

# Effectiveness of a Personally Controlled Electronic Health Record Intervention in Older Adults with Chronic Disease

## Mohammadreza Najaftorkaman

School of Information and Communication Technology, Griffith University  
Gold Coast, Queensland, 4222, Australia  
E-mail: mohammadreza.najaftorkaman@griffithuni.edu.au

## Amir Hossein Ghapanchi

School of Information and Communication Technology, Griffith University  
Gold Coast, Queensland, 4222, Australia  
E-mail: a.ghapanchi@griffith.edu.au

## Amir Talaei-Khoei

School of Systems, Management and Leadership, University of Technology Sydney  
CB11.06.214, PO Box 123, Broadway, Ultimo NSW 2007, Australia  
E-mail: amir.talaei@uts.edu.au

## Abstract

In this study, we used a randomized control trial (RCT) to assess the effectiveness of a personally controlled electronic health record (PCEHR) on chronic disease self-management of seniors. One hundred and nine participants with chronic diseases were randomized to intervention (n=55) or control group (n=54). Our outcome measures came from the health belief model (HBM). The results show that the intervention group had significant improvement in perceived usefulness, perceived barriers, perceived self-efficacy, cues to action, and total likelihood to take up self-management behaviour after using the PCEHR ( $p < 0.05$ ). On the other hand, we found that there were no significant differences in perceived susceptibility and perceived severity of participants in intervention after eight week chronic disease self-management program ( $p > 0.05$ ).

**Keywords** self-management, chronic disease, personal health record, PCEHR

## 1 Introduction

Patients with chronic illnesses should take the responsibility to manage their own health condition (Wagner & Brath, 2012). This responsibility can involve changing life style, taking medication, taking appropriate preventive action to control health status, actively monitoring and managing symptoms and signs of the condition(s), having more collaboration with their healthcare professionals. Individuals' involvement in the management of their own care can be defined as self-management (Walters et al., 2012). According to Barlow and colleagues self-management is an "individual's ability to manage the symptoms, treatment, physical and psychosocial consequences and life style changes inherent in living with a chronic condition" (Barlow, Wright, Sheasby, Turner, & Hainsworth, 2002) (p. 178). The number of interventions has been increased to help patients to manage their chronic health conditions (Clarke, Baird, Perera, Hagger, & Teede, 2014; K. Lorig, Ritter, Ory, & Whitelaw, 2013; Steinsbekk, Rygg, Lisulo, Rise, & Fretheim, 2012; Wootton, 2012). The major objective of these interventions is to increase patients' involvement in and control of their treatment and its consequences on their lives.

One of the most important computer-based interventions to help patients to manage chronic conditions is an electronic personal health record (PHR) (Hibbard & Greene, 2013; Najaftorkaman, Ghapanchi, Talaei-Khoei, & Ray, 2013a, 2013b; Tenforde, Jain, & Hickner, 2011). A PHR allows individuals to access their own medical records, self-management tools,

and communication features with their healthcare providers (Najaftorkaman, Ghapanchi, & Talaei-Khoei, 2014). At a basic level, PHRs allow individuals to manually insert health-related information onto an online portal where it can later be available as needed from the Internet (Sittig, 2002; Tang & Lee, 2009). On the other hand, advanced PHRs (interoperable systems) can electronically transfer an individual's clinical data from the electronic health records (EHR) of different healthcare organizations (e.g. hospitals, pharmacies, and health insurers) to an individual-controlled PHR system (Najaftorkaman & Ghapanchi, 2014; Tenforde et al., 2011).

In Australia in 2009, the National Health and Hospitals Reform Commission (NHHRC) suggested an individual-controlled EHR for every person to improve healthcare productivity and safety (Mooranian, 2013; Xu, 2014). Although it has been claimed that the Australian healthcare system is one of the best in the world, it has nonetheless faced challenges such as medication errors, fragmented sources of health information, repetition of tests, and growth in chronic illness, health workforce resource constraints, and the problem was because individuals' expectations were changing towards technology. These challenges led to the Australian government's development of the personally controlled electronic health record the PCEHR system as a part of their national e-health strategy in 2010. By the launch of the PCEHR system (during 2010 to 2012), the Australian government had invested approximately \$467 million into the development of the system's core infrastructure. July 1<sup>st</sup> 2012, the PCEHR was used to register consumers. Based on the last released report from the review of the PCEHR in May 2014, it had faced various complexities and obstacles during its journey such as limited number of health IT professionals, few numbers of IT vendors in the Australian market, political and economic situations, security and privacy concerns, time consuming concerns, legal concerns, and few potential users knew about the systems (Mooranian, 2013).

To date, evaluating the effectiveness of PHR systems (PCEHR) in order to improve individuals' self-management behaviors and maximize their uptake remains unclear. In particular, there has been little explanation from the seniors' perspective as to how PHR can support them to manage their chronic conditions (Archer, Fevrier-Thomas, Lokker, McKibbin, & Straus, 2011; Bourgeois, Simons, Olson, Brownstein, & Mandl, 2008). The aim of this study is an evaluation of the efficacy of the PCEHR system in changing health-related behaviors and health statuses. The current study uses a randomized control trial (RCT) approach to investigate whether the use of the PCEHR by seniors (older adults) will lead to improvement of individual satisfaction and totally improved health self-management behaviors.

## **2 METHODS**

The chronic disease self-management program had a two-arm (control group and intervention group) study in which the group receiving the intervention (PCEHR) is compared with the control group receiving no intervention.

### **2.1 Participants and Randomization**

The population for this part of the research was selected from members of the University of the Third Age (U3A) which is non-profit incorporated association on the Gold Coast in Australia. U3A provides socializing, learning, and tutoring for mature people, aged over 50 (Swindell, Vassella, Morgan, & Sayer, 2011). First of all, we sent an invitation email to almost 400 seniors in U3A and encouraged them to participate in the chronic disease self-management program. We asked them to attend this program if they had the following criteria:

1. They had a confirmed diagnosis of a chronic illnesses or were affected by chronic pain
2. They were not registered on the PCEHR system
3. They had a basic computer and Internet knowledge

One hundred and nine seniors met selection criteria and successfully registered in the chronic disease self-management program. Because we were using a randomized control trial approach in this study to identify the effectiveness of the PCEHR on chronic disease self-management, we divided our participants into two separate groups. Eligible participants were randomly assigned to the intervention and control groups. We applied the RANDBETWEEN Function in Microsoft Excel to generate a sequence of random numbers. Finally, we assigned 54 participants to the control group and 55 participants to the intervention group. The overall ratio of intervention to control was 1:1.

## **2.2 Intervention Description**

The chronic disease self-management intervention in this study was the PCEHR system. The system enables health providers such as physicians, pharmacists, pathologists to access patients' health information, monitor their medical record, and upload clinical documents, diagnostic imaging reports, and pathology reports (McDonald, 2012). On the other side, individuals can connect to a consumer portal in the PCEHR and share their health information with the healthcare providers and access medical information such as allergy information, over-the counter medications, or a child's immunization history (Fry, Spriggs, Arnold, & Pearce, 2014). For example, in the Personal Health Note section, individuals can write their health issues such as allergies and medication problems, and this feature is very useful during chronic disease treatment. Moreover, the Personal Health Summary section allows individuals to enter information about their health (e.g. allergies, adverse reactions, and medications) and share it with their healthcare professionals.

We sent an email to all participants (control and intervention) and invited them to attend at a U3A seminar room to have chat about their chronic condition and receive a brief explanation of the self-management program. On that day, we explained the advantages of the self-care program in chronic disease conditions and motivated them to continue in this study. We explained our research approach (randomized control trial) to the participants and that we had to divide them into two separate groups. In this session, all participants signed an informed consent form that was based on ethical approval obtained from Griffith University research ethics committee for this study. After that, we ran our pre-test and asked participants to complete the paper-based survey. We put all participants in the control group on a waiting-list to use the PCEHR after eight weeks, when the intervention workshops had concluded.

Participants in the intervention group attended eight weeks of chronic disease-management workshops. We provided a booklet that explains all the section of the PCEHR (e.g. how to register on the system, how to view a medical document, how to insert, update and delete a document, how to manage privacy and security features). Each week, they read the week's content from the booklet and logged-in to the PCEHR and completed that particular activity. We organized two hours of interactive workshops and assisted participants to manage their health-related information in the PCEHR. Furthermore, we encouraged all participants to motivate their healthcare providers such as their local general practitioner to upload clinical documents, diagnostic imaging reports, and pathology reports. After completing eight weeks of workshops, we asked all participants (control and intervention) to complete our post-test to evaluate the effectiveness of the PCEHR on self-management of chronic conditions. Those who completed pre-test and post-test surveys were given a valuable small gift as a token of our appreciation.

## **2.3 Outcome Measures**

In this study, we assessed the effectiveness of the PCEHR to improve self-management of chronic conditions by older adults based on the health belief model (HBM). The HBM was proposed to predict the behaviour reaction of people who had chronic or acute diseases to the treatment they receive (Janz & Becker, 1984; Ronis & Harel, 1989). The basic concept of the HBM is that if individuals do not feel vulnerable to a disease, they will not take healthy or preventive actions, and they should be psychologically ready to accept healthy behaviours

(Che et al., 2014). Outcome measures were collected from both groups at baseline (pre-test) and at the end of the workshop in week 8 using a survey. The survey focused on six main constructs in the HBM that we measured in this part. The questions regarding HBM constructs were designed applying a five-point Likert scale (ranging from “strongly agree” to “strongly disagree”). The first construct is perceived susceptibility (perceived risk) which refers to an individual’s perception of the risk or the chances of contracting a health disease or condition. Next, perceived severity (seriousness) is identified as the degree to which individuals think a specific disease or condition is serious. The third construct is perceived usefulness which refers to individuals’ evaluation of the value or efficacy of engaging in a health-promoting behaviour to reduce the risk of a health condition. Next, perceived barriers refers to an individual's evaluation of the obstacles to behaviour change. The fifth construct is perceived self-efficacy which refers to an individual's perception of his or her skill to successfully complete a specific task (behaviour change). Finally, cues to action are the stimulus necessary to trigger the decision-making process to accept in taking a recommended health action. If an individual perceives a larger health threat (perceived susceptibility and severity), as well as more benefits in acting and fewer barriers while engaging in preventive healthy action, then the likelihood of this individual taking such action becomes greater (Ahadzadeh, Sharif, Ong, & Khong, 2015). The expert panel in the field of health informatics was used to evaluate the validity of the survey, and Cronbach’s alpha coefficient was used to measure the internal consistency and reliability of the survey. Cronbach’s alpha coefficient for each of the six main constructs of the HBM and the last part of the survey (likelihood of engaging in health-promoting behaviour) were as follows: Perceived susceptibility, 0.76; perceived severity, 0.85; perceived usefulness, 0.73; perceived barriers, 0.63; perceived self-efficacy, 0.7; cues to action, 0.77; likelihood of taking action, 0.72; and total, 0.82.

## 2.4 Data Analysis

Statistical analyses were performed using SPSS statistical software 22.0 (IBM Corp., New York). We applied the Shapiro–Wilk test (Shapiro & Wilk, 1965) to evaluate normality within independent variables because the sample size is a small number of cases (da Costa et al., 2012). The baseline features of participants and independent variables did not show a normal distribution according to the Shapiro–Wilk test. We used a chi-squared test (Greenwood, 1996) and Fisher's exact test (if it was needed) (Fisher, 1922) to evaluate baseline characteristics of participants in both groups (control and intervention). For inter-group comparisons, Mann–Whitney U test (Mann & Whitney, 1947) was employed to see if the PCEHR caused a difference between the groups based on HBM constructs. The significance level used in this study was 95%.

## 3 RESULTS

### 3.1 Baseline Data

Of the almost 400 seniors who were asked to participate in this research, 134 agreed to participate and registered in the program. Of the 134 subjects agreeing to participate in this study, 109 participants had met our selection criteria. From these 109 participants (54 in control group and 55 in intervention group), 91 completed the eight week study (38 in the control group and 53 in the intervention group).

Table1 shows that there are not any statistical differences in the baseline characteristics between the intervention and control groups based on the chi square and Fisher’s exact test ( $p > 0.05$ ). The majority of participants in both the control and intervention group were women, single and aged between 70 and 80 who had computer access and Internet access in their home. All participants in both groups expressed that they had at least one major chronic condition including diabetes, heart disease, asthma, and allergy. A total of 23.1% of participants in both groups stated that they had other chronic conditions such as (percentages show in both groups) glaucoma (1.82%), chronic renal disease (3.64%), epilepsy (2.73%), Parkinson’s disease (0.91%), arthritis (2.73), and cancer (7.28%). Furthermore, the majority of participants noted that they had never used any method to store their health-

related information, and 22% of them created a paper-based notebook and folder to store and manage their information, and only 15.4% of participants used a computer to save their scanned information and health-related data.

		Control	Intervention	Total	p-Value
Age	<60	6 (15.8%)	7 (13.2%)	13 (14.3%)	0.97 <sup>a</sup>
	60-69	14 (36.8%)	22 (41.5)	36 (39.6%)	
	70-80	12 (31.6%)	16 (30.2%)	28 (30.7%)	
	>80	6 (15.8%)	8 (15.1%)	14 (15.4%)	
Gender	Female	20 (52.6)	33 (63.3%)	53 (58.2%)	0.35 <sup>a</sup>
	Male	18 (47.4%)	20 (37.7%)	38 (41.8%)	
Education	Less than high school	9 (23.7%)	8 (15.1%)	17 (18.7%)	0.77 <sup>a</sup>
	High school	7 (18.4%)	9 (17.0%)	16 (17.6%)	
	Some college/diploma	14 (36.8%)	24 (45.3%)	38 (41.8%)	
	Bachelor degree	7 (18.4%)	9 (17.0%)	16 (17.6%)	
	Master degree or higher	1 (2.6%)	3 (5.7%)	4 (4.4%)	
Marital status	Married/partnered	17 (44.7%)	20 (37.7%)	37 (40.7%)	0.50 <sup>a</sup>
	Single	21 (55.3%)	33 (62.3)	54 (59.3%)	
Chronic condition	Diabetes	9 (23.7%)	6 (11.3%)	15 (16.5%)	0.11 <sup>a</sup>
	Heart disease	5 (13.2%)	9 (17.0%)	14 (15.3%)	
	Asthma	7 (18.4%)	13 (24.5%)	20 (22.0%)	
	Allergy	5 (13.2%)	16 (30.2%)	21 (23.1%)	
	Other	12 (31.6%)	9 (17.0%)	21 (23.1%)	
Computer access	Yes	35 (92.1%)	45 (84.9%)	80 (87.9%)	0.34 <sup>b</sup>
	No	3 (7.9%)	8 (15.1%)	11 (12.1%)	
Internet access	Yes	27 (71.1%)	37 (69.8%)	64 (70.3%)	0.89 <sup>a</sup>
	No	11 (28.9%)	16 (30.2%)	27 (29.7%)	
Doctor visit	Yes	35 (92.1%)	46 (86.8%)	81 (89.0%)	0.51 <sup>b</sup>
	No	3 (7.9%)	7 (13.2%)	10 (11.0%)	
Self-management method	Paper-based	7 (18.4%)	13 (24.5%)	20 (22.0%)	0.62 <sup>a</sup>
	Computer-based	5 (13.2%)	9 (17.0%)	14 (15.4%)	
	Nothing	26 (68.4%)	31 (58.5%)	57 (62.6%)	

a) Chi-squared test  
b) Fisher Exact test

Table 1. Baseline characteristics of participants

### 3.2 Inter-group Comparison of the Health Belief Model Constructs

Inter-group comparison of the health belief model constructs before intervention is given in Table 2. These results show that before using the PCEHR system there was no statistically significant difference between control and intervention groups ( $p > 0.05$ ). After introducing the PCEHR to participants in the intervention group, we compared health belief model constructs between control and intervention groups in week 8. Inter-group comparison of the results of the post-test is given in Table 3. These results suggest that the perceived susceptibility difference between the post-test result of the control (mean = 47.26) and intervention group (mean = 45.09) was not statistically significant ( $U = 959.00$ ,  $p > 0.05$ ). Similarly, the results show that there was not a statistically significant difference ( $U = 913.50$ ,  $p > 0.05$ ) between participants' perception toward severity of health condition between control group (mean = 43.54) and intervention group (mean = 47.76).

	<b>Control group mean rank</b>	<b>Intervention group mean rank</b>	<b>Z-Value</b>	<b>U-Value</b>	<b>p-Value</b>
Perceived susceptibility	45.13	46.62	-0.302	947.00	0.763
Perceived severity	43.20	48.01	-1.109	900.50	0.267
Perceived usefulness	47.12	45.20	-0.352	964.50	0.725
Perceived barriers	44.51	47.07	-0.475	950.50	0.635
Perceived self-efficacy	46.64	45.54	-0.210	982.50	0.834
Cues to action	50.42	42.83	-1.384	839.00	0.166
Likelihood to take self-management behavior	42.82	48.28	-1.047	835.50	0.295
* p-Value < 0.05. Statistical test: Mann-Whitney U-test.					

*Table 2. Inter-group comparison of health belief model constructs before intervention (pre-test)*

On the other hand, inter-group comparison of the rest of the health belief model constructs (perceived usefulness, perceived barriers, perceived self-efficacy, cues to action, and likelihood to take up self-management behavior) revealed that there were significant differences between control and intervention. For example, participants in the intervention group (mean = 55.28) had a greater mean rank in perceived usefulness compared to the control group (mean = 33.05), and based on the Mann–Whitney U test there is a statistical significance between the two groups (U = 515.00, p < 0.05).

	<b>Control group mean rank</b>	<b>Intervention group mean rank</b>	<b>Z-Value</b>	<b>U-Value</b>	<b>p-Value</b>
Perceived susceptibility	47.26	45.09	-0.480	959.00	0.632
Perceived severity	43.54	47.76	-0.930	913.50	0.352
Perceived usefulness	33.05	55.28	-4.120	515.00	0.000*
Perceived barriers	62.57	34.12	-5.367	377.50	0.000*
Perceived self-efficacy	28.09	58.84	-5.682	326.50	0.000*
Cues to action	38.74	51.21	-2.295	731.00	0.022*
Likelihood to take self-management behavior	29.51	57.82	-5.217	380.50	0.000*
* p-Value < 0.05. Statistical test: Mann-Whitney U-test.					

*Table 3. Inter-group comparison of health belief model constructs after intervention (post-test)*

## 4 DISCUSSION

### 4.1 Significance

In this study, we applied the main constructs of the HBM to evaluate the effectiveness of the PCEHR to improve self-management of chronic conditions by older adults. The results showed there were no significant differences in perceived susceptibility and perceived severity of individuals who used the PCEHR before and after intervention. Using the PCEHR does not impact on an individual's belief in the risk or the chances of contracting a health problem (new chronic disease). Furthermore, it shows that this system does not influence

individuals' behaviour in accepting that their current chronic condition and its consequences are serious (perceived severity).

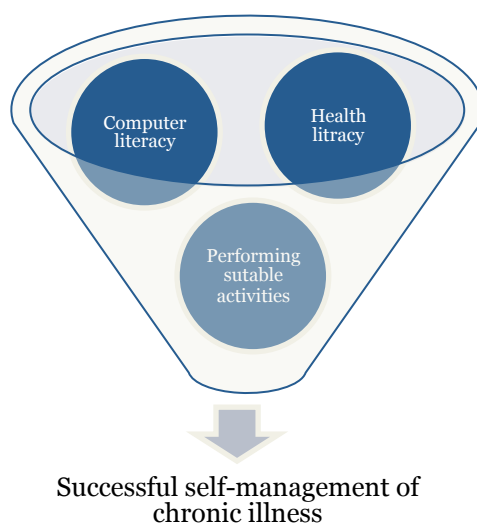
On the other hand, we found significant improvement in perceived usefulness in participants in the intervention group after applying the PCEHR. Before intervention, 62.6% of participants never used any techniques (paper-based or computer-based) to manage their own health information. The majority of seniors generally have technology (computer) anxiety, and they do not know the benefits of using technology in their personal life (McMurtrey, Downey, Zeltmann, & McGaughey, 2011, 2012; Mitzner et al., 2014). After introducing the system features and functions in the workshops, participants know more about the PCEHR benefits such as decreasing the time consumers and healthcare providers spend repeating and sharing information across the health sector, easy access to the records via Internet connection, providing a wide array of credible health-related information uploaded by healthcare professionals onto an individual's record, reducing the need for individuals to recite their medical history or remember their medicine regime at every visit to a different healthcare professional, and last but not least are the privacy features of the PCEHR such as Record Access Code (RAC) Settings which allow individuals to restrict healthcare provider organizations from accessing an eHealth record. Furthermore, this study showed that there was a significant difference in perceived barriers of the participants in intervention group. Before intervention, the majority of individuals had concerns about the PCEHR functions (user-friendly issues), security and privacy issues, and obtaining medical records (according to the survey questions). During the workshop, we provided a booklet that explained every section of the PCEHR and how they can upload new medical documents, check medical history, and control security settings. After intervention (post-test), participants stated that they had less concern in using the PCEHR to manage their own health conditions.

In addition, the results showed that individuals who used the PCEHR in the eight weeks of training workshops and applied the system in their life had better self-efficacy to monitor and manage their own health information. They inserted different data in the Personal Health Summary section of the PCEHR and shared that data with their healthcare providers. They knew that they could play an active role in their own health, communicate with their doctors effectively, and they do not have to remember medical history every time that they see a healthcare provider. The PCEHR improved participants' perceptions of their own skill to adhere to medication regimens and manage health history. According to the literature, if individuals have greater self-efficacy, they believed in themselves and have a positive attitude to chronic self-management (Ritter & Lorig, 2014).

Moreover, analysis revealed a significant difference between pre-test and post-test of the cues to action factor in the intervention group. Participants in the intervention group inserted their medical history such as allergies, family history of drug allergies, or other harmful (adverse) drug reactions and side effects into the PCEHR. They knew more about their health status (internal trigger) by using the system in their life. While using the PCEHR, participants visited their doctors, and they received feedback from their healthcare professionals. In addition, we provided a booklet that discussed the advantages and disadvantages of using the PCEHR (external trigger) (Kim, Sargent-Cox, Cherbuin, & Anstey, 2014). Finally, we assessed the likelihood of engaging in health self-management behaviour. The analysis revealed that there was a significant improvement in self-management/self-regulation behaviours after using the PCEHR. This system is a vehicle for helping individuals to improve skills and techniques to enhance self-care of their chronic condition. We found that older adults showed statistically meaningful improvements in self-management behaviour as a result of participating in the chronic disease self-management program using the PCEHR.

According to our observation and literature (Lieberman, 2001; K. R. Lorig, Ritter, Laurent, & Plant, 2006; Schulman-Green et al., 2012) (see Figure 1), successful self-management of chronic conditions using computer-based systems needs individuals to master three separate aspects. Firstly, individuals must have basic health literacy. They should have sufficient

knowledge about their health conditions and treatment to make informed decisions about their healthcare. Individuals should have sufficient skills to seek, understand, and utilize health-related information to participate in making decisions about their own health. Secondly, individuals should perform activities aimed at managing their own conditions such as maintaining nutrition and diet based on their health status, more interactions with healthcare providers, recognizing and responding to symptoms, using medicine, managing acute episodes and emergency situations, maintaining adequate exercise (Freedman et al., 2014; K. Lorig, Holman, & Sobel, 2013; K. R. Lorig et al., 2006; Ory et al., 2014). Thirdly, we realized that one of the most important barriers to user adoption of computer-based systems was lack of computer literacy. The PCEHR has a basic and user-friendly online platform, but it took time to teach all the aspects of this system to seniors during these eight weeks of workshops. During the workshops we tried to improve the following computer skills to increase the adoption rate of participants: using a mouse or touchpad to point, click, and double-click, recognizing and launching a web browser, going to a specified web address ([www.ehealth.gov.au/](http://www.ehealth.gov.au/)), and inserting, deleting, and editing documents.



*Figure 1: Three main factors to have successful chronic disease self-management*

## 4.2 Strength and limitations

A primary aim of this study was to examine the effectiveness of using PHR systems (PCEHR in this study) to evaluate chronic disease self-management behaviors among seniors. This was the first study to examine the effects of PCEHR on chronic disease self-management of older adults applying HBM. HBM is one of the patterns of behavioral science theories applied to evaluate health-related problems and is widely applied to clarify behavior of chronic disease controlling (Ahadzadeh et al., 2015; Das & Evans, 2014; Yue, Li, Weilin, & Bin, 2015). We found that this intervention (PCEHR) can play an important role in enhancing the quality of self-care and improves the likelihood of self-management behavior.

The potential limitations of this study are recognized. Firstly, the sample population concentrated only on seniors living on the Gold Coast, Australia. The sample was not representative of the Australian senior population. A more comprehensive future research is suggested to include people of different age groups and health problems (e.g. mental health disorder, gastrointestinal problems, depression and anxiety). Secondly, apart from the HBM constructs which were evaluated in this study, future research should also consider other factors that could be included in chronic disease self-management research such as vicarious experiences, social persuasion, past experience, technology anxiety, trust (e.g. security, privacy, and accuracy), patient-clinician relationship, and information-seeking. Thirdly, this study represents one intervention (PCEHR) and, thus, may not be generalizable to all other



PHR systems with different structure in different countries. Finally, future research should encompass healthcare professionals who are using PCEHR in their clinics. PCEHR is the system that involves individuals on one side and healthcare professionals on the other side. It is really important to evaluate the effectiveness of the system in their job performance.

## 5 CONCLUSION

Numerous studies to date have examined effects of IT in a wide variety of domains (Ghanbarzadeh, Ghapanchi, & Blumenstein, 2015; Ghanbarzadeh, Ghapanchi, Blumenstein, & Talaei-Khoei, 2014; Ghapanchi, 2013; Khosravi & Ghapanchi, 2015; Khosravi, Ghapanchi, & Blumenstein, 2015; Khosravi, Rezvani, Subasinghage, & Perera, 2012; Rezvani, Khosravi, Subasinghage, & Perera, 2012). This is the first study we are aware of that employed a randomized control trial to evaluate the effectiveness of PCEHR as a self-management intervention for older adults with chronic diseases. This study assessed HBM constructs which were proposed to predict the behavior reaction of people who had chronic or acute diseases to the treatment they receive. The results showed participants who applied PCEHR in their life had a significant improvement in perceived usefulness, perceived barriers, perceived self-efficacy, cues to action, and total likelihood to take up self-management behavior. On the other hand, we found that there were no significant differences in perceived susceptibility and perceived severity of participants in intervention or control groups. It showed that PCEHR did not have any influence on individuals' behavior in accepting that their current chronic condition and its consequences are serious. In conclusion, according to HBM, if individuals perceived more benefit and fewer barriers of the system (PCEHR) while having greater cues to action (internal and external triggers) to motivate them to use the system and greater self-efficacy, then the likelihood of individuals taking up healthy behavior (e.g. self-management behavior in this study) become larger.

## 6 References

- Ahadzadeh, A. S., Sharif, S. P., Ong, F. S., & Khong, K. W. (2015). Integrating Health Belief Model and Technology Acceptance Model: An Investigation of Health-Related Internet Use. *Journal of medical Internet research*, 17(2).
- Archer, N., Fevrier-Thomas, U., Lokker, C., McKibbin, K. A., & Straus, S. (2011). Personal health records: a scoping review. *Journal of the American Medical Informatics Association*, 18(4), 515-522.
- Barlow, J., Wright, C., Sheasby, J., Turner, A., & Hainsworth, J. (2002). Self-management approaches for people with chronic conditions: a review. *Patient education and counseling*, 48(2), 177-187.
- Bourgeois, F. T., Simons, W. W., Olson, K., Brownstein, J. S., & Mandl, K. D. (2008). Evaluation of influenza prevention in the workplace using a personally controlled health record: randomized controlled trial. *Journal of medical Internet research*, 10(1).
- Che, S.-R., Barrett, E. S., Velez, M., Conn, K., Heinert, S., & Qiu, X. (2014). Using the Health Belief Model to Illustrate Factors That Influence Risk Assessment during Pregnancy and Implications for Prenatal Education about Endocrine Disruptors. *Policy Futures in Education*, 12(7), 961-974.
- Clarke, D. M., Baird, D. E., Perera, D. N., Hagger, V. L., & Teede, H. J. (2014). The INSPIRED study: a randomised controlled trial of the Whole Person Model of disease self-management for people with type 2 diabetes. *BMC public health*, 14(1), 134.
- da Costa, T. M., Barbosa, B. J. P., e Costa, D. A. G., Sigulem, D., de Fátima Marin, H., Castelo Filho, A., & Pisa, I. T. (2012). Results of a randomized controlled trial to assess the effects of a mobile SMS-based intervention on treatment adherence in HIV/AIDS-

- infected Brazilian women and impressions and satisfaction with respect to incoming messages. *International Journal of Medical Informatics*, 81(4), 257-269.
- Das, B. M., & Evans, E. M. (2014). Understanding Weight Management Perceptions in First-Year College Students Using the Health Belief Model. *Journal of American College Health*, 62(7), 488-497.
- Fisher, R. A. (1922). On the interpretation of  $\chi^2$  from contingency tables, and the calculation of P. *Journal of the Royal Statistical Society*, 87-94.
- Freedman, V. A., Kasper, J. D., Spillman, B. C., Agree, E. M., Mor, V., Wallace, R. B., & Wolf, D. A. (2014). Behavioral adaptation and late-life disability: A new spectrum for assessing public health impacts. *American Journal of Public Health*, 104(2), e88-e94.
- Fry, C. L., Spriggs, M., Arnold, M., & Pearce, C. (2014). Unresolved Ethical Challenges for the Australian Personally Controlled Electronic Health Record (PCEHR) System: Key Informant Interview Findings. *AJOB Empirical Bioethics*, 5(4), 30-36.
- Ghanbarzadeh, R., Ghapanchi, A. H., & Blumenstein, M. (2015). Characteristics of Research on the Application of Three-Dimensional Immersive Virtual Worlds in Health *Health Information Science* (pp. 213-224): Springer.
- Ghanbarzadeh, R., Ghapanchi, A. H., Blumenstein, M., & Talaei-Khoei, A. (2014). A decade of research on the use of three-dimensional virtual worlds in health care: a systematic literature review. *Journal of medical Internet research*, 16(2).
- Ghapanchi, A. H. (2013). Rallying competencies in virtual communities: A study of core processes and user interest in open source software projects. *Information and Organization*, 23(2), 129-148.
- Greenwood, P. E. (1996). *A guide to chi-squared testing* (Vol. 280): John Wiley & Sons.
- Hibbard, J. H., & Greene, J. (2013). What the evidence shows about patient activation: better health outcomes and care experiences; fewer data on costs. *Health affairs*, 32(2), 207-214.
- Janz, N. K., & Becker, M. H. (1984). The health belief model: A decade later. *Health Education & Behavior*, 11(1), 1-47.
- Khosravi, P., & Ghapanchi, A. H. (2015). Investigating the effectiveness of technologies applied to assist seniors: A systematic literature review. *International Journal of Medical Informatics*.
- Khosravi, P., Ghapanchi, A. H., & Blumenstein, M. (2015). Investigating Various Technologies Applied to Assist Seniors *Health Information Science* (pp. 202-212): Springer.
- Khosravi, P., Rezvani, A., Subasinghage, M., & Perera, M. (2012). *Individuals' absorptive capacity in enterprise system assimilation*. Paper presented at the ACIS 2012: Location, location, location: Proceedings of the 23rd Australasian Conference on Information Systems 2012.
- Kim, S., Sargent-Cox, K., Cherbuin, N., & Anstey, K. J. (2014). Development of the Motivation to Change Lifestyle and Health Behaviours for Dementia Risk Reduction Scale. *Dementia and geriatric cognitive disorders extra*, 4(2), 172.
- Lieberman, D. A. (2001). Management of chronic pediatric diseases with interactive health games: Theory and research findings. *The Journal of ambulatory care management*, 24(1), 26-38.
- Lorig, K., Holman, H., & Sobel, D. (2013). *Living a Healthy Life with Chronic Conditions: For Ongoing Physical and Mental Health Conditions*: Bull Publishing Company.

- Lorig, K., Ritter, P. L., Ory, M. G., & Whitelaw, N. (2013). Effectiveness of a Generic Chronic Disease Self-Management Program for People With Type 2 Diabetes A Translation Study. *The Diabetes Educator*, 39(5), 655-663.
- Lorig, K. R., Ritter, P. L., Laurent, D. D., & Plant, K. (2006). Internet-based chronic disease self-management: a randomized trial. *Medical care*, 44(11), 964-971.
- Mann, H. B., & Whitney, D. R. (1947). On a test of whether one of two random variables is stochastically larger than the other. *The annals of mathematical statistics*, 50-60.
- McDonald, K. (2012). Practice guide to clinical software PCEHR functionality, from [http://www.pulseitmagazine.com.au/index.php?option=com\\_content&view=article&id=1236:practice-guide-to-clinical-software-pcehr-functionality&catid=16:australian-ehealth&Itemid=32](http://www.pulseitmagazine.com.au/index.php?option=com_content&view=article&id=1236:practice-guide-to-clinical-software-pcehr-functionality&catid=16:australian-ehealth&Itemid=32)
- McMurtrey, M. E., Downey, J. P., Zeltmann, S. M., & McGaughey, R. E. (2011). Seniors and technology: results from a field study. *Journal of Computer Information Systems*, 51(4), 22.
- McMurtrey, M. E., Downey, J. P., Zeltmann, S. M., & McGaughey, R. E. (2012). Seniors and Information Technology: A MIS-Fit? *Journal of International Technology and Information Management*, 21(4), 1.
- Mitzner, T. L., Rogers, W. A., Fisk, A. D., Boot, W. R., Charness, N., Czaja, S. J., & Sharit, J. (2014). Predicting older adults' perceptions about a computer system designed for seniors. *Universal Access in the Information Society*, 1-10.
- Mooranian, A., Emmerton, L., Hattingh, L. (2013). The introduction of the national e-health record into Australian community pharmacy practice: pharmacists' perceptions. *International Journal of Pharmacy Practice*, 21(6), 405-412.
- Najaftorkaman, M., & Ghapanchi, A. H. (2014). *Antecedents to the User Adoption of Electronic Medical Record*. Paper presented at the The 18th Pacific Asia Conference on Information Systems (PACIS 2014).
- Najaftorkaman, M., Ghapanchi, A. H., & Talaei-Khoei, A. (2014). *Analysis of Research in Adoption of Person-Centred Healthcare Systems: The Case of Online Personal Health Record*.
- Najaftorkaman, M., Ghapanchi, A. H., Talaei-Khoei, A., & Ray, P. (2013a). Recent Research Areas and Grand Challenges in Electronic Medical Record: A Literature Survey Approach. *The International Technology Management Review*, 3(1), 12-21.
- Najaftorkaman, M., Ghapanchi, A. H., Talaei-Khoei, A., & Ray, P. (2013b). A Taxonomy of Antecedents to User Adoption of Health Information Systems: A Synthesis of Thirty Years of Research *Journal of the American Society for Information Science and Technology*.
- Ory, M. G., Smith, M. L., Ahn, S., Jiang, L., Lorig, K., & Whitelaw, N. (2014). National Study of Chronic Disease Self-Management Age Comparison of Outcome Findings. *Health Education & Behavior*, 41(1 suppl), 34S-42S.
- Rezvani, A., Khosravi, P., Subasinghage, M., & Perera, M. (2012). *How does contingent reward affect enterprise resource planning continuance intention? The role of contingent reward transactional leadership*. Paper presented at the ACIS 2012: Location, location, location: Proceedings of the 23rd Australasian Conference on Information Systems 2012.
- Ritter, P. L., & Lorig, K. (2014). The English and Spanish Self-Efficacy to Manage Chronic Disease Scale measures were validated using multiple studies. *Journal of clinical epidemiology*, 67(11), 1265-1273.

- Ronis, D. L., & Harel, Y. (1989). Health beliefs and breast examination behaviors: Analyses of linear structural relations. *Psychology and Health, 3*(4), 259-285.
- Schulman-Green, D., Jaser, S., Martin, F., Alonzo, A., Grey, M., McCorkle, R., . . . Whittemore, R. (2012). Processes of Self-Management in Chronic Illness. *Journal of Nursing Scholarship, 44*(2), 136-144.
- Shapiro, S. S., & Wilk, M. B. (1965). An analysis of variance test for normality (complete samples). *Biometrika, 59*1-611.
- Sittig, D. F. (2002). Personal health records on the internet: a snapshot of the pioneers at the end of the 20th Century. *International Journal of Medical Informatics, 65*(1), 1-6.
- Steinsbekk, A., Rygg, L., Lisulo, M., Rise, M. B., & Fretheim, A. (2012). Group based diabetes self-management education compared to routine treatment for people with type 2 diabetes mellitus. A systematic review with meta-analysis. *BMC health services research, 12*(1), 213.
- Swindell, R., Vassella, K., Morgan, L., & Sayer, T. (2011). University of the Third Age in Australia and New Zealand: Capitalising on the cognitive resources of older volunteers. *Australasian journal on ageing, 30*(4), 196-201.
- Tang, P. C., & Lee, T. H. (2009). Your doctor's office or the Internet? Two paths to personal health records. *New England Journal of Medicine, 360*(13), 1276-1278.
- Tenforde, M., Jain, A., & Hickner, J. (2011). The value of personal health records for chronic disease management: what do we know? *Family Medicine-Kansas City, 43*(5), 351.
- Wagner, K.-H., & Brath, H. (2012). A global view on the development of non communicable diseases. *Preventive medicine, 54*, S38-S41.
- Walters, J. A., Courtney-Pratt, H., Cameron-Tucker, H., Nelson, M., Robinson, A., Scott, J., . . . Wood-Baker, R. (2012). Engaging general practice nurses in chronic disease self-management support in Australia: insights from a controlled trial in chronic obstructive pulmonary disease. *Australian journal of primary health, 18*(1), 74-79.
- Wootton, R. (2012). Twenty years of telemedicine in chronic disease management—an evidence synthesis. *Journal of telemedicine and telecare, 18*(4), 211-220.
- Xu, J., Gao, X., Sorwar, G., Croll, P. (2014). Current Status, Challenges, and Outlook of E-Health Record Systems in Australia *Knowledge Engineering and Management* (pp. 683-692): Springer.
- Yue, Z., Li, C., Weilin, Q., & Bin, W. (2015). Application of the health belief model to improve the understanding of antihypertensive medication adherence among Chinese patients. *Patient education and counseling, 98*(5), 669-673.