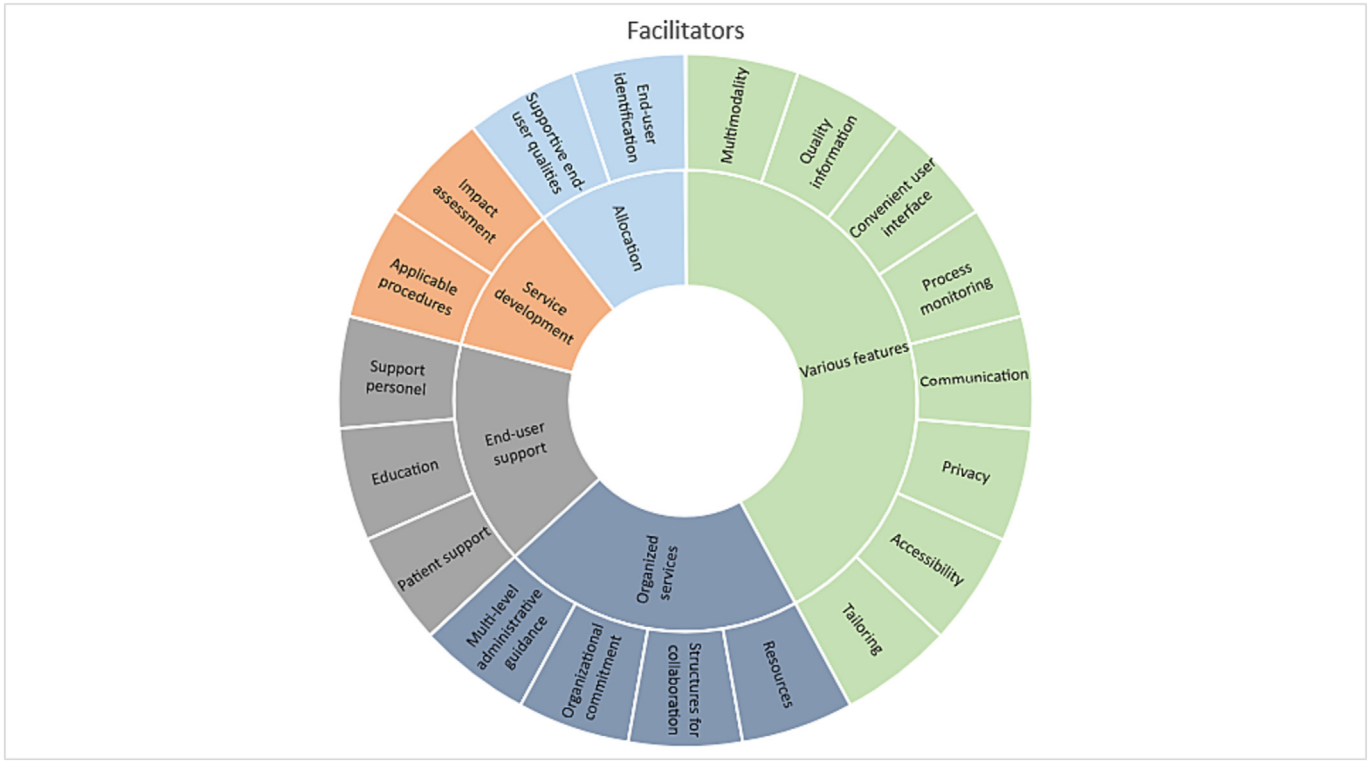

Fig. 2. Facilitators to using digital services.

experiences, given that health services and digital services are often utilized by relatives on behalf of elderly and critically ill individuals (Malhotra and Ramakrishnan, 2022). It is also important to consider vulnerable groups of patients who may face barriers in the use of digital services, potentially exacerbating existing health inequities (Kunonga et al., 2021). Addressing disparities with tailored, accessible, and

Fig. 3. Barriers to using digital services.

affordable digital services with support of digital literacy ensuring equitable access to digital services should be prioritized to maximize the benefits of digital services (O'Connor et al., 2016).

4.4. Impact of digital services on healthcare professionals' satisfaction

The topic of HCP satisfaction in digital services has been relatively understudied in previous studies (Eze et al., 2020), which was evident in this review as well. The review provided insights that the use of digital services on HCP experiences varied, while the impact on HCP satisfaction was limited. There are concerns about the potential erosion of patient–provider boundaries and the perception that technology may diminish clinical skills and increase workload (Odendaal et al., 2020). The experiences and satisfaction of HCP can influence the success of digital services (Konttila et al., 2019; Henry et al., 2017) and therefore should be considered in the implementation and development of digital services.

4.5. Impact of digital services on costs

Given the projected increase in health expenditures in the coming decades (Dieleman et al., 2017), reliable data on cost-effective healthcare interventions becomes imperative. In the umbrella review, digital services showed mixed impact on costs and resource utilization but in most of the studies costs were lower. Conversely, in previous literature digital services may have reduced in-person appointments, but the easy accessibility of such services had potentially increased the demand for healthcare (Shigekawa et al., 2018). In the long run, this may reduce more costly unplanned and tertiary-level care as patients resume an active role in self-management (Anderson et al., 2022). Potential timesaving from digital services was not identified in the review, although it is important, as cost savings can be realized through the time saved for patients who no longer need to travel to a healthcare facility for their appointments.

4.6. Facilitators and barriers to using digital services

The review identified several facilitators and barriers to using digital services. One key facilitator was user-centered functionalities (e.g., usability, accessibility, and tailorability) of services with barriers associated with technology and infrastructure. These are also identified as factors affecting the digital patient experience (Wang et al., 2022). One digital solution alone cannot address all factors, highlighting the need to research and create different service structures with digital and usual care practices that can cater to them as a whole. Considering that healthcare services are used by heterogeneous patient populations (i.e., varying individual qualities and possibilities), research should also focus on the identification of patients who require support and/or benefit the most from digital services. As healthcare and social welfare are often intertwined in service provision, it would be beneficial to collaborate more in research to create equally beneficial evidence.

4.7. Recommendations for future research, policy, and practice

Currently, the evidence from previous literature (Eze et al., 2020; Shigekawa et al., 2018) and this review indicate that the impact of digital services on the use, access, or duplication of services in healthcare remains unclear, although positive discoveries have been made. Instead of overly focusing on improved health outcomes, digital services could be evaluated from the perspective of providing equal or improved health outcomes, with less costs and resources along with guaranteed patient and HCP satisfaction. More research is needed, with the Quadruple Aim framework providing a useful lens to guide assessment and research. The assessment of probable utility could also be useful to evaluate in terms of process outcomes, transaction costs, population access to services, and the ability for the system to produce more services (Abimbola et al., 2019).

Digital services need guidance, management, structure, and funding on all levels of decision-making in healthcare. Digital services, such as new interventions or programs in healthcare, should be integrated as part of the services with support and education offered not only for patients but to HCP which, along with collegial support, as they are essential in building positive HCP experiences in digitalization and support digital competence (Konttila et al., 2019).

4.8. Limitations

There are some limitations to this review. An extensive, rigorous search was performed on relevant databases, with the utilization of informatics and social science expertise. Still, relevant research may remain unidentified, hence the lack of similarity with previous research (Eze et al., 2020). On the other hand, the studies in this review add new information to previous research. Digital services and related terminology have changed significantly over the last decade, challenging comparisons. In this review, digital services were defined based on WHO categorization. The search strategy had various terms to describe specific types of digital services, but using the search word "tele*", for example, could have yielded more results. One major setback was a lack of representation of intended social work studies; this could signal a lack of synthesis on digitalization with systematic methodology in social welfare. Potential bias could have resulted, as data extraction from the reviews was divided between two reviewers. On the other hand, the results were discussed and analyzed by an interprofessional review team with expertise in effectiveness research, medicine, and health sciences, adding reliability. As the results of the included reviews are heterogenous, with the possibility of publication bias acknowledged, our recommendations and conclusions should be considered with due caution.

4.9. Conclusion

Digital services have a mixed impact compared to usual care on population health and costs, with possible savings in healthcare costs and resources supporting their wider adoption. Digital services can be viable alternatives or additions to healthcare services in certain contexts. Patient satisfaction is often associated with the use of digital services, along with less and more cautious reporting of health care professionals' satisfaction. To ensure successful implementation and sustainability of digital services, attention must be paid to addressing barriers and supporting facilitators at all levels in health care provision. Further long-term and diverse research with the use of valid instruments to measure the quadruple effects of digital services is needed in healthcare, and especially in social welfare.

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CRediT authorship contribution statement

Henna Härkönen: Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Conceptualization. **Sanna Lakoma:** Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Conceptualization. **Anastasiya Verho:** Writing – original draft, Methodology, Investigation, Conceptualization. **Paulus Torkki:** Writing – review & editing, Validation, Project administration, Methodology, Funding acquisition, Conceptualization. **Riikka-Leena Leskelä:** Writing – review & editing, Project administration, Methodology, Funding acquisition, Conceptualization. **Paula Pennanen:** Writing – review & editing, Project administration, Methodology, Conceptualization.

Elina Laukka: Writing – review & editing, Visualization, Methodology, Formal analysis, Conceptualization. **Miia Jansson:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Funding acquisition, Formal analysis, Conceptualization.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used ChatGPT in order to refine language and reporting as English is not their native language. After using this OpenAI tool the authors reviewed and edited the content as needed and the manuscript was reviewed by an academic proof-reading service. The authors take full responsibility for the content of the publication.

Data availability

The data used in this study are available from the corresponding author on reasonable request.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijnurstu.2024.104692.

References

Abimbola, S., et al., 2019. The medium, the message and the measure: a theory-driven review on the value of telehealth as a patient-facing digital health innovation. Heal. Econ. Rev. 9 (1), 1–14. https://doi.org/10.1186/S13561-019-0239-5/FIGURES/2 (Jul.).

Ali, S.H., et al., 2019. Application of mobile health technologies aimed at salt reduction: systematic review. J. Med. Internet Res. Uhealth 7 (4), e13250. https://doi.org/10.2196/13250.

Anderson, G., Rega, M.L., Casasanta, D., Graffigna, G., Damiani, G., Barello, S., 2022. The association between patient activation and healthcare resources utilization: a systematic review and meta-analysis. Public Health 210, 134–141. https://doi.org/10.1016/j.puhe.2022.06.021 (Sep.).

Aromataris, E., Fernandez, R., Godfrey, C.M., Holly, C., Khalil, H., Tungpunkom, P., 2015. Summarizing systematic reviews: methodological development, conduct and reporting of an umbrella review approach. Int. J. Evid. Based Healthc. 13 (3), 132–140. https://doi.org/10.1097/XEB.0000000000000055 (Sep.).

Arsenijevic, J., Tummers, L., Bosma, N., 2020. Adherence to electronic health tools among vulnerable groups: systematic literature review and meta-analysis. J. Med. Internet Res. 22 (2), e11613. https://doi.org/10.2196/11613.

Aspry, K.E., et al., 2013. Effect of health information technology interventions on lipid management in clinical practice: a systematic review of randomized controlled trials. J. Clin. Lipidol. 7, 546–560. https://doi.org/10.1016/j.jacl.2013.10.004.

Bakhit, M., et al., 2021. Antibiotic prescribing for acute infections in synchronous telehealth consultations: a systematic review and meta-analysis. Br. J. Gen. Pract. 5 (6). https://doi.org/10.3399/BJGPO.2021.0106.

Barnett, P., et al., 2021. Implementation of telemental health services before COVID-19: rapid umbrella review of systematic reviews. J. Med. Internet Res. 23 (7). https://doi.org/10.2196/26492 (Jul.).

Berryhill, M.B., et al., 2019. Videoconferencing psychological therapy and anxiety: a systematic review. Fam. Pract. 36 (1), 53–63. https://doi.org/10.1093/fampra/cmy072.

Berwick, D.M., Nolan, T.W., Whittington, J., 2008. The triple aim: care, health, and cost. Health Aff. 27 (3), 759–769. https://doi.org/10.1377/hlthaff.

Bodenheimer, T., Sinsky, C., 2014. From triple to quadruple aim: care of the patient requires care of the provider. Ann. Fam. Med. 12 (6), 573–576. https://doi.org/10.1370/AFM.1713 (Nov.).

Bradford, N.K., Caffery, L.J., Smith, A.C., 2016. Telehealth services in rural and remote Australia: a systematic review of models of care and factors influencing success and sustainability. Rural Remote Health 16 (4), 3808. https://doi.org/10.22605/RRH3808.

Brainard, J.S., Ford, J.A., Steel, N., Jones, A.P., 2016. A systematic review of health service interventions to reduce use of unplanned health care in rural areas. J. Eval. Clin. Pract. 22 (2), 145–155. https://doi.org/10.1111/jep.12470.

Carrillo De Albornoz, S., Sia, K.-L., Harris, A., 2022. The effectiveness of teleconsultations in primary care: systematic review. Fam. Pract. 39 (1), 168–182. https://doi.org/10.1093/fampra/cmab077.

Chan, A.H.Y., Horne, R., 2021. Preventing a post-pandemic double burden of disease in the COVID-19 pandemic. Glob. Adv. Health Med. 10, 1–3. https://doi.org/10.1177/21649561211010137 (May).

Cohen, I.G., Gerke, S., Kramer, D.B., 2020. Ethical and legal implications of remote monitoring of medical devices. Milbank Q. 98 (4), 1257. https://doi.org/10.1111/1468-0009.12481 (Dec.).

Cresswell, K., Sheikh, A., 2012. Organizational issues in the implementation and adoption of health information technology innovations: an interpretative review. Int. J. Med. Inform. 82, e73–e86. https://doi.org/10.1016/j.ijmedinf.2012.10.007.

Dawes, A.J., Lin, A.Y., Varghese, C., Russell, M.M., 2021. Mobile health technology for remote home monitoring after surgery: a meta-analysis. Br. J. Surg. 108 (11), 1304–1314. https://doi.org/10.1093/bjs/znab323.

Devi, R., Singh, S., Powell, J., Fulton, E., Igbinedion, E., Rees, K., 2015. Internet-based interventions for the secondary prevention of coronary heart disease (review). Cochrane Database Syst. Rev. (12) https://doi.org/10.1002/14651858.CD009386.pub2.

Dieleman, J.L., et al., 2017. Future and potential spending on health 2015-40: development assistance for health, and government, prepaid private, and out-of-pocket health spending in 184 countries. Lancet 389 (10083), 2005–2030. https://doi.org/10.1016/S0140-6736(17)30873-5 (May).

Dol, J., Delahunty-Pike, A., Anwar Siani, S., Campbell-Yeo, M., 2017. eHealth interventions for parents in neonatal intensive care units: a systematic review. JBI Database System Rev. Implement. Rep. 15 (12), 2981–3005. https://doi.org/10.11124/JBISRIR-2017-003439.

Dubey, S., et al., 2020. Psychosocial impact of COVID-19. Diabetes Metab. Syndr. 14 (5), 779. https://doi.org/10.1016/J.DSX.2020.05.035 (Sep.).

Eze, N.D., Mateus, C., Hashiguchi, T.C.O., 2020. Telemedicine in the OECD: an umbrella review of clinical and cost-effectiveness, patient experience and implementation. PLoS One 15 (8 August). https://doi.org/10.1371/journal.pone.0237585 (Aug.).

Farwati, M., Riaz, H., Tang, W.H.W., 2021. Digital health applications in heart failure: a critical appraisal of literature. Curr. Treat. Options Cardiovasc. Med. 23 (2). https://doi.org/10.1007/s11936-020-00885-z (Feb.).

Flodgren, G., Rachas, A., Farmer, A., Inzitari, M., Shepperd, S., 2015. Interactive telemedicine: effects on professional practice and health care outcomes (review). Cochrane Database Syst. Rev. (9) https://doi.org/10.1002/14651858.CD002098.pub2.

Fortuna, K.L., et al., 2020. Digital peer support mental health interventions for people with a lived experience of a serious mental illness: systematic review. J. Med. Internet Res. Mental Health 7 (4), e16460. https://doi.org/10.2196/16460.

Garin, N., et al., 2016. Global multimorbidity patterns: a cross-sectional, population-based, multi-country study. J. Gerontol. A Biol. Sci. Med. Sci. 71 (2), 205–214. https://doi.org/10.1093/gerona/glv128 (Feb.).

Gee, B.L., Griffiths, K.M., Gulliver, A., 2016. Effectiveness of mobile technologies delivering Ecological Momentary Interventions for stress and anxiety: a systematic review. J. Am. Med. Inform. Assoc. 23 (1), 221–229. https://doi.org/10.1093/jamia/ocv043.

Golinelli, D., Boetto, E., Carullo, G., Nuzzolese, A.G., Landini, M.P., Fantini, M.P., 2020. Adoption of digital technologies in health care during the COVID-19 pandemic: systematic review of early scientific literature. J. Med. Internet Res. 22 (11). https://doi.org/10.2196/22280 (JMIR Publications Inc., Nov. 01).

Greenwood, H., et al., 2022. Telehealth versus face-to-face psychotherapy for less common mental health conditions: systematic review and meta-analysis of randomized controlled trials. J. Med. Internet Res. Mental Health 9 (3), e31780. https://doi.org/10.2196/31780.

Gunter, R.L., et al., 2016. Current use of telemedicine for post-discharge surgical care: a systematic review HHS public access. J. Am. Coll. Surg. 222 (5), 915–927. https://doi.org/10.1016/j.jamcollsurg.2016.01.062.

Haberlin, C., O'dwyer, T., Mockler, D., Moran, J., O'donnell, D.M., Broderick, J., 2018. The use of eHealth to promote physical activity in cancer survivors: a systematic review. Support Care Cancer 26 (10), 3323–3336. https://doi.org/10.1007/s00520-018-4305-z.

Han, S.M., Greenfield, G., Majeed, A., Hayhoe, B., 2020. Impact of remote consultations on antibiotic prescribing in primary health care: systematic review. J. Med. Internet Res. 22 (11), e23482. https://doi.org/10.2196/23482.

Hand, L.J., 2022. The role of telemedicine in rural mental health care around the globe. Telemed. e-Health 28 (3), 285–294. https://doi.org/10.1089/tmj.2020.0536.

Henry, B.W., Block, D.E., Ciesla, J.R., McGowan, B.A., Vozenilek, J.A., 2017. Clinician behaviors in telehealth care delivery: a systematic review. Adv. Health Sci. Educ. 22 (4), 869–888. https://doi.org/10.1007/s10459-016-9717-2 (Oct.).

Inglis, S., Clark, R., Dierckx, R., Prieto-Merino, D., Cleland, J., 2015. Structured telephone support or non-invasive telemonitoring for patients with heart failure (review). Cochrane Database Syst. Rev. (10) https://doi.org/10.1002/14651858.CD007228.pub3.

Iribarren, S.J., Cato, K., Falzon, L., Stone, P.W., 2017. What is the economic evidence for mHealth? A systematic review of economic evaluations of mHealth solutions. PLoS One 12 (2), e0170581. https://doi.org/10.1371/journal.pone.0170581.

James, H.M., et al., 2021. Spread, scale-up, and sustainability of video consulting in health care: systematic review and synthesis guided by the NASSS framework. J. Med. Internet Res. 23 (1), e23775. https://doi.org/10.2196/23775.

Jansson, M.M., Hyvämäki, P., Pikkarainen, M., 2020. Computer-and telephone-delivered interventions on patient outcomes and resource utilization in patients with orthopaedic conditions a systematic review and narrative synthesis. Orthop. Nurs. 39 (5), 340–352. https://doi.org/10.1097/NOR.0000000000000699.

Jones, J.E., Damery, S.L., Phillips, K., Retzer, A., Nayyar, P., Jollyid, K., 2022. Real-time remote outpatient consultations in secondary and tertiary care: a systematic review of inequalities in invitation and uptake. PLoS One 17 (6), e0269435. https://doi.org/10.1371/journal.pone.0269435.
de Jongh, T., Gurol-Urganci, I., Vodopivec-Jamsek, V., Car, J., Atun, R., 2012. Mobile phone messaging for facilitating self-management of long-term illnesses (review). Cochrane Database Syst. Rev. (12) https://doi.org/10.1002/14651858.CD007459.pub2.
Kaner, E., et al., 2017. Personalised digital interventions for reducing hazardous and harmful alcohol consumption in community-dwelling populations (review). Cochrane Database Syst. Rev. (9) https://doi.org/10.1002/14651858.CD011479.pub2.
Kew, K., Cates, C., 2016a. Home telemonitoring and remote feedback between clinic visits for asthma (review). Cochrane Database Syst. Rev. (8) https://doi.org/10.1002/14651858.CD011714.pub2.
Kew, K., Cates, C., 2016b. Remote versus face-to-face check-ups for asthma (review). Cochrane Database Syst. Rev. (4) https://doi.org/10.1002/14651858.CD011715.pub2.
Kirakalaprathapan, A., Oremus, M., 2022. Efficacy of telehealth in integrated chronic disease management for older, multimorbid adults with heart failure: a systematic review. Int. J. Med. Inform. 162, 1386–5056. https://doi.org/10.1016/j.ijmedinf.2022.104756.
Koh, J., Tng, G.Y.Q., Hartanto, A., 2022. Potential and pitfalls of mobile mental health apps in traditional treatment: an umbrella review. J. Pers. Med. 12 (9). https://doi.org/10.3390/jpm12091376 (Sep.).
Konttila, J., et al., 2019. Healthcare professionals' competence in digitalisation: a systematic review. J. Clin. Nurs. 28, 745–761. https://doi.org/10.1111/jocn.14710.
Kraef, C., Van Der Meirschen, M., Free, C., 2020. Digital telemedicine interventions for patients with multimorbidity: a systematic review and meta-analysis. BMJ Open 10, 36904. https://doi.org/10.1136/bmjopen-2020-036904.
Kunonga, T.P., et al., 2021. Effects of digital technologies on older people's access to health and social care: umbrella review. J. Med. Internet Res. 23 (11). https://doi.org/10.2196/25887 (JMIR Publications Inc., Nov. 01).
Kuo, A., Dang, S., 2016. Secure messaging in electronic health records and its impact on diabetes clinical outcomes: a systematic review. Telemed. e-Health 22 (9), 769–777. https://doi.org/10.1089/tmj.2015.0207.
Kyngäs, H., 2019. Part 1 content analysis: inductive content analysis. In: Kyngäs, H., Mikkonen, K., Kääriäinen, M. (Eds.), The Application of Content Analysis in Nursing Science Research, 1st ed. Springer Cham https://doi.org/10.1007/978-3-030-30199-6 Accessed Jan. 10, 2023. [Online]. Available:.
Laver, K., Adey-Wakeling, Z., Crotty, M., Lannin, N., George, S., Sherrington, C., 2020. Telerehabilitation services for stroke (review). Cochrane Database Syst. Rev. (1) https://doi.org/10.1002/14651858.CD010255.pub3.
Leonardsen, A.C.L., Hardeland, C., Helgesen, A.K., Grøndahl, V.A., 2020. Patient experiences with technology enabled care across healthcare settings - a systematic review. BMC Health Serv. Res. 20 (1). https://doi.org/10.1186/s12913-020-05633-4 (BioMed Central, Aug. 24).
Lin, L., Casteel, D., Shigekawa, E., Soulsby Weyrich, M., Roby, D.H., McMenamin, S.B., 2019. Telemedicine-delivered treatment interventions for substance use disorders: a systematic review. J. Subst. Abus. Treat. 101, 38–49. https://doi.org/10.1016/j.jsat.2019.03.007.
López-Liria, R., et al., 2022. Teledermatology versus face-to-face dermatology: an analysis of cost-effectiveness from eight studies from Europe and the United States. Public Health 19, 2534. https://doi.org/10.3390/ijerph19052534.
Ma, D., Cheng, K., Ding, P., Li, H., Wang, P., 2018. Self-management of peripherally inserted central catheters after patient discharge via the WeChat smartphone application: a systematic review and meta-analysis. PLoS One 13 (8), e0202326. https://doi.org/10.1371/journal.pone.0202326.
Malhotra, C., Ramakrishnan, C., 2022. Complexity of implementing a nationwide advance care planning program: results from a qualitative evaluation. Age Ageing 51 (10), 1–10. https://doi.org/10.1093/AGEING/AFAC224 (Oct.).
Mashhadi, S.F., et al., 2021. Post discharge mHealth and teach-back communication effectiveness on hospital readmissions: a systematic review. Int. J. Environ. Res. Public Health no. 18, 10442. https://doi.org/10.3390/ijerph181910442.
Massoudi, B., Holvast, F., Bockting, C.L.H., Burger, H., Blanker, M.H., 2018. The effectiveness and cost-effectiveness of e-health interventions for depression and anxiety in primary care: a systematic review and meta-analysis. J. Affect. Disord. (245), 728–743 https://doi.org/10.1016/j.jad.2018.11.050.
McCleery, J., Laverty, J., Quinn, T., 2021. Diagnostic test accuracy of telehealth assessment for dementia and mild cognitive impairment (review). Cochrane Database Syst. Rev. (7) https://doi.org/10.1002/14651858.CD013786.pub2.
McLean, S., Nurmatov, U., Liu, J.L.Y., Pagliari, C., Car, J., Sheikh, A., 2012. Telehealthcare for chronic obstructive pulmonary disease: Cochrane review and meta-analysis. Br. J. Gen. Pract. 62 (604). https://doi.org/10.3399/bjgp12X658269 (Nov.).
Mcphail, S.M., 2016. Multimorbidity in chronic disease: impact on health care resources and costs. Risk Manag. Healthc. 9, 143–156. https://doi.org/10.2147/RMHP.S97248.
Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., 2010. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. Int. J. Surg. 8 (5), 336–341. https://doi.org/10.1016/J.IJSU.2010.02.007.
Mold, F., et al., 2015. Patients' online access to their electronic health records and linked online services: a systematic review in primary care. Br. J. Gen. Pract. 65 (632), e141–e151. https://doi.org/10.3399/bjgp15X683941 (Royal College of General Practitioners, Mar. 01).
Munro, J., Angus, N., Leslie, S.J., 2013. Patient focused internet-based approaches to cardiovascular rehabilitation-a systematic review. J. Telemed. Telecare 19 (6), 347–353.
Nguyen, O.T., Alishahi Tabriz, A., Huo, J., Hanna, K., Shea, C.M., Turner, K., 2021. Impact of asynchronous electronic communication-based visits on clinical outcomes and health care delivery: systematic review. J. Med. Internet Res. 23 (5), e27531. https://doi.org/10.2196/27531.
Nordesjö, K., Scaramuzzino, G., Ulmestig, R., 2021. The social worker-client relationship in the digital era: a configurative literature review. Eur. J. Soc. Work. https://doi.org/10.1080/13691457.2021.1964445.
Nordheim, L.V., Haavind, M.T., Iversen, M.M., 2014. Effect of telemedicine follow-up care of leg and foot ulcers: a systematic review. BMC Health Serv. Res. (14), 565 https://doi.org/10.1186/s12913-014-0565-6.
O'Connor, S., Hanlon, P., O'Donnell, C.A., Garcia, S., Glanville, J., Mair, F.S., 2016. Understanding factors affecting patient and public engagement and recruitment to digital health interventions: a systematic review of qualitative studies. BMC Med. Inform. Decis. Maki ng 16 (1). https://doi.org/10.1186/s12911-016-0359-3 (BioMed Central Ltd, Sep. 15).
Odendaal, W.A., et al., 2020. Health workers' perceptions and experiences of using mHealth technologies to deliver primary healthcare services: a qualitative evidence synthesis. Cochrane Database Syst. Rev. 2020 (3). https://doi.org/10.1002/14651858.CD011942.pub2 (Mar.).
Oliver, D.P., Demiris, G., Wittenberg-Lyles, E., Washington, K., Day, T., Novak, H., 2012. Original research a systematic review of the evidence base for telehospice. Telemed. eHealth 18 (1), 38–47. https://doi.org/10.1089/tmj.2011.0061.
Palmer, M., et al., 2021. MMobile phone-based interventions for improving adherence to medication prescribed for the primary prevention of cardiovascular disease in adults (review). Cochrane Database Syst. Rev. (3) https://doi.org/10.1002/14651858.CD012675.pub3.
Pandor, A., et al., 2013. Home telemonitoring or structured telephone support programmes after recent discharge in patients with heart failure: systematic review and economic evaluation. Health Technol. Assess. (Rockv) 17 (32), 1–207. https://doi.org/10.3310/hta17320 (v–vi).
Parker, S., Prince, A., Thomas, L., Song, H., Milosevic, D., Harris, M.F., 2018. Open access electronic, mobile and telehealth tools for vulnerable patients with chronic disease: a systematic review and realist synthesis on behalf of the IMPACT Study Group. BMJ Open 8, 19192. https://doi.org/10.1136/bmjopen-2017-019192.
Petracca, F., Ciani, O., Cucciniello, M., Tarricone, R., 2020. Harnessing digital health technologies during and after the COVID-19 pandemic: context matters. J. Med. Internet Res. 22 (12). https://doi.org/10.2196/21815 (JMIR Publications Inc., Dec. 01).
Radhakrishnan, K., Xie, B., Berkley, A., Kim, M., 2016. Barriers and facilitators for sustainability of tele-homecare programs: a systematic review health services research. Health Serv. Res. 51 (1), 48–75. https://doi.org/10.1111/1475-6773.12327.
Rat, C., et al., 2018. Use of smartphones for early detection of melanoma: systematic review. J. Med. Internet Res. 20 (4), e135. https://doi.org/10.2196/jmir.9392.
Robson, N., Hosseinzadeh, H., 2021. Impact of telehealth care among adults living with type 2 diabetes in primary care: a systematic review and meta-analysis of randomised controlled trials. Public Health 18, 12171. https://doi.org/10.3390/ijerph182212171.
Sartori, A., Balla, A., Agresta, F., Guerreri, M., Ortenzi, M., 2021. Telemedicine in surgery during COVID-19 pandemic. Are we doing enough? Systematic literature review. Minerva Surg. https://doi.org/10.23736/S2724-5691.21.09100-0.
Scott, A.M., et al., 2022. Meta-analysis real-time telehealth versus face-to-face management for patients with PTSD in primary care: a systematic review and meta-analysis. J. Clin. Psychiatry 83 (4), 21r14143. https://doi.org/10.4088/JCP.21r14143.
Shigekawa, E., Fix, M., Corbett, G., Roby, D.H., Coffman, J., 2018. The current state of telehealth evidence: a rapid review. Health Aff. 37 (12), 1975–1982. https://doi.org/10.1377/HLTHAFF.2018.05132 (Dec.).
Singh, A.K., Gupta, R., Ghosh, A., Misra, A., 2020. Diabetes in COVID-19: prevalence, pathophysiology, prognosis and practical considerations. Diabetes Metab. Syndr. 14 (4), 303–310. https://doi.org/10.1016/J.DSX.2020.04.004 (Jul.).
Skou, S.T., et al., 2022. Multimorbidity. Nat. Rev. Dis. Prim. 8 (1), 1–22. https://doi.org/10.1038/s41572-022-00376-4 (Jul.).
Snoswell, C.L., Taylor, M.L., Comans, T.A., Smith, A.C., Gray, L.C., Caffery, L.J., 2020. Determining if telehealth can reduce health system costs: scoping review. J. Med. Internet Res. 22 (10), e17298. https://doi.org/10.2196/17298.
Snoswell, C.L., et al., 2021. The clinical effectiveness of telehealth: a systematic review of meta-analyses from 2010 to 2019. J. Telemed. Telecare, 1357633X2110229 https://doi.org/10.1177/1357633x211022907 (Jun.).
So, C.F., Chung, J.W., 2018. Telehealth for diabetes self-management in primary healthcare: a systematic review and meta-analysis. J. Telemed. Telecare 24 (5), 356–364.
Speckman, R.A., Friedly, J.L., 2019. Asking structured, answerable clinical questions using the population, intervention/comparator, outcome (PICO) framework. PM R 11 (5), 548–553. https://doi.org/10.1002/pmrj.12116 (May).
Stewart, E., et al., 2022. Review eHealth tools that assess and track health and well-being in children and young people: systematic review. J. Med. Internet Res. 24 (5), e26015. https://doi.org/10.2196/26015.
Sul, A.-R., Lyu, D.-H., Park, D.-A., 2020. Effectiveness of telemonitoring versus usual care for chronic obstructive pulmonary disease: a systematic review and meta-analysis. J. Telemed. Telecare 26 (4), 189–199.
Svendsen, M.J., et al., 2020. Barriers and facilitators to patient uptake and utilisation of digital interventions for the self-management of low back pain: a systematic review of qualitative studies. BMJ Open 10, 38800. https://doi.org/10.1136/bmjopen-2020-038800.
Tan, K., Lai, N., 2012. Telemedicine for the support of parents of high-risk newborn infants (review). Cochrane Database Syst. Rev. (6) https://doi.org/10.1002/14651858.CD006818.pub2.
Taylor, G., Dalili, M., Semwal, M., Civljak, M., Sheikh, A., Car, J., 2017. Internet-based interventions for smoking cessation (review). Cochrane Database Syst. Rev. (9) https://doi.org/10.1002/14651858.CD007078.pub5.

Timpel, P., Oswald, S., Schwarz, P.E.H., Harst, L., 2020. Mapping the evidence on the effectiveness of telemedicine interventions in diabetes, dyslipidemia, and hypertension: an umbrella review of systematic reviews and meta-analyses. J. Med. Internet Res. 22 (3). https://doi.org/10.2196/16791 (JMIR Publications Inc., Mar. 01).

Tornivuori, A., Outi, Mnsc, T., Salanterä, S., Kosola, S., 2020. A systematic review on randomized controlled trials: coaching elements of digital services to support chronically ill adolescents during transition of care. J. Adv. Nurs. 76, 1293–1306. https://doi.org/10.1111/jan.14323.

Tzelepis, F., et al., 2019. Real-time video counselling for smoking cessation (review). Cochrane Database Syst. Rev. (10) https://doi.org/10.1002/14651858.CD012659.pub2.

Urquhart, C., Currell, R., Harlow, F., Callow, L., 2017. Home uterine monitoring for detecting preterm labour (review). Cochrane Database Syst. Rev. (2) https://doi.org/10.1002/14651858.CD006172.pub4.

Vázquez-De Sebastián, J., Ciudin, A., Castellano-Tejedor, C., 2021. Clinical medicine analysis of effectiveness and psychological techniques implemented in mHealth solutions for middle-aged and elderly adults with type 2 diabetes: a narrative review of the literature. J. Clin. Med. (10), 2701 https://doi.org/10.3390/jcm10122701.

Versluis, A., Schnoor, K., Chavannes, N.H., Talboom-Kamp, E.P., 2022. Direct access for patients to diagnostic testing and results using eHealth: systematic review on eHealth and diagnostics. J. Med. Internet Res. 24 (1), e29303. https://doi.org/10.2196/29303.

Wang, T., Giunti, G., Melles, M., Goossens, R., 2022. Digital patient experience: umbrella systematic review. J. Med. Internet Res. 24 (8). https://doi.org/10.2196/37952 (JMIR Publications Inc., Aug. 01).

Wong, Z.S., Siy, B., Da Silva Lopes, K., Georgiou, A., 2020. Improving patients' medication adherence and outcomes in nonhospital settings through eHealth: systematic review of randomized controlled trials. J. Med. Internet Res. 22 (8), e17015. https://doi.org/10.2196/17015.

World Health Organization, 2018. Classification of Digital Health Interventions v 1.0: a shared language to describe the uses of digital technologies for health. [Online]. Available: http://who.int/reproductivehealth/topics/mhealth/en/. (Accessed 14 November 2022).

World Health Organization, 2022. Noncommunicable Diseases Progress Monitor 2022.

Yang, F., et al., 2017. Continuity of care to prevent readmission for patients with chronic obstructive pulmonary disease: a systematic review and meta-analysis. COPD: J. Chron. Obstruct. Pulmon. Dis. 14 (2), 251–261. https://doi.org/10.1080/15412555.2016.1256384.

Zanaboni, P., et al., 2018. Methods to evaluate the effects of internet-based digital health interventions for citizens: systematic review of reviews. J. Med. Internet Res. 20 (6). https://doi.org/10.2196/10202.

Zhang, W., Zhao, S., Wan, X., Yao, Y., 2021. Study on the effect of digital economy on high-quality economic development in China. PLoS One 16 (9), e0257365. https://doi.org/10.1371/JOURNAL.PONE.0257365 (Sep.).

Zhang, A., et al., 2022. A meta-analysis of the effectiveness of telemedicine in glycemic management among patients with type 2 diabetes in primary care. Int. J. Environ. Res. Public Health 19 (7). https://doi.org/10.3390/ijerph19074173 (MDPI, Apr. 01).