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The Effect of Mobile Health Applications on the Knowledge of Patients of Heart Failure

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ABSTRACT

Background: A lack of knowledge among patients of heart failure represents a significant problem that could lead to an increase in adverse outcomes, such as lengthening the hospitalization period and increasing the readmission rate. ***Purpose:*** This study aimed to identify the effect of mobile health education applications on the knowledge of patients of heart failure and identify the associated factors that would contribute to patients' knowledge of heart failure. ***Methods:*** A quasi-experimental design (two groups with pretest-posttest design) was used. A non-probability convenient sample of 160 patients was recruited. The participants were assigned randomly to an experimental group and a control group. The Dutch Heart Failure Knowledge Scale was used to assess the patients' level of knowledge. Descriptive statistics, independent t-test and multiple-regression analysis were used to analyze the data. ***Results*:** The total number of participants was 126. The overall Jordanian patients' level of knowledge regarding the non-pharmacological management of heart failure was moderate (M = 9.4, SD = 2.07). Significant differences between study groups were found in terms of levels of knowledge. The intervention group (M = 12.26, SD = 2.36) had significantly higher mean scores of knowledge level of heart failure compared to the control group (M = 9.76, SD = 2.01); t = 6.361, p = 0.000). The result of the regression analysis was significant (adjusted R^2 = 0.222, F $(_{16,109})$= 3.226, P=*0.*000). ***Conclusion*:** Mobile health education could be a promising solution for managing different chronic diseases, particularly HF. ***Implications for Nursing*:** Mobile health could be a more cost-effective approach to patient education than other traditional approaches recently applied in clinical practice.

Keywords: Heart failure, Patient education, Knowledge, Telehealth, Mobile health applications.

What does this paper add?

1. Adopting mobile health applications as a part of practice would call for a change in current practice processes and routines at the level of healthcare providers and the organizational level.
2. Telehealth is a new technology approved for its effectiveness in saving the cost of healthcare services, as well as the stakeholders' and administrators' need to activate and adopt mobile health applications.

Introduction

The high prevalence of heart failure (HF) and the economic burden emphasize the importance of managing HF. Patients with HF need to follow a therapeutic regimen to prevent further complications

and deterioration of their health status.

A lack of knowledge of patients of HF could contribute to hospital readmission, a decreased quality of life and poor self-care and comorbidities and ultimately challenge the healthcare system, which struggles to accommodate a massive economic burden of healthcare costs (Bonin et al., 2014).

Patient education has been listed as one of the most essential and highly prioritized points in non-pharmacological management for many chronic diseases such as HF (Du et al., 2015). It is considered an integral part of the management plan for patients with chronic illnesses (Du et al., 2015). The educational intervention could improve patients' HF knowledge and self-care (Hwang et al., 2014). Thus, health education for patients is significant and crucial. However, an effective education program should be accessible and easy to use. Patients with heart failure need proper health education, which would help them accommodate, adapt and clearly understand their health condition (Athilingam et al., 2016).

The use of technology to deliver healthcare remotely could be one of the medical revolutions of the 21st century. As an application for health informatics, telehealth is considered one of the novel strategies to provide optimum healthcare (Seto et al., 2012). Telehealth would help provide education tailored to the patients (Deng Alan, 2015).

The evolution of advanced communication technology, telehealth and patient-friendly equipment, such as smartphones or tablets, would be effective for patients' education. Telehealth is considered one of the new methods that healthcare providers have used to manage chronic diseases (Lee et al., 2018). Telehealth has entered all healthcare settings, significantly improving health and patient well-being (Athilingam et al., 2016).

Mobile Health (mHealth) is a telehealth application that provides health information to help overcome health literacy barriers (Athilingam et al., 2016). Mobile Health (mHealth), a subset of telehealth, has invaded the healthcare system. It plays a significant role in improving health status and well-being (Anderson, 2016). One of its roles is to improve patient knowledge, directly impacting patient adherence to therapeutic management and enhancing self-care (The AmericanTelemedicine Association, 2013). An international study of countries, including Jordan, reported that more than 95% of Jordanian-owned cell phones are used for different purposes (Anderson, 2016).

Thus, this study aimed to assess the effect of mobile health applications on the knowledge of patients of HF. Furthermore, it aimed to identify the associated factors contributing to patients' knowledge of HF.

Methods

Design and Setting

A quasi-experimental design (two-group pretest-posttest design) was used to examine the effect of mobile health applications on the knowledge of patients of HF. The study was conducted at one of the largest university-affiliated hospitals, which serves 17.8% of the population with 678 beds and has a specialized center for catheterization, a coronary care unit and a cardiac intensive care unit for patients' post-cardiac surgery. The cardiac outpatient clinic was the setting to approach the patients. In outpatient clinics, patients have less intense care than in-patients. The estimated number of patients who visited the clinic ranged from 30 to 50 patients/day.

Participants

A non-probability convenient sample was used. The inclusion criteria were: being patients 18 years or older, male and female, willing to participate, with the diagnosis of HF regardless of etiology, duration of HF, able to read and write Arabic, own and can use smartphones or tablets. The exclusion criteria were: being patients with severe cognitive impairment or neurological discorders as indicated by their medical records.

The anticipated sample size was based on a power of 0.80, alpha (0.05), medium effect size (0.15) and regression analysis, which revealed 107. However, given that there will be 2 study groups, sixty-four (64) patients for each group (control group and intervention group) were needed for the study, with a total of 128 patients (Cohen, 1992). However, the number was increased by 20% to overcome attrition (Polit & Beck, 2018). Therefore, the anticipated sample size was 160 patients.

Ethical Considerations

Approval from the Institution Review Board (IRB) was obtained from the Jordan University of Science and

Technology/King Abdullah University Hospital (number 6/107/2017) to collect data and access patient records. In addition, an informed written consent was obtained from the patients in the study. The researchers explained the study purpose and its expected outcomes. Participation was voluntary and the patients were assured that they could withdraw without penalty, which would not affect their routine or regular treatment. The patients were assured that their responses would be treated confidentially. The original authors also approved the use of the instrument.

Intervention

The mobile application for the current study was developed through two main steps. The first step was the theoretical phase to extract essential information based on "Caring for Your Heart: Living Well with Heart Failure," adapted from the North Carolina Program on Health Literacy (2014). The second step was the technical production phase done by the application programmer. The information from phase one was utilized to develop the mobile application. The information provided through the mobile application was suited to education levels "eighth-to tenth-grade levels", characterized by being concise, simple, practical, written in Arabic, easy to understand and presented in a patient-friendly manner.

The application includes images or clipart to ease apprehension. The information captures the HF definition, the medication for patients with HF, the importance of daily weight, fluid-and salt-intake restriction, HF-related worsening signs and symptoms and HF sign and symptom recognition (Kommuri et al., 2012). It was tested for proper operation by the developer and was upgraded to comply with feedback from the research team after the pilot study. The simplest application installation method for patient devices was by sharing the application link to the participants' devices (e.g. WhatsApp as a message). For the current study, more than 81 cards were designed, including the most important topics that the participants with heart failure should know about HF for self-care management.

The first interface includes the participants' demographics to initiate a patient profile. The user had three options – pretest, education screen and posttest. By selecting the educational level, the user could choose the category that he/she wants to learn about (e.g. weight). All the information about patients with HF weight is provided *via* cards.

Measurement

The first part of the instrument was the demographic and clinical-related information. The second part was the Dutch Heart Failure Knowledge Scale (DHFKS). The scale consists of 15 multiple-choice questions on different topics related to HF. General questions (4 items) include the cause of HF, the function of the heart, means of HF and water pills. HF management contains fluid management, activity and diet (6 items), as well as sign and symptom recognition (5 items). The participant was asked to choose the correct answer from three choices. The score of this scale ranges from 0 to 15 (0 is the lowest level of knowledge, while 15 is the highest level of knowledge). The DHFKS is a valid and reliable instrument that can be used to evaluate the effect of education on patients with HF and to measure their HF knowledge. The instrument's reliability was tested by van der Wal et al. (2005) in 19 hospitals in the Netherlands. Cronbach's alpha of the scale was 0.62 (van der Wal et al., 2005).

Bilingual experts performed translation and back-translation to overcome cross-cultural differences (Brislin, 1970). The reliability and content validity of the translated tool were assessed. Cronbach's alpha of the scale in the study was 0.68, which was close to the original authors' value. The content validity was tested by four experts, which revealed a content validity index of 0.96.

Data Collection and Procedure

The department head of the outpatient clinic was approached to facilitate the data collection procedure and identify patients with HF who met the inclusion criteria. Patients who met the inclusion criteria were approached by the department head, who informed them about the study. If the patient was willing to participate, the research assistant/researcher approached the patient, explained the study details and signed a consent form upon agreement.

One of the researchers and two research assistants collected the required data. The researcher trained the two research assistants before conducting the study. They were staff nurses with master's degree in nursing. All data measures were explained to them and the researcher performed a follow-up to ensure that the data-collection process was being conducted correctly.

It was difficult to recruit all patients (N=160) and randomly assign them to control and intervention groups. Thus, a frame from (1-160) was established based on the anticipated number of patients. Using cards numbered from 1-160 and shuffling manually, the number was selected randomly and assigned to the intervention group or the control group, with the first participant assigned to the intervention group. For example, if number (8) was obtained, the patient who was met in the order of (8) was assigned to the intervention group and the process contined until the anticipated number for each group was obtained.

The timeline for the data-collection procedure included two different times. Time one (T1) is for the baseline (pretest), which is the time of approaching the participants and introducing them to the researcher or the research assistants. Also, at this time, the participants filled part one of the instrument (demographic and clinical-related characteristics) and the DHFKS. In addition, for the intervention group, it was time to install the mobile application on the participants' smartphones. Time two (T2) (posttest) was one month after the baseline data and after using the mobile application by the participants in the intervention group. One month was decided based on the literature (Baker et al., 2011; DelaCruz, 2015; Desai & Stevenson, 2012; Varaei et al., 2017).

After randomization, the control group received routine care, which included a visit to the physician, any diagnostic procedures or lab tests and a prescription of usual medications taken, in addition to usual health education from the nurse or physician, if provided. The intervention group, however, received the mobile application about self-care management of HF. The research assistants helped download the application on the patients' smartphones after receiving the link. Follow-up phone calls were conducted four times over one month. Each week, a follow-up phone call was made to ask the participants whether they had any questions regarding the information presented through the application or any problems with the application. The contact information of the researcher and the research assistants was provided for all patients for any further questions regarding the information presented in the application or any problems with it.

Data Analysis

The data was analyzed using the Statistical Package for Social Sciences (SPSS), version (22) for Windows. Descriptive statistics (mean, standard deviation, range and frequency) were used to describe and summarize the demographic and clinical-related characteristics based on the level of measurements. T-test was used to assess the knowledge difference between groups, while regression analysis was used to identify the factors best contributing to a patient's knowledge of HF.

Results

A total of 126 patients with HF were randomly assigned to the control group (n= 59) and the intervention group (n= 67). Figure (1) depicts the Consolidated Standards of Reporting Trials (CONSORT) diagram of the number of participants recruited and the study phases.

The participants' mean age was 56.27 (*SD* =9.19, *R*=30-82). Most participants were female (n=77, 61.1%) and more than two-thirds of the patients were married (n=103, 81.7%). The mean number of medication intakes was 6.30 (*SD*=2.96, R=1-19) and 91.3% had insurance. All participants lived with their families. Most participants were diagnosed with hypertension (n= 119, 94.4%). In addition, more than two-thirds took their medications independently and without family assistance (87%, n=69). There were no significant differences in knowledge between both study groups at the baseline. There were only significant differences between the study groups regarding age; the control group had a significantly higher mean age than the intervention group (t= 2.75; p= 0.007) (Table 1).

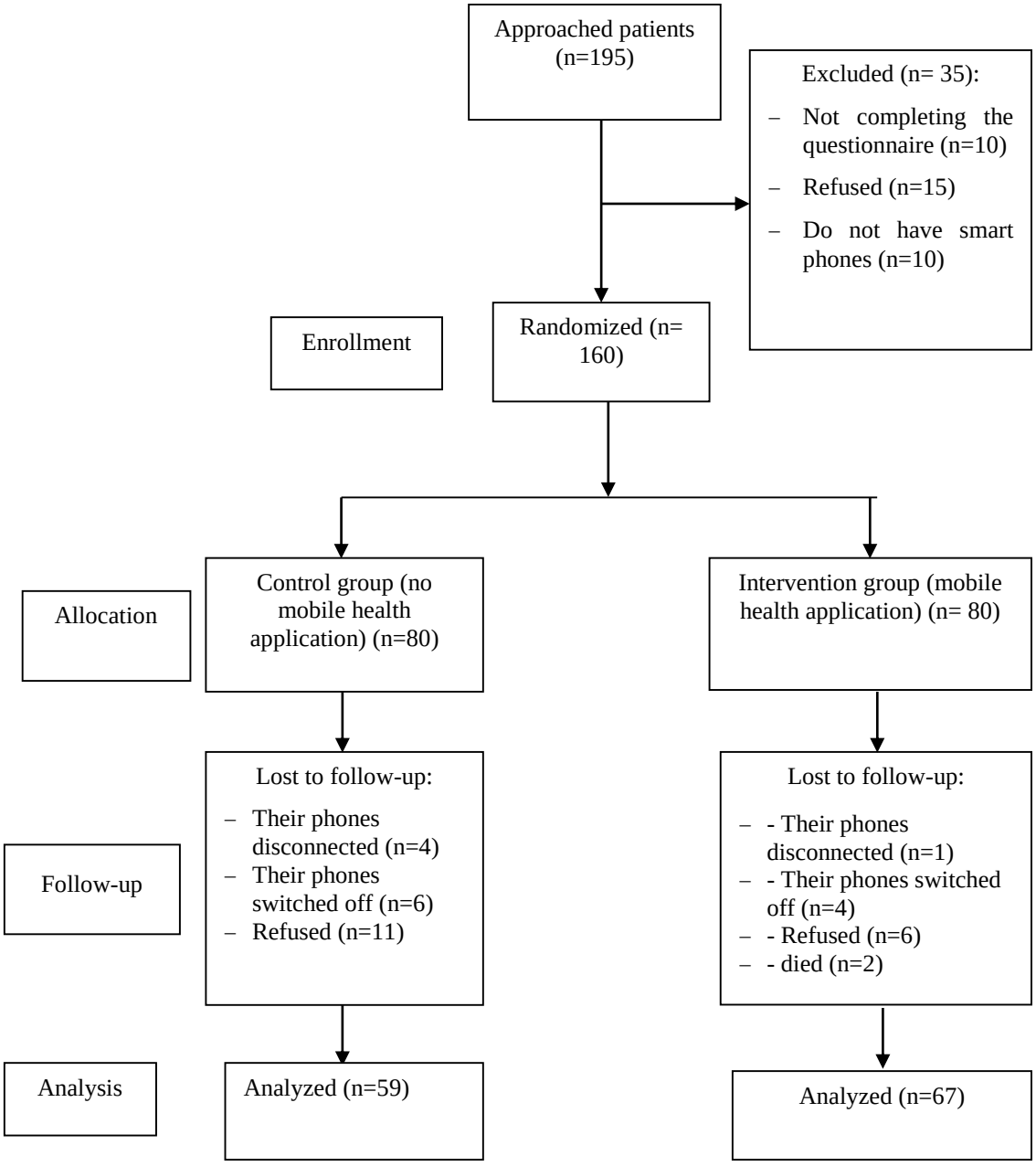

Figure 1. Consolidated standards of reporting trials (CONSORT) guidelines flow chart of participation in the mobile health education application study

Participants' Level of Knowledge Regarding HF

Participants' level of knowledge regarding the non-pharmacological management of HF was moderate *(M= 9.4, SD=2.07)*. Quartile was used to categorize the participants based on their scores. More than 17% (n = 22) of participants were in Q1, which represents the cases below the 25th percentile; those participants were classified as having low levels of knowledge, while more than 30% (n = 38) were in Q2, representing from the 25th percentile to below the 50th percentile, being classified to have a moderate level of knowledge. In addition, 23% (n = 29) were in Q3, representing from the 50th percentile to the 75th percentile, being classified as having adequate knowledge. Furthermore, more than 37 (29%) participants were in Q4, representing cases above the 75th percentile, being determined to have a high level of knowledge.

Table 1. Participants' baseline assessment data (N=126)

Variable	Intervention group (n=67)	Control group (n=59)	*t*	χ^2	*p*
	***F*(%)**	***F*(%)**			
Age (M, SD)	54.21(8.58)	58.61(9.37)	2.75		0.007*
Number of medications (M, SD)	6.20 (2.92)	6.42 (3.03)	0.404		0.687
Gender					
Male	27 (55.1)	22 (44.9)		0.120	0.729
Female	40 (51.9)	37 (48.1)			
Marital Status					
Single	2 (33.3)	4 (66.7)		1.23	0.744
Married	55 (53.4)	48 (46.6)			
Widowed	9 (60)	6 (40)			
Divorced	1 (50)	1 (50)			
Education level					
Secondary or below	42 (49.4)	43 (50.6)		1.48	0.152
Undergraduate or more	25 (61)	16 (39)			
Health insurance					
Yes	62 (53.91)	53 (46.1)		0.288	0.411
No	5 (45.5)	6 (54.5)			
Type of health insurance					
Ministry of Health	49 (57)	37 (43)		2.72	0.436
Private	7 (53.8)	6 (46.2)			
University	5 (50)	5 (50)			
Other	6 (35.3)	11 (64.7)			
Occupation					
Unemployed	48 (52.71)	43 (47.31)		0.024	0.877
Employed	19 (54.3)	16 (45.71)			
Residency					
Irbid	53 (53)	47 (47)		0.138	0.93
Ramtha	8 (57.1)	6 (42.9)			
Other	6 (50)	6 (50)			
Next visit					
One month	46 (53.5)	40 (46.5)		0.011	1
Three months	21 (52.5)	19 (47.5)			

Effect of the Mobile Application on Patients with HF Knowledge

An independent *t*-test was used to determine the differences between the participants with HF level of knowledge in the control and intervention groups before and after using the mobile application. The intervention group *(M=12.26, SD=2.36)* has a significantly higher mean score of knowledge level about HF compared to that of the control group *(M=9.76, SD=2.01); t=6.361, p<0.005*) (Table 2).

Table 2. Independent t-test for participants' knowledge scores between the intervention group and the control group

Test score	Intervention group (n=67) *M (SD)*	Control group (n=59) *M (SD)*	*t*	*p*
Pretest-knowledge score	9.61 (1.85)	9.18 (2.30)	1.148	0.253
Posttest-knowledge score	12.26 (2.36)	9.76 (2.01)	6.361	0.000*

Forced multiple regression was done to determine the factors best predicting patients' knowledge about HF. The regression-analysis results were significant (adjusted R^2 = 0.222, $F_{(16,109)}$ = 3.226, p = 0.000), explaining 22.2% of the variance. The number of medications was significantly the strongest predictor of participants' knowledge *(B=0.380, p=0.000).* Income was also a significant predictor of participants' knowledge *(B=0.376, p=0.000).* In addition, being a widow *(B= 0.272, p=0.003)* and having private health insurance *(B=0.179, p=0.048)* were significant predictors of participants' knowledge. Table 3 represents the results of the regression analysis.

Table 3. Forced multiple regression for factors predicting the level of patients' knowledge

	SE	*B*	*t*	*p*
Age (year)	0.022	-0.151	1.56	0.120
Gender				
Male=0	0.446	-0.028	0.0268	0.790
Female=1				
Number of medications	0.259	0.380	4.297	0.000*
Helping in taking medication				
No=0	0.380	-0.020	0.237	0.813
Yes=1				
Occupation				
Unemployed=0	0.507	0.051	0.469	0.640
Employed=1				
Income	0.221	0.376	3.686	0.000*
Type of health insurance				
Private *vs.* MOH	0.611	0.179	2.00	0.048*
University *vs.* MOH	0.644	0.143	1.704	0.091
Other *vs.* MOH	0.525	-0.047	0.548	0.585
Living (residency)				
Ramtha *vs.* Irbid	0.564	-0.046	0.539	0.591
Others *vs.* Irbid	0.602	0.007	0.086	0.932
Education				
Secondary or less=0	0.440	-0.073	0.731	0.466
Undergraduate or more = 1				
Next visit				
One month =0	0.371	-0.132	1.57	0.117
Three months =1				
Marital Status				
Widowed *vs.* married	0.574	0.272	3.028	0.003*
Single *vs.* married	0.834	-0.068	0.791	0.431
Divorced *vs.* married	1.415	-0.063	0.733	0.465

F= 3.39; df = (16,109); R^2= 0.321; $_{\text{Adjusted}}$ R^2= 0.222; p = 0.000.

Participants who used the application showed significant changes in the items of the Dutch Heart Failure Knowledge Score. These include the items related to the frequency of weight monitoring for patients with HF *(X^2=14.082, p=0.000),* the importance of daily weight *(x^2=5.843, p=0.021),* the amount of fluid that should be consumed daily by the patients with HF *(x^2=11.249, p=0.001),* the best action could be done if shortness of breath or edema increased (x^2=11.919, p=0.001), the causes that could worsen HF symptoms *(x^2=6.485, p=0.016),* the importance of following a low-salt diet for patients with HF *(x^2=8.723, p=0.006),* the importance of exercising regularly with taking a rest *(x^2=5.927, p=0.024),* the allowed increment of kilograms within 2 to 3 days and if occurred to inform the nurse or the physician *(x^2=6.771, p=0.012)* and finally the best action to be done when patients with HF feel thirsty (x^2=22.737, p=0.000).

Discussion

HF is a globally appealing health problem that would impact the patient's quality of life, increase the readmission rate and negatively affect the economic status and the utilization of healthcare resources (Wonggom et al., 2018). Telehealth is a new, innovative approach approved for its effectiveness in persuading patients, motivating them to adopt healthy behaviors and improving health outcomes (Andrade et al., 2015). Many healthcare facilities have adopted it for educational purposes, such as communication, especially after discharge, for follow-up home care (Delaney et al., 2013). Mobile Health (mHealth) has recently become very popular with the advances in mobile technology. The evidence confirms its effect on follow-up and self-care management for many chronic diseases (Lee et al., 2018). In addition, it enhances the relationship between patients and healthcare providers (Tsiantou et al., 2010).

In the current study, it is worth mentioning that there was an enhancement in the level of knowledge among patients who utilized the mobile application for HF. Higher education was a marker of a higher level of disease-specific knowledge (Sui & Ahmed, 2009). Consequently, patients with lower education should be targeted to be involved in educational interventions to improve their level of knowledge.

There were associated co-morbidities, such as diabetes and ischemic heart disease, in many cardiac diseases. However, hypertension was the most reported disease among the current study participants. It is worth noting that ischemic heart disease accounted for 18% of Jordan's top 10 causes of death (The Centers for Disease Control and Prevention, 2010) and deaths from hypertension in Jordan reached 1,311 or 4.95% of the total deaths (World Health Organization, 2017). Indeed, managing HF is very challenging, especially with other co-morbidities or health conditions which share some commonalities with the HF symptoms, such as hypertension. Active participation of the patient in self-care management would play a significant role in disease management (Athilingam et al., 2016).

Management of HF requires a collaborative and interdependent relationship between the patient and the healthcare professional to help decrease HF complications, prevent emergency visits and reduce hospital readmission (Perri & Bellows, 2016). Patient self-care management could be improved by providing proper, cost-effective, timely and accessible information, which can be achieved using mobile health education applications. Information provided to the patients, verbally or written upon discharge, can be forgotten or lost (Athilingam et al., 2016).

The participants in the current study own smartphones, enabling them to use and manipulate the selected health program for educational purposes. The idea that all participants of different ages had smartphones supports current trends in using mobile health (mHealth) to manage chronic illnesses. A global survey by the WHO in 2016 emphasized the importance of using telehealth in different aspects of health in managing other chronic diseases to enhance the quality, cost and accessibility of the provided healthcare services (World Health Organization, 2016).

In the current study, the number of medications, income, marital status and private health insurance were significantly associated with the knowledge level of patients regarding HF. Being a widow with fewer medications, a good income and private health insurance can affect a patient's level of knowledge. In Jordan, patients with private health insurance are active participants in the care. Patients with private insurance - whereby they are treated at private hospitals - can ask more questions and ask for clarification about their disease, health and self-care management. The patient-healthcare provider ratio will likely be lower than the one with governmental insurance; thus, healthcare

providers can spend more time with each patient to educate and explain self-care management strategies. In addition, the number of patients is likely less than that in governmental hospitals. It could also be that most private health insurances are under control by many health insurance companies, which prioritize customer service and satisfaction with the provided health services.

The knowledge about disease management, including daily weight monitoring, fluid restriction and the causes that worsened patients' health, was higher among HF patients who used the application than among those who received the traditional treatment, which confirms that providing health education with follow-up regarding adherence to the therapeutic regimen, medication, diet, self-monitoring and weight gain would improve patients' self-care management.

Fortunately, HF can be managed in outpatients by providing patients with proper discharge planning instructions that help the patient live well and prevent readmission (Scott et al., 2014). The study's results provided evidence that having the mobile application as an educational tool would improve patients' level of knowledge, enhance self-care management of the disease and finally help adhere to the recommended regimen. Increasing patients' knowledge level would encourage them to adopt healthy behaviors and manage their health, leading them to maintain their daily activities smoothly and live better physically and emotionally.

Patients with HF have complex co-morbidities that require many medications, which will affect patients' compliance due to forgetfulness to take all drugs or to memorize time regimens. A smaller number of drugs was associated with better knowledge and compliance from the patients' perspective. In addition, being a widow promotes the level of knowledge. One possible explanation is that widows have fewer responsibilities and more time to care for themselves, become socially active and explore various options to promote their health and knowledge about their diseases.

Limitations

The study results should be taken with the consideration of some limitations. Although it is considered one of the most potent designs (Polit & Beck, 2010), many confounding variables could affect the results. These confounding variables are out of our control because of their invisibility and unattainability. Firstly, as an educational intervention, the mobile application is challenging to double-blind either the participants or the research assistants who will insert the application into the participants' phones and make the follow-up phone calls. The second limitation is using the convenience-sampling technique, which limits the results' generalizability, since it represents a specific group of people, not the whole population. We suggest that further research be conducted using the random-sampling technique. In addition, history and testing are study biases of the design that would affect the study findings.

Conclusion

The use of mobile applications for improving the knowledge of patients with HF of their disease could be a beneficial way to improve their level of knowledge, enhance their adoption of healthy behaviors and live well with HF without getting stressed or overwhelmed by the illness. Mobile health could be a more cost-effective approach to patient education than other traditional methods recently applied in clinical practice. Further studies are suggested to replicate the findings of our research.

Implications for Nursing

Our findings revealed the effectiveness of mobile applications in improving the knowledge of patients with heart failure. Mobile applications could be a promising transition from the current paper-based tracking system to a more automated wireless electronic tracking method.

The study findings could impact patients' continuity of care by receiving constant feedback and follow-up from healthcare providers on their progress, updating their care plans and goals as needed and adjusting any changes in their treatment plans. Adopting mobile applications as a part of practice would call for a change in current practice processes and routines at both the level of healthcare providers and the organizational level.

In this era of shifting to mobile applications, the study findings consider integrating mobile applications into the more extensive e-health care system, particularly among patients with heart failure. Such integration would allow for the consideration of various information sources. It would support practices and

process changes to successfully adopt mobile applications as a part of heart-failure patient care.

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Conflict of Interest

The researchers have no conflict of interest. Also, they are the sole authors of the sole paper entitled "The Effect of Mobile Health Applications on the Knowledge of Patients of Heart Failure" and certify that all the paper's content is their original work.

REFERENCES

Anderson, M. (2016). *Technology device ownership: 2015*. Pew Research Center; 2015.

Andrade, A.D., Anam, R., Karanam, C., Downey, P., & Ruiz, J.G. (2015). An overactive bladder online self-management program with embedded avatars: A randomized controlled trial of efficacy. *Urology*, *85* (3), 561-567. https://doi.org/10.1016/j.urology.2014.11.017

Athilingam, P., Osorio, R.E., Kaplan, H., Oliver, D., O'neachtain, T., & Rogal, P.J. (2016). Embedding patient education in mobile platform for patients with heart failure: Theory-based development and beta testing. *Computers Informatics Nursing*, *34* (2), 92-98.

Baker, D.W., DeWalt, D.A., Schillinger, D., Hawk, V., Ruo, B., Bibbins-Domingo, K., Weinberger, M., Macabasco-O'Connell, A., Grady, K.L., & Holmes, G.M. (2011). The effect of progressive, reinforcing telephone education and counseling *versus* brief educational intervention on knowledge, self-care behaviors and heart failure symptoms. *Journal of Cardiac Failure*, *17* (10), 789-796.

Bonin, C.D.B., Santos, R.Z.D., Ghisi, G.L.D.M., Vieira, A.M., Amboni, R., & Benetti, M. (2014). Construction and validation of a questionnaire about heart-failure patients' knowledge of their disease. *Arquivos Brasileiros de Cardiologia*, *102* (4), 364-373.

Brislin, R.W. (1970). Back-translation for cross-cultural research. *Journal of Cross-cultural Psychology*, *1* (3), 185-216.

Cohen, J. (1992). A power primer. *Psychological Bulletin*, *112* (1), 155.

DelaCruz, F. (2015). *The impact of a one-on-one coaching session on heart-failure patients' knowledge of self-care disease management*. Azusa Pacific University.

Delaney, C., Apostolidis, B., Bartos, S., Morrison, H., Smith, L., & Fortinsky, R. (2013). A randomized trial of telemonitoring and self-care education in heart-failure patients following home care discharge. *Home Health Care Management & Practice*, *25* (5), 187-195. https://doi.org/10.1177/1084822312475137

Deng Alan. (2015). Genetics of systolic and diastolic heart failure. *Journal of Hypertension*, *33* (1), 3-13.

Desai, A., & Stevenson, L. (2012). *Rehospitalization for heart failure: Predict or prevent?* Circulation [Internet]. 2012, Jul. 24; *126* (4), 501-506.

Du, S., Hu, L., Dong, J., Xu, G., Jin, S., Zhang, H., & Yin, H. (2015). Patient education programs for cancer-related fatigue: A systematic review. *Patient Education and Counseling*, *98* (11), 1308-1319.

Hwang, B., Moser, D.K., & Dracup, K. (2014). Knowledge is insufficient for self-care among heart-failure patients with psychological distress. *Health Psychology*, *33* (7), 588.

Kommuri, N.V., Johnson, M.L., & Koelling, T.M. (2012). Relationship between improvements in heart-failure patient disease-specific knowledge and clinical events as part of a randomized controlled trial. *Patient Education and Counseling*, *86* (2), 233-238.

Lee, J.A., Choi, M., Lee, S.A., & Jiang, N. (2018). Effective behavioral intervention strategies using mobile health applications for chronic disease

management: A systematic review. *BMC Medical Informatics and Decision Making*, *18* (1), 12. https://doi.org/10.1186/s12911-018-0591-0

Perri, M., & Bellows, M. (2016). Interdependency and heart-failure self-care management. *Canadian Journal of Cardiology*, *32* (10), S328.

Polit, D.F., & Beck, C.T. (2010). *Essentials of nursing research: Appraising evidence for nursing practice*. Lippincott Williams & Wilkins.

Polit, D.F., & Beck, C.T. (2018). *Essentials of nursing research: Appraising evidence for nursing practice* (Ninth edn.). Lippincott Williams & Wilkins.

Scott, I., Shohag, H., & Ahmed, M. (2014). Quality of care factors associated with unplanned readmissions of older medical patients: A case–control study. *Internal Medicine Journal*, *44* (2), 161-170.

Seto, E., Leonard, K.J., Cafazzo, J. A., Barnsley, J., Masino, C., & Ross, H. J. (2012). Mobile phone-based telemonitoring for heart failure management: A randomized controlled trial. *Journal of Medical Internet Research*, *14* (1), e31.

Sui, X., & Ahmed, A. (2009). Higher levels of education may be a marker of higher disease-specific knowledge in patients with chronic heart failure. *International Journal of Cardiology*, *144* (1), 93-94. https://doi.org/10.1016/j.ijcard.2009.01.014

The AmericanTelemedicine Association. (2013). *What is telemedicine*? *http://www.americantelemed.org/learn*

The Centers for Disease Control and Prevention. (2010). *The CDC in Jordan.* https://www.cdc.gov/globalhealth/countries/jordan/pdf/jordan.pdf

Tsiantou, V., Pantzou, P., Pavi, E., Koulierakis, G., & Kyriopoulos, J. (2010). Factors affecting adherence to anti-hypertensive medication in Greece: Results from a qualitative study. *Patient Preference and Adherence*, *4* (default), 335-343. https://doi.org/10.2147/PPA. S12326

Varaei, S., Shamsizadeh, M., Cheraghi, M. A., Talebi, M., Dehghani, A., & Abbasi, A. (2017). Effects of a peer education on cardiac self-efficacy and readmissions in patients undergoing coronary artery bypass graft surgery: A randomized-controlled trial. *Nursing in Critical Care*, *22* (1), 19-28.

Wonggom, P., Du, H., & Clark, R.A. (2018). Evaluation of the effectiveness of an interactive avatar-based education application for improving heart-failure patients' knowledge and self-care behaviours: A pragmatic randomized controlled trial protocol. *Journal of Advanced Nursing*, *74* (11), 2667-2676. https://doi.org/10.1111/jan.13768

World Health Organization. (2016). *Launch of global diffusion of eHealth: Making universal health coverage achievable*. https://www.who.int/goe/publications/global_diffusion/en/

World Health Organization. (2017). *Hypertension in Jordan: World life expectancy*. https://www.worldlifeexpectancy.com/jordan-hypertension