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ORIGINAL ARTICLE

Development and evaluation of a self-management application for patients with gout

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Abstract

Aim: The present study aimed to develop a self-management application for patients with gout and determine the clinical feasibility of the application.

Methods: A self-management application (GoutCare) was developed from July 1, 2016, to October 30, 2016, by reflecting on the key elements of Fisher & Fisher's information-motivation-behavioral skills model. In order to determine the clinical feasibility of the application, a non-equivalent, control group, pre-test-posttest study was conducted among patients with gout who visited a university hospital from January to April 2017. Twenty-seven subjects in the experimental group used the smartphone allocation for 8 weeks, and 29 subjects in the control group were provided a leaflet with information on gout self-management. Knowledge of gout, self-management attitude, perceived social support, self-efficacy, self-management performance, and health-related quality of life before and after the intervention were measured using a structured questionnaire.

Results: The self-management application (GoutCare) developed for patients with gout was found to be effective in improving the knowledge of gout, self-management attitude, perceived social support, self-efficacy, self-management performance, and physical health-related quality of life.

Conclusion: In conclusion, the application contributed to improving the self-management performance and health-related quality of life in the patients with gout. Therefore, this application can be used as a nursing intervention program for promoting self-management in patients with gout.

KEYWORDS

gout, lifestyle, quality of life

1 | INTRODUCTION

Gout is a chronic progressive disease involving the accumulation of uric acid in the body due to abnormal purine metabolism that causes paroxysmal inflammation of the joints (Choi, Mount, & Reginato, 2005). Due to the aging population and changes in eating habits, the incidence, prevalence, and economic burden of gout are accordingly increasing (Zhu, Pandya, & Choi, 2011).

Gout causes severe joint pain and joint deformation. However, proper treatment and care can help prevent gout attacks and reduce severe complications (Song, 2016). For gout patients, lifestyle modifications along with appropriate medical treatment are emphasized. Alcohol consumption is a strong risk factor for gout attacks because it increases the level of uric acid in the blood and inhibits its excretion (Seo *et al.*, 2011); therefore, it is the most important lifestyle choice that must be modified. Obesity also increases the

incidence of gout. Therefore, gout patients are advised to maintain a normal weight, manage stress, quit smoking, and ensure proper fluid intake (Khanna *et al*., 2012; Williams, 2008).

Although treatment and management methods for gout are more specific than those for other types of arthritis (Harrold *et al*., 2012), gout patients are known to be less compliant with therapeutic recommendations (Rees, Jenkins, & Doherty, 2013). Similar to those with other chronic diseases, gout patients are required to have sufficient knowledge and skills to control their disease and change established behavioral patterns. Therefore, self-management of gout should be promoted by caregivers.

The information-motivation-behavioral skills model (IMB model), which consists of knowledge enhancement, behavior motivation, and self-efficacy promotion, has been used as a theoretical framework for positive behavioral change (Fisher, Fisher, & Shuper, 2009).

According to the IMB model, when there is a high level of information about health behaviors, motivation regarding changes in behavior, and promotion of the skills necessary for those changes, it is highly likely that individuals will change and maintain their health behaviors (Fisher & Fisher, 1992). In this study, the first component of the IMB model, "information," was defined as the knowledge of gout patients' self-management, and was composed as the app's menu.

The second component, "motivation," includes personal motivation and social motivation as a component to practice self-management; personal motivation was defined by self-management attitude, and social motivation was defined by perceived social support.

The third component, "behavioral skills," is defined as self-efficacy for self-management, meaning skills and confidence to perform self-management. The program was structured to help users understand their current states and to improve self-confidence through achievement of self-management by having them record and check self-management performance such as dietary habits, alcohol consumption, exercise, weight management, and administration of prescription drugs and providing feedback based on their level of management.

Individualized education using an application reduces the effort necessary for patients to retrieve information directly from the internet and enables patients to change their behavior by providing appropriate information at any time (Yoo, 2014). It is more efficient for gout patients to use applications that help their self-management at their convenience rather than programs that can only be used at specific places and times (Jeon & Kim, 2016).

Based on the IMB model, we constructed the theoretical framework (Figure 1) to develop an application to promote self-management among gout patients and to evaluate its effectiveness. We also confirmed its usefulness as a nursing intervention strategy for gout patients.

2 | METHODS

We performed a quasi-experimental study of a non-equivalent control group that assessed the effects of 8 weeks self-management application developed for gout patients.

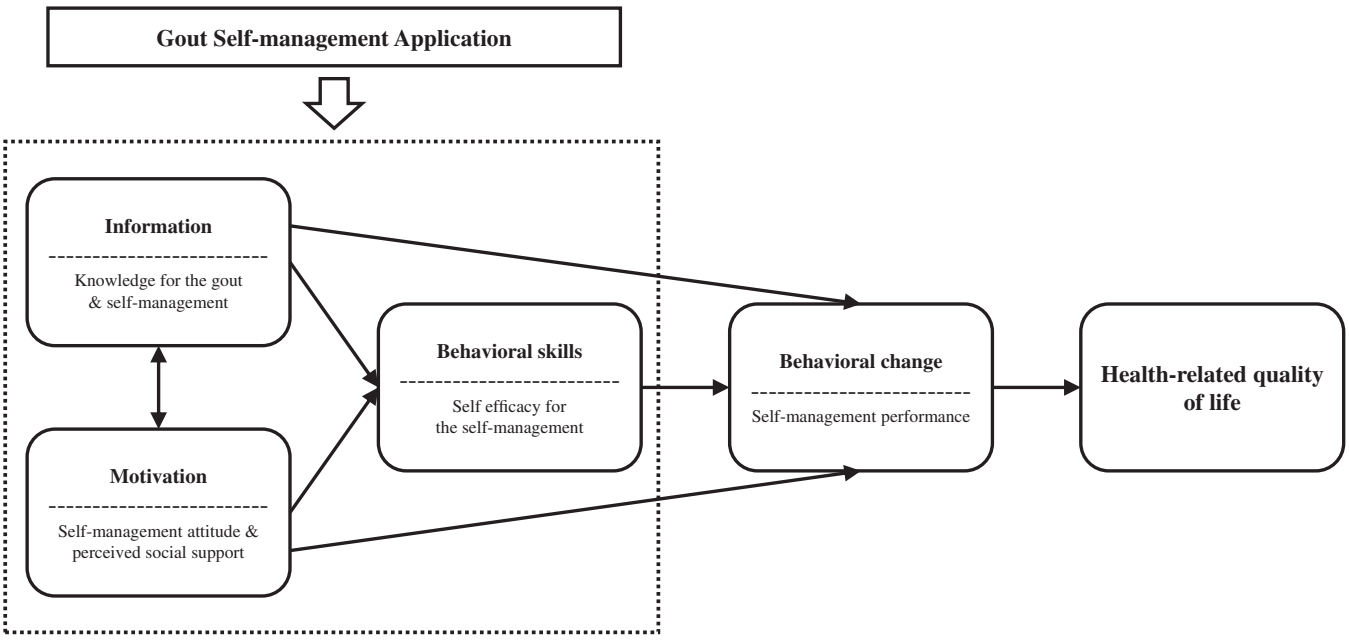

FIGURE 1 Conceptual framework of the study

2.1 | Participants

Study participants were selected from those visiting the rheumatology clinic of a general hospital and understood the purpose of the study and agreed to participate. Patients 20 to 80 years of age who were diagnosed with gout and had never participated in a self-care education program were selected. Participants who were able to use an Android (Google, Mountain View, CA, USA) smartphone and the application were selected as the experimental group.

The sample size for the program was calculated by the G*Power 3.1.2 program. Using an effect size (d) of .80, which reflected the effect size of intervention reported in a previous study (Oh *et al*., 2013), a significance level (α) of .05, and power (1-ß) of .80, the minimum number of individuals required for each group was 26. Considering a dropout rate of 20%, a total of 62 subjects were selected (experimental group, 31 subjects; control group, 31 subjects).

Three individuals who had never used the program and one who did not participate in the follow-up investigation were excluded from the experimental group. Two individuals who did not participate in the post-test were excluded from the control group. Finally, 27 individuals in the experimental group and 29 in the control group participated in the analysis. The subjects were assigned to groups according to the day of the hospital visit. Subjects who visited on Mondays and Wednesdays were assigned to the experimental group, and those who visited on Tuesdays and Thursdays were assigned to the control group.

2.2 | Measures

2.2.1 | Knowledge of gout

We used the gout knowledge tool that was used in a previous study (Oh *et al*., 2013) to verify the effectiveness of the web-based self-management intervention program for gout patients. The knowledge tool consists of a total of 12 items with questions about the level of knowledge regarding the cause, symptoms, diagnosis, treatment, prognosis, complications, and self-management (obesity, diet, alcohol consumption, etc) of gout. The higher the score, the higher the level of gout knowledge. The test–retest reliability of the instrument performed at 2-week intervals was .88 for 20 gout patients.

2.2.2 | Attitude toward self-management

To measure the self-management attitude of gout patients, we modified and used the self-care attitude tool used for other chronic diseases. The content validity (content validity index = .80) was tested by a panel of experts (two nursing professors, two rheumatologists, and two nurses at the gout clinic). In this study, reliability was .88 when measured using Cronbach's α.

The attitude measurement tool consisted of 10 items with responses ranging from very unlikely (score of 0) to fully agree (score of 4) on a Likert scale. The higher the score, the more positive the attitude toward self-management.

2.2.3 | Social support

We used the Medical Outcomes Study (MOS) Social Support Survey tool (Sherbourne & Stewart, 1991), translated by Lim (2002) into Korean, to measure the perceived social support. The tool consisted of 19 items regarding material support, affection support, emotional support, information support, and positive social interaction. Each item had a possible score of five points on a Likert scale; a higher score indicated more social support. The reliability of the instrument at the time of development was .97, and the reliability in this study was .98 (Cronbach's α).

2.2.4 | Self-efficacy

We used the self-efficacy tool for gout patients developed by Kang, Lee, and Lee (2014). The instrument consisted of five items, each with a possible score of 10 to 100 points. The higher the score, the more self-efficacy for self-management. In the study by Kang *et al*. (2014), the reliability was .92, the reliability in this study was .94 (Cronbach's α).

2.2.5 | Self-management performance

The self-management performance tool developed by Kang *et al*. (2014) for gout patients was used for this study. A total of 15 items were measured using a five-point scale. The higher the score, the higher the level of self-management. In the study by Kang *et al*. (2014), the reliability was .95, the reliability in this study was .95 (Cronbach's α).

2.2.6 | Health-related quality of life

Health-related quality of life was measured using MOS SF-12 (Ware, Kosinski, & Keller, 1996). SF-12 is a 12-item questionnaire consisting of a physical component score (PCS) and mental component score (MCS). The higher the score, the better the quality of life. The reliability of this tool was .67 for the PCS and .70 (Cronbach's α) for MCS in the study by Ware *et al*. (1996). In this study, the reliability was .87 for the PCS and .84 (Cronbach's α) for the MCS.

3 | DATA COLLECTION AND RESEARCH PROCEDURE

We received approval to perform this study from the University Hospital Institutional Review Board before we approached the participants. To recruit participants, advertisement materials were posted on the bulletin board of the rheumatology clinic of the hospital from January 17, 2017 to April 14, 2017.

3.1.1. | Pre-test

The pre-test was performed in the outpatient counseling room on the day of the patient's visit to the rheumatology clinic. The subjects assigned to the experimental group and the control group completed a questionnaire about general characteristics and outcome variables. The time required to complete this was approximately 15–20 min.

3.1.2. | Intervention

We explained to the experiment group how to use the application by installing the self-management application on their personal smartphones and providing a user manual. Subjects were asked to use it for 8 weeks. The application usage time in the study by Park *et al*. (2015) was 8 weeks, and 4 weeks in the studies by Jeon and Kim (2016) and Kim (2014), to derive significant effects from the smartphone app. Therefore, the intervention period was determined to be 8 weeks in this study as well.

In the program development stage, analysis of the program usability and users were conducted among gout patients, and we found that more than 84% of the respondents were under 60 years of age, and more than 87% of the respondents had above-average proficiency in using smartphones. Furthermore, when trained on how to use the application, the subjects learned and were proficient within 1 hour. Therefore, we thought 8 weeks was sufficient time to get used to the new application. The control group received leaflets containing the same information regarding gout and self-care as that in the application.

3.1.3. | Post-test

Both the experimental group and the control group performed the post-test after completing the pre-test and intervention. Those patients who visited the hospital 8 weeks later were asked to complete a written questionnaire. Those who could not revisit the hospital answered survey questions read to them by a research assistant via telephone. The time required to complete the survey was 15–20 minutes.

3.1 | Statistical analysis

The collected data were analyzed using the SPSS/WIN 22.0 program (IBM Corp, Armonk, NY, USA). A homogeneity test was conducted for general characteristics and dependent variables among the groups, which were analyzed using the χ^2 test, t test, and Mann–Whitney U test.

Hypothesis testing to compare the differences in dependent variables between the experimental and control groups was performed using the t test and Mann–Whitney U test after performing the Kolmogorov–Smirnov test.

4 | RESULTS

4.1 | Development of the self-management application for gout patients

4.1.1 | Analysis phase of the application configuration

We analyzed the level of knowledge and identified the needs of gout patients to develop a program tailored to the users. The survey was conducted for 132 gout patients by using a structured questionnaire at a rheumatology clinic of a university hospital. In the survey of 132 gout patients to understand the knowledge level of the subjects, the questions related to “the relationship between gout and smoking,” “the relationship between gout and weight,” “complications of gout,” “diet for gout” had low percentage of correct answers. As a result, we focused on dietary and weight management in the program's contents. In addition, results of a survey to understand the program's usability showed the highest requirements for “self-management method,” “medication alarm,” and so on. Therefore, these elements were actively reflected in the components of the app. Also, analysis of the smartphone usage experience showed “ease of use,” “easy to see configuration”. Therefore, these elements were actively reflected in the design of the app. Therefore, we believe that the app was developed by amply reflecting the opinions and usage experience of gout patients, to the extent that we can say it was co-designed with gout patients before the app design and development stage.

In addition, we reviewed the literature and analyzed other applications to determine the contents and purposes of subcategories to be included in the program. Furthermore, program experts identified technical components, such as hardware and software, required for program development and operation.

4.1.2 | Design phase

First, based on the IMB theory, the components and goals of smartphone applications were established. Details based on

the goals were applied so that self-management could be improved by analyzing the results of the needs.

Second, we designed the relationship and action of smartphone terminals, the application management servers, and the administrator application servers. When an application is downloaded to a smartphone and registered through membership, the device is registered on the company's server. The identification and information of the participant are stored on the server, and the application contents are executed through the server. The bulletin board information, entered by participants, was also stored on the company's server, and the connection time, frequency, and self-managing input of the subjects were available to the administrator through the company's server.

Third, an entity-relationship diagram was designed prior to the database design to explore the relationships between tables. Based on this, the database was created, tables were created in the database, and the relationships between the required functions and each component were planned.

Fourth, based on the results from the previous phase, the screen of the actual application was designed. A draft and description of the screen design were visualized by the researcher using PowerPoint (Microsoft, Redmond, WA, USA).

4.1.3 | Development phase

Based on the results of the analysis and design phase, we implemented the application for 3 months (from July 1, 2016, to September 30, 2016). Programmers and computer design experts who worked for a professional smartphone application production company participated in the development phase. Our application, which was called GoutCare, was produced through a revision process using feedback between the researcher and the programmer.

4.1.4 | Pilot test

During the pilot test stage, we provided the smartphone application to six experts and five gout patients and asked them to use it for 2 weeks (beginning on October 1, 2016). The overall program usage pattern was monitored, and the errors, appropriateness, and feasibility of the program were examined. To evaluate the usability, surveys involving the six experts and five gout patients were conducted with the mobile app rating scale (MARS) developed by Stoyanov *et al.* (2015). To enhance the "entertainment item" which was rated the lowest, we added an image that looks like a funny face in the "self-management feedback" area, and animation elements in the area where they enter their weight and height to make the app feel more familiar and fun. In addition, to improve the aesthetic aspect, we reinforced the zoom function.

4.1.5 | Self-management application of gout patients

The main screen of the application has six menus: gout information, self-management, my stats, alarm setting, bulletin board, logout. "Gout information" shows a screen configuration of knowledge related to the gout and self-management. It has a total of eight areas, and users can touch each area to check the related contents.

The self-management screen has a total of nine areas: alcohol consumption, exercise, diet, weight, drug administration, pain level, pain site, pain frequency and duration, and uric acid level. It is programmed so that when users touch each area to input the relevant information, a preset feedback is provided to them.

The alarm screen is programmed so that when users set the gout medication administration time and the dates for their regular hospital check-ups, an alarm message will be shown on their phone.

The bulletin board consists of four areas: notice, questions and answers (Q&A), information exchange, and the open bulletin board. In the Q&A, subjects can write questions about gout or using the program, and the manager can write replies. The open bulletin board was set as a place for users to share gout cases and encouragements, and ordinary everyday stories (Figure 2)

4.2 | Verification of the effectiveness of the self-management application

4.3 | Homogeneity test between experimental group and control group

There were 27 subjects in the experimental group and 29 in the control group. The homogeneity test revealed no significant difference in the general characteristics and dependent variables of the experimental group and control group. Therefore, the homogeneity of the two groups was confirmed (Tables 1 and 2).

4.4 | Hypothesis testing

4.4.1 | Gout knowledge

In the experimental group, the level of knowledge regarding gout was increased by 2.15 points, from 7.04 to 9.19. In the control group, the level of knowledge was decreased by 0.38 points, from 6.10 to 5.72. There were statistically significant

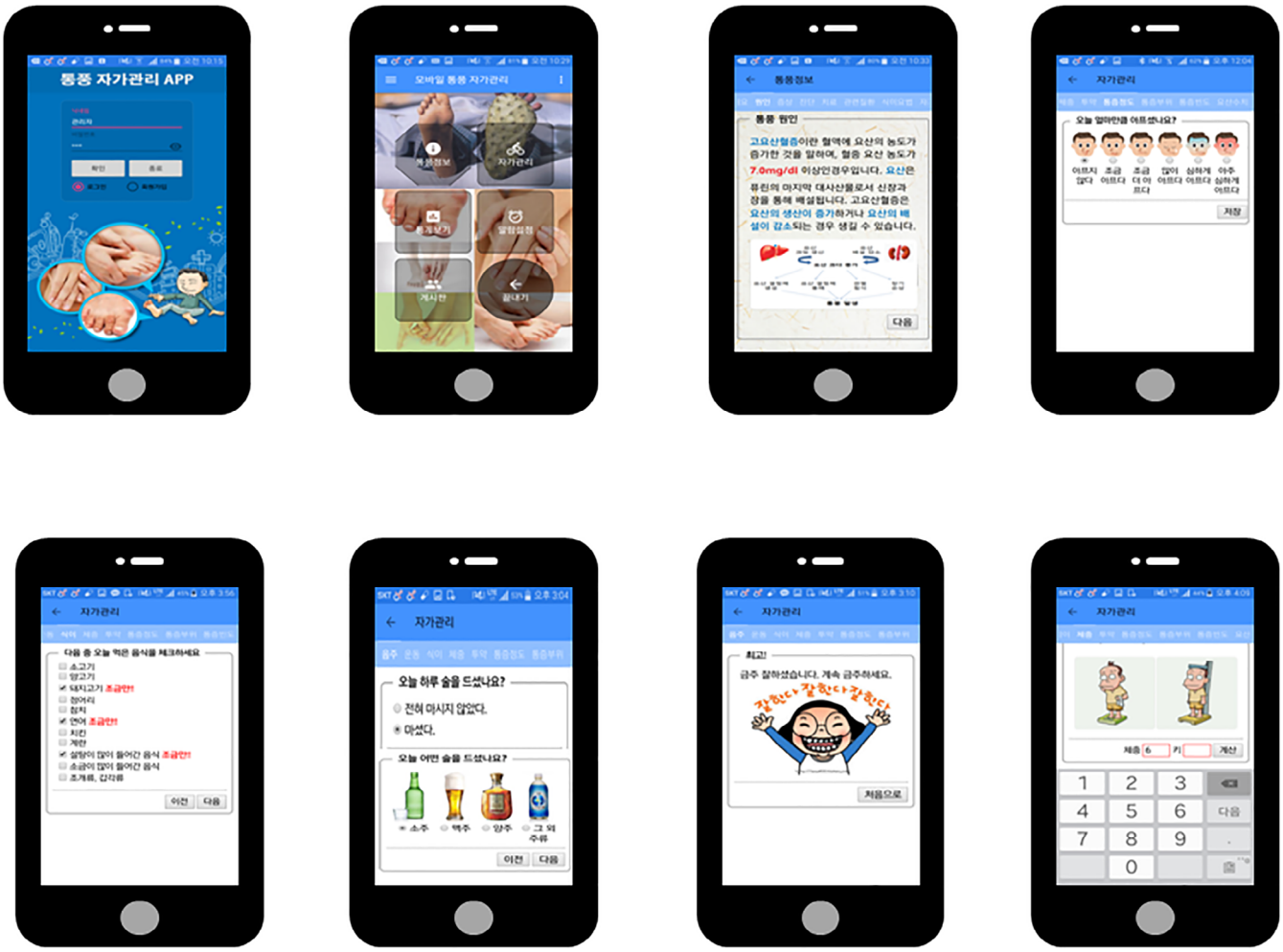

FIGURE 2 Application of GoutCare

differences in the level of gout knowledge of the two groups ($t = 4.08$; $P < .001$). The effect size was 1.67.

4.4.2 | Self-management attitude

The self-management attitude score of the experimental group increased by 4.44 points, from 33.04 to 37.48, and that of the control group decreased by 3.07 points, from 33.07 to 30.00. There was a statistically significant difference in the self-management attitude scores of the two groups ($Z = -5.91$; $P < .001$). The effect size was 3.85.

4.4.3 | Perceived social support

The perceived social support of the experimental group increased by 4.89 points, from 66.26 to 71.15, and that of the control group decreased by 1.07 points, from 63.14 to 62.07. A statistically significant difference was found in the perceived social support scores of the two groups ($t = 6.56$; $P < .001$). The effect size was 3.43.

4.4.4 | Self-efficacy

The self-efficacy level of the experimental group increased by 20.52 points, from 50.96 points to 71.48 points, and that of the control group decreased by 2.37 points, from 51.34 to 48.97. There was a statistically significant difference in the levels of self-efficacy of the two groups ($Z = -6.36$; $P < .001$). The effect size was 8.00.

4.4.5 | Self-management performance

The self-management performance of the experimental group increased by 12.15 points, from 41.15 to 53.30, and that of the control group decreased by 2.89 points, from 44.72 to 41.83 points. A statistically significant difference was observed in the level of self-management performance of the two groups ($t = 10.46$; $P < .001$). The effect size was 6.84.

TABLE 1 Homogeneity test for the general characteristics ($N = 56$)

Characteristics	Classification	Exp ($n = 27$)	Cont ($n = 29$)	χ^2 or t	P
		n (%) or mean ± SD			
Gender	Male	25 (92.6)	26 (89.7)	.148	1.000
	Female	2 (7.4)	3 (10.3)		
Age	20–39	6 (22.2)	6 (20.7)	.024	1.000
	40–59	13 (48.1)	14 (48.3)		
	60–79	8 (29.7)	9 (31.0)		
		50.26 ± 12.22	51.55 ± 13.07	−.382	.704
Education	Middle school or lower	4 (14.8)	10 (34.5)	2.980	.258
	High school	12 (44.4)	9 (31.0)		
	College or higher	11 (40.8)	10 (34.5)		
Marital status	Single	5 (18.5)	4 (13.8)	.256	.924
	Married	18 (66.7)	20 (69.0)		
	Divorce, bereavement	4 (14.8)	5 (17.2)		
Occupation	Unemployed	6 (22.2)	8 (27.6)	1.744	.489
	Office worker	13 (48.1)	9 (31.0)		
	Self-employment	8 (29.7)	12 (41.4)		
People living with	Family	22 (81.5)	23 (79.3)	1.883	.390
	Friend	2 (7.4)	2 (6.9)		
	Alone	3 (11.1)	4 (13.8)		
Income level	High	3 (11.1)	4 (13.8)	.386	.860
	Moderate	18 (66.7)	17 (58.6)		
	Low	6 (22.2)	8 (27.6)		
Duration of disease		6.85 ± 6.20	7.93 ± 7.66	−.577	.566
Other disease	Yes	13	14	.000	1.000
	No	14	15		

TABLE 2 Homogeneity test for the variables ($N = 56$)

Variables (range)		Exp ($n = 27$) Mean ± SD	Cont ($n = 29$) Mean ± SD	t / Z	P
Disease-related knowledge (0–15)		7.04 ± 2.53	6.10 ± 2.04	1.52	.134
Attitude toward self-management (0–40)		33.04 ± 1.35	33.07 ± 1.34	−0.16[a]	.880
Perceived social support (19–95)		66.26 ± 15.27	63.14 ± 19.27	0.67	.290
Self-efficacy (10–100)		50.96 ± 25.25	51.34 ± 22.04	−0.13[a]	.900
Self-management performance (15–75)		41.15 ± 13.25	44.72 ± 13.82	−0.99	.328
Health-related quality of life	PCS	67.37 ± 16.80	65.24 ± 15.00	0.50	.619
	MCS	76.19 ± 12.22	75.86 ± 15.86	0.09	.933

[a]Mann–Whitney U test. Abbreviations; MCS, mental component score; PCS, physical component score.

4.4.6 | Health-related quality of life

The level of health-related quality of life was divided into the physical area and the mental area. The physical health-related quality of life score (PCS) increased by 3.23 points, from 38.67 to 41.90 points, in the experimental group, and it decreased by 1.03 points, from 39.81 to 38.78 points, in the control group. There was a statistically significant difference in the quality of life related to physical health of the two groups ($Z = -1.90$; $P = .046$). The effect size was 2.85.

The mental health-related quality of life scores (MCS) increased by 0.06 points, from 65.80 to 65.86, in the experimental group, and it decreased by 0.27, from 65.51 to 65.24, in the control group. There was no statistically significant difference in mental health-related quality of life scores of the two groups ($Z = -1.28$; $P = .291$) (Table 3).

4.5 | Additional analysis

Evaluation of the program utilization rate showed that the average utilization rate over 8 weeks per person was 32.8 times. In other words, it was used an average of 4.1 times per week. The most frequently used menu was "self-management", whereas the least frequently used was the "bulletin board".

5 | DISCUSSION

This study aimed to develop an application to promote self-management among gout patients and to evaluate its effectiveness. We observed that our self-management application improves gout knowledge, self-management attitudes, perceived social support, self-efficacy, perceived self-management, and physical health-related quality of life.

5.1 | Self-management application for gout patients

The self-management application used as an intervention method in this study was different from one-on-one interviews, telephone consultations, and web-based interventions because necessary information could be viewed at any time. When subjects uploaded their self-management experience to the application, they could share and discuss their information with other patients. This interaction with other subjects helped them acquire information and strengthen their motivation.

The difference between our application and the existing web-based self-management programs is that it can be used while traveling with a smartphone and without being significantly affected by the speed of site access. Moreover, using the application is an efficient way to maintain a self-management diary that can be accessed any time; therefore, the subjects used it more often.

Individual education using an application reduces the effort required by patients to retrieve information from the internet and allows the appropriate information to be transmitted at the appropriate time to allow for behavior changes (Yoo, 2014). The use of an application rather than a program requiring a specific location and time seemed to be more

TABLE 3 Hypothesis test for the effectiveness of the intervention using application ($N = 56$)

Variables		Groups	Pre-test Mean ± SD	Post-test Mean ± SD	Post-pre Mean ± SD	*t*/*Z*	*P*
Disease-related knowledge		Exp	7.04 ± 2.53	9.19 ± 1.15	2.15 ± 2.21	4.08	<.001
		Cont	6.10 ± 2.04	5.72 ± 2.66	−0.34 ± 2.35		
Attitude for self- management		Exp	33.04 ± 1.35	37.48 ± 7.12	4.44 ± 3.33	−5.91	<.001
		Cont	33.07 ± 1.34	30.00 ± 6.62	−3.07 ± 4.20		
Perceived social support		Exp	66.26 ± 15.27	71.15 ± 13.12	4.89 ± 4.40	6.56	<.001
		Cont	63.14 ± 19.27	62.07 ± 19.53	−1.07 ± 1.77		
Self-efficacy		Exp	50.96 ± 25.25	71.48 ± 15.53	20.52 ± 11.74	−6.36	<.001
		Cont	51.34 ± 22.04	48.97 ± 21.04	−2.35 ± 4.84		
Self-management performance		Exp	41.15 ± 13.25	53.30 ± 8.41	12.15 ± 6.91	10.46	<.001
		Cont	44.72 ± 13.82	41.83 ± 12.43	−2.72 ± 2.71		
Health-related quality of life	PCS	Exp	38.67 ± 6.86	41.90 ± 4.55	3.23 ± 2.47	−1.90	.046
			(67.37 ± 16.80)	(68.67 ± 14.41)	(1.30 ± 4.79)		
		Cont	39.81 ± 6.24	38.78 ± 5.41	−1.08 ± 2.13		
			(65.24 ± 15.00)	(63.59 ± 14.73)	(−1.66 ± 5.39)		
	MCS	Exp	65.80 ± 5.18	65.86 ± 5.39	0.06 ± 1.47	−1.28	.291
			(76.19 ± 12.22)	(76.26 ± 12.37)	(0.07 ± 2.20)		
		Cont	65.51 ± 6.24	65.24 ± 6.02	−0.27 ± 0.79		
			(75.86 ± 15.86)	(75.55 ± 15.63)	(−0.31 ± 0.93)		

Abbreviations: Cont, control group; Exp, experimental group; MCS, mental component score; PCS, physical component score.

effective for helping gout patients perform continuous self-management (Jeon & Kim, 2016).

Nguyen *et al*. (2016) pointed out that in currently existing apps for gout patients, not all functions worked within the app itself. For example, if the subjects previously had to use email to communicate with each other or use the calendar function on their phones rather than the app, the app developed in this study substantially differs in that all functions work within the app. In addition, another differentiating point is that while existing apps are very descriptive and tediously list the contents, the app in this study was visualized for fun and enjoyment by enhancing the visual and entertainment aspects.

5.2 | Effectiveness of the gout self-management application

As a result of this study, the level of knowledge related to gout of the experimental group using the gout self-management application significantly increased in contrast to that of the control group. This is in line with the findings of a study of developing a nutrition education program for premature children, which indicated that self-management programs using applications have generated interest and have enabled consistent use (Kang, 2012).

In this study, the subjects did not unilaterally acquire knowledge. Individualized and personalized education may have helped subjects to improve the level of gout knowledge. The results of this study fully reflected the advantage of self-directed learning (Han, Park, Jun, & Kang, 2010) using downloaded applications for educational purposes. Individual education suitable for personal situations was conducted through interactive communication using the applications, resulting in desired behavioral changes (Yoo, 2014).

The self-care attitude score of the experimental group using the gout management application was significantly higher than those of the control group, indicating that the self-management attitude changed positively with the use of the application. This is different from the results indicating that the self-care attitude score did not change significantly in the study using a web-based diabetes self-management program developed with the IMB model (Jung, 2015). Jung (2015) suggested that the self-management attitude score did not change because of the low discussion participation rate and less experience using the internet. Writing a goal on the bulletin board before starting the program and checking the performance seemed to have a positive effect on the self-management attitude and personal motivation.

Furthermore, the level of perceived social support of the experimental group using the gout management application was significantly higher than that of the control group. Therefore, it was believed that social support and social motivation were strengthened and that a sense of bonding was developed through sharing experiences with other subjects with the same disease. Support and motivation were also influenced by establishing intimacy through the use of the bulletin boards, telephone counseling with the researcher, and encouragement. Because no studies have measured social motivation for subjects with gout, it was difficult to compare perceived social support and social motivation. However, for patients with a disease that requires self-management throughout their lifetime, determining their own health-related goals, improving their personal motivation, participating in regular self-help meetings, and communicating with health providers are very important for strengthening their social motivation (Schoster, Callahan, Meire, Mielenz, & DiMartino, 2005). In the present study, only the medical staff and patients participated, and social support and social motivation were enhanced; however, a strategy involving family members could further enhance self-management.

The self-efficacy level of the experimental group using the gout self-management application significantly increased compared to the control group. Self-efficacy improved by providing personal feedback regarding self-management and similar experiences when using the web-based diabetes self-management program (Jung, 2015). Kim and Park (2017) suggested that self-monitoring is effective for promoting self-efficacy. The method of promoting self-efficacy varies based on previous experience with successful accomplishments, vicarious experiences, verbal persuasion, and support from others (Bandura, 1986). Using our application, the successful self-management experiences of gout patients were shared with others through the bulletin board, and self-efficacy was increased by providing personalized feedback regarding self-management behaviors. In addition, encouraging messages were delivered to the subjects more than once every week through the application. These results were supported by the results of the study by Lorig *et al*. (2010), which indicated that self-efficacy was increased by monitoring self-management patterns and accordingly providing feedback. In the IMB model, behavioral skills are defined by self-efficacy, which is determined by subjective self-confidence and objective performance. This study was limited because behavioral skills were subjectively measured using self-efficacy measuring tools. In the future, it will be necessary to develop a tool that can objectively measure the behavioral skills of gout patients.

In this study, we noted that self-management of the experimental group using the gout self-management application significantly increased in contrast to that of the control group. This is consistent with the results of the study by Yoo (2014), which indicated that an application program was

effective for the self-management of diabetes patients. The main difference from the self-management intervention program of existing gout patients using telephone consultation or the web-based program was that subjects could integrate various elements such as a self-management diary and alarm. It is well known that simply motivating patients to monitor themselves can increase desired behaviors and reduce undesirable behaviors (Klasnja & Pratt, 2012). This was used as a strategy in this study and contributed to enhanced performance.

As suggested by the IMB model, information regarding self-management and personal and social motivation for self-management improved behavioral skills and promoted behavior changes. Through information education, the enhancement of personal motivation by establishing and achieving self-management goals, enhancement of social motivation through sharing experiences with colleagues and professional counseling, and promotion of self-efficacy through self-monitoring, self-management performance was improved (Kim & Park, 2017). In addition, the researcher periodically analyzed program utilization and self-management performance of the subjects using the application server. The researcher then made suggestions to help the subjects improve their self-management performance. It was previously reported (Jeon & Kim, 2016) that checking the performance level daily by using the self-care diary was effective for promoting self-care.

As a result of this study, the level of physical health-related quality of life of the experimental group using the gout management application significantly improved in comparison to that of the control group. These results are consistent with those of a previous study that reported that the quality of health-related life was low for those with uncontrolled gout (Khanna *et al*., 2012; Konshin, 2009) and that improved self-management and control of gout symptoms contributed to enhanced health-related quality of life.

Although the physical quality of life score increased in the experimental group with improved self-managing, the mental quality of life scores did not increase. It was thought that the 8-week intervention period was insufficient to improve the mental quality of life score. Song (2001) reported that changes in the perception of the quality of life of patients with chronic diseases could require more than 6 months of intervention. Another possible reason for the ineffectiveness regarding the mental health quality of life is that a mental health program was not included in the application. Revision of the application, use of the revised application for at least 6 months, and further research are required to examine the effects on mental health-related quality of life, including stress management and other mental health areas.

The primary limitation to the generalization of these results is the recruitment process of participants. Because only patients who visited the rheumatology clinic at one university hospital in one area were included due to the convenience of recruiting and tracking participants of the study, caution should be taken when generalizing results of the study to other gout patients. The second limitation is that the possibility of migration biases cannot be ruled out because statistical analysis of intention to treat was not used. Therefore, later studies will require a more rigorous research design to evaluate the effectiveness of application for patients with gout (GoutCare).

6 | CONCLUSIONS

Our gout self-management application called GoutCare, which was developed for this study, effectively improved gout knowledge, self-management attitudes, perceived social support, self-efficacy, perceived self-management performance, and physical health-related quality of life. This suggests that acquiring information about gout, irrespective of time and place, and motivating and promoting behavioral skills may improve self-management and health-related quality of life for gout patients. Therefore, we believe that our gout self-management application can be used as an effective intervention program.

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CONFLICT OF INTEREST

All the authors declare that they have no conflict of interest.

AUTHOR CONTRIBUTIONS

S. K. K. made substantial contributions to the conceptions and design of the study, collection of the data, and analysis and interpretation of the data; E. N. L. participated in drafting the articles or revising it critically. Both authors gave final approval of the version to be submitted and any subsequent revised version.

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