

## Factors that affect the use of electronic personal health records among patients: A systematic review



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### ARTICLE INFO

**Keywords:**

Electronic personal health record  
Tethered personal health record  
Patient portal  
Adoption  
Acceptance  
Intention to use

### ABSTRACT

**Background:** Electronic personal health records (ePHRs) are web-based tools that enable patients to access parts of their medical records and other services. In spite of the potential benefits of using ePHRs, their adoption rates remain very low. The lack of use of ePHRs among patients leads to implementation failures of these systems. Many studies have been conducted to examine the factors that influence patients' use of ePHRs, and they need to be synthesised in a meaningful way.

**Objective:** The current study aimed to systematically review the evidence regarding factors that influence patients' use of ePHRs.

**Methods:** The search included: 42 bibliographic databases (e.g. Medline, Embase, CINHAL, and PsycINFO), hand searching, checking reference lists of the included studies and relevant reviews, contacting experts, and searching two general web engines. Study selection, data extraction, and study quality assessment were carried out by two reviewers independently. The quality of studies was appraised using the Mixed Methods Appraisal Tool. The extracted data were synthesised narratively according to the outcome: intention to use, subjective measures of use, and objective measures of use. The identified factors were categorised into groups based on Or and Karsh's conceptual framework.

**Results:** Of 5225 citations retrieved, 97 studies were relevant to this review. These studies examined more than 150 different factors: 59 related to intention to use, 52 regarding subjectively-measured use, and 105 related to objectively-measured use. The current review was able to draw definitive conclusions regarding the effect of only 18 factors. Of these, only three factors have been investigated in connection with every outcome, which are: perceived usefulness, privacy and security concerns, and internet access.

**Conclusion:** Of the numerous factors examined by the included studies, this review concluded the effect of 18 factors: 13 personal factors (e.g. gender, ethnicity, and income), four human-technology factors (e.g. perceived usefulness and ease of use), and one organisational factor (facilitating conditions). These factors should be taken into account by stakeholders for the successful implementation of these systems. For example, patients should be assured that the system is secure and no one can access their records without their permission in order to decrease their concerns about the privacy and security. Further, advertising campaigns should be carried out to increase patients' awareness of the system. More studies are needed to conclude the effect of other factors. In addition, researchers should conduct more theory-based longitudinal studies for assessing factors affecting initial use and continuing use of ePHRs among patients.

### 1. Introduction

Electronic Personal Health Records (ePHRs) are secure internet-based systems that allow patients to view parts of their medical records

and share them with trusted others [1]. Such systems may also provide services to patients such as messaging healthcare providers, requesting repeat prescriptions, and booking appointments [2].

Despite the potential benefits of ePHRs, their adoption rates are

**Abbreviations:** AA, Alaa Abd-alrazaq; ePHRs, electronic personal health Records; EHRs, electronic health records; EMRs, electronic medical records; MK, Mohammad Khasawneh; MMAT, mixed methods appraisal tool; TAM, technology acceptance model

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often very low [2–6]. For example, three American national surveys conducted by California HealthCare Foundation [7], Markle Foundation [8], and Markle Foundation [9] reported that about 7%, 3%, and 10% of adults had ever utilised ePHRs, respectively. In the United Kingdom, the adoption rate of ePHRs (i.e. HealthSpace) did not exceed 0.13% [10]. The uptake rates of ePHRs in other Europe countries (e.g. France, Denmark, Estonia, etc.) reached only around 5% [11].

The lack of use of ePHRs among patients leads to a failure of the implementation of these systems [12,13]. Identifying factors that influence patients' use of ePHRs is crucial to increasing patients' adoption and improving implementation success of ePHRs [4,5,14]. Many studies have investigated factors that affect patients' use of ePHRs. To date, no meaningful synthesis of findings has been produced. Therefore, the current study aimed to systematically review the evidence regarding factors that influence patients' use of ePHRs.

A conceptual framework used by Or and Karsh [15] in a review of consumer health information technology acceptance was used in this review as a theoretical lens to group factors. Or and Karsh adopted this framework from other frameworks developed by Holden and Karsh [16] and Karsh [17]. According to this framework, adoption of health information technologies is predicted by: (i) individual factors, which refer to sociodemographic characteristics, personality characters, and health status; (ii) human-technology interaction factors, which refer to individual's perceptions and expectations about a technology; (iii) organisational factors, which refer to facilitating conditions provided by organisations, implementation processes, organisation's structures, and end-user perceptions of them; (iv) social factors, which refer to the effect of other people to which a person belongs; (v) environmental factors, which refer to characteristics of the physical setting where a system is used; and (vi) task factors, which refer to the degree to which a technology influences a task and individual's perceptions of this effect [15].

## 2. Methods

The systematic review followed guidelines recommended by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [18]. The protocol for this systematic review is registered at PROSPERO with the number CRD42017056050.

### 2.1. Search strategy

#### 2.1.1. Search sources

This review utilised five search sources. First, we searched 42 electronic bibliographic databases including Medline, Embase, CINAHL, PsycINFO, and Scopus. A list of all 42 databases is shown in Appendix A. The search process started on 25th June 2018 and finished on 30th June 2018. Second, we checked the references of all studies included in the current review, and of reviews identified in the search (backward reference list checking). In addition, we conducted forward reference list checking to identify studies that cited the included studies using the "cited by" function available in Google Scholar. Third, we undertook hand searching in recent issues of journals where a large number of the included studies were published (e.g. International Journal of Medical Informatics and Journal of the American Medical Informatics Association). Fourth, we contacted 12 authors who published more than one of the included studies. Fifth, we searched two general search engines; Google Scholar and Turning Research Into Practice (TRIP).

#### 2.1.2. Search terms

The search terms were identified based on three elements: population (e.g. patient\* and consumer\*), intervention (e.g. personal health record\*, personal medical record\*, personally controlled health record\*, and patient portal\*), and outcome (e.g. use\*, adopt\*, intention, and accept\*). Appendix A shows the search terms used for searching

each electronic database.

### 2.2. Study eligibility criteria

The eligibility criteria were developed according to seven elements. Population: participants had to be patients. Studies were excluded where participants were healthcare providers, caregivers, or designers. Intervention was constrained to tethered PHRs (as it is the most common type worldwide [19,20]). Tethered PHRs are connected with EMRs in one setting, and patients may not have or partially have control over their records [21]. Studies which had as their intervention only standalone PHRs (i.e. not connected with EHRs or Electronic Medical Records (EMRs)) or integrated PHRs (i.e. connected to EHRs in multiple settings) were excluded. Outcome of interest was intention to use as well as initial use. The outcome could be measured by asking the patients (i.e. subjectively-measured use) or by checking the system logs (i.e. objectively measured use). Studies were excluded if concerned only with continuing use. Studies could be quantitative, qualitative, or mixed methods. Only English language studies were included. Publications were considered for inclusion if they were peer-reviewed articles, theses, and conference proceedings in addition to unpublished studies (grey literature). The year of publication was restricted to studies published in 2000 and onwards as ePHRs were not widespread before the year 2000 or even before 2006 [22].

### 2.3. Study selection

The selection process consisted of two steps: firstly, screening titles and abstracts of all retrieved studies; secondly, reading full texts of studies included from the first step. Each step was carried by the principal reviewer (AA) and a research assistant (MK) independently. Any disagreements were resolved through further examination and discussion between both assessors (AA & MK). The interrater agreement, assessed using Cohen's kappa [23], was 0.83 and 0.88 in the first and second step of the selection process, respectively, indicating a very good agreement [24].

### 2.4. Data extraction

The reviewers developed a data extraction form, which was piloted using 10 included studies and modified accordingly. The data extraction process was carried out by two reviewers (AA & MK) independently. Any disagreements were resolved through further examination and discussion. The interrater agreement of 0.78 indicated a good agreement [24].

### 2.5. Study quality assessment

The Mixed Methods Appraisal Tool (MMAT) was used to assess the quality of included studies (see Appendix B) [25]. The MMAT consists of 21 criteria that are categorised into four groups [25]. The first group has two screening questions that must be applied to all studies regardless of their design. The second group is composed of four questions that are specific to assess the quality of qualitative studies and the qualitative part of mixed methods studies. The third group consists of 12 criteria for appraising quantitative studies and the quantitative part of mixed methods studies. The last group includes three criteria that must be applied to mixed methods studies. The quality of studies was assessed by two reviewers (AA & MK) independently. Disagreements on individual items were resolved through further examination and discussion. Interrater agreement was calculated at the item level. The interrater agreement was 0.84 indicating a very good agreement [24].

### 2.6. Data synthesis

The findings of the included studies were synthesised narratively.

Factors were categorised into three groups according to the outcome assessed: intention to use, subjectively-measured use, and objectively-measured use. Factors in each group were categorised into subgroups based on Or and Karsh's conceptual framework [15].

Findings of the included studies could not be synthesised statistically due to extreme heterogeneity of the studies in terms of outcome, setting, study method, statistical analyse, and study design. For this reason, the current review developed the following conditions that a factor needed to meet to draw a conclusion regarding its effect. Firstly, the factor must be examined by at least four studies. Factors that were examined by fewer studies (e.g. 2 or 3 studies) were not selected as the current review included many studies with weak and moderate quality, thereby, more studies were required to confirm the effect of a factor. In the same time, more studies (e.g. 5 or 6) were not selected as a cut-off point as this reduces considerably the number of factors that could meet this criterion. Four studies was a compromise which enabled a sufficient number of factors to be included for consideration while at the same time ensuring enough data was available to make an informed decision on the factors effect. Secondly, the effect of the factor must have a consensus among most studies that examined it. Thirdly, those studies that have consensus on the effect of the factor must be superior to the few studies that show a contrary effect in terms of study quality, sample size, and study method.

### 3. Results

#### 3.1. Search results

As shown in Fig. 1, the search process of 42 bibliographic databases and two web engines retrieved 5225 citations. After removing 1602 duplicates, 3623 unique titles and abstracts remained. Of those titles and abstracts, 3345 citations were excluded after scanning their titles and abstracts. By reading the full text of the 278 remaining citations, 85 publications were included. Nineteen additional studies were identified from others sources. In total, 104 publications were included in the synthesis. The 104 publications describe 97 unique studies as a dataset was used in more than one publication and each publication reported on different factors.

#### 3.2. Characteristics of studies

Most studies were quantitative ( $n = 85$ , 88%), survey ( $n = 76$ , 78%), journal article ( $n = 88$ , 91%), published in the USA ( $n = 81$ , 84%), published between 2012 and 2018 ( $n = 74$ , 76%), non-theory based studies ( $n = 81$ , 84%), and not restricted to people with certain conditions ( $n = 63$ , 65%) (Table 1). The mean age reported in 48 studies was 54 years. The mean of female percentage reported in 93 studies was 52.5%. While 34 studies had a low quality score ( $\leq 25\%$ ), 45 studies had high quality ( $\geq 75\%$ ).

#### 3.3. Quality of studies

In general, the quality of the quantitative studies ( $n = 85$ ) was moderate. As depicted in Fig. 2, 44% of the quantitative studies had a representative sample of the population. Approximately 58% of quantitative studies used an appropriate and valid data collection instrument and defined clearly the variables. About 71% of quantitative studies addressed the most important factors, listed the key demographic information, and took into account any dissimilarities between groups in the analysis. Lastly, 54% of quantitative studies had adequate outcome data ( $\geq 80\%$ ) in addition to a high response rate ( $\geq 60\%$ ).

Generally, the quality of the eight qualitative studies was moderate and slightly higher than quantitative studies. As presented in Fig. 3, 88% of qualitative studies selected the appropriate data sources and data analysis and discussed the influence of the context on the findings. However, none of the qualitative studies clarified how their findings

were affected by the researchers' perspective, role and interactions with participants.

In general, the quality of the four mixed-methods studies was low. As shown in Fig. 4, none of these studies reported the researchers' influence on the findings and the limitations of the integration process of qualitative and quantitative data. Similarly, the integration process did not clearly address the research question in any of the studies. Only one of the four studies had suitable data sources, appropriate and valid data collection instruments, and a representative sample. Two of the four studies met criteria regarding the relevance of data analysis, completeness of outcome data, and comparability of groups. Lastly, three of the mixed-methods studies explained the effect of context on the findings, and the appropriateness of mixed-methods design to answer the research question.

### 3.4. Results of studies

#### 3.4.1. Factors affecting intention to use

Twenty-nine publications (25 studies) assessed the effect of 59 factors on patients' intention to use ePHRs [26–54]. These factors were categorised into four main groups based on Or and Karsh's conceptual framework [15]: 38 personal factors, 10 human-technology interaction factors, 10 organisational factors, and one social factor. Further, personal factors were subdivided into three subgroups: 11 socio-demographic factors, 13 digital divide-related factors, and 14 health-related factors. All these grouped factors and their effects on intention to use ePHRs are presented in Appendix C.

Of those 59 factors, we were able to draw definitive conclusions regarding the effect of eight factors (see Appendix D). Four of those factors positively affect patients' intention to use: internet access, perceived usefulness, facilitating conditions, and internet use. On the other hand, there was no effect of three factors on intention to use: ethnicity, sex, and health status. The last factor (privacy and security concerns) has a negative effect on patients' intention.

#### 3.4.2. Factors affecting subjectively-measured use

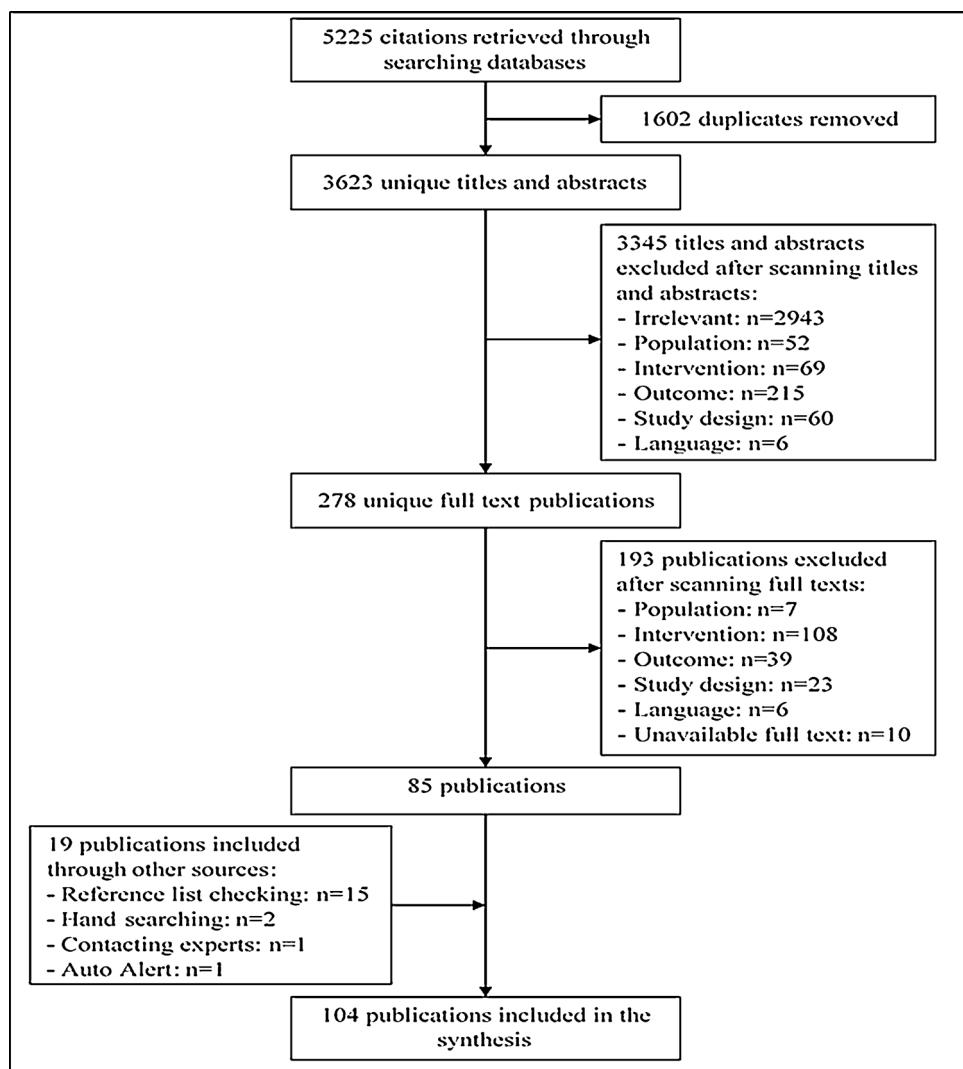
Twenty publications (19 studies) examined the influence of 52 factors on subjectively-measured use of ePHRs [32,47,50,55–71]. These factors were grouped into four main categories according to Or and Karsh's conceptual framework [15]: 35 personal factors, 9 human-technology interaction factors, 7 organisational factors, and 1 social factor. Further, personal factors were subdivided into three subgroups: 15 sociodemographic factors, 9 digital divide-related factors, and 11 health-related factors. All these grouped factors and their effects on subjectively-measured use of ePHRs are presented in Appendix E.

Of those 52 factors, decisive conclusions could be drawn regarding the impact of eight factors on the subjectively-measured use of ePHRs (see Appendix F). Four of those factors positively affect subjectively-measured use: education, income, internet access, perceived usefulness, perceived ease of use, and awareness of ePHRs. While sex does not affect subjectively-measured use, privacy and security concerns negatively affect it.

#### 3.4.3. Factors affecting objectively-measured use

The influence of 105 factors on objectively-measured use of ePHRs has been assessed by 59 publications (57 studies) [32,72–129]. The factors were classified into three main groups according to Or and Karsh's conceptual framework [15]: 80 personal factors, 9 human-technology interaction factors, and 16 organisational factors. The personal factors were subdivided into three subgroups: 15 socio-demographic factors, 12 digital divide-related factors, and 53 health-related factors. All these grouped factors and their effects on objectively-measured use of ePHRs are presented in Appendix G.

Of those 105 factors, we were able to draw definitive conclusions regarding the effect of 12 factors: education level, income, language, employment status, marital status, socioeconomic status, residence



**Fig. 1.** Flow chart of the study selection process.

place, internet access, internet use, computer access, perceived usefulness, and privacy and security concerns (see Appendix H). All these factors positively affect objectively-measured use except the latter factor, which negatively affects objectively-measured use.

#### 4. Discussion

##### 4.1. Principal findings

This review aimed to identify factors that affect patients' use of ePHRs. We identified ninety-seven individual studies examining the effect of more than 150 different factors: 59 factors related to intention to use, 52 factors regarding subjectively-measured use, and 105 factors related to objectively-measured use. In spite of this large number of factors, the current review was able to draw definitive conclusions regarding the effect of only 18 factors. For the remaining factors, definitive conclusions regarding their effect could not be drawn because they did not meet at least one of the three predefined criteria. This does not mean that those factors are not influential more than there is insufficient evidence to draw a firm conclusion.

Of the 18 factors, three factors affected each of intention to use, subjectively-measured use, and objectively-measured use: perceived usefulness, internet access, and privacy and security concerns (see Fig. 5). Sex did not affect intention to use and subjectively-measured

use. Internet use affected intention to use and objectively-measured use. Two factors, income and level of education, influenced subjectively-measured use and objectively-measured use. Three factors were related to only intention to use: facilitating conditions, health status, and ethnicity. Two factors influenced only subjectively-measured use: awareness of ePHRs and perceived ease of use. The remaining six factors affected only objectively-measured use: language, employment status, marital status, socioeconomic status, computer access, and residence place (see Fig. 5).

The 18 factors in the current review are represented across the five previous reviews [5,15,20,130,131]. More specifically, perceived usefulness [5,15,20], perceived ease of use [5,15,20], employment [5,15,20], marital status [5,15,20], privacy and security concerns [5,20,130], facilitating condition [5,20,130], education [5,20,130], awareness of ePHRs [5,20,130], health status [5,20,130], internet access [5,15,20,131], and income [5,15,20,131] were all factors identified in at least three of the previous reviews. Only Or and Karsh [15] supported our conclusions regarding gender, ethnicity, socioeconomic status, and internet use. Two reviews identified language and place of residence [15,20] as factors that were commonly identified as of importance to patients' use of ePHRs. The effect of computer access in our review was supported by two reviews [20,131]. The current review extends the findings of the five previous reviews by seeking to determine the effect of these factors.

**Table 1**  
Characteristics of the included studies.

Characteristics	Number of publications (number of studies) <sup>1</sup>		
<b>Study method</b>	Quantitative: 90 (85)	Qualitative:10 (8)	Mixed methods:4
<b>Study design</b>	Cross-sectional studies:83 (76)	Cohort:19	Case-control:2
<b>Type of publication</b>	Journal article:88	Conference proceeding:7	Thesis:9
<b>Country</b>	USA:85 (81) Finland:1 Jordan:1	Canada:8 (6) Portugal:1 Korea:1	Netherlands:4 New Zealand:2 (1) Argentina:1
<b>Year of publication</b>	2000-2005:0	2006-2011:30	2012-2018:74
<b>Study quality</b>	0%:14	25%:20	50%:21 (18)
<b>Theory used</b>	TAM:14 (10) PMT & TTF:1	UTAUT & URM:1 C-TAM & TPB:1	UTAUT2:1 SCT:1 IDT:1
<b>Sample size</b>	<500:48 (43)	500-999:8	1000-4999:14 <sup>2</sup>
<b>Mean age</b>	54 <sup>3</sup> years		≥5000:35 <sup>2</sup> (33)
<b>Age range</b>	18-98 <sup>4</sup>		
<b>Sex</b>	Female:52.5% <sup>5</sup>		
<b>Conditions</b>	General:67 (63) Diabetes:18 (17) Chronic diseases:4 Without diseases:4 (2) HIV:3 Cancer:2	Rheumatic diseases:1 Kidney diseases:1 Multiple sclerosis:1 Depression:1 Hypertension:1 Cardiac diseases:1	
<b>ePHR name</b>	MyChart:15 My HealtheVet:8 kp.org:6 (5) MyGroupHealth:6 (5) MyHealthManager:5 MyHealthAt Vanderbilt:4 Digitaal Logboek:3 Patient Gateway:2 PatientSite:2 UPMC HealthTrak:2	Portal Personal de Salud:1 OpenNotes:1 HealthView Portal:1 MyMDAnderson:1 MiCare:1 DirectMD:1 DTC PHR:1 My UNC Chart:1 eClinicalWorks:1	
<b>ePHR provided by</b>	Primary care:33 (29) Various settings:12	Specialised clinic:21	Hospital:14
<b>ePHR functions</b>	Accessing records:97 Booking appointments:74 Setting reminders:13 Adding information:9 Requesting referrals:4 Discussion groups:3 Communicating peers:1 Calendar:1	Messaging providers:93 Refilling prescriptions:74 Educational materials:44 Tracking system:10 Assessment tools:5 Checking billing:6 Tele-monitoring:1 Clinical decision support system:1	
<b>Tips</b>	1: Numbers in brackets refer to number of studies not publications. 2: One study has 2 different samples. 3: Mean Age was reported in 48 studies. 4: Age range was reported in 19 studies. 5: Sex was reported in 93 studies.		
<b>Abbreviations</b>	C-TAM & TPB: Combined TAM and TPB, IDT: Innovation Diffusion Theory, PMT: Protection Motivation Theory, SCT: Social Cognitive Theory, TAM: Technology Acceptance Model, TTF: Task Technology Fit, URM: User Resistance Model, UTAUT 2: Unified Theory of Acceptance and Use of Technology 2		

#### 4.2. Strengths and limitations

##### 4.2.1. Strengths

Of the eight previous reviews assessing factors that affect patients' adoption of ePHRs and patient portals [i.e. 5,15,20,130–134], the current review is the only one that differentiated between factors affecting the intention to use, subjectively-measured use, and objectively-measured use. This classification of factors provides more specificity in identifying the influential factors and allowed us to draw conclusions about the effect of 18 of the factors identified.

In comparison with the abovementioned reviews, this review is the only one that utilised five search sources (i.e. searching 42 bibliographic databases, checking reference lists, hand searching, contacting

experts and professionals, and searching two general web engines). As a result, this review contained the largest number of relevant studies (97 studies).

This review is the only one focused on the tethered PHRs while other literature either did not identify the type of ePHRs [e.g. 132 or included all types [e.g. 5]. The factors that affect patients' use of tethered PHRs may be different from those affecting other types of ePHRs due to the differences in the characteristics and functionalities [135–140].

The current review identified the largest number of factors (more than 150 different factors) in comparison with the other reviews. These factors were also grouped into main categories and subcategories (i.e. personal, human-technology interaction, organisational, social factors)

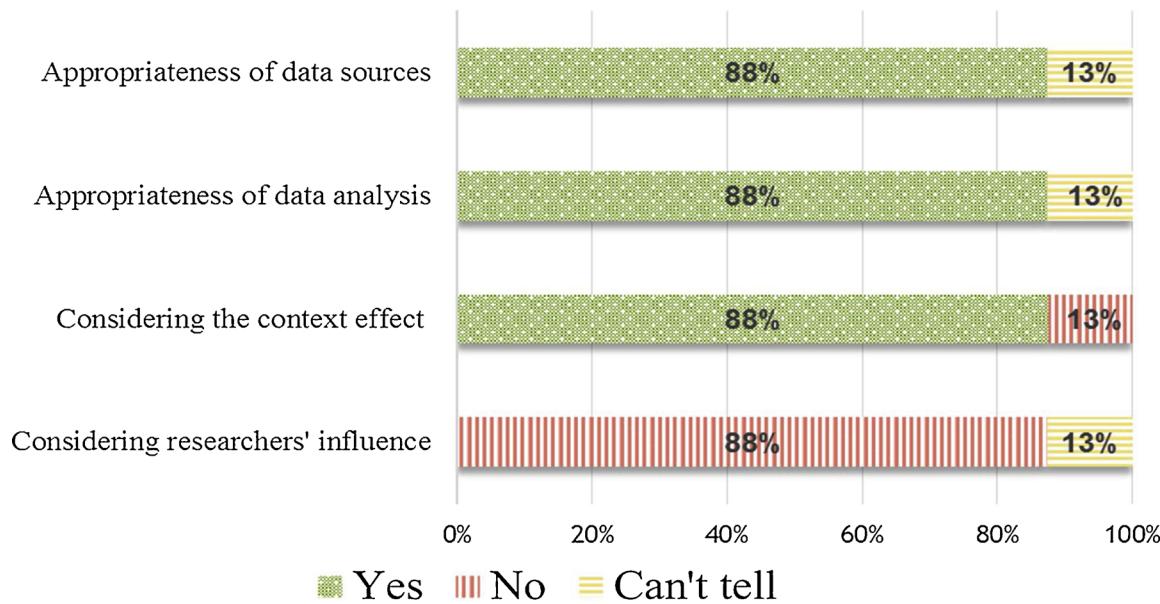


Fig. 2. Proportion of quality criterion met for qualitative studies.

based on a well-developed conceptual framework to enhance the understanding of ePHRs adoption.

Lastly, the current review is the first review that endeavoured to draw definitive conclusions regarding the effect of factors, and this was based on predefined criteria developed by the reviewer.

#### 4.2.2. Limitations

Although investigating factors affecting the use of ePHRs among healthcare providers and caregivers are very important [15,141], the current review concentrated on patients' adoption only. This is attributed to the fact that ePHRs is designed to be used by patients in the first place, thereby, their adoption is the most important aspect to be assessed.

This study focused on the adoption of tethered PHRs, and so may limit the ability to generalise the findings of this review to other types of ePHRs (i.e. stand-alone and integrated PHRs). This may be attributed to the fact that standalone and integrated PHRs have features and functions different from the tethered PHRs, thereby, the factors affecting patients' use of each type of ePHRs might be different [21,142,143]. For example, perceived privacy and security may have stronger effect on adoption of standalone PHRs than adoption of tethered PHRs as standalone PHRs are more vulnerable to hack attacks, theft, and damage [144,145]. Similarity, price value may play an

important role in adoption of standalone PHRs but not tethered PHRs as several standalone PHRs are not provided for free as with tethered PHRs [146].

As this review focused on factors that influence the initial use and intention to use ePHRs, its findings may not be generalised to factors affecting continuing use. This is because factors affecting initial use may be different from those influencing continuing use [41,147–151]. For example, perceived ease of use of a technology is a strong predictor of initial use but not continuing use [152]. In contrast, habit is an influential factor in relation to continuing use of a technology but not to initial use [153–155]. It is likely that some factors included in this review are not independent of one another (e.g. education and income). Included studies did not assess the moderating and mediating effects of the factors. Therefore, the relative contribution of each predictor cannot be ascertained.

The search process was restricted to studies published in 2000 onwards. This restriction should not affect the findings of this review because this review did not find any relevant study published between 2000 and 2005 indicating a likely paucity of research published before 2000.

As 84% of the included studies were conducted in the USA, the findings of this review may not be generalisable to other countries. Finally, the data were not synthesised statistically in this review (e.g.

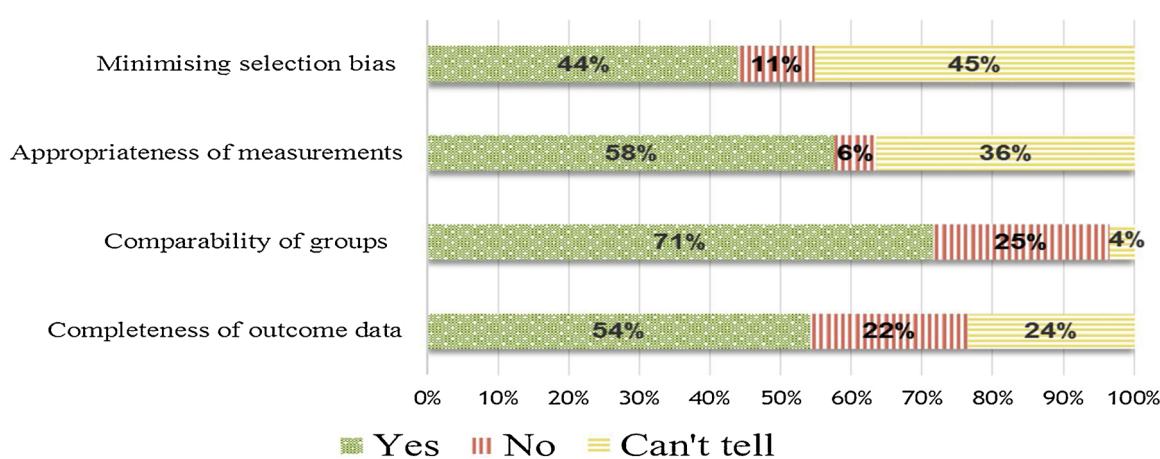
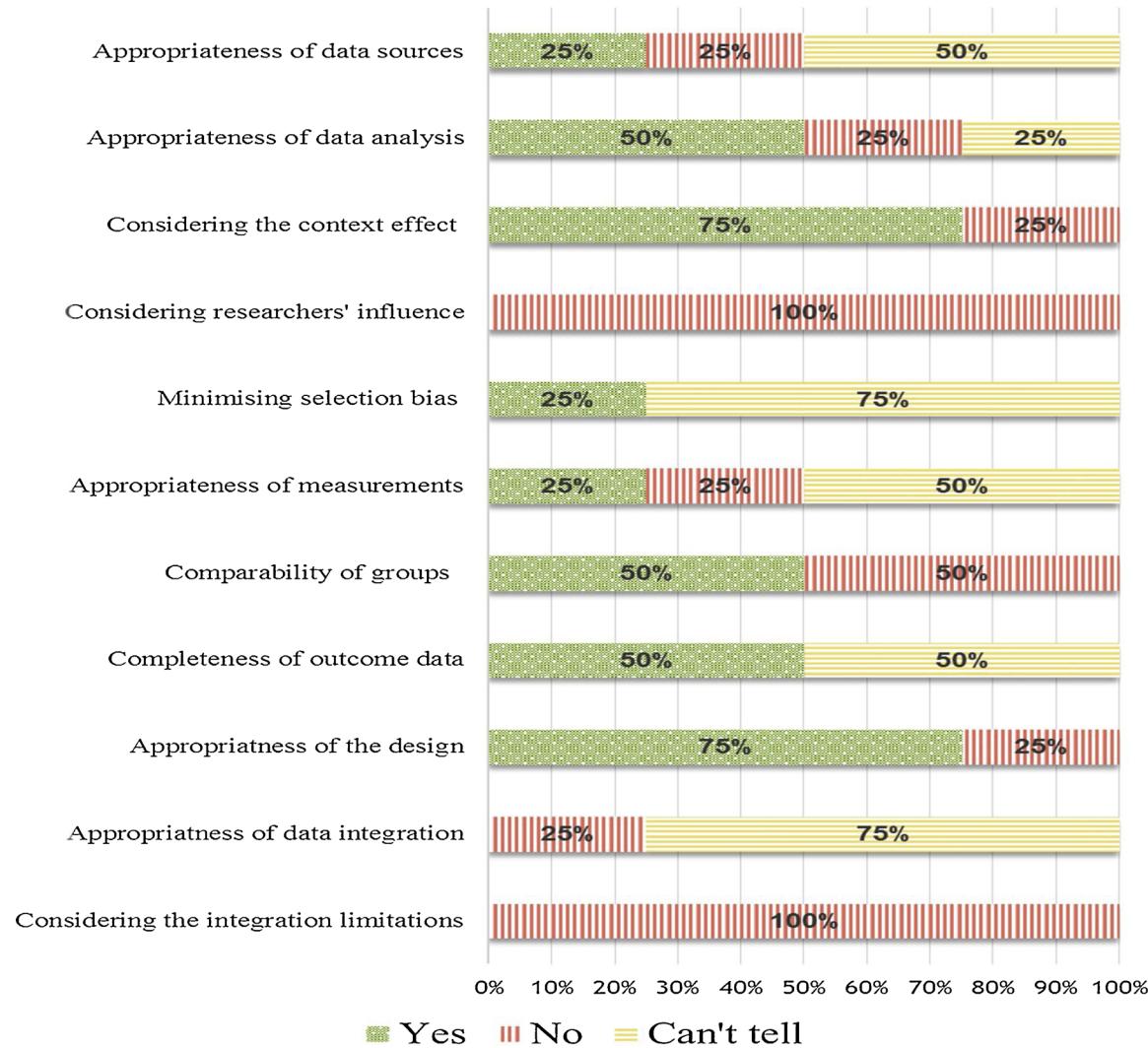


Fig. 3. Proportion of quality criterion met for quantitative studies.



**Fig. 4.** Proportion of quality criterion met for mixed-methods studies.

meta-analysis). A statistical synthesis could not be performed due to extreme heterogeneity of the studies in terms of outcome, setting, study method, statistical analyse, and study design.

#### 4.3. Practical and research implications

##### 4.3.1. Practical implications

Healthcare practices, policy makers, and developers of ePHRs should consider the factors found in this review, especially the 18 factors that the review drew definitive conclusions regarding their effect on adoption of ePHRs. For example, since the perceived usefulness and ease of use are identified as influential factors in the current review, developers of ePHRs should develop a system that is compatible with patients' skills, preferences and desires by involving patients in the process of designing, developing, and implementing systems. Further, healthcare practices should increase patients' perceptions regarding the benefits and ease of use of ePHRs through outreach programs.

As this review found concerns about privacy and security as an influential factor, patients should be assured by practices that the system is secure and no one can access their records without their permission. Furthermore, ePHR developers should protect the system with strong firewalls, complex passwords, regular security reviews, and software updates.

This review concluded that particular facilitating conditions positively affect the intention to use ePHRs. Therefore, practices should

provide patients with manuals, online assistance, technical support, and training sessions. Given the positive effect of patients' awareness of ePHRs on using the system, practices should increase patients' awareness of the system using advertising campaigns through different marketing channels, such as public media, social media, and face-to-face communication.

As several personal factors affect patients' adoption of ePHRs (e.g. income, education, employment status, language, using the internet, and having computer and internet access), providers of ePHRs should assess the characteristics of patients in the setting where the system will be implemented. If their characteristics are not comparable with the characteristics of users of the system that were found in the current review, system providers should postpone the implementation of the system and provide suitable solutions and interventions to facilitate those groups to use the system. For example, if the majority of patients registered in a practice do not use the internet, the practice should offer training sessions about using the internet for them. Further, if their first language is different from the language in the system, the developer should investigate whether amendments need to be made to facilitate ease of understanding and use (e.g. readability of content, translation of material). To increase the likelihood that systems are inclusive of ethnicity, income, gender or education system developers should ensure they seek input from a representative sample of users throughout design, development, and implementation.

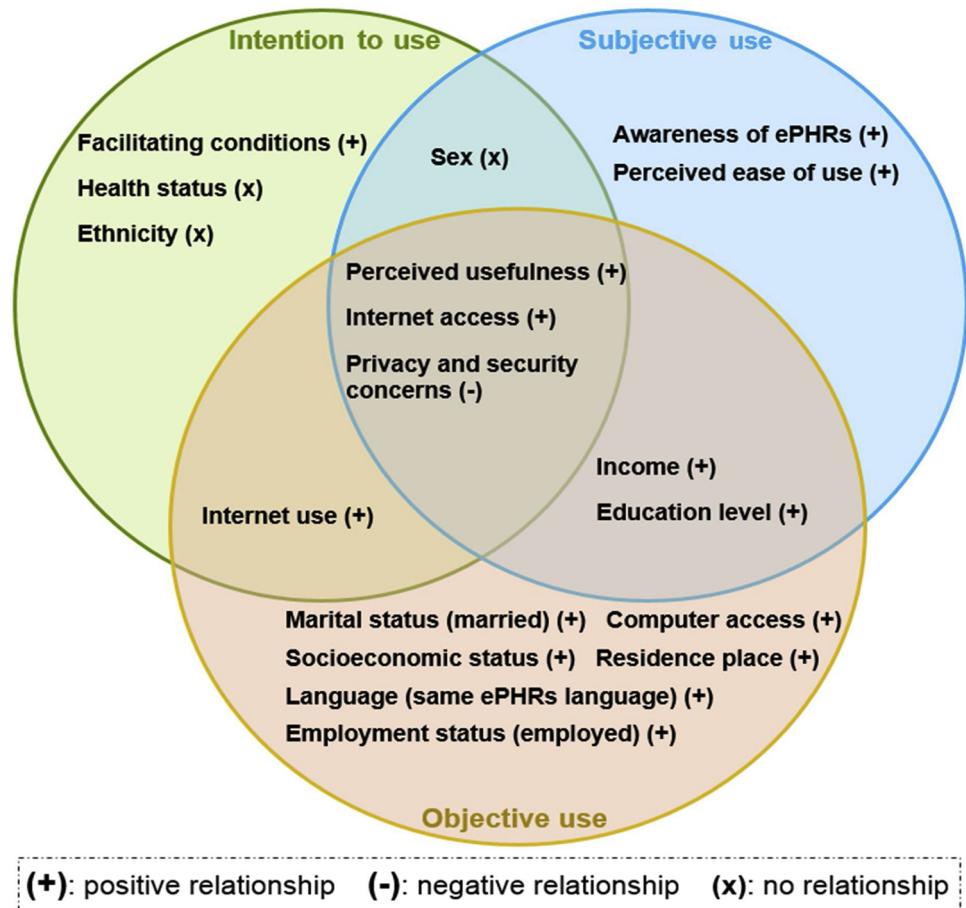


Fig. 5. Factors that had definitive conclusion regarding their effect.

#### 4.3.2. Research implications

All included studies were subject to the common method bias because they examined independent variables and dependent variables at one point in time and using one data collection instrument [21,148,156]. Therefore, future researchers should avoid this bias through examining the independent variables and dependent variables at two different time points and using at least two different instruments (such as questionnaires, system logs, and patient records).

Only 16 of the included studies were theory-based despite the importance of using a theoretical framework [5,12,14,20,79,157]. Furthermore, 10 of those 16 studies utilised the technology acceptance model (TAM) despite the existence of other competing theories such as the theory of reasoned action and unified theory of acceptance and use of technology [5,20]. Accordingly, the current review recommends researchers to conduct more theory-based studies and adopt other theories rather than TAM.

Most of the studies included in the current review focused on personal factors. Investigating a broader range of factors will enhance our understanding of ePHRs adoption [15]. Thus, future studies should include human-technology interaction factors, social factors, organisational factors, environmental factors as well as personal-factors.

Assessing moderating and mediating effects on relationships between the independent variables and dependent variables enhances understanding of factors that affect the adoption [15]. However, none of the included studies examined moderating and mediating effects on the proposed relationships. Therefore, future research should consider adding moderators and mediators to their models.

Although the included studies tested more than 150 factors, other factors were tested by studies included in other reviews but not in our review (because they did not meet all eligibility criteria); such as health

consciousness, perceived complexity of treatment, autonomy, self-management perception, provider quality measure, interoperability, trust in the provider, promotional adds, and social divide [5]. Consequently, future studies should examine the abovementioned factors.

As long-term viability and eventual success of information technologies count on continuing use more than initial use [147,148,153,158], researchers should endeavour to conduct studies and systematic reviews to assess factors that affect continuing use of ePHRs.

The majority of studies in this review were quantitative and carried out in the USA. Thus, researchers should conduct more mixed-methods studies in other developed and developing countries.

Lastly, included studies had low quality in several aspects such as representativeness of the sample, appropriateness of measurements, comparability of groups, and completeness of outcome data. Accordingly, researchers should conduct better quality studies by applying the MMAT criteria and reporting sufficient, standardised data to enable reviewers to synthesise the findings statistically.

## 5. Conclusion

Of the numerous factors examined by the included studies, this review concluded the effect of 18 factors: 13 personal factors (e.g. gender, ethnicity, and income), four human-technology factors (e.g. perceived usefulness and ease of use), and one organisational factor (facilitating conditions). These factors should be taken into account by stakeholders for the successful implementation of these systems. More studies are needed to conclude the effect of other factors. In addition, researchers should conduct more theory-based longitudinal studies for assessing factors affecting initial use and continuing use of ePHRs among

patients.

## Authors' contribution

The review was conducted by AA, with guidance from and under the supervision of BMB, TF, and PG. AA drafted the manuscript, and it was revised critically for important intellectual content by all authors. All authors approved the manuscript for publication and agree to be accountable for all aspects of the work.

## Conflicts of interest

The authors have no competing interests to declare.

## Summary Tables

What was already known on this topic:
<ul style="list-style-type: none"> <li>• Electronic personal health records are useful tools for converting the care from physician-centred to patient-centred.</li> <li>• Adoption rates of electronic personal health records are usually very low.</li> <li>• Many studies assessed factors affecting adoption of electronic personal health records.</li> </ul>
What this study added to our knowledge:
<ul style="list-style-type: none"> <li>• This review provides a long list of possible factors affecting patients' use and intention to use ePHRs, and these factors are categorised into four main groups.</li> <li>• This review demonstrated that previous studies focused mainly on personal factors.</li> <li>• Of the factors identified, the review concluded the effect of 18 factors: 13 personal factors (e.g. gender, ethnicity, and income), four human-technology factors (e.g. perceived usefulness and ease of use), and one organisational factor (facilitating conditions).</li> <li>• It is not necessarily that factors affecting intention to use influence the use as well, and vice versa.</li> </ul>

## Acknowledgements

The Authors would like to thank the research assistant Mohammad Khasawneh (MK) for his help in the screening of studies for inclusion in the review, extracting data from the included studies, and assessing the studies' quality.

## Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.ijmedinf.2019.03.014>.

## References

- [1] Markle Foundation, The Personal Health Working Group: Final Report, (2003) (12.08.18), [http://www.markle.org/sites/default/files/final\\_phwg\\_report1.pdf](http://www.markle.org/sites/default/files/final_phwg_report1.pdf).
- [2] B. Tulu, J. Trudel, D.M. Strong, S.A. Johnson, D. Sundaresan, L. Garber, Patient portals: an underused resource for improving patient engagement, *Chest* 149 (2016) 272–277 <https://doi.org/10.1378/chest.14-2559>.
- [3] J. Arauwou, Older Adults' Perceptions of the UTAUT2 Factors Related to Intention to Use a Patient Portal for Engagement in Their Healthcare, Doctor of Philosophy, School of Business and Technology Management, Northcentral University, 2017.
- [4] M.W. Huygens, J. Vermeulen, R.D. Friese, O.C. van Schayck, J.D. de Jong, L.P. de Witte, Internet services for communicating with the general practice: barely noticed and used by patients, *Interact. J. Med. Res.* 4 (2015) 1–12, <https://doi.org/10.2196/ijmr.4245>.
- [5] M. Najaftorkaman, A.H. Ghapanchi, A. Talaei-Khoei, Analysis of research in adoption of person-centred healthcare systems: the case of online personal health record, 25th Australasian Conference on Information Systems, Auckland, New Zealand, (2014), pp. 1–10.
- [6] A.A. Ozok, H. Wu, A.P. Gurses, Exploring patients' use intention of personal health record systems: implications for design, *Int. J. Hum. Comput. Int.* 33 (2017) 265–279, <https://doi.org/10.1080/10447318.2016.1277637>.
- [7] California HealthCare Foundation, Consumers and Health Information Technology: a National Survey, California HealthCare Foundation, 2010, pp. 1–40.
- [8] Markle Foundation, Americans Overwhelmingly Believe Electronic Personal Health Records Could Improve Their Health, (2008) <http://www.markle.org/sites/default/files/ResearchBrief-200806.pdf> (6 June 2016).
- [9] Markle Foundation, Markle Survey: PHR Adoption on the Rise; 1 in 10 Say They Have Electronic PHR, (2011) [http://www.markle.org/sites/default/files/5\\_PhRs.pdf](http://www.markle.org/sites/default/files/5_PhRs.pdf) (15 July 2016).
- [10] T. Greenhalgh, S. Hinder, K. Stramer, T. Bratan, J. Russell, Adoption, non-adoption, and abandonment of a personal electronic health record: case study of HealthSpace, *Br. Med. J.* 341 (2010) 1–11, <https://doi.org/10.1136/bmj.c5814>.
- [11] S. de Lusignan, P. Ross, M.A. Shiffrin, M. Hercigonja-Szekeres, B. Seroussi, A comparison of approaches to providing patients access to summary care records across old and new europe: an exploration of facilitators and barriers to implementation, *Stud. Health Technol. Inform.* 192 (2013) 397–401.
- [12] L.M. Daulby, Predictors of Electronic Personal Health Record Adoption among Health Care Consumers: a Case for "meaningful Use" Engagement, Doctor of Philosophy, School of Business and Technology, Capella University, 2015.
- [13] C.F. Liu, Y.C. Tsai, F.L. Jang, Patients' acceptance towards a web-based personal health record system: an empirical study in Taiwan, *Int. J. Environ. Res. Public Health* 10 (2013) 5191–5208, <https://doi.org/10.3390/ijerph10105191>.
- [14] C.K.L. Or, B.T. Karsh, D.J. Severtson, L.J. Burke, R.L. Brown, P.F. Brennan, Factors affecting home care patients' acceptance of a web-based interactive self-management technology, *J. Am. Med. Inform. Assoc.* 18 (2011) 51–59, <https://doi.org/10.1136/jamia.2010.007336>.
- [15] C.K.L. Or, B.T. Karsh, A Systematic review of patient acceptance of consumer health information technology, *J. Am. Med. Inform. Assoc.* 16 (2009) 550–560, <https://doi.org/10.1197/jamia.M2888>.
- [16] R.J. Holden, B. Karsh, A theoretical model of health information technology usage behaviour with implications for patient safety, *Behav. Inform. Technol.* 28 (2009) 21–38, <https://doi.org/10.1080/01449290601138245>.
- [17] B.T. Karsh, Beyond usability: designing effective technology implementation systems to promote patient safety, *Qual. Saf. Health Care* 13 (2004) 388–394, <https://doi.org/10.1136/qhc.13.5.388>.
- [18] A. Liberati, D.G. Altman, J. Tetzlaff, C. Mulrow, P.C. Götzsche, J.P. Ioannidis, M. Clarke, P.J. Devereaux, J. Kleijnen, D. Moher, The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration, *Brit. Med. J.* 62 (2009) e1–e34, <https://doi.org/10.1136/bmj.b2700>.
- [19] D.L. Davis, Acceptance of Personal Health Record Technology: a Survey Analysis of the Elderly, Doctor of Philosophy, Capella University, 2008.
- [20] M.J. Thompson, J.D. Reilly, R.S. Valdez, Work system barriers to patient, provider, and caregiver use of personal health records: a systematic review, *Appl. Ergon.* 54 (2016) 218–242, <https://doi.org/10.1016/j.apergo.2015.10.010>.
- [21] V. Assadi, Adoption of Integrated Personal Health Record Systems: a Self-determination Theory Perspective, Doctor of Philosophy, School of Graduate Studies, McMaster University, 2013.
- [22] T. Irizarry, A. DeVito Dabbs, C.R. Curran, Patient portals and patient engagement: a state of the science review, *J. Med. Internet Res.* 17 (2015) 1–15, <https://doi.org/10.2196/jmir.4255>.
- [23] J. Higgins, J. Deeks, Chapter 7: selecting studies and collecting data, in: J. Higgins, S. Green (Eds.), Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0, John Wiley & Sons, Sussex, UK, 2008, pp. 151–185.
- [24] D.G. Altman, Practical Statistics for Medical Research, Chapman and Hall, London, 1991.
- [25] P. Pluye, E. Robert, M. Cargo, G. Bartlett, A. O'Cathain, F. Griffiths, F. Boardman, M.-P. Gagnon, M. Rousseau, Proposal: a Mixed Methods Appraisal Tool for Systematic Mixed Studies Reviews, (2011) <http://mixedmethodsappraisaltoolpublic.pbworks.com> (17.08.18).
- [26] E.L. Abramson, V. Patel, A. Edwards, R. Kaushal, Consumer perspectives on personal health records: a 4-community study, *Am. J. Manag. Care* 20 (2014) 287–298.
- [27] R. Agarwal, C. Anderson, J. Zarate, C. Ward, If we offer it, will they accept? Factors affecting patient use intentions of personal health records and secure messaging, *J. Med. Internet Res.* 15 (2013) 1–14, <https://doi.org/10.2196/jmir.2243>.
- [28] N. Archer, M. Cocosila, Canadian patient perceptions of electronic personal health records: an empirical investigation, *J. Assoc. Inf. Syst.* 34 (2014) 389–406.
- [29] A.H. Cho, N.H. Arar, D.E. Edelman, P.H. Hartwell, E.Z. Oddone, W.S. Yancy Jr, Do diabetic veterans use the Internet? Self-reported usage, skills, and interest in using My HealthVet Web portal, *Telemed. J. E. Health* 16 (2010) 595–602.
- [30] M. Cocosila, N. Archer, Consumer perceptions of the adoption of electronic personal health records: an empirical investigation, *A. Proceedings (Ed.) AMCIS 2012 Proceedings, AMCIS 2012 Proceedings*, (2012).
- [31] M. Cocosila, N. Archer, Modeling consumer acceptance of electronic personal health records, *J. Electron. Commer. Res.* 19 (2018) 119–134.
- [32] N.P. Gordon, M.C. Hornbrook, Differences in access to and preferences for using patient portals and other ehealth technologies based on race, ethnicity, and age: a database and survey study of seniors in a large health plan, *J. Med. Internet Res.*

- 18 (2016) 1–28, <https://doi.org/10.2196/jmir.5105>.
- [33] S.Y. Kim, H.R. Kim, J. Bae, Y. Kim, The consumers' perceptions and requirements for personal health records in Korea, *J. Korean Soc. Med. Inform.* 15 (2009) 273–284, <https://doi.org/10.4258/jksmi.2009.15.3.273>.
- [34] R. Klein, An empirical examination of patient-physician portal acceptance, *Eur. J. Inf. Syst.* 16 (2007) 751–760, <https://doi.org/10.1057/palgrave.ejis.3000719>.
- [35] D.J. Laugesen, Adoption of Electronic Personal Health Records by Chronic Disease Patients: Integrating Protection Motivation Theory and Task-technology Fit, *Doctor of Philosophy, DeGroote School of Business, McMaster University*, 2013.
- [36] A.J. Lazarid, I. Watkins, M.S. Mackert, B. Xie, K.K. Stephens, H. Shalev, Design simplicity influences patient portal use: the role of aesthetic evaluations for technology acceptance, *J. Am. Med. Inform. Assoc.* 23 (2016) e157–e161, <https://doi.org/10.1093/jamia/ocv174>.
- [37] P. Nambisan, Factors that impact Patient Web Portal Readiness (PWPR) among the underserved, *Int. J. Med. Inform.* 102 (2017) 62–70, <https://doi.org/10.1016/j.ijmedinf.2017.03.004>.
- [38] A. Noblin, Intention to Use a Personal Health Record (PHR) a Cross Sectional View of the Characteristics and Opinions of Patients of One Internal Medicine Practice, *Doctor of Philosophy Public Affairs University of Central Florida*, 2010.
- [39] A. Noblin, T. Wan, M. Fottler, The impact of health literacy on a patient's decision to adopt a personal health record, *Perspect. Health Inf. Manag.* 9 (2012) 1–13.
- [40] A. Noblin, T. Wan, M. Fottler, Intention to use a personal health record: a theoretical analysis using the technology acceptance model, *Int. J. Healthcare Technol. Manag.* 14 (2013) 73–89, <https://doi.org/10.1504/IJHTM.2013.055085>.
- [41] V.N. Patel, E. Abramson, A.M. Edwards, M.A. Cheung, R.V. Dhopeshwarkar, R. Kaushal, Consumer attitudes toward personal health records in a beacon community, *Am. J. Manag. Care* 17 (2011) e104–e120.
- [42] V.N. Patel, R.V. Dhopeshwarkar, A. Edwards, Y. Barron, A. Likourezos, L. Burd, D. Olshansky, R. Kaushal, Low-income, ethnically diverse consumers' perspective on health information exchange and personal health records, *Inform. Health Soc. Care* 36 (2011) 233–252, <https://doi.org/10.3109/17538157.2011.554930>.
- [43] V.N. Patel, R.V. Dhopeshwarkar, A. Edwards, Y. Barron, J. Sparenborg, R. Kaushal, Consumer support for health information exchange and personal health records: a regional health information organization survey, *J. Med. Internet Res.* 36 (2012) 1043–1052, <https://doi.org/10.1007/s10916-010-9566-0>.
- [44] J. Razmak, C. Bélanger, Using the technology acceptance model to predict patient attitude toward personal health records in regional communities, *Inform. Tech. People* 31 (2018) 306–326, <https://doi.org/10.1108/ITP-07-2016-0160>.
- [45] B. Samhan, Why do people resist patient portal systems?: an application of the dual factor model of IT usage, *Int. J. Healthc. Inf. Syst. Inform.* 12 (2017) 68–86, <https://doi.org/10.4018/IJHISI.2017100105>.
- [46] M.R. Sanders, P. Winters, R.J. Fortuna, M. Mendoza, M. Berliant, L. Clark, K. Fiscella, Internet access and patient portal readiness among patients in a group of inner-city safety-net practices, *J. Ambulatory Care Manag.* 36 (2013) 251–259, <https://doi.org/10.1097/JAC.0b013e31829702f9>.
- [47] J. Tavares, T. Oliveira, Electronic health record patient portal adoption by health care consumers: an acceptance model and survey, *J. Med. Internet Res.* 18 (2016) 1–19, <https://doi.org/10.2196/jmir.5069>.
- [48] C.A. Torres, Examining the Role of Anxiety and Apathy in Health Consumers' Intentions to Use Patient Health Portals for Personal Health Information Management, *Doctor of Philosophy, College of Communication and Information Florida State University*, 2011.
- [49] R. van der Vaart, C.H. Drossaert, E. Taal, M.A. van de Laar, Patient preferences for a hospital-based rheumatology Interactive Health Communication Application and factors associated with these preferences, *Rheumatology* 50 (2011) 1618–1626, <https://doi.org/10.1093/rheumatology/ker161>.
- [50] D.S. Wakefield, R.L. Kruse, B.J. Wakefield, R.J. Koopman, L.E. Keplinger, S.M. Canfield, D.R. Mehr, Consistency of patient preferences about a secure internet-based patient communications portal: contemplating, enrolling, and using, *Am. J. Med. Qual.* 27 (2012) 494–502, <https://doi.org/10.1177/1062860611436246>.
- [51] Q. Nguyen, The Views and Expectations of Young Healthy Adults About Using an Online Personal Health Record, *Master of Science, Department of Family Medicine, McGill University*, 2011.
- [52] Q. Nguyen, G. Bartlett, C. Rodriguez, P.-P. Tellier, Young adults on the perceived benefits and expected use of personal health records: a qualitative descriptive study, *J. Innov. Health Inform.* 23 (2016) 466–475, <https://doi.org/10.14236/jhi.v23i1.171>.
- [53] S.L. Zickmund, R. Hess, C.L. Bryce, K. McTigue, E. Olshansky, K. Fitzgerald, G.S. Fischer, Interest in the use of computerized patient portals: role of the provider-patient relationship, *J. Gen. Intern. Med.* 23 (2008) 20–26, <https://doi.org/10.1007/s11606-007-0273-6>.
- [54] A.E. Luque, A. van Keken, P. Winters, M.C. Keefer, M. Sanders, K. Fiscella, Barriers and facilitators of online patient portals to personal health records among persons living with HIV: formative research, *JMIR Res. Protoc.* 2 (2013) 1–9, <https://doi.org/10.2196/resprot.2302>.
- [55] T.A. Arcury, S.A. Quandt, J.C. Sandberg, D.P. Miller Jr, C. Latulipe, X. Leng, J.W. Talton, K.P. Melius, A. Smith, A.G. Bertoni, Patient portal utilization among ethnically diverse low income older adults: observational study, *JMIR Med. Inform.* 5 (2017) 1–16, <https://doi.org/10.2196/medinform.8026>.
- [56] J.M. Butler, M. Carter, C. Hayden, B. Gibson, C. Weir, L. Snow, J. Morales, A. Smith, K. Bateman, A.V. Gundlapalli, M. Samore, Understanding adoption of a personal health record in rural health care clinics: revealing barriers and facilitators of adoption including attributions about potential patient portal users and self-reported characteristics of early adopting users, *AMIA Annu. Symp. Proc.* 2013 (2013) 152–161.
- [57] K.D. McInnes, S.L. Shimada, S.R. Rao, A. Quill, M. Duggal, A.L. Gifford, C.A. Brandt, T.K. Houston, M.E. Ohl, K.S. Gordon, K.M. Mattocks, L.E. Kazis, A.C. Justice, Personal health record use and its association with antiretroviral adherence: survey and medical record data from 1871 US veterans infected with HIV, *AIDS Behav.* 17 (2013) 3091–3100, <https://doi.org/10.1007/s10461-012-0399-3>.
- [58] A.A. Morton, Examining Acceptance of an Integrated Personal Health Record (PHR), *Doctor of Philosophy, Nursing University of Maryland*, 2012.
- [59] J.G. Ruiz, A.D. Andrade, C. Hogue, C. Karanam, S. Akkineni, D. Cevallos, R. Anam, J. Sharit, The association of graph literacy with use of skills using an online personal health record in outpatient veterans, *J. Health Commun.* 21 (2016) 83–90, <https://doi.org/10.1080/10810730.2016.1193915>.
- [60] D. Sherifi, Perceived Usefulness and Perceived Ease of Use Impact on Patient Portal Use, *Doctor of Philosophy, Walden University*, 2018.
- [61] J. Tsai, R.A. Rosenheck, Use of the internet and an online personal health record system by US veterans: comparison of Veterans Affairs mental health service users and other veterans nationally, *J. Am. Med. Inform. Assoc.* 19 (2012) 1089–1094, <https://doi.org/10.1136/amiajnl-2012-000971>.
- [62] K. Day, Y. Gu, Influencing factors for adopting personal health record (PHR), *Stud. Health Technol. Inform.* 178 (2012) 39–44, <https://doi.org/10.3233/978-1-61499-078-9-39>.
- [63] Y. Gu, K. Day, Propensity of people with long-term conditions to use personal health records, *Stud. Health Technol. Inform.* 188 (2013) 46–51, <https://doi.org/10.3233/978-1-61499-266-0-46>.
- [64] K. Dontje, W.D. Corser, G. Holzman, Understanding patient perceptions of the electronic personal health record, *J. Nurse Pract.* 10 (2014) 824–828, <https://doi.org/10.1016/j.nurpra.2014.09.009>.
- [65] R. Hess, C.L. Bryce, S. Paone, G. Fischer, K.M. McTigue, E. Olshansky, S. Zickmund, K. Fitzgerald, L. Siminerio, Exploring challenges and potentials of personal health records in diabetes self-management: Implementation and initial assessment, *Telemed. J. E. Health* 13 (2007) 509–517, <https://doi.org/10.1089/tmj.2006.0089>.
- [66] R.G. Mishuris, M. Stewart, G.M. Fix, T. Marcello, D.K. McInnes, T.P. Hogan, J.B. Boardman, S.R. Simon, Barriers to patient portal access among veterans receiving home-based primary care: a qualitative study, *Health Expect.* 18 (2015) 2296–2305, <https://doi.org/10.1111/hex.12199>.
- [67] L. Tieu, U. Sarkar, D. Schillinger, J.D. Ralston, N. Ratanawongsa, R. Pasick, C.R. Lyles, Barriers and facilitators to online portal use among patients and caregivers in a safety net health care system: a qualitative study, *J. Med. Internet Res.* 17 (2015) 1–11, <https://doi.org/10.2196/jmir.4847>.
- [68] A.N. Turner, K. Osterhage, J. Joe, A. Hartzler, L. Lin, G. Demiris, Use of patient portals: personal health information management in older adults, *AMIA Annu. Symp. Proc.* (2015) 1234–1241.
- [69] L.S. Mayberry, S. Kripalani, R.L. Rothman, C.Y. Osborn, Bridging the digital divide in diabetes: family support and implications for health literacy, *Diabetes Technol. Ther.* 13 (2011) 1005–1012, <https://doi.org/10.1089/dia.2011.0055>.
- [70] C.Y. Osborn, L.S. Mayberry, K.A. Wallston, K.B. Johnson, T.A. Elasy, Understanding patient portal use: implications for medication management, *J. Med. Internet Res.* 15 (2013) e133, <https://doi.org/10.2196/jmir.2589>.
- [71] B. Tulu, D. Strong, S. Johnson, I. Bar-On, J. Trudel, L. Garber, Personal health records: identifying utilization patterns from system use logs and patient interviews, *45th Hawaii International Conference on System Science IEEE* (2012) 2716–2725.
- [72] J.S. Ancker, Y. Barron, M.L. Rockoff, D. Hauser, M. Richardson, A. Szerencsy, N. Calman, Use of an electronic patient portal among disadvantaged populations, *J. Gen. Intern. Med.* 26 (2011) 1117–1123, <https://doi.org/10.1007/s11606-011-1749-y>.
- [73] J.S. Ancker, S.N. Osorio, A. Cherif, C.L. Cole, M. Silver, R. Kaushal, Patient activation and use of an electronic patient portal, *Inform. Health Soc. Care* 40 (2015) 254–266, <https://doi.org/10.3109/17538157.2014.908200>.
- [74] J.S. Ancker, S. Nosal, D. Hauser, C. Way, N. Calman, Access policy and the digital divide in patient access to medical records, *Health Policy Technol.* 6 (2016) 3–11, <https://doi.org/10.1016/j.hapt.2016.11.004>.
- [75] J.E. Cahill, L. Lin, G. LoBiondo-Wood, T.S. Armstrong, A.A. Acquaye, E. Vera-Bolanos, M.R. Gilbert, N.S. Padhye, Personal health records, symptoms, uncertainty, and mood in brain tumor patients, *Neurooncol. Pract.* 1 (2014) 64–70, <https://doi.org/10.1093/nop/npu005>.
- [76] D. Carrell, J.D. Ralston, Variation in adoption rates of a patient web portal with a shared medical record by age, gender, and morbidity level, *AMIA Annu. Symp. Proc.* (2006) 871.
- [77] E. Chang, K. Blondon, C.R. Lyles, L. Jordan, J.D. Ralston, Racial/ethnic variation in devices used to access patient portals, *Am. J. Manag. Care* 24 (2018) e1–e8.
- [78] S.E. Davis, C.Y. Osborn, S. Kripalani, K.M. Goggins, G.P. Jackson, Health literacy, education levels, and patient portal usage during hospitalizations, *AMIA Annu. Symp. Proc. Am. Med. Inform. Assoc.* (2015) 1871–1880.
- [79] S. Emani, C.K. Yamin, E. Peters, A.S. Karson, S.R. Lipsitz, J.S. Wald, D.H. Williams, D.W. Bates, Patient perceptions of a personal health record: a test of the diffusion of innovation model, *J. Med. Internet Res.* 14 (2012) 1–15, <https://doi.org/10.2196/jmir.2278>.
- [80] S. Furniss, Characteristics of Patients Using a Patient Portal Via Mobile Technology, *Master of Science, The Ohio State University*, 2017.
- [81] T. Garrido, M. Kanter, M. Di, M. Turley, W. Jian, V. Sue, L. Scott, Race/Ethnicity, personal health record access, and quality of care, *Am. J. Manag. Care* 21 (2015) e103–e113.
- [82] D.E. Gerber, A.L. Laccetti, B. Chen, J. Yan, J. Cai, S. Gates, Y. Xie, S.J. Lee, Predictors and intensity of online access to electronic medical records among

- patients with cancer, *J. Oncol. Pract.* 10 (2014) e307–e312, <https://doi.org/10.1200/JOP.2013.001347>.
- [83] M.S. Goel, T.L. Brown, A. Williams, A.J. Cooper, R. Hasnain-Wynia, D.W. Baker, Patient reported barriers to enrolling in a patient portal, *J. Am. Med. Inform. Assoc.* 18 (2011) i8–i12, <https://doi.org/10.1136/amiajnl-2011-000473>.
- [84] M.S. Goel, T.L. Brown, A. Williams, R. Hasnain-Wynia, J.A. Thompson, D.W. Baker, Disparities in enrollment and use of an electronic patient portal, *J. Gen. Intern. Med.* 26 (2011) 1112–1116, <https://doi.org/10.1007/s11606-011-1728-3>.
- [85] I. Graetz, J. Huang, R.J. Brand, J. Hsu, C.K. Yamin, M.E. Reed, Bridging the digital divide: mobile access to personal health records among patients with diabetes, *Am. J. Manag. Care* 24 (2018) 43–48.
- [86] A. Griffin, A. Skinner, J. Thornhill, M. Weinberger, Patient Portals: who uses them? What features do they use? and do they reduce hospital readmissions? *Appl. Clin. Inform.* 7 (2016) 489–501, <https://doi.org/10.4338/ACI-2016-01-RA-0003>.
- [87] J.H. Hibbard, J. Greene, Who are we reaching through the patient portal: engaging the already engaged? *Int. J. Pers. Cent. Med.* 1 (2011) 788–793, <https://doi.org/10.5750/ijpcm.v1i4.152>.
- [88] M. Horvath, J. Levy, P. L'Engle, B. Carlson, A. Ahmad, J. Ferranti, Impact of health portal enrollment with email reminders on adherence to clinic appointments: a pilot study, *J. Med. Internet Res.* 13 (2011) 1–14, <https://doi.org/10.2196/jmir.1702>.
- [89] M. Jhamb, K.L. Cavanaugh, A. Bian, G. Chen, T. Alp Ikizler, M.L. Unruh, K. Abdel-Kader, Disparities in electronic health record patient portal use in nephrology clinics, *Clin. J. Am. Soc. Nephrol.* 10 (2015) 2013–2022, <https://doi.org/10.2215/CJN.01640215>.
- [90] M. Lau, H. Campbell, T. Tang, D.J. Thompson, T. Elliott, Impact of patient use of an online patient portal on diabetes outcomes, *Can. J. Diabetes* 38 (2014) 17–21, <https://doi.org/10.1016/j.jcjd.2013.10.005>.
- [91] S.G. Leveille, R. Mejilla, L. Ngo, A. Fossa, J.G. Elmore, J. Darer, J.D. Ralston, T. Delbanco, J. Walker, Do patients who access clinical information on patient internet portals have more primary care visits? *Med. Care* 54 (2016) 17–23, <https://doi.org/10.1097/MLR.0000000000000442>.
- [92] C.R. Lyles, L.T. Harris, L. Jordan, L. Grothaus, L. Wehnies, R.J. Reid, J.D. Ralston, Patient race/ethnicity and shared medical record use among diabetes patients, *Med. Care* 50 (2012) 434–440, <https://doi.org/10.1097/MLR.0b013e318249d81b>.
- [93] C.R. Lyles, U. Sarkar, J.D. Ralston, N. Adler, D. Schillinger, H.H. Moffet, E.S. Huang, A.J. Karter, Patient-provider communication and trust in relation to use of an online patient portal among diabetes patients: The Diabetes and Aging Study, *J. Am. Med. Inform. Assoc.* 20 (2013) 1128–1131, <https://doi.org/10.1136/amiajnl-2012-001567>.
- [94] W. Manard, J.F. Scherrer, J. Salas, F.D. Schneider, Patient portal use and blood pressure control in newly diagnosed hypertension, *J. Am. Board Fam. Med.* 29 (2016) 452–459, <https://doi.org/10.3122/jabfm.2016.04.160008>.
- [95] M. Martinez, A. Baum, A.M. Gomez Saldano, A. Gomez, D. Luna, F. Gonzalez Bernaldo de Quiros, Predictive variables of the use of personal health record: the Hospital Italiano de Buenos Aires study, *Stud. Health Technol. Inform.* 192 (2013) 1–6, <https://doi.org/10.3233/978-1-61499-289-9-1171>.
- [96] S.P. Mikles, T.J. Mielenz, Characteristics of electronic patient-provider messaging system utilisation in an urban health care organisation, *J. Innov. Health Inform.* 22 (2015) 214–221, <https://doi.org/10.14236/jhi.v22i1.75>.
- [97] H. Miller, B. Vandembosch, D. Ivanov, P. Black, Determinants of personal health record use: a large population study at Cleveland Clinic, *J. Healthc. Inf. Manag.* 21 (2007) 44–48.
- [98] P.J. Mook, A.W. Trickey, K.E. Krakowski, S. Majors, M.A. Theiss, C. Fant, M.A. Friesen, Exploration of portal activation by patients in a healthcare system, *Comput. Inform. Nurs.* 36 (2018) 18–26, <https://doi.org/10.1097/CIN.0000000000000392>.
- [99] K.M. Nazi, Veterans' voices: use of the american customer satisfaction index (ACSI) survey to identify my HealtheVet personal health record users' characteristics, needs, and preferences, *J. Am. Med. Inform. Assoc.* 17 (2010) 203–211, <https://doi.org/10.1136/jamia.2009.000240>.
- [100] A.S. Nielsen, J.D. Halamaik, R.P. Kinkel, Internet portal use in an academic multiple sclerosis center, *J. Am. Med. Inform. Assoc.* 19 (2012) 128–133, <https://doi.org/10.1136/amiajnl-2011-000177>.
- [101] T.E. Palen, C. Ross, J.D. Powers, S. Xu, Association of online patient access to clinicians and medical records with use of clinical services, *J. Am. Med. Assoc.* 308 (2012), <https://doi.org/10.1001/jama.2012.14126> 2012–2019.
- [102] J. Pecina, F. North, M.D. Williams, K.B. Angstman, Use of an on-line patient portal in a depression collaborative care management program, *J. Affect. Disord.* 208 (2017) 1–5, <https://doi.org/10.1016/j.jad.2016.08.034>.
- [103] A.T. Perzynski, M.J. Roach, S. Shick, B. Callahan, D. Gunzler, R. Cebul, D.C. Kaelber, A. Huml, J.D. Thornton, D. Einstadter, Patient portals and broadband internet inequality, *J. Am. Med. Inform. Assoc.* 24 (2017) 927–932, <https://doi.org/10.1093/jamia/oxz020>.
- [104] T.S. Raghu, K. Frey, Y.H. Chang, M.R. Cheng, S. Freimund, A. Patel, Using secure messaging to update medications list in ambulatory care setting, *Int. J. Med. Inform.* 84 (2015) 754–762, <https://doi.org/10.1016/j.ijmedinf.2015.06.003>.
- [105] J.D. Ralston, D. Carrell, R. Reid, M. Anderson, M. Moran, J. Hereford, Patient web services integrated with a shared medical record: patient use and satisfaction, *J. Am. Med. Inform. Assoc.* 14 (2007) 798–806, <https://doi.org/10.1197/jamia.1M2302>.
- [106] J.D. Ralston, J. Hereford, D. Carrell, Use and satisfaction of a patient Web portal with a shared medical record between patients and providers, *AMIA Annu. Symp. Proc.* (2006) pp. 1070.
- [107] J.D. Ralston, M.J. Silverberg, L. Grothaus, W.A. Leyden, T. Ross, C. Stewart, S. Carzasty, M. Horberg, S.L. Catz, Use of web-based shared medical records among patients with HIV, *Am. J. Manag. Care* 19 (2013) e114–e124.
- [108] I. Riippa, M. Linna, I. Ronkko, V. Kroger, Use of an electronic patient portal among the chronically ill: an observational study, *J. Med. Internet Res.* 16 (2014) 1–10, <https://doi.org/10.2196/jmir.3722>.
- [109] J.R. Robinson, S.E. Davis, R.M. Cronin, G.P. Jackson, Use of a patient portal during hospital admissions to surgical services, *AMIA Annu. Symp. Proc. Am. Med. Inform. Assoc.* (2016) 1967–1976.
- [110] D.W. Roblin, T.K. Houston Ii, J.J. Allison, P.J. Joski, E.R. Becker, Disparities in use of a personal health record in a managed care organization, *J. Am. Med. Inform. Assoc.* 16 (2009) 683–689, <https://doi.org/10.1197/jamia.M3169>.
- [111] D.M. Rodman, *Meaningful Use: the Utilization of Patient Portals*, Master of Science, D'Youville College, 2015.
- [112] M.C. Ronda, L.T. Dijkhorst-Oei, K.J. Gorter, J.W. Beulens, G.E. Rutten, Differences between diabetes patients who are interested or not in the use of a patient Web portal, *Diabetes Technol. Ther.* 15 (2013) 556–563, <https://doi.org/10.1089/dia.2013.0023>.
- [113] M.C. Ronda, L.T. Dijkhorst-Oei, G.E. Rutten, Reasons and barriers for using a patient portal: survey among patients with diabetes mellitus, *J. Med. Internet Res.* 16 (2014) 1–12, <https://doi.org/10.2196/jmir.3457>.
- [114] M.C. Ronda, L.T. Dijkhorst-Oei, G.E. Rutten, Patients' experiences with and attitudes towards a diabetes patient web portal, *PLoS One* 10 (2015) 1–11, <https://doi.org/10.1371/journal.pone.0129403>.
- [115] R. Sandefur, *Predicting Personal Healthcare Management: Impact of Individual Characteristics on Patient Use of Health Information Technology*, Doctor of Philosophy, University of Minnesota, 2017.
- [116] U. Sarkar, A.J. Karter, J.Y. Liu, N.E. Adler, R. Nguyen, A. Lopez, D. Schillinger, The literacy divide: health literacy and the use of an internet-based patient portal in an integrated health system-results from the diabetes study of northern California (DISTANCE), *J. Health Commun.* 15 (2010) 183–196, <https://doi.org/10.1080/10810730.2010.499988>.
- [117] U. Sarkar, A.J. Karter, J.Y. Liu, N.E. Adler, R. Nguyen, A. Lopez, D. Schillinger, Social disparities in internet patient portal use in diabetes: evidence that the digital divide extends beyond access, *J. Am. Med. Inform. Assoc.* 18 (2011) 318–321, <https://doi.org/10.1197/jamia.2010.006015>.
- [118] S.L. Shimada, C.A. Brandt, H. Feng, D.K. McInnes, S.R. Rao, J.A. Rothendler, D.A. Haggstrom, E.A. Abel, L.S. Ciuffari, T.K. Houston, Personal health record reach in the veterans health administration: a cross-sectional analysis, *J. Med. Internet Res.* 16 (2014) 1–13, <https://doi.org/10.2196/jmir.3751>.
- [119] A.-L. Silvestre, V.M. Sue, J.Y. Allen, If you build it, will they come? The Kaiser Permanente model of online health care, *Health Aff.* 28 (2009) 334–344, <https://doi.org/10.1377/hlthaff.28.2.334>.
- [120] S.G. Smith, R. O'Conor, W. Aitken, L.M. Curtis, M.S. Wolf, M.S. Goel, Disparities in registration and use of an online patient portal among older adults: findings from the LitCog cohort, *J. Am. Med. Inform. Assoc.* 22 (2015) 888–895, <https://doi.org/10.1193/jamia.ocv025>.
- [121] V.M. Sue, M.T. Griffin, J.Y. Allen, Individual characteristics associated with PHR use in an integrated care organization, 44th Hawaii International Conference on System Sciences, Kauai, USA, (2011), pp. 1–9.
- [122] V.M. Sue, M.T. Griffin, J.Y. Allen, Beyond adoption: individual differences in the use of personal health record features in an integrated healthcare organisation, *Int. J. Biomed. Eng. Tech.* 11 (2013) 252–269, <https://doi.org/10.1504/IJBET.2013.055375>.
- [123] M. Tenforde, A. Nowacki, A. Jain, J. Hickner, The association between personal health record use and diabetes quality measures, *J. Gen. Intern. Med.* 27 (2012) 420–424, <https://doi.org/10.1007/s11606-011-1889-0>.
- [124] B. Tulu, A.C. Trapp, D.M. Strong, S.A. Johnson, M. Hoque, J. Trudel, L. Garber, An analysis of patient portal utilization: what can we learn about online patient behavior by examining portal click data? *Health Syst.* 5 (2016) 66–79, <https://doi.org/10.1057/hs.2015.5>.
- [125] L.S. Wallace, H. Angier, N. Huguet, J.A. Gaudino, A. Krist, M. Dearing, M. Killerby, M. Marino, J.E. DeVoe, Patterns of electronic portal use among vulnerable patients in a nationwide practice-based research network: from the OCHIN practice-based research network (PBRN), *J. Am. Board Fam. Med.* 29 (2016) 592–603, <https://doi.org/10.3122/jabfm.2016.05.160046>.
- [126] S.N. Weingart, D. Rind, Z. Tofias, D.Z. Sands, Who uses the patient internet portal? The PatientSite experience, *J. Am. Med. Inform. Assoc.* 13 (2006) 91–95, <https://doi.org/10.1197/jamia.M1833>.
- [127] W.G. Weppner, J.D. Ralston, T.D. Koepsell, L.C. Grothaus, R.J. Reid, L. Jordan, E.B. Larson, Use of a shared medical record with secure messaging by older patients with diabetes, *Diabetes Care* 33 (2010) 2314–2319, <https://doi.org/10.2337/dc10-1124>.
- [128] S.S. Woods, C.W. Forsberg, E.C. Schwartz, K.M. Nazi, J.H. Hibbard, T.K. Houston, M. Gerrity, The association of patient factors, digital access, and online behavior on sustained patient portal use: a prospective cohort of enrolled users, *J. Med. Internet Res.* 19 (2017) 1–14, <https://doi.org/10.2196/jmir.7895>.
- [129] C.K. Yamin, S. Emani, D.H. Williams, S.R. Lipsitz, A.S. Karson, J.S. Wald, D.W. Bates, The digital divide in adoption and use of a personal health record, *Arch. Intern. Med.* 171 (2011) 568–574, <https://doi.org/10.1001/archinternmed.2011.34>.
- [130] K.R. Powell, Patient-perceived facilitators of and barriers to electronic portal use: a systematic review, *Comput. Inform. Nurs.* 35 (2017) 565–573, <https://doi.org/10.1097/CIN.0000000000000377>.
- [131] D.J. Amante, T.P. Hogan, S.L. Pagoto, T.M. English, A systematic review of electronic portal usage among patients with diabetes, *Diabetes Technol. Ther.* 16

- (2014) 784–793, <https://doi.org/10.1089/dia.2014.0078>.
- [132] A. Jabour, J.F. Jones, Facilitators and barriers to patients' engagements with personal health records: systematic review, in: A.M. Stephanidis C (Ed.), *Universal Access in Human-Computer Interaction. Applications and Services for Quality of Life*, Springer, Berlin, Germany, 2013, pp. 472–481.
- [133] C. Showell, Barriers to the use of personal health records by patients: a structured review, *PeerJ*. 5 (2017) e3268, <https://doi.org/10.7717/peerj.3268>.
- [134] D.K. Sakaguchi-Tang, A.L. Bosold, Y.K. Choi, A.M. Turner, Patient portal use and experience among older adults: systematic review, *JMIR Med. Inform.* 5 (2017) 1–14.
- [135] N. Archer, U. Fevrier-Thomas, C. Lokker, K.A. McKibbon, S.E. Straus, Personal health records: a scoping review, *J. Am. Med. Inform. Assoc.* 18 (2011) 515–522, <https://doi.org/10.1136/amiajnl-2011-000105>.
- [136] G. Feistel, *Technology Acceptance Model: Factors Influencing Consumers' Intent to Use Electronic Personal Health Records*, Doctor of Philosophy, Central Michigan University, 2014.
- [137] P.M. Gee, *Electronic Personal Health Records for Disease Self-management: Experiences of the Chronically Ill Adult*, Doctor of Philosophy, University of California, Davis, 2014.
- [138] K. Jackman, Exploring Electronic Personal Health Record Services As Sexual Health Discussion Tools: a Mixed-methods Study Among Young Black Adults, Doctor of Public Health, Morgan State University, 2016.
- [139] R.C. Rice, Healthcare Leaders' Lived Experiences Regarding the Implementation of Electronic Personal Health Records, Doctor of Philosophy, Walden University, 2014.
- [140] T. Toscos, C. Daley, L. Heral, R. Doshi, Y. Chen, G.J. Eckert, R.L. Plant, M.J. Mirro, Impact of electronic personal health record use on engagement and intermediate health outcomes among cardiac patients: a quasi-experimental study, *J. Am. Med. Inform. Assoc.* 23 (2016) 119–128, <https://doi.org/10.1093/jamia/ocv164>.
- [141] J.N. Haun, J.D. Lind, S.L. Shimada, T.L. Martin, R.M. Gosline, N. Antinori, M. Stewart, S.R. Simon, Evaluating user experiences of the secure messaging tool on the Veterans Affairs' patient portal system, *J. Med. Internet Res.* 16 (2014) 1–13, <https://doi.org/10.2196/jmir.2976>.
- [142] M. Cocosila, N. Archer, Perceptions of chronically ill and healthy consumers about electronic personal health records: a comparative empirical investigation, *Brit. Med. J. Open* 4 (2014) 1–9, <https://doi.org/10.1136/bmjjopen-2014-005304>.
- [143] C.M. DesRoches, R. Agarwal, C.M. Angst, M.A. Fischer, Differences between integrated and stand-alone e-prescribing systems have implications for future use, *Health Aff.* 29 (2010) 2268–2277, <https://doi.org/10.1377/hlthaff.2010.0557>.
- [144] D. Daglish, N. Archer, *Electronic Personal Health Record Systems: a Brief Review of Privacy, Security, and Architectural Issues*, World Congress on Privacy, Security, Trust and the Management of e-Business, IEEE, Saint John, Canada, 2009, pp. 110–120.
- [145] D. Detmer, M. Bloomrosen, B. Raymond, P. Tang, Integrated personal health records: transformative tools for consumer-centric care, *BMC Med. Inform. Decis. Mak.* 8 (2008) 1–14, <https://doi.org/10.1186/1472-6947-8-45>.
- [146] P.C. Tang, J.S. Ash, D.W. Bates, J.M. Overhage, D.Z. Sands, Personal health records: definitions, benefits, and strategies for overcoming barriers to adoption, *J. Am. Med. Inform. Assoc.* 13 (2006) 121–126, <https://doi.org/10.1197/jamia.2005.0225>.
- [147] A. Bhattacherjee, Understanding information systems continuance: an expectation-confirmation model, *Manag. Inf. Syst. Q.* 25 (2001) 351–370, <https://doi.org/10.2307/3250921>.
- [148] L. Gebauer, M. Söllner, J.M. Leimeister, Towards understanding the formation of continuous use, 34th International Conference on Information Systems, Milan, Italy, (2013), pp. 1–17.
- [149] S. Han, Individual Adoption of Information Systems in Organizations: a Literature Review of Technology Acceptance Model, (2003) <http://www.tucs.fi/publications/attachment.php?fnname=TR540.pdf> (25.08.18).
- [150] E. Karahanna, D.W. Straub, N.L. Chervany, Information technology adoption across time: a cross-sectional comparison of pre-adoption and post-adoption beliefs, *Manag. Inf. Syst. Q.* 23 (1999) 183–213, <https://doi.org/10.2307/249751>.
- [151] S.T. Peek, E.J. Wouters, J. van Hoof, K.G. Luijkx, H.R. Boeije, H.J. Vrijhoeve, Factors influencing acceptance of technology for aging in place: a systematic review, *Int. J. Med. Inform.* 83 (2014) 235–248, <https://doi.org/10.1016/j.ijmedinf.2014.01.004>.
- [152] V. Venkatesh, M.G. Morris, G.B. Davis, F.D. Davis, User acceptance of information technology: toward a unified view, *Manag. Inf. Syst. Q.* 27 (2003) 425–478, <https://doi.org/10.2307/30036540>.
- [153] H.A. Forquer, J.L. Christensen, A.S. Tan, Predicting continuance—findings from a longitudinal study of older adults using an eHealth newsletter, *Health Commun.* 29 (2014) 937–946, <https://doi.org/10.1080/10410236.2013.833580>.
- [154] S.S. Kim, N.K. Malhotra, A longitudinal model of continued IS use: an integrative view of four mechanisms underlying postadoption phenomena, *Manag. Sci.* 51 (2005) 741–755, <https://doi.org/10.1287/mnsc.1040.0326>.
- [155] M. Limayem, S.G. Hirt, C.M. Cheung, How habit limits the predictive power of intention: the case of information systems continuance, *Manag. Inf. Syst. Q.* 31 (2007) 705–737, <https://doi.org/10.2307/25148817>.
- [156] A. Bhattacherjee, *Social Science Research: Principles, Methods, and Practices*, (2012).
- [157] A. Stolyar, *A Study of Low-income Health Care Consumers: Motivations for Using Electronic Personal Health Record Systems*, Doctor of Philosophy, University of Washington, 2011.
- [158] N. Nijland, J.E. van Gemert-Pijnen, S.M. Kelders, B.J. Brandenburg, E.R. Seydel, Factors influencing the use of a Web-based application for supporting the self-care of patients with type 2 diabetes: a longitudinal study, *J. Med. Internet Res.* 13 (2011) 1–16, <https://doi.org/10.2196/jmir.1603>.