



Review article

Using digital interventions for self-management of chronic physical health conditions: A meta-ethnography review of published studies



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ARTICLE INFO

Article history:

Received 19 April 2016

Received in revised form 16 September 2016

Accepted 19 October 2016

Keywords:

Self-management

Qualitative

Digital

Interventions

ABSTRACT

Objectives: To understand the experiences of patients and healthcare professionals (HCPs) using self-management digital interventions (DIs) for chronic physical health conditions.

Methods: A systematic search was conducted in 6 electronic databases. Qualitative studies describing users' experiences of self-management DIs were included, and authors' interpretations were synthesised using meta-ethnography.

Results: 30 papers met the inclusion criteria, covering a range of DIs and chronic conditions, including hypertension, asthma and heart disease. The review found that patients monitoring their health felt reassured by the insight this provided, and perceived they had more meaningful consultations with the HCP. These benefits were elicited by simple tele-monitoring systems as well as multifaceted DIs. Patients appeared to feel more reliant on HCPs if they received regular feedback from the HCP. HCPs focused mainly on their improved clinical control, and some also appreciated patients' increased understanding of their condition.

Conclusions: Patients using self-management DIs tend to feel well cared for and perceive that they adopt a more active role in consultations, whilst HCPs focus on the clinical benefits provided by DIs.

Practice implications: DIs can simultaneously support patient condition management, and HCPs' control of patient health. Tele-monitoring physiological data can promote complex behaviour change amongst patients.

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1. Introduction

With the increasing burden of chronic disease on health services, recent health policy has emphasised the central role of patient self-management in future healthcare [1]. Digital interventions (DIs) provide a potentially effective means to deliver self-management support to patients via technological media. DIs may use tools such as education or behaviour change support to promote activities which contribute to condition management, for example medication adherence or increasing physical activity. Systematic reviews of the impact of self-management DIs show small benefits to illness outcomes in asthma, diabetes and cardiovascular disease [2–5] although the evidence for these programmes remains inconsistent [6] and our understanding of what makes them more effective is still developing [7].

A distinction can be made between multifaceted DIs which incorporate several components to support self-management, and standalone tele-monitoring systems in which patients self-monitor health parameters (such as blood pressure) and transmit these data to a healthcare professional (HCP) or automated device to receive feedback on their health status and in some cases, advice on actions to respond to indicators of deteriorating health. Researchers have not always classified standalone tele-monitoring systems as self-management interventions [8], but there is evidence that just monitoring one's own health data can prompt changes in behaviour [7]. The recognition of tele-monitoring as a form of self-management is consistent with Schermer [9] who proposed that tele-monitoring systems mainly facilitate 'compliant self-management', whereby patients adhere to clinical recommendations, but that systems could enhance more 'concordant self-management' whereby patients assimilate their own knowledge of their condition with clinical recommendations to adopt an integrated management regime.

Schermer's distinction between compliance and concordance reflects a wider ambiguity over the goals of self-management in healthcare. It has been argued that DIs favour clinical outcomes over quality of life, offering a "one size fits all" solution at the cost of ignoring individual needs and dynamic management solutions that the patient has developed [10,11]. This conflict in the goals of self-management can present difficulties for HCPs in facilitating the patient to make their own decisions which can contradict clinical recommendations [12].

Recently, many self-management DIs have been developed and a number of studies have used qualitative methods to investigate users' views, but these papers are distributed across different

health conditions and types of DI. The current qualitative synthesis aimed to bring together findings from a diverse range of DIs and conditions to develop a detailed understanding of patient and HCP experiences of using self-management DIs [2].

2. Methods

2.1. Design

This systematic review adopted a meta-ethnography approach [13] to synthesise the findings of qualitative studies, as this inductive method allows an interpretive analysis [14] which fits well with the aim of developing our understanding of how digital self-management is experienced. The ENTREQ checklist (enhancing transparency in reporting the synthesis of qualitative research) was used to ensure systematic reporting of the review [15].

2.2. Criteria for including studies

Table 1 shows the review inclusion and exclusion criteria. We sought to identify qualitative studies investigating adult patients' or HCPs' experiences of using a self-management DI, excluding studies in which participants consider their views on a hypothetical DI. It was important that the primary components of the intervention were delivered digitally, as interventions delivered by telephone or video conference provide real-time interaction which is more akin to a face-to-face consultation. We used a broad definition of self-management to include any behaviour fostering increased responsibility for condition management or increasing confidence, as we held no prior assumptions about which types of intervention might affect patients' self-management. Initial scoping searches indicated that some studies of standalone tele-monitoring DIs reported relevant reactions in terms of patients' self-management behaviours, and thus we wanted to adopt an inclusive approach to defining self-management to incorporate a range of interventions.

2.3. Systematic search strategy

Systematic literature searches were conducted in August 2016. No date limits were applied to searches as we did not want to exclude potentially relevant studies. Thesaurus terms and abstract key word searches were used across four categories: E-health; intervention; qualitative methods; and chronic illness (see Appendix A). Searches were conducted using CINAHL; Embase;

Table 1
Inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
<p>Population: Adults with a chronic physical health condition (including any physical health condition requiring long-term management, such as asthma, diabetes, or heart disease), or HCPs involved in their care.</p> <p>Intervention: Digital interventions for self-management. Self-management was defined as any behaviour which fosters an increased responsibility for condition management or aims to increase an individual's confidence to become more actively involved in managing the physical and/or emotional impact of their condition, including self-monitoring, medication management, and remote reporting of health parameters to HCPs.</p> <p>Delivered digitally, including via Internet, text messaging, smartphone apps, or tele-monitoring (patient health data monitoring with feedback).</p> <p>User experiences of a DI.</p> <p>Study type: Qualitative studies.</p> <p>Data collected in semi-structured interviews or focus groups; mixed methods papers were included.</p> <p>Qualitative analysis which summarised and categorised the data and ideally also identified themes or common concepts within the data.</p> <p>Qualitative reporting including adequate detail and depth in description of findings to interpret meaning and context.</p>	<p>Where the main digital component is live/synchronous, i.e. video conferencing or telephone.</p> <p>Perceptions of a hypothetical DI, e.g. studies that explore whether DIs might be acceptable and/or what features participants might find useful and engaging but which do not involve collecting data on experiences of actually using a DI.</p> <p>Open-ended questionnaire data, forums.</p> <p>Simple usability assessment.</p>

PsycINFO; MEDLINE; Web of Science; and The Cochrane Library. Initial key word search terms were identified by author consensus and in consultation with a specialist librarian. The terms were expanded through referral to a quantitative systematic review of asthma self-management DIs [2]; which added several e-health and self-management terms; and a qualitative meta-synthesis of e-health for depression and anxiety [16]; which added e-health and qualitative methods terms. The search terms were developed iteratively to ensure a balance between sensitivity and specificity; informed by the results in each database. The references of retrieved articles were searched; and a manual hand search of Journal of Medical Internet Research issues from the last five years was also conducted because early searches indicated that this was a consistently useful source for relevant articles.

The searches aimed to be exhaustive in terms of identifying all relevant papers relating to asthma and hypertension, as the synthesis was conducted in the context of a research programme investigating the integration of DIs into primary care for these conditions. The search terms 'chronic disease/chronic illness' were used in the thesaurus search and Web of Science key word search to identify papers from other chronic physical health conditions to determine whether the findings could be applied more widely (the decision of where to include these search terms was informed by the specificity of the results in each database). This approach is consistent with the literature on conducting searches for a meta-ethnography which advises that it is not necessary to conduct a thoroughly exhaustive search, but rather to select relevant papers which are likely to contribute to the development of new understanding [13,14].

2.4. Identification of studies

The title and abstract screening and full text screening were completed by the primary author (KM). All of the papers deemed eligible based on title/abstract screening were read in full by KM to decide whether they merited inclusion. 10% of these were also read in full by a second reviewer (LD), plus any papers that the primary author was uncertain about. Discrepancies were resolved through discussion (KM, LD, LY).

2.5. Data extraction

The following data were extracted into a database: author, year of publication, country, health condition, aims, DI, participants, target self-management behaviours, HCP involvement, data

collection, data analysis, and main findings. The data extraction was performed by KM, and checked by LD.

2.6. Analysis and synthesis

The papers were initially grouped by condition and DI design to facilitate cross-comparison between contexts [14,17]. First order constructs (quotes from study participants) and second order constructs (study authors' interpretations of their data) were compared within conditions and DI types and across all papers as an iterative process. This helped the authors become highly familiar with the data, and to organise the data coherently for the analysis whilst constantly bearing context in mind. Both the results and discussion sections of papers were included.

To synthesise the translations of the second order constructs, Noblit and Hare's line of argument approach was used whereby similarities and differences were identified between groups of studies to compare findings across conditions and DIs [13], in order to gain an advanced understanding of the relationships between the key concepts and develop conceptual third order constructs. The primary author (KM) performed the analysis, facilitated by regular discussion within the research team. The research team have extensive experience in qualitative methods and synthesis, and include specialists within health psychology, digital interventions, and sociological implementation, as well as clinical expertise in Primary Care and hypertension.

The GRADE-CERQual approach [18] was used to evaluate confidence in the third order constructs developed in the review (Appendix B). This approach encourages transparency in qualitative syntheses by assessing each third order construct on four criteria: methodological limitations of the primary studies contributing to a finding; relevance of the studies in relation to the review question; coherence of the finding itself; and adequacy of the data contributing to a finding [18].

2.7. Quality appraisal

The eligible papers were appraised by KM against the well-established multi-dimensional National Institute for Health and Clinical Excellence (NICE) quality appraisal checklist for qualitative studies [19]. This covers domains of quality including theoretical approach, design, data collection, trustworthiness, analysis and ethics. This process enabled us to be transparent about any potential limitations in the primary studies which could affect confidence in the review findings [20]. Papers of low quality were

not excluded or given less weight than high quality papers, but the findings were interpreted in the context of possible limitations [21].

3. Results

3.1. Searches

The searches identified 120 papers as potentially eligible based on the title and abstract screening. The PRISMA flow-chart (Fig. 1) shows that 30 papers met the inclusion criteria, and the most common reason for exclusion after full-text screening was insufficient qualitative analysis.

3.2. Study characteristics

Table 2 shows the characteristics of the 30 studies included in the review. The health conditions addressed were: hypertension (n=8 papers), diabetes (n=7), chronic obstructive pulmonary disease (COPD, n=7), asthma (n=4), heart disease (n=3) and

chronic back pain (n = 1). The 30 studies described 25 different DIs; most were designed for use in Primary Care and involved interaction or support from the HCP.

Nine of the DIs were standalone tele-monitoring systems, which could be broken down into four categories: monitoring with a pre-defined algorithm for medication change (n = 1); monitoring with automated feedback (n = 1); monitoring with HCP feedback (n = 2); and monitoring with automated and HCP feedback (n = 5). Thirteen were multifaceted DIs with components such as education, behaviour change support, and forums. Two DIs were text-message reminder systems to prompt self-management behaviours, and one provided tailored questions for the patient's next consultation.

Target self-management behaviours included self-monitoring of health readings (e.g. blood pressure, blood glucose), symptoms, or healthy lifestyle habits, engaging in physical activity or healthy diet changes, and adhering to recommended medication changes. Most studies collected data via semi-structured interviews (n = 26), though focus groups (n = 6) and ethnographic observations (n = 2) were also used.

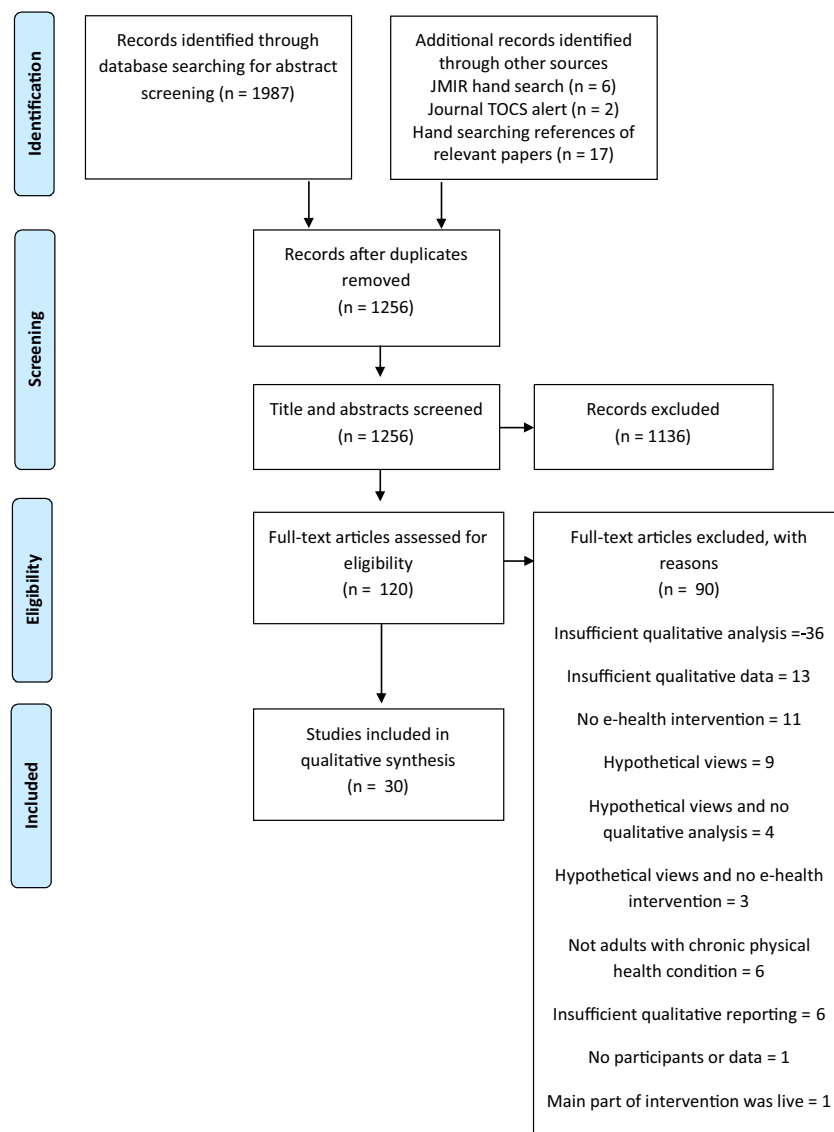


Fig. 1. PRISMA 2009 flow diagram.

Table 2
Characteristics of eligible studies (total n = 30).

Lead author	Year	Country	Health condition	Stated aims	Intervention	Target self-management behaviour	Participants	Design	Main findings
Anhoj [22]	2004	Denmark	Asthma	To describe use of the intervention and evaluate users' perceptions.	Multifaceted web-based DI (LinkMedica): Self-monitoring with automated feedback, education and online forum. Data is accessible to HCP.	Self-monitor morning peak flow, doses of rescue medication, and asthma symptoms at night. Follow automated instructions for dose adjustments.	8 adult patients, 2 mothers, 5 GPs	Semi-structured interviews	Patients did not enter their asthma readings daily, and did not respond to the automated feedback. GPs were happy to support patients using the DI but were concerned about the impact on their time and resources.
Burner [23]	2014	USA	Diabetes	To uncover those components of the TEXT-MED intervention that participants perceived as most beneficial.	Text-message reminder intervention. Twice daily text messages consisting of educational/motivational messages, medication reminders, knowledge facts, and healthy living challenges.	Medication adherence, healthy lifestyle behaviours (diet and physical activity), relaxation.	24 Patients	Focus groups	Medication reminders and lifestyle challenges were most popular with patients – cued specific behaviours. Patients would have liked more personalisation of the messages.
Cottrell [24]	2012	UK	Hypertension	To investigate experiences of and feedback from intervention patients who used an innovative interactive simple telehealth strategy to monitor and manage their hypertension.	Tele-monitoring: Transmission of home blood pressure readings, automated, personalised feedback messages including advice on medication changes. Healthcare professional reviewed readings weekly, or more frequently if required, and provided advice.	Self-monitor blood pressure, adhere to automated feedback and personalised feedback from HCP on medication changes.	24 Patients	Discussion groups	Patients had a better understanding about hypertension, felt reassured seeing their blood pressure readings and more motivated to adhere to medication, and had feelings of support and companionship from DI.
Dinesen [25]	2013	Denmark	COPD	To describe patients' attitudes towards tele-rehabilitation in the Danish TELEKAT project, in order to better understand patients' behaviour when performing tele-rehabilitation activities in home surroundings.	Multifaceted web-based DI: Monitoring health indicators to receive regular feedback from HCP advising about symptoms, medication, exercises and general questions. Web portal to network with other COPD patients. Provided with training exercises to perform at home.	Self-monitor values such as blood pressure, pulse, weight, oxygen level and lung function, use a step counter, perform home-based exercises and follow advice of HCP.	22 Patients and 26 HCPs	Semi-structured interviews	Patients felt secure knowing that their data were being monitored, and were learning to better manage their condition and how to perform exercises. Seeing their readings motivated patients to try and improve these, unless their readings remained stable over time. HCPs supported patients to become more actively involved in their care.
Fairbrother [26]	2014	Scotland	Chronic heart failure	To understand the views of patients and professionals on the acceptability and perceived usefulness of tele-monitoring in the management of chronic heart failure in the context of day-to-day care provision.	Multifaceted DI: Transmission of symptoms and health data, HCP contacted patient if readings exceeded a threshold. Educational online video to promote self-management.	Self-monitor symptoms, blood pressure readings, weight, oxygen saturation; and self-titrate medication if instructed by HCP.	18 Patients and 5 HCPs	Semi-structured interviews	Patients were monitoring to provide the HCPs with information and placed full trust in their HCP to look after them, though many also found it helpful to see their own data. HCPs were concerned with level of patient dependence and felt patients needed more education to self-manage.
Fairbrother [27]	2012	Scotland	COPD	To explore the views of patients and professionals on tele-monitoring for COPD.	Tele-monitoring (Telescot): Transmission of symptoms and health data, HCP contacted patient if readings exceeded a threshold. Patients provided with antibiotics to start if condition worsens.	Self-monitor symptoms and oxygen saturation daily, and self-monitor weight and peak flow weekly. Start medication if symptoms worsen and HCP recommends it.	38 Patients and 32 HCPs	Semi structured interviews	Patients felt they had improved continuity of care, and were reassured by HCP watching over them. HCPs wanted to know the wider context when interpreting patient readings, and were concerned about patients over-treating.
	2013	Scotland	COPD						

Fairbrother [28]				To explore patient and professional views on self-management in the context of tele-monitoring in chronic obstructive pulmonary disease (COPD).	Tele-monitoring: Same DI as Fairbrother 2012	Self-monitor symptoms, self-monitor oxygen saturation daily, and self-monitor weight and peak flow weekly. Start medication if symptoms worsen and HCP recommends it.	38 Patients and 32 HCPs	Semi-structured interviews	Patients used their data to decide their capacity for physical activity, and whether to adjust treatment or seek professional advice. HCPs felt DI was useful for clinical compliance, and increased communication with patient.
Hallberg [29]	2015	Sweden	Hypertension	To explore patients' experiences of an interactive mobile phone-based system designed to support the self-management of hypertension.	Multifaceted DI: Transmission of health data, symptoms, medication and lifestyle activities for tailored text message feedback. Programme also provided reminders and shared data with HCP for next consultation.	Self-monitor blood pressure readings, symptoms, side effects, medication adherence, and lifestyle activities. Improve hypertension through changes to physical activity, diet and medication adherence in response to feedback.	49 Patients	Semi-structured face to face or telephone Interviews	Patients were motivated to improve lifestyle and medication adherence when they saw the relationship with their readings. Patients with stable readings over time did not feel this motivation. Patients felt their consultations were more meaningful.
Hanley [30]	2013	Scotland	Hypertension	To explore the experiences of patients and professionals taking part in an RCT of remote blood pressure monitoring.	Tele-monitoring: Transmission of home blood pressure readings to HCP. DI provided automated feedback on whether patient should contact their HCP. Online record of readings available.	Self-monitor blood pressure, engage in medication changes.	25 Patients, 11 nurses, 9 doctors	Semi-structured Interviews	Patients trusted the average readings as being accurate, and reported having a more meaningful consultation with the HCP due to additional data. HCPs appreciated being able to titrate medication more accurately and rapidly, but were concerned about workload and how to respond to borderline readings.
Hanley [31]	2015a	UK	Hypertension in stroke patients	To investigate the likely recruitment rate to a trial, feasibility of using the tele-monitoring service and the experiences and perspectives of those using the tele-monitoring service and those who may not choose to do so.	Tele-monitoring: Same DI as Hanley 2013.	Self-monitor blood pressure, engage in medication changes.	16 patients and 3 nurses	Semi-structured interviews	Patients were not clear on how to respond to their readings, and were unsure if their HCP had seen them. In some cases there was poor communication amongst the healthcare team. Some found monitoring their readings reassuring.
Hanley [32]	2015b	UK	Diabetes	To explore the experiences of patients and professionals taking part in a randomised controlled trial (RCT) of blood glucose, blood pressure (BP) and weight telemonitoring in type 2 diabetes supported by primary care, and identify factors facilitating or hindering the effectiveness of the intervention and those likely to influence its potential translation to routine practice.	Tele-monitoring: Transmission of home blood glucose, blood pressure (BP) and weight readings to the patients' usual HCP. Online record of readings available. Received automated feedback and nurses checked results weekly.	Self-monitor blood glucose, BP and weight, engage in medication changes.	23 patients, 6 nurses and 4 doctors	Semi-structured interviews	Many patients used self-monitoring to support their own self-management. There was some uncertainty in who was responsible for responding to out-of-range readings. HCPs liked being able to change patients' medication more quickly, although some GPs did not use home readings.
Hartmann [33]	2007	USA	Asthma	To investigate the impact and experience of an interactive patient website and assess the impact of such an intervention on the patient-provider relationship.	Interactive website to educate asthma patients and provide tailored feedback on questions to ask in their next HCP consultation.	Ask HCP questions in healthcare appointment.	37 Patients	Semi-structured telephone interviews	Patients understood their own role in their care, and perceived a more positive relationship with the HCP.
Hoas [34]	2016	Norway	COPD	The aim of the current study was to explore the patients'	Multifaceted DI: Tele-rehabilitation with tailored	Physical activity, self-monitoring symptoms,	10 Patients	Semi-structured focus groups	Patients gained insights into their condition through self-

Table 2 (Continued)

Lead author	Year	Country	Health condition	Stated aims	Intervention	Target self-management behaviour	Participants	Design	Main findings
				perspectives in long-term tele-rehabilitation in COPD. We focused our study on adherence and patients' experiences, aiming to identify factors affecting satisfaction and potential for improvements that might increase adherence.	treadmill exercise programme, daily symptom, physiological data and activity monitoring, and weekly feedback sessions with HCP by videoconference.	physiological data and activity levels.			monitoring, and the DI helped them to accept their condition. They increased their confidence to manage their condition, and felt motivated to engage in physical activity where they could see improvements. Motivation waned during and after periods of illness or holiday.
Jones [35]	2012	UK	Hypertension	To explore the views and experiences of those who had undertaken blood pressure self-management.	Tele-monitoring: Home blood pressure monitoring with ability to activate pre-agreed medication changes when readings were high according to algorithm.	Self-monitor blood pressure and self-titration of medication according to pre-planned schedule when readings exceed a threshold.	23 Patients and 6 family members	Semi-structured interviews	Some patients were willing to take responsibility for changes to their medication but others preferred to see the GP, especially those with carers or relatives involved. Patients liked seeing their own readings, and felt motivated to control their condition.
Jones [36]	2013	UK	Hypertension	To explore the views of healthcare professionals in primary care participating in a trial of patient self-monitoring with self-titration of antihypertensives	Tele-monitoring: Same DI as Jones 2012.	Self-monitor blood pressure and self-titration of medication according to pre-planned schedule when readings exceed a threshold.	13 GPs, 2 Practice nurses, 1 Healthcare assistant	Semi-structured interviews	GPs were positive about patients engaging in home monitoring of blood pressure, and could see the benefits for patients. They were less confident about patients self-managing their medication, and had concerns about the additional workload at the clinic and the expense of training patients.
Kerr [37]	2010	UK	Heart disease	To explore the effectiveness of a web-based intervention in decreasing inequalities in access to self-management support in patients with coronary heart disease.	Multifaceted web-based DI: Interactive information, behaviour change support, and peer and expert support.	Usage of the web intervention	19 Patients	Interviews	DI usage was relatively low. Patients had a high level of trust in their HCP, and some did not perceive a need to use the DI.
Koopman [38]	2013	US	High blood pressure and type 2 diabetes	To examine the process of implementing home tele-monitoring of blood glucose and blood pressure for patients with diabetes in six primary care practices.	Tele-monitoring: Transmission of blood pressure and blood glucose to nurses, which were assessed twice weekly and data summaries passed on to physicians. HCPs provided feedback to patient by phone.	Self-monitor blood glucose and blood pressure daily, and respond to HCP feedback.	6 nurses, 12 physicians, 93 Patients	Nurses and physicians took part in semi-structured interviews, participants took part in brief telephone exit interviews from which notes were taken.	HCPs appreciated improved clinical care of patients. Physicians preferred data summaries as felt they had insufficient time to review raw data. Nurses were aware of the benefits to patients of increased understanding of their condition.
Lambert-Kerzner [39]	2010	US	Hypertension	To gather in-depth understanding of the experience of participating in a multifaceted hypertension intervention, with a focus on technology.	Tele-monitoring: Home monitoring of blood pressure reported via an interactive voice recognition system with automated feedback messages. Pharmacist recommended medication changes by phone in response to readings. Option to listen to educational messages.	Self-monitor blood pressure, engage with medication adherence.	146 Patients	Semi-structured interviews	Patients were reassured by seeing their blood pressure readings, and the DI helped them see how their behaviour affected their health readings. They felt they had a more bi-directional relationship with the HCP, and some perceived companionship from the DI.
Langstrup [40]	2008	Denmark	Asthma	To explore the reasons why information and communication technologies	Multifaceted web-based DI (LinkMedica): Same DI as Anhoj	Self-monitor morning peak flow, number of doses of rescue medication, and asthma	8 GPs, 1 nurse	Ethno-graphic case study, including semi-structured	GPs felt it was a tool for the patient, did not see the value of the decision support tool for

				intended to connect chronic patients with their care provider fail to become a durable part of treatment practices.		symptoms at night. Follow automated instructions for management. GPs to use decision support tool.		interviews with HCPs and observation of patient.	them and felt it would be a burden to review the data. Patient only entered her readings for the nurse to see at an appointment, who over-rode the DI automated feedback due to contextual factors.
Leon [41]	2015	South Africa	Hypertension	To investigate the wider potential for health interventions delivered via mobile phone by exploring patients' experience of the trial.	Text-message reminder intervention: Weekly tailored text reminders to encourage treatment adherence using goals and planning, and facilitate interaction with healthcare system.	Medication adherence, appointment attendance.	37 Patients	Focus groups and interviews	Personalised messages made some patients feel cared for, and this triggered motivation to engage in self-management. Patients found the reminders for medication adherence useful, particularly those with high levels of stress.
Roblin [42]	2011	US	T2 Diabetes	To collect preliminary data on usability of mobile Information Communication Technology for self-management of blood glucose (SMBG) adherence and value added of peer support for SMBG adherence.	Tele-monitoring: Transmission of blood glucose readings, automated feedback provided to patient and their selected supporter with advice for action. Texts were sent every 5 days. Supporter is trained in motivational interviewing skills to encourage the patient to self-monitor.	Measure blood glucose regularly and follow feedback advice to improve glycaemic control.	15 Patients	Focus groups	Some diabetes patients reported improved attention to self-monitoring, and increased self-efficacy. Some motivational messages were found to be discouraging.
Seto [43]	2012	Canada	Heart failure	To provide in-depth insight into the effects of tele-monitoring on self-care and clinical management, and to determine the features that enable successful heart failure tele-monitoring.	Tele-monitoring: Transmission of daily weight and blood pressure readings, and self-assessed symptoms via mobile phone to receive automated feedback. Readings stored on hospital repository and physician alerted if readings outside target range, to contact patient with recommendations. Multifaceted smart phone DI: Self-monitoring of blood glucose, step counter with feedback, data tracking tool, habit recording of diet, goal setting for diet and PA, and tips for self-management.	Self-monitor weight, blood pressure and symptoms; modify lifestyle behaviours (e.g. salt and fluid restrictions, diuretic dose, and exercise) in response to automated and HCP feedback.	22 Patients and 5 HCPs	Semi-structured interviews	Increased self-awareness about condition, reassurance someone was watching over them, and motivation for self-care. HCPs liked having alerts for when they needed to contact patients, but were concerned about the burden of responding.
Tatara [44]	2013	Norway	Diabetes T2	To contribute toward accumulating knowledge about factors associated with usage and usability of a mobile self-management application over time through a thorough analysis of multiple types of investigation on each participant's engagement. To explore the perceptions of patients and professionals about the pilot implementation of the COPD tele-monitoring service.	Tele-monitoring: Same DI as Fairbrother 2012	Self-monitor blood glucose readings, diet, step-counter; increase physical activity and healthier diet.	12 Patients	Semi-structured interviews	Patients liked seeing trends in their data over time, and were motivated to engage in healthy lifestyle behaviours.
Ure [45]	2012	Scotland	COPD	To evaluate the experience of patients and providers using an	Multifaceted web-based DI: Monitoring blood pressure, blood glucose and weight, with	Self-monitor symptoms, self-monitor oxygen saturation daily, and self-monitor weight and peak flow weekly. Start medication if symptoms worsen and HCP recommends it.	20 Patients and 25 HCPs	Interviews, focus group and ethnographic observation	Patients felt benefit of being monitored and having easier access to HCP advice, and most were confident to take action themselves in response to deteriorating symptoms. Clinicians had concerns about over-treatment, increased workload, and uncertainty about how to respond to readings and wanted more clinical information to interpret the readings.
Urowitz [46]	2012	Canada	Diabetes	To evaluate the experience of patients and providers using an	Multifaceted web-based DI: Monitoring blood pressure, blood glucose and weight, with	Self-monitor blood pressure, blood glucose, and weight,	17 Patients	Semi-structured telephone interviews	Patients were reassured that HCP was monitoring their readings, and liked being able to

Table 2 (Continued)

Lead author	Year	Country	Health condition	Stated aims	Intervention	Target self-management behaviour	Participants	Design	Main findings
				online diabetes management portal for patients.	HCP feedback, and interactive education and online health record.	manage diabetes with changes to diet and exercise.			track their own data over time. This was the most well-used feature, education materials were not well-used. Those with stable readings did not perceive such a benefit. HCPs were concerned about the burden of monitoring readings, and did not see the necessity for the DI as felt patients already managed their condition well.
Van Kruijssen [47]	2015	Netherlands	Asthma and COPD	The aim of this qualitative study was to understand health-care professionals' and subjects' perceptions and behaviors related to self-management diary use.	Multifaceted web-based DI: Self-management online diary to record symptoms and medication, and identify when they are experiencing personally defined health states. DI sends reminders for self-selected personalised actions to manage their health. Patients can ask for advice from HCP via website.	Detect exacerbations and respond by working towards personally defined goals. Regular self-monitoring of symptoms.	12 Patients, 4 HCPs (NB 14 patients who did not use DI are not included)	Semi-structured interviews	Asthma patients used the DI to identify exacerbations, and inform their medication dosage. Some were more confident than others. Both COPD and asthma patients gained increased insight into their condition. HCPs liked improved clinical control of patient's condition, and being able to have more meaningful discussions with patient in consultation.
Voncken-Brewster [48]	2014	Netherlands	COPD	To gauge the feasibility of adding a web-based patient self-management support application to yearly COPD consultations with practice nurses.	Multifaceted web-based DI: Website included health risk appraisal with personalised feedback from the nurse, and behaviour change modules on medication adherence, smoking cessation and physical activity.	Behaviour change adherence.	7 Patients	Semi-structured interviews	Some patients liked being reminded to change their behaviour, others did not feel the need. Patients liked personalised messages, nurses would like better integration with e-health record.
Williams [49]	2014	UK	COPD	To explore patients' expectations and experiences of using a mobile telehealth-based (mHealth) application and to determine how such a system may impact on their perceived wellbeing and ability to manage their COPD.	Multifaceted tablet computer DI: Self-monitoring pulse oximetry and symptoms daily, nurse reviews data and patient contacts nurse in emergency. Education on smoking cessation, diet, and breathing/inhaler techniques.	Self-monitor data and symptoms, adhere to treatment, detect exacerbations, know when to contact HCP	19 Patients	Interviews	Patients felt reassured by nurse reviewing their data, and experienced increased self-awareness of condition, feeling encouraged to engage in self-management behaviour in response to symptoms.
Yu [50]	2014	Canada	Diabetes	To determine the effect of a web-based patient self-management intervention on psychological (self-efficacy, quality of life, self-care) and clinical (blood pressure, cholesterol, glycaemic control, weight) outcomes.	Multifaceted web-based DI: Self-monitoring blood glucose with automated feedback, goal-setting, and shared forums with peers and experts.	Self-monitor blood glucose, physical activity changes	21 Patients	Qualitative interviews	Patients felt they could not control their condition when seeing variation in health readings over time. Blog was the most well-used feature.
Zufferey [51]	2009	Switzerland	Chronic back pain	To investigate the influences of a self-management website on patients' chronic low back pain self-management attitudes and behaviours.	Multifaceted web-based DI: Educational material, virtual gym, online chat rooms, testimonials.	Website usage, exercises for back pain	18 Patients	Semi-structured interviews	Patients better understood their condition, but found it more useful if they were not already active self-managers and were ready to take on self-management themselves.

3.3. Quality appraisal

The quality was high overall with 22 papers rated as high quality, 4 as medium [39,45,47,51], and 4 as low [22,24,40,42] (Appendix C). The most common criteria which papers failed to meet were reflection on the influence of the researcher, inclusion of ethical details, and justification of decisions about triangulating data. Some of these shortcomings did not necessarily indicate lack of rigour in data collection and interpretation, but may have been due to limited space for reporting [17].

3.4. Meta-ethnography analysis

Table 3 shows the key concepts from constant comparison, the first order constructs (primary quotes from the participants in the studies), second order constructs (study authors' interpretations) and third-order constructs, which represent the new understanding derived from the meta-ethnography analysis. Due to the large number of studies in the review, Table 3 is based on a sub-sample of the studies contributing to each third order construct (purposely selected for richness, relevance and diversity of first and second order constructs), but the contribution of all studies is described in the line of argument. As almost half the studies included in the review used standalone tele-monitoring DIs, reactions to self-monitoring data became an important focus of the synthesis

The CERQual evaluation found moderate confidence in all three third-order constructs, meaning it is likely that these findings are a reasonable representation of patient and HCP experiences of self-management DIs [18].

3.5. Line of argument

3.5.1. Perceived purpose of the DI: who is responsible?

Self-management DIs can facilitate HCPs to care for patients, or patients to care for themselves. The studies in this review showed that both goals can be achieved simultaneously. Patients using self-management DIs generally perceive that they are more aware of their condition [23–26,28,30–32,34,35,41,43,44,46–49,51], better able to make decisions about their own health [23,25,28,32,34,35,39,44,45,47,49] and engage as an equal with the HCP in meaningful discussions [25,29,30,33,35,39,47] indicating that the DI facilitated self-management of their condition. Often in the same studies, HCPs focus on the improved clinical control afforded to them by self-management DIs, being able to track patients' physiological data over time to detect exacerbations or change medication [26,28,30,32,36,43,45–47]. This shows that these different goals of self-management DIs can operate in tandem, as both patients and HCPs perceive different benefits from the same DIs, and this was apparent across the various health conditions.

However, as well as improving self-management skills in patients, the same DIs can also initiate feelings of reliance on HCPs to manage their health. This reaction was particularly evident when HCPs contacted patients when their home readings were out-of-range. This led patients to feel that they were continually being monitored by their HCP [25–28,32,43,45,46]. These patients still interpreted their own readings and used their data to inform decisions (indicating adoption of self-management), but at the same time relied on their HCP to detect when there was a problem. This DI design appeared to be more prevalent in conditions such as COPD and CHF, possibly because of the risk of deterioration or severe exacerbations in these conditions, and dependency increased when symptoms became worse. This feeling of 'being monitored' was a positive experience for patients, who felt reduced anxiety about their condition and were reassured by this level of

care [25,26,28,32,43,45,46], but HCPs felt burdened by unrealistic patient expectations of continual monitoring and were concerned that this might lessen patients' responsibility to detect exacerbations themselves [26,45,46]. In one study, COPD patients were responsible for contacting the HCP when their readings were high rather than the other way around, and they still benefited from a feeling of being well cared for just through knowing that the HCP had access to their readings and was using them to inform their care [49]. Therefore it seems beneficial for patients' peace of mind to know that their home readings are being used by a HCP, but from a practical perspective, not necessarily to rely on HCP feedback for detecting problems. In some studies, patients and HCPs reported feeling uncertain about who was responsible for responding to out-of-range readings [31,32,38,45]. Careful use of appropriate feedback and ensuring that patients and HCPs have clear instructions about how to respond if a reading is out-of-range might help to prevent over-reliance on HCPs.

While HCPs tended to focus on their own responsibility to clinically control the patient's condition rather than the patient's self-management, in a few studies HCPs reported seeing the benefit for patients of increased self-awareness about their condition when using DIs [25,30,36,38,40,46,47] or wanting to act as the patients' coach to encourage them to self-manage their condition [22,25,28]. Therefore self-management DIs promoted both patient self-management and HCP clinical control, and patients and HCPs each tended to focus mainly on their own improved control of the condition, although feedback expectations could influence patients' perceived responsibility. HCPs seemed to weigh up the benefit of improved clinical control against the additional time required to process the patients' data and make medical decisions [22,26–28,30,32,36,38,43,45,46], and in some cases the poor integration of the DI with existing systems was highlighted as an issue for HCPs [27,38,46]. This was more of an issue for physicians/GPs than nurses, and implies that HCPs need an accessible format for reviewing patients' data to minimise additional workload.

3.5.2. Perceiving meaning in self-monitored data

The other two third-order constructs identified in the meta-ethnography were focused on specific aspects of patient self-management, and therefore fall under the broader concept of patient responsibility described above. Patients' reactions to self-monitoring their physiological data were complex. Understanding self-monitored physiological or symptom readings in the context of lifestyle behaviours such as medication adherence or physical activity appeared to give patients across conditions a sense of control over their condition and allowed them to assign meaning to their readings [24,25,29,32,39,43,44,47], which made the self-monitoring process more worthwhile to maintain over time. Perceiving an interaction between lifestyle activities and physiological data not only encouraged patients to continue self-monitoring, but also seemed to motivate them to engage in self-management behaviours in order to see an improvement in their readings, for example, to adhere to medication in order to reduce their blood pressure [24,29–31,35,39], to better manage their diabetes through physical activity and diet [32,44,46], or to engage in more physical exercise to control their COPD [25,34]. This motivation to change behaviour based on physiological data was found even amongst patients using standalone tele-monitoring systems with no behaviour change support or educational tools [24,30–32,35,39], indicating that just having access to the data was sufficient to trigger behaviour change. Hoas gives a useful insight into patients' motivation to engage in self-management behaviours over a longer period of time, as this study ran for 2 years [34]. They found that some patients lost motivation to continue engaging in physical activity when they could no longer see an

Table 3
Meta-ethnography synthesis, including key concepts, first-order constructs from study participants' quotes, second-order constructs from study authors' interpretations, and third-order constructs from the meta-ethnography.

Key concepts	First order constructs	Second order constructs	Third order constructs
Level of patient/HCP responsibility	<p>Patient: "Normally you go for a visit [. . .] and they check your blood pressure and just say it's good, but I don't know what would be good or bad, really. Now I know more; that gives me an awareness of how my body works. Yes, now the visit's different for both me and the nurse. Now I had information collected over a longer period of time; before it's only been about when you're there [at the visit] . . . " [29]. Hypertension.</p> <p>Patient: "If you have a bad reading you're not going to go out and do the gardening or go up and clean the bathroom or something. . . You know that's the day you need to just take it easy" [28]. COPD.</p> <p>Patient: "It keeps you in the picture . . . And you know exactly what's going on from day to day . . . " [26]. CHF.</p> <p>Patient: ". . . It tends to eliminate one of the biggest problems of being sick and that's a sense of isolation, because I know that there's regular (ongoing) contact. So, if I'm not feeling well, I know I'm going to be getting a phone call and it seems to me that's worth gold." [43]. CHF.</p> <p>Patient: "But I don't know what to do if . . . I think that if it goes above 15, you have to do it again or something like that . . . I would let my practice get in touch with me, because I'm not very sure of what it all means". [32]. Diabetes.</p> <p>HCP: "It's a piece of information and a piece of patient learning, which lead to subjects knowing better what their disease is. During a consultation. . . patients can ask different types of questions; they know more, so you can more or less skip the basic questions and move on." [47]. Asthma and COPD.</p> <p>HCP: "I feel that the COPD patients are getting to be more active and motivated to do training at home. I feel like a coach for them." [25]. COPD.</p> <p>HCP: "It allows us to look at patients every single day, as opposed to, at the moment, seeing people, maybe every four, six or twelve weeks, dependent on the patient, so you get a much better picture of their daily condition . . . things get picked up a lot quicker" [26]. CHF.</p> <p>HCP: "Because you can tweak things, adjust medications, rather than having them wait 6 months or 3 months when they come in, and I think you can get a tighter control." [38]. Diabetes and hypertension.</p> <p>HCP: "Some patients take less responsibility in their self-management of the disease as they feel that the health care provider is in constant review of their blood sugars." [46]. Diabetes.</p>	<p>They (patients) described their participation during the visit as playing a more active role in the conversation and taking more responsibility for discussing their health, compared with previous health-care visits. Moreover, they perceived it as a better and more meaningful consultation as the graphs functioned as a common ground for discussion. [29]. Hypertension</p> <p>A number of patients used oxygen saturation measurements to inform decisions about their capacity to undertake domestic activities, such as household chores or taking family excursions. [28]. COPD.</p> <p>Many (patients) found it helpful to know their weight, blood pressure and oxygen saturation score and to have the facility to monitor data trends over time. This was considered beneficial in determining state of health. [26]. CHF.</p> <p>The patients also felt more reassured, because they were more connected to their healthcare team and their clinicians had more information about their condition. [43]. CHF.</p> <p>Some patients would wait for the practice nurse to contact them, which many did, others would initiate the communication themselves. [32]. Diabetes.</p> <p>N/A</p> <p>The healthcare professionals viewed themselves as the patients' coaches in the tele-rehabilitation programme. [25]. COPD.</p> <p>Professionals perceived that tele-monitoring facilitated 'closer monitoring' of patients. Tele-monitoring data were attributed as providing a more detailed picture of patient health than usual care, enabling the professional to take pro-active approaches to clinical management. [26]. CHF.</p> <p>Physicians and nurses were able to closely follow patients with whom they had just made treatment adjustments [38]. Diabetes and hypertension.</p> <p>Some providers expressed concern that patients assumed providers were watching their health status on the portal all of the time and might therefore leave problems unreported [46]. Diabetes</p>	<p>Perceived purpose of the DI: Who is responsible? Patients across conditions felt that they engaged more with their HCP because the self-management DI had given them a clearer insight into their condition. Patients also indicated that they make their own decisions about their life informed by their use of the DI, demonstrating how the DI facilitated self-management of their condition. HCPs tended to focus on the clinical control afforded to them by DIs, in that they could track patients' progress via their health readings. In a minority of studies, HCPs also considered that DIs could help patients to self-manage their condition. If HCPs contacted patients when their readings were high, patients became more reliant on HCP feedback for reassurance, which led to HCPs feeling burdened.</p>
Self-awareness and empowerment	<p>Patient: "The most important thing I've learned is that you should be more physically active . . . now you can actually see it on the curve . . . you get motivated to do something beyond the norm." [29]. Hypertension.</p> <p>Patient: "It's really taught me what the correlation is between salt intake and weight and water retention. An above normal sodium intake will show up immediately the next day as a weight gain and then as you clear that out of your system it goes back." [43]. CHF.</p> <p>Patient: "I get motivated when I see my data on the web portal . . . It is a milestone, and I want to improve my values by exercising." [25]. COPD.</p>	<p>Although they (patients) knew in a general sense that physical activity is good for decreasing high blood pressure, this became more obvious and they gained new knowledge that it really is true. [29]. Hypertension</p> <p>Patients expressed feeling more in control, confident, and accountable, because they could directly observe the effects of their lifestyle choices on their health and become active participants in their own health. [43]. CHF.</p> <p>Being able to actually see the graphically presented data (blood pressure, pulse, weight, spirometry and saturation) on the web portal or tele-health monitor motivated the patients to continue training and to compete with themselves, especially when the measured values showed improvement over time. [25]. COPD.</p>	<p>Perceiving meaning in self-monitored data Self-monitoring symptoms or physiological readings over time tended to be a rewarding process for patients when they could understand a link between their readings and their daily activities, such as medication adherence or healthy lifestyle behaviours. Perceiving a link with lifestyle was sufficient to promote engagement with self-management behaviours, but it was important to perceive that readings were meaningful and could be controlled by medication or lifestyle, otherwise self-monitoring became a frustrating or worthless experience. This motivation to change behaviour based on perceived interactions between behaviours and health demonstrates that both multi-faceted self-management DIs and standalone tele-monitoring systems can enhance the patient's self-management of their condition.</p>

	<p>Patient: "I think it is fine to have 8000 [as a goal], because this I can manage [to walk], but not 10 [ten thousand]. Then I become sad, and think 'oh no, I cannot achieve the pre-set goal'" [44]. Diabetes.</p> <p>Patient: "I could not run faster, but I could increase the duration and walk for a longer time. Then I felt an accomplishment" [34]. COPD.</p>	<p>Feedback showing progress toward goals was most important for encouraging daily physical activity and good nutrition habits. [44]. Diabetes.</p> <p>Participants considered these graphs as motivational factors and learning opportunities . . . However, this group of patients cannot increase their physical capacity infinitely. One of the participants, who adhered very well to the study, was able to set new goals when the "upward feeling" was lost. [34]. COPD.</p> <p>A 67 year old lady was very happy with using (the intervention) –she said that when she finished using the system she missed the contact and felt that she had 'lost a friend.'" [24]. Hypertension.</p> <p>Other patients did not experience the self-management system as very useful, mainly because they had had stable blood pressure or had not perceived any symptoms. [29]. Hypertension</p> <p>A small number of patients (5/22) experienced indifference toward the tele-rehabilitation measures. The patients argued that it was because the measured values were stable. These patients reported that they were unable to observe any connection between measured values and physical training over time. [25]. COPD.</p>	
	N/A		
	N/A		
	<p>Patient: "I don't feel that measuring my values makes a difference for me—They are stable all the time." [25]. COPD.</p>	<p>Participants reported feeling frustrated with the uncontrolled nature of their disease, and the collection of self-monitoring information that showed a lack of metabolic control exacerbated this frustration. [50]. Diabetes.</p>	
Perceptions of medication change	<p>Patient: "Part of it is, when you see the blood sugar is really high, I already know it's high. I'm not taking the medication. So to log the fact that they are high, ends up making you more frustrated. So why do that?" [50]. Diabetes</p>	<p>Participants reported feeling frustrated with the uncontrolled nature of their disease, and the collection of self-monitoring information that showed a lack of metabolic control exacerbated this frustration. [50]. Diabetes.</p>	
	<p>Patient: "There's no way you're going to cheat the machine so it's . . . it is a good thing like. You cannot kid yourself on with it" [30]. Hypertension.</p>	<p>There was consensus between both patients and professionals that the home monitoring system provided a more accurate assessment of BP than surgery measurements and better evidence for action, facilitating rapid tailoring of medication. [30]. Hypertension.</p>	<p>Patients carefully consider recommended medication changes Making medication changes can be challenging for patients, and this appeared to vary between conditions. Patients with hypertension and COPD were more confident to change their medication, whilst those with CHF tended to be less confident. Those with asthma sometimes did not trust the feedback that their medication needed changing, but this seemed to depend on the format of the DI feedback. Confidence and belief in necessity of medication change were important factors in determining whether a patient adheres to a medication change.</p>
	N/A	<p>Most (patients) perceived that having access to readings and emergency supplies of antibiotics at home gave them confidence to respond to deteriorating symptoms themselves. [45]. COPD</p>	
	<p>Patient "A couple of times they phoned me telling me that my blood pressure was too high and telling me that they'd be sending me a new prescription through the post which they did. I thought that was bloody wonderful". [32]. Diabetes and hypertension.</p> <p>Patient: "When I've got it bad and it's great to know that you can just take a reading and say; 'well, I do need a doctor or I do need to start these steroids.'" [28]. COPD.</p>	<p>Some GPs were willing to adjust BP medication remotely which was very acceptable to patients. [32]. Diabetes and hypertension.</p>	
	<p>Patient: "Then I get an impression of when there are peaks, when it goes well, how much medication I need. and whether or not I can reduce my medications". [47]. Asthma.</p>	<p>Many patients reported using tele-monitoring data to validate their decision to self-medicate and/or to contact healthcare professionals in order to prevent exacerbations and hospitalization. [28]. COPD.</p>	
	<p>Patient: "I might have had a low peak flow for a couple of days. But it kept instructing me to increase the dose, and I did not think it was necessary".[22]. Asthma</p> <p>Patient: "As a result of [tele-monitoring], they increased the quantity of one of the drugs I'm taking . . . which hasn't made the slightest difference". [26]. CHF</p>	<p>N/A</p> <p>Patients do not readily accept advice from a virtual expert if this advice conflicts with the patient's own previous experience and attitudes. [22]. Asthma.</p> <p>Reticence was identified among some patients relating to their involvement in self-directed medication during tele-monitoring. Patients held the view that professionals, rather than themselves, held central responsibility for the management of their condition. [26]. CHF.</p>	
	<p>Patient: " There was a couple of times, where it was borderline and the once I did say I didn't want to change . . . and I thought well I'd like to see how it pans out before changing". [35]. Hypertension.</p>	<p>Patients were generally confident about implementing a medication change when their blood pressure was consistently above target levels. However, eight of the 17 patients who had implemented an initial medication change chose not to implement a subsequent change, mostly when their readings were borderline raised. [35]. Hypertension.</p>	
	N/A	<p>This group of patients received prior instruction from their cardiologist to take extra diuretic medication in this situation, but they still often felt uncertain of making the decision to take the extra medication on their own. [43]. CHF.</p>	

NB: First and second order constructs in this Table represent a sub-sample of all studies contributing to third-order constructs, but the line of argument below includes all studies.

improvement or after a spell of inactivity, but if patients adjusted their goals, e.g. to focus on duration rather than intensity of exercise, this helped to keep them motivated. Diabetic patients felt that feedback showing an improvement towards goals is a key source of motivation to self-manage their condition [44]. Therefore, self-monitoring data is motivating to patients, especially when they can detect an improvement, but careful goal-setting strategies may be needed in cases where improvement is not obvious.

Where diabetic patients had failed to adhere to a behaviour change to control their readings or felt that high readings were out of their control, they found self-monitoring to be a frustrating process [42,50]. Those who had stable readings which did not vary over time were less likely to feel a benefit from monitoring and this was the case across health conditions [25,29,46], as readings did not then convey any meaning about their condition.

3.5.3. Patients carefully consider recommended medication changes

Self-monitoring could also contribute to patients' engagement with medication change if patients felt confident enough to change their medication based on their readings. Confidence appeared to be high in COPD patients [25,28,45] and some hypertensive patients [30,32], but lower for CHF patients who were concerned about taking diuretic medication in response to high readings, even when based on prior advice from their HCP [26,43]. It should be noted that age might also be a factor influencing confidence to adjust medication, as CHF patients are on average older than those with COPD.

As well as feeling confident, patients also needed to perceive that a recommended medication change was necessary. For example, hypertensive patients who felt that their readings were borderline were less likely to follow advice to change their medication because they didn't feel their blood pressure was high enough to warrant a change [35]. Asthma patients could be

reluctant to follow automated advice to change medication if this conflicted with their own beliefs about not needing steroid medication regularly [22]. However, when using a self-management diary to track symptoms and identify exacerbations, some asthma patients were happy to adjust their medication to control their symptoms [47]. Asthma patients in this intervention created personally defined health states and individual treatment plans, and it may be that this personal tailoring helped them to believe in the necessity of medication adjustment when they could see their symptoms were poorly controlled.

Fig. 2 shows a visual representation of the third order constructs.

4. Discussion and conclusion

4.1. Discussion

This review provides an in-depth analysis of patients' and HCPs' experiences of using self-management DIs across common chronic health conditions. Patients and HCPs were found to perceive different benefits of using self-management DIs, showing that the same DI could facilitate both patient self-management and HCP clinical control. Some DIs were designed with an explicit focus on improving clinical control, but even without the tools to encourage self-management, patients tended to feel more involved in their condition management and better informed to make decisions. Appropriate feedback is important for managing patients' expectations about the level of monitoring from their HCP, and for ensuring that both patients and HCPs know who is responsible for responding to out-of-range readings.

4.1.1. Interpretations in the context of current literature

This review extends our understanding of the self-care-dependency continuum referred to in a recent meta-synthesis

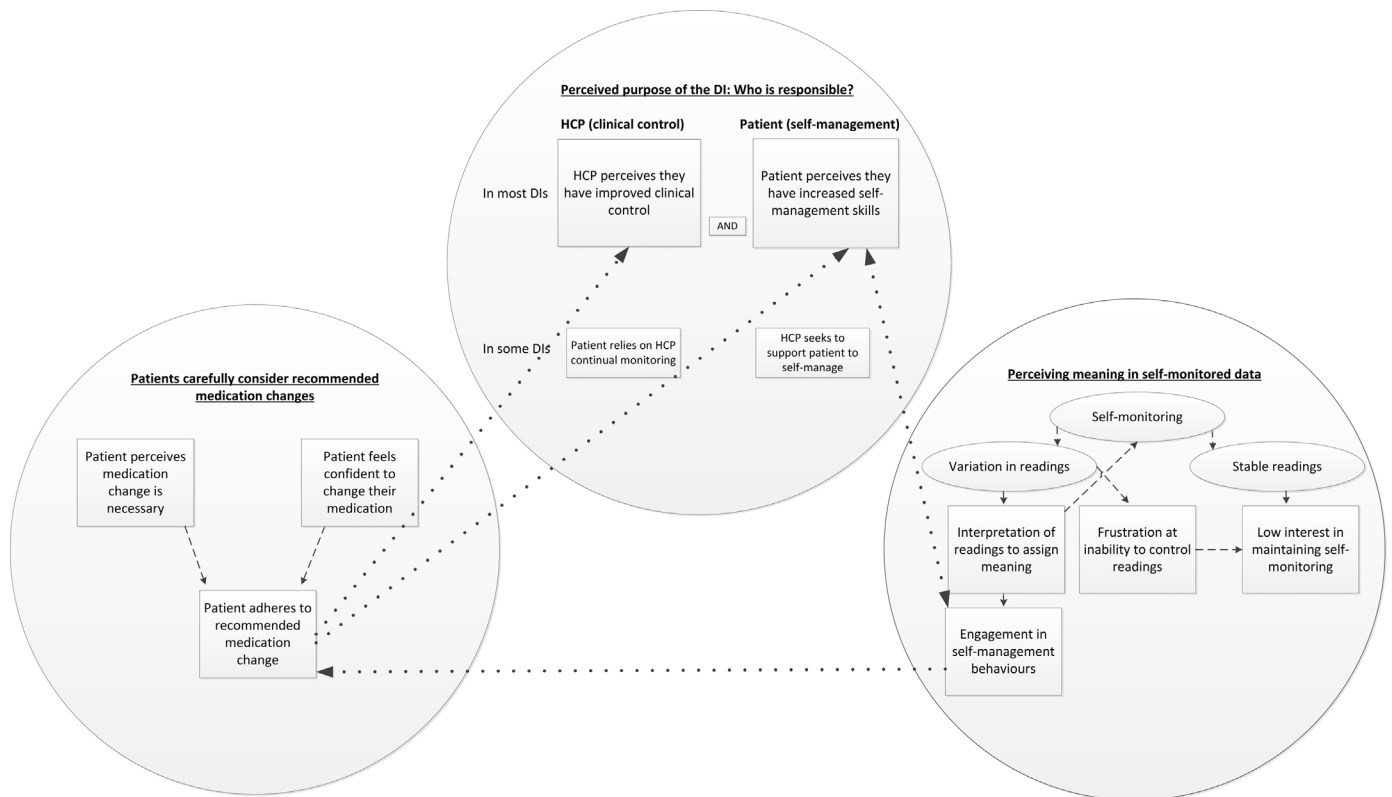


Fig. 2. Visual representation of the third order constructs.

on tele-health for COPD patients [52]. The present findings suggest that self-care and dependency are not necessarily incompatible, as both self-management and dependent patient behaviours can be promoted by DIs, although the style of feedback has an important influence on how much responsibility the patient adopts for self-management. Patients in all studies tend to describe increased awareness and improved decision-making skills when using a self-management DI, indicating more engagement in self-management. Receiving HCP feedback on physiological data encouraged patients to feel that they were being monitored and that responsibility remained with the HCP, implying increased dependency. Whereas dependency has been viewed as a negative outcome of self-management DIs [52], it was not a problem from the patient perspective as they felt very well looked after and reassured by the idea that HCPs were monitoring their health status, but it is more problematic for HCPs who are concerned about meeting patients' expectations of continual monitoring. Therefore decisions about how and when patients using self-management DIs will receive feedback are important for optimising their experience of self-management and minimising over-reliance on HCPs.

In terms of evaluating perceived benefits of the DI, patients focused on the positive effects on their understanding and acceptance of their condition, whilst HCPs focused on the clinical benefits DIs offered them for managing the patients' condition. As reported in the synthesis of COPD patients' experiences of tele-health, HCPs were less positive about the use of self-management DIs than patients [52] and had concerns about the increased workload. This finding is also consistent with a recent synthesis which reported that clinicians can find it challenging to share control of condition management with the patient [53]. Explicit guidance for HCPs about how best to deliver support for patients using self-management DIs might help address these concerns.

Patients' motivation to change their behaviour when they have access to their own data is in line with research on visualisation which shows that making health data visible can add meaning to activities which interact with these data [54]. Mamykina's model of sense-making [55] describes how patients construct explanations of their health data based on their daily activities, which enables them to make lifestyle decisions in order to improve their health data. The feedback loop between actions and health status is more easily detected in some conditions than others, for example the benefits of adhering to asthma prevention medication are not immediate but accumulate over time [22]. This highlights the importance of designing digital tools with meaningful feedback systems to help patients review their data and develop a comprehensive understanding of these interactions [55]. The review found that where physiological data remained stable over time, patients were less motivated to engage with self-monitoring, and therefore where self-management behaviours are only likely to have a small impact on physiological data, other forms of encouragement may be needed to encourage patients to stay motivated.

The finding that standalone tele-monitoring DIs without behaviour change support promoted patient self-management supported the concept that tele-monitoring is a complex behaviour change process in itself [30]. This is consistent with a review of patient experiences of self-monitoring hypertension (with or without other intervention elements to support self-management) which found positive effects of self-monitoring behaviour on reassurance, patient empowerment and the HCP relationship [56].

The concerns patients expressed about medication changes in this review can be explained by the extended self-regulatory model [57], which incorporates beliefs about *necessity* of treatment and *concerns* about adverse treatment effects into

the original self-regulatory model of illness perceptions [58]. Hypertensive patients' non-adherence to recommended medication changes when their readings only slightly exceeded a threshold, and asthma patients' decision not to increase regularity of steroid dose demonstrate the importance of beliefs in the necessity of treatment for adherence. Concerns about adverse effects of treatment were evident in the finding that CHF patients lacked confidence to change their medication and wanted responsibility to remain with their HCP. This suggests that in order to improve adherence to medication change advice DIs need to convince patients about the necessity of medication changes, and address their concerns about adverse treatment effects. Appropriate, reliable feedback could be essential for this, as differences in tailoring of automated feedback seemed able to influence patients' acceptance of advice about medication changes [22,47].

Many of the findings which emerged from our inductive analysis mapped well on to the constructs from Normalisation Process Theory (NPT) [59], which provides a useful framework and standardised terminology for describing how interventions are adopted by HCPs and patients in routine practice [60]. Patients demonstrated *cognitive participation* by engaging in sense-making of their data, and their experience of a closer and more meaningful relationship with the HCP showed positive *reflexive monitoring* of intervention benefits. The uncertainty of some HCPs in how to respond to patients' readings and the feeling that reviewing patient data was burdensome suggested low *coherence* for HCPs regarding the DI's goals, as well as a lack of confidence in the resources available to them (*collective action*). Implementation into daily practice could be promoted through highlighting the dual benefits of self-management DIs to HCPs to increase *coherence* and *reflexive monitoring*.

4.1.2. Limitations of the current review

This review potentially represents a particularly positive patient perception of self-management DIs as it is based only on patients who volunteered to participate in trials and follow-up qualitative research, which is usually only a small sub-sample of those invited. This potential bias did not appear to be evident in the HCPs' perspectives. The authors are also aware that their own preconceptions could have influenced the analysis of the data. We attempted to limit this by adopting an inductive approach, grounding our themes in the data, and we prioritised transparency by keeping a record of all emerging themes and discussing the analysis regularly to obtain shared viewpoints.

The CERQual evaluation of the review findings indicated moderate confidence in the three third-order constructs generated by the review, meaning that it is likely that these are a reasonable representation of patient and HCP experiences of self-management DIs.

4.2. Conclusion

The evidence from this review of qualitative research suggests that patients using self-management DIs perceived closer contact with HCPs, and felt better cared for. This is in line with previous findings that self-management does not replace professional care but rather enables patients to attain the best healthcare [1]. Monitoring their own health data gave patients a greater self-awareness of their condition and they were motivated to engage in lifestyle behaviours to help improve their data, even when using standalone tele-monitoring DIs without explicit behaviour change support. HCPs perceived clinical benefits to self-management DIs, but raised some concerns about the burden of monitoring patient data.

4.3. Practice implications

The finding that standalone tele-monitoring systems promoted feelings of motivation for condition management suggests that tele-monitoring could be more widely used to promote patient self-management and should not be regarded only as a clinical tool for tailoring treatment. Where physiological data are likely to remain stable over time, patients may need additional forms of encouragement to stay motivated to engage in self-management. Providing explicit guidance to patients and HCPs about responding to home readings might help to manage patient expectations and address HCPs' concerns about the time involved in monitoring patients.

Conflicts of interest

Elizabeth Murray is the Managing Director of HeLP Digital, a not-for-profit Community Interest Company which disseminates digital health interventions to the NHS. She has not, and will not, receive any remuneration for this work.

Authors' contributions

KM wrote the first and subsequent drafts of this manuscript, with initial feedback from LY and LD, followed by comments from

CM and EM and then the remaining authors. KM completed the searches, title and abstract screening, and full text screening. LD screened a sub-sample of papers, and provided a second check on the CERQual evaluation of the review findings. LY and LD provided guidance on the qualitative synthesis analysis, and contributed to the development of third-order constructs. EM provided expert advice on the reporting of methods, CM advised on some of the theoretical aspects of the synthesis, whilst PL and RMCM provided clinical expertise and HCP experience. All authors read and approved the final manuscript.

Acknowledgements

This independent research was funded by the National Institute for Health Research (NIHR) Programme Grants for Applied Research Programme (Grant Reference Number RP-PG-1211-20001). The views expressed are those of the author(s) and not necessarily those of the NHS, the NIHR, or the Department of Health.

Appendix A. Search terms for thesaurus and key word searches

see [Tables A1–A3](#).

Table A1

Search terms for thesaurus searches by database.

Database	Thesaurus terms
CINAHL	Self care Asthma, Hypertension (exploded), chronic disease Online systems, online services, internet, world wide web, computer systems, therapy computer assisted
Medline	Self-care Asthma, Hypertension, Blood pressure, Chronic disease Internet, online systems, computers, computer systems
Psycinfo	Self –care skills, self management, self monitoring Asthma, hypertension, essential hypertension, blood pressure, diastolic pressure, systolic pressure, chronic illness Internet, communication systems, information systems, computer applications, computer mediated communication, online therapy, telecommunications media, telemedicine, websites, computer assisted therapy, computer mediated communication, computer programming
Embase	Self care, self help, self medication Asthma, hypertension, elevated blood pressure, chronic disease Internet, online system, computer program, computer, computer assisted drug therapy, computer system, computer assisted therapy

Table A2

Search terms for Ebscohost key word searches (PSYCinfo, Medline and CINAHL).

Source	E-health terms	Intervention terms	Qualitative methods terms	Chronic illness terms
Author consensus	Internet Online Digital Web E-health Telemonit*	Intervention Programme	Qualitative Interview Focus group Experience View Perspective Feedback Ethnograph* Thematic Theme Mixed methods Usability Thinkaloud Think aloud	Asthma Hypertens* Blood Pressure
Morrison review terms	Computer* Technolog* Telecommunication* Multimedia PC Website WWW Cellular Phone Cell phone Mobile Smartphone Smart phone Electronic Ehealth Mhealth M-health	Self-management Self management health education Self care Self-care Self-monit* Self monit*		
Knowles review terms	Telemedicine Text messag* Email Telehealth Teletherap*		Open-ended Semi-structured	

Table A3

Search terms for Web of Science key word search.

Source	E-health terms	Intervention terms	Qualitative methods terms	Chronic illness terms	Self-management
Author consensus	Internet Online Digital Web E-health Computer	Intervention Programme	Qualitative Interview Focus group Experience View Perspective Feedback Ethnograph* Thematic Theme Mixed methods	Asthma Hypertens* Blood Pressure Chronic illness Chronic disease	Self-management Self management

Appendix B. CERQual evaluation of confidence in the third-order constructs

CERQual categories	Studies contributing to the construct	Methodological limitations	Relevance	Coherence	Adequacy of data	Overall CERQual assessment of confidence	Explanation of decision
		Problem in design of primary studies that contribute to this concept.	The extent to which the body of evidence from the primary studies supporting a review finding is applicable to the context (perspective or population, phenomenon of interest, setting) specified in the review question.	The extent to which the review finding is well grounded in data from the contributing primary studies and provides a convincing explanation for the patterns found in these data.	An overall determination of the degree of richness and quantity of data supporting a review finding.		
Perceived purpose of the DI: Who is responsible?	Fairbrother [26], van Kruijssen [47], Seto [43], Zufferey [51], Dinesen [25], Voncken Brewster [48], Williams [49], Fairbrother [28], Hoas [34], Burner [23], Urowitz [46], Tataru [44], Hanley [32], Cottrell [24], Hanley [30], Hanley [31], Jones 2012, Leon [41], Lambert Kerzner [39], Ure [45], Hartmann [33], Hallberg [29], Koopman [38], Jones [36], Langstrup [40], Anhoj [22], Fairbrother [27]	Minor concerns about methodological limitations: 20 of the studies contributing to this review finding met all or most of the NICE checklist criteria, 4 studies met some of the criteria and where they had not been met this was unlikely to affect the conclusions, and 3 studies had low quality meeting only a few of the criteria and this was likely to have affected the conclusions.	High relevance to review question: Studies concern patient population with chronic illness and a range of self-management Dis within the inclusion criteria.	Minor concerns about the coherence of this finding. The evidence from the studies provided a coherent argument and where there were exceptions, this seemed to be accounted for by DI design. However, more evidence would be useful to help account for why HCPs sometimes focus more on patient self-management.	No concerns about adequacy of data. There were rich data to support the finding across many studies.	Moderate confidence*	Many of the studies in the review contributed to this finding, and the pattern of results was consistent. Where there were discrepancies in the findings, these could be accounted for by the DI design.
Perceiving meaning in self-monitored data	Jones [35], Hallberg [29], Hanley [30], Lambert-Kerzner [39], Cottrell [24], Seto [43], Dinesen [25], Urowitz [46], Tataru [44], Yu [50], Van Kruijssen [47], Hanley [32], Williams [49], Roblin [42], Hanley [31]	Minor concerns about methodological limitations: 11 studies contributing to this finding met all or most of the checklist criteria, 2 studies met some of the criteria and where they had not been met this was unlikely to affect the conclusions, and 2 studies had low quality meeting only a few of the criteria and this was likely to have affected the conclusions. Importantly though, one of the two studies which was a disconfirmatory case for this construct had low quality due to poorly explained data analysis and shallow results, limiting our confidence to account for the discrepancy [42].	No concerns about relevance: All studies used a relevant self-management DI for a chronic health condition, and were relevant to the review.	Minor concerns about coherence: Studies are mainly consistent that having access to digital data promotes self-awareness and motivation to manage condition. Yu [50] and Roblin [42] refuted this finding, which was explained in terms of patients not feeling motivated to self-manage when they perceive their condition was not controllable, but more data would be needed to explore more fully whether this accounts for the discrepancy.	No concerns about adequacy of data: The studies contributing to this finding were rich and varied.	Moderate confidence*	This finding was reported across a range of rich studies, mainly of high quality. There were minor concerns about coherence in that two studies showed patients were not motivated to self-manage by self-monitoring, and our ability to account for this was limited, especially as one of these studies was of low methodological quality. Further research would be needed to confirm or refute the explanation we have proposed.
Patients carefully consider recommended medication changes	Jones [35], Seto [43], Fairbrother [28], Fairbrother [26], Hanley [30], Dinesen [25], Ure [45], Anhoj [22], Van Kruijssen [47], Hanley [32]	Minor concerns about methodological limitations: 7 studies contributing to this finding met all or most of the checklist criteria, 2 studies met some of the criteria and where they had not been met this was unlikely to affect the conclusions, and 1 study had low quality meeting only a few of the criteria and this was likely to have affected the conclusions.	Minor concerns about relevance: Studies from a range of conditions and DI formats contributed to this finding. The level of HCP involvement and type of feedback provided to patients was not fully reported in some papers, giving rise to some uncertainty when interpreting the findings, and causing minor concerns about uncertain relevance.	Minor concerns about coherence: Evidence was consistent across studies, and where a discrepancy occurred in asthma patients' perceived necessity to change medication, this could be accounted for by different DI formats [22,47].	Moderate concerns about the adequacy of data: Although some studies discussed perceptions about medication change in detail [30,35] others did not provide rich data around this topic because it was not the focus of their research [25,28] and therefore there is only relatively thin data to support the finding.	Moderate confidence*	The finding concerning medication change perceptions in different health conditions appeared to be relatively consistent, giving rise to a coherent and relevant finding. However, further evidence from studies focusing on medication change would be useful to explore this further, and additional data may change or add to this finding.

*Definitions of levels of confidence from the CERQual evaluation [18]:

High confidence: It is highly likely that the review finding is a reasonable representation of the phenomenon of interest.

Moderate confidence: It is likely that the review finding is a reasonable representation of the phenomenon of interest.

Low confidence: It is possible that the review finding is a reasonable representation of the phenomenon of interest.

Very low confidence: It is not clear whether the review finding is a reasonable representation of the phenomenon of interest.

Appendix C. Quality appraisal of studies using the NICE checklist for qualitative studies

Checklist Item*	Theoretical approach		Study design	Data collection	Trustworthiness			Analysis			Conclusions			Ethics	Relevance	Overall assessment
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Checklist Item*	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Anhoj [22]	1	2	1	2	3	2	1	3	1	2	1	1	2	2	1	–
Burner [23]	1	1	1	1	2	1	1	1	2	1	1	1	1	2	1	++
Cottrell [24]	1	1	3	1	3	3	1	3	3	3	1	1	1	2	1	–
Dinesen [25]	1	1	1	1	3	1	1	1	1	1	1	1	2	1	1	++
Fairbrother [27]	1	1	1	1	1	1	1	1	2	1	1	1	1	2	1	++
Fairbrother [28]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	++
Fairbrother [26]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	++
Hallberg [29]	1	1	1	1	3	1	1	1	1	2	1	1	1	1	1	++
Hanley [30]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	++
Hanley [31]	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	++
Hanley [32]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	++
Hartmann [33]	1	1	1	1	3	1	2	1	1	1	1	1	1	1	1	++
Hoas [34]	2	1	1	2	1	1	1	1	1	1	1	1	1	1	1	++
Jones [35]	1	1	1	1	3	1	1	3	1	1	1	1	1	1	1	++
Jones [36]	1	1	1	1	3	2	2	1	1	2	1	1	1	1	1	++
Kerr [37]	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1	++
Koopman [38]	1	1	1	2	3	1	1	1	1	1	1	1	1	2	1	++
Lambert-Kerzner [39]	1	1	1	1	2	3	1	3	3	1	3	1	3	2	1	+
Langstrup [40]	1	1	1	2	3	3	2	3	1	3	3	1	1	2	1	–
Leon [41]	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	++
Roblin [42]	2	1	3	1	3	1	2	3	3	3	2	1	2	1	2	–
Seto [43]	1	1	1	1	3	2	1	2	1	1	1	1	1	2	1	++
Tatara [44]	1	1	1	2	1	1	1	2	1	2	1	1	1	2	1	++
Ure [45]	2	1	1	1	3	1	1	2	1	1	2	1	2	2	1	+
Urowitz [46]	1	1	1	2	3	1	1	1	1	1	1	1	1	2	1	++
Vn Kruijssen [47]	1	1	1	1	3	1	2	2	3	2	2	1	1	1	1	+
Voncken Brewster [48]	1	1	1	1	3	1	1	1	2	2	1	1	1	1	1	++
Williams [49]	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	++
Yu [50]	2	1	1	1	2	1	1	1	1	1	1	1	1	1	1	++
Zufferey [51]	2	2	1	1	3	1	2	2	2	2	2	1	1	2	1	+

*Checklist items:

- A. Is a qualitative approach appropriate?
- B. Is the study clear in what it seeks to do?
- C. How defensible/rigorous is the research design/methodology?
- D. How well was the data collection carried out?
- E. Is the role of the researcher clearly described?
- F. Is the context clearly described?
- G. Were the methods reliable?
- H. Is the data analysis sufficiently rigorous?
- I. Is the data 'rich'?
- J. Is the analysis reliable?
- K. Are the findings convincing?
- L. Are the findings relevant to the aims of the study?
- M. Conclusions.
- N. How clear and coherent is the reporting of ethics?
- O. Is the study relevant to the review being conducted?
- P. Overall assessment: As far as can be ascertained from the paper, how well was the study conducted?

Scoring:

The NICE checklist's 3-point criteria were used for appraising each item. A '1' signifies the paper achieved the highest level for quality for that indicator, and a '3' signifies the lowest level of quality.

Overall assessment:

- ++ All or most of the checklist criteria have been fulfilled, where they have not been fulfilled the conclusions are very unlikely to alter.
- + Some of the checklist criteria have been fulfilled, where they have not been fulfilled, or not adequately described, the conclusions are unlikely to alter.
- Few or no checklist criteria have been fulfilled and the conclusions are likely or very likely to alter.

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