How mHealth Apps with Higher Usability Effects on Patients with Breast Cancer?

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Background and Method:
This study compared the effects of self-management mHealth (mobile health) apps and conventional intervention (brochure) on the quality of life (QoL) and exercise engagement of patients with breast cancer. Moreover, the current research aimed to investigate how usability improvement in mHealth leads to increased exercise engagement and QoL. To select apps with different levels of usability, a heuristic usability testing was conducted. Three apps with varying scores of usability—low, average, and high—were selected to enter in a randomized control trial (RCT) experiment. We formed 4 groups of intervention including the app with the highest usability (App5), the app with average usability (App4), the app with the lowest usability (App3), and the brochure. In each group, 5 patients, randomly selected from 20 patients, entered to the experiment and started to use the assigned mHealth app for 6 weeks.

Results:
The results showed that QoL scores were significantly higher for all participants in app groups compared to the brochure group. Further analysis of the results showed that the participants in App5 group reported higher QoL compared to patients in App4, App3, and brochure groups. In addition, patients in App5 and App4 groups reported more engagement in physical activities. Self-reported engagement in exercise data was not wholly consistent with engagement data logged by phones. Usability evaluation of apps from the patients’ perspective showed that, similar to heuristic usability, the patients rated App5 with higher usability score. The correlation analysis showed that user usability score was positively correlated with heuristic usability score. Moreover, other correlation analysis revealed that patients who rated the app with higher usability score, reported more commitment to physical activities. These results may imply that, compared to conventional intervention (brochure), mHealth apps engaged the patients in physical activities with a higher degree, and consequently improved their QoL.

Keywords: mHealth, Breast Cancer, Heuristic Usability, User Usability

Introduction
Breast cancer is an important disease regarding incidence and mortality, and the most common cancer in women in the world (Kelsey 1993, Tao, Shi et al. 2015). Because of impairment in the lymphatic system, patient with breast cancer experiences a chronic disease with multiple associated symptoms. In addition, the quality of life of these patients is significantly affected by the chronic symptoms of the disease. Proactive and preventive intervention such as education and physical activities is crucial for early management and treatment of breast cancer. Some developed and comprehensive interventions with more focus on educating patients and engagement to physical exercises have been offered to improve the quality of life and increase the effectiveness of treatment. Recent observational evidence and empirical findings reported that these interventions not only improve the quality of life, even reduce the risk of cancer-caused mortality (Kang, Lee et al. 2017).

With the advent of technologies and applications, mHealth (mobile health) has been proposed for delivery of healthcare or health-related services using applications in portable devices, especially smartphones (Zapata, Fernández-Alemán et al. 2015, Marcolino, Oliveira et al. 2018). Different types of mHealth including monitoring supervised healthcare, assisted healthcare and self-health management are developed to improve patients’ health status, behavior, and knowledge (Marcolino, Oliveira et al. 2018).

A growing body of studies has explored the effect of self-health management applications on HIV, mental disorder, cardiovascular disease, diabetes, Parkinson, autism, and some types of cancer (Hamine, Gerth-Guyette et al. 2015). However, to the best of our knowledge, no study evaluated how self-health management mHealth apps effect on patients with breast cancer. In addition, usability issues have been considered as an essential factor in the quality of services provided in mHealth, but there is a gap that we need to understand how improving usability leads to higher engagement in using apps, and bring significant health outcomes in patients’ quality of life.

This study aims to explore these two questions: 1- how self-management mHealth apps effect on the QoL and exercise engagement compared to conventional intervention (brochure), 2- how mHealth with higher usability compared to apps with lower usability can lead to increased exercise engagement and QoL among patients with breast cancer.

Method

Selecting apps:
All self-management mHealth apps with a focus on breast cancer were reviewed and screened based on parts, cost, date
of release, and updates. Free apps released after December 31, 2015, and had the last update after December 31, 2017, were screened. Nine apps were identified as free, responsive, and active apps that are specifically designed to help patients who have breast cancer. Among these 9 apps, just 5 had three main parts with similar contents including 1- knowledge and information, 2- exercises and scheduling, 3- connection with health practitioners.

Heuristic usability testing:
To select apps with different level of usability, a heuristic usability testing was conducted. Heuristic usability testing is an expert-based evaluation to uncover potential usability issues based on a set of guidelines, heuristics or questions in a step-wise approach, derived from general knowledge about how users process through tasks. The most widely used heuristics methods are Nielsen's ten heuristics, Shneiderman's eight golden rules of design, and Norman's seven principles(Nielsen 1994, Shneiderman and Plaisant 2010, Norman 2013). Because of simplicity and comprehensiveness, we employed Shneiderman's eight golden rules. Three human factors experts in healthcare and design explored the usability of these 5 apps. As shown in Figure1, 3 apps with varying scores of usability - lowest, average, and highest- were selected to enter in a randomized control trial (RCT) experiment.

Figure 1. Results of heuristic usability testing

Controlled Experiment:

Setting and selection of participants:
Thirty patients diagnosed with breast cancer with a similar level of severity were selected from a hospital. Patients' medical history was screened by 3 nurses to ensure the criteria of cancer severity, age, and comorbidity with other deceases. In the second phase of screening, the patients were screened to verify their English proficiency and familiarity with the smartphone. Finally, 20 patients met the criteria and were selected to enter a randomized controlled trial (RCT).

We formed 4 groups of intervention including the app with the highest usability (App5), the app with average usability(App4), the app with the lowest usability (App3), and the brochure. In each group, 5 patients, randomly selected from 20 patients, entered to the experiment and started to use the assigned mHealth for 6 weeks. During this time all patients received the same medication, and the only difference was the type of intervention.

Main Outcome Measures
QoL: The primary outcome was quality of life (QoL) of patients in different groups of intervention, which typically is used as an improvement measure in breast cancer intervention. QoL was evaluated using EORTC QLQ-C30. This questionnaire has been shown to have good validity and reliability properties.

Exercise Engagement: We also measured the level of exercise engagement based on time logged by phones and self-reported data.

User Usability: The third measure was user usability results in which patients rated the usability of each app at the end of the sixth week. At the end of the experiment, the participants were asked to rate the usability of the mHealth using the Post Study System Usability Questionnaire (PSSUQ) which is a 19-item questionnaire to evaluate patients’ satisfaction on a scale ranging from 1 (strongly agree) to 7 (strongly disagree)(Lewis 1995).

![Figure 2. Randomized controlled trial (RCT) design for the experiment](image)

Results and Discussion

Impact of mHealth on quality of life:
The results showed that QoL scores were significantly higher for all participants in app groups compared to the brochure group (F(14, 3)=5.74, p < 0.05). Similar to this finding, (Sundberg, Wengström et al. 2017, Ulm, Yoo et al. 2017) showed that mHealth significantly contributed to the quality of life of patients with breast and prostate cancer. Unfortunately, the literature related to the effects of cancer mHealth app on the QoL is limited, and most of the previous studies did not explore QoL as a dependent variable (Kearney, McCann et al. 2009, Quintiliani, Mann et al. 2016, Valle, Deal et al. 2017).

Further analysis of the results showed that the patients in App5 group reported higher QoL (M=72.21, SD=12.5)
compared to patients in App4 (M=52.2, SD=23.4). App3 (M=49.42, SD=32.2), and brochure (M=42.2, SD=12.2).

However, post hoc analysis did not reveal a significant difference between QoL score of App3 and App4 (p <0.05). These results may confirm the importance of usability in effectiveness of mHealth app. Previous studies discussed that usability consideration on the cancer-related mHealth app is the main prerequisite for developing useful and practical health applications (Mirkovic, Kaufman et al. 2014). Details results of QoL questionnaire is presented in Figure 3. As shown in this figure, patients in the brochure group significantly reported a higher level of experiencing symptoms and functional limitations. This may imply that patients who used the app with the highest usability score (in heuristic analysis) experienced more quality of life. This finding is consistent with (Uhm, Yoo et al. 2017) where they discussed that app with quality certification received higher ranking in patients satisfaction.

**Impact of mHealth on exercise engagement:**

Patients in App5 and App4 groups reported more engagement in physical activity (F (14, 3) =3.01, p<0.05). Moreover, users’ activity time logged by phones showed that patients who used the app with higher heuristics usability score spent more time to follow the exercise schedule. Interestingly, self-reported engagement in exercise data was not completely consistent with engagement data logged by phones. Patients in App3, App4, and brochure groups reported higher engagement in physical activities than what they have actually engaged in the exercises based on activity time logged by phones. Similarly, (Ijibb, Cafazzo et al. 2017) showed that higher usability in mHealth results in more user engagement. Patients’ higher engagement in the app with highest usability score indicates that they spent more time to do physical activities provided in the app, and consequently they experienced a lower level of the chronic symptom over time.

**Patients usability testing:**

Usability evaluation of the apps from the patients’ perspective showed that similar to heuristic usability, the patients rated App5 with higher usability score (M=68.89, SD=21.4, F(14, 3)=5.29, p<0.01). However, the ratings for the other two apps were not significantly different (M_App4= 45.21, SD_App4=12.3, M_App3=39.4, SD_App3=20.1). The correlation analysis showed that user usability score was positively correlated with heuristic usability score (r=0.42, p<0.05). Moreover, other correlation analysis revealed that patients who rated the app with higher usability score reported more commitment to physical activities (r=0.59, p<0.05). In contrast to these results, previous studies discussed that user usability results and expert evaluation findings are not necessarily associated. They stated that the combination of these two approaches effectively improve an iterative design process and bring about the highest users satisfaction and performance (Kantner and Rosenbaum 1997, Manzari and Trinidad-Christensen 2006).

The findings of this research are significant because they provide more insight into whether using mHealth apps help patients with breast cancer. These results showed that compared to conventional intervention (brochure), mHealth apps engage patients in physical activities with a higher level, and consequently improve the quality of life. The apps helped patients to receive information and knowledge conveniently. Also, these apps provided activities, scheduled regularly on a daily basis with feedbacks and follow-ups. As a result, patients in app groups were more aware of their cancer and were more engaged in physical exercises. Moreover, the results revealed that improving the usability of mHealth to some extent contribute to exercise engagement. Patients who used the app with the highest usability followed the exercise schedule, actively. Finally, the finding related to expert usability score and user usability score may imply that heuristic usability results were associated with user usability results. In this study, the results of Shneiderman’s eight golden rules was positively correlated with results of PSSUQ.

**Limitations**

This study had several limitations, indicating directions for future research. Our research was a randomized controlled trial with a small number of participants and no control group to compare for intervention effects. Although the brochure group was considered as a control group, the patients in this group also received an intervention. Future research should employ a randomized controlled trial design with a larger sample and considering a control group without having intervention. Additionally, we did not collect QoL information from patients before starting the intervention. Then, we failed to compare before and after QoL scores. This study also was designed for a short-term follow-up period, but a study with longer follow-up time is required to validate the results.

**References**


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