Original Article

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Effectiveness of an Innovative Nursing Approach Through a Smartphone Application in Promoting Medication Adherence Among Patients with Schizophrenia

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Abstract:

Objective: This study aimed to investigate the effects of an innovative nursing approach using a smartphone application, namely "Kin Ya Kan Na" or "Let's take Medications," on medication adherence behaviors among patients with schizophrenia.

Material and Methods: Purposive sampling was used to recruit the participants (n=84). They were randomly assigned into either an experimental (n=42) or control (n=42) group. The experimental group installed this application on their smartphones and used it for one month, along with usual nursing care while the control group received only the usual nursing care. Data were collected before and after the intervention using: 1) a demographic data form, 2) the Medication Adherence Scale in Thai (MAST), and 3) a satisfaction towards application usability' scale. These two scales yielded Cronbach alpha coefficients of 0.94 and 0.86, respectively. Descriptive statistics and analysis of covariance (ANCOVA) were employed for data analyses.

Results: The post-intervention analysis showed that the medication adherence behaviors between the two groups were significantly different ($F_{1,81}$=65.225, p-value<0.001), with higher mean scores for medication adherence behaviors in theexperimental group. The application users reported that they were highly satisfied with the application (M=4.51, S.D.=0.38).

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Conclusion: The study found that use of this innovative nursing approach significantly improved medication adherence behaviors among these patients. Therefore, nurses and related healthcare providers could apply this approach to promote medication adherence behaviors in patients with mental illness, particularly schizophrenia.

Keywords: innovative nursing approach, medication adherence, patients with schizophrenia, smartphone application

Introduction

Medication adherence refers to a patient's behaviors in terms of taking their prescribed medications consistently and showing effective medication management according to the treatment plan[1]. This entails abstaining from medication withdrawal behaviors on their own, taking medications with the proper routes and times, abstaining from taking medications that are expired or beyond the treatment plan, and regularly attending appointments to monitor their treatment[2]. Medication adherence behaviors can be characterized into three levels: first, complete adherence in which the patient follows the recommended dosage schedule 80% or more of treatment plan, second, partial adherence in which the patient follows treatment plan 50–79%, and third, non-adherence in which the patient ceases taking medication on their own over 50% or one week[3]. Non-adherence can result in increased symptom severity, resulting in hospital readmissions for the patients, and problems for the health care system via an increased number of admissions and the attendant cost to the health care system[4]. Patients and their families can be affected by either partial adherence or non-adherence to medications in terms of suffering from severity of psychiatric symptoms. In 2021 in Thailand, 284,273 patients with schizophrenia received services in outpatient departments of general hospitals or under the Department of Mental Health. Of these, up to 3,815 cases were classified as patients at risk for violence in the community in a category called "Serious Mental Illness with High Risk to Violence: SMI-V"[5]. In such patients, adherence to medications is particularly important in helping these patients have a good prognosis and recovery as well as reducing the incidence of crimes against themselves or society[6,7]. Unfortunately, 2 out of 5 patients do not respond to treatment due to non-persistence in pharmacotherapy[8].

Non-adherence to medication can be categorized as intentional (purposeful) or unintentional. Intentional medication non-adherence involves a patient's deliberate and reasoned decision not to take medications according to the treatment plan and stop taking medications on their own[4]. One study suggested that possible causes included not acknowledging and/or accepting the illness, having a negative attitude towards taking medications, having poor relationships with healthcare professionals, and feeling stigmatized[9]. Assisting this group of patients requires specific and effective therapeutic approaches to address their problems, including psychoeducation, cognitive modification, motivation enhancement therapy, and family counseling[4,10].

Unintentional medication non-adherence refers to patients who acknowledge and accept their illness and have a positive attitude towards taking medication, but who often have trouble following a medication schedule for various reasons, such as forgetfulness, poor attention or neglecting medications, falling asleep, or forgetting follow-up appointments. In addition, some patients are unable to take the scheduled dose due to their busy life or medication side effects[4,11]. Possible nursing interventions for this group should focus on enhancing a patient's self-regulation and self-prompting strategies to help them manage their medications appropriately and sustainably[10,11].

Information technology is widespread in the health field nowadays. Previous findings have supported

a technology-based approach to enhance patients' medication adherence behaviors. For instance, a meta-analytic study found that smartphone applications combined with other therapeutic approaches significantly increased medication adherence behaviors when compared with the control group (mean difference 0.90, 95% CI 0.03-1.78, p-value=0.04). Using a smartphone application allows the patient to gain insight into their behaviors. It help to reminds and encourages patients to keep track of their medication intake and motivates them to follow their treatment plan[12].

In Thailand, the smartphone applications to promote medication adherence behaviors among patients with schizophrenia have not yet been developed. In previous studies, these types of medication-adherence applications were employed only for patients undergoing antiretroviral or antimicrobial treatment,[13] although one study used a telephone-based intervention to keep track of medication adherence behaviors and other symptoms in patients with schizophrenia[14]. This current study developed a smartphone application based on the concepts of self-regulation theory[15] and social support[16], with other information on similar applications discussed in a previous study[17]. The evidence indicates that applying a technology-based approach through smartphone applications could be an effective tool to monitor and support a patient's self-medication management behaviors as per the treatment plan. This study aimed to examine the effectiveness of an innovative nursing approach using a smartphone application developed by the study team and called "Kin Ya Kan Na" on medication adherence behaviors among patients with schizophrenia and their satisfaction with the application's usability.

Material and Methods

Study design and setting

This quasi-experimental research with two groups pre and post intervention was conducted with patients with schizophrenia receiving treatment services at the Psychiatric Outpatient Department of Buddhasothorn Hospital, Chachoengsao province, Thailand.

Population and sample

The target population of this study was patients with schizophrenia. A total of 84 participants who met the following inclusion criteria were recruited: (1) schizophrenic patients diagnosed by a psychiatrist based on the International Classification of Diseases-10 (ICD-10) who received treatment services at the Psychiatry OPD at Buddhasothorn Hospital during September to October 2022, (2) adults aged between 20 and 59 years old, (3) history of unintentional medical non-adherence through problems such as forgetting, neglecting, or missing taking prescribed medications during the prior 6 months as determined by asking patients or from medical records, (4) no severe psychiatric residual symptoms that could affect self-care ability from initial screening by a psychiatrist and their illness acceptance, and (5) had and could use an android smartphone. The exclusion criteria were (1) receiving only injectable psychiatric drugs, and (2) recurrence of severe psychotic symptoms affecting the ability to participate in this study.

Sample size determination

The sample size was calculated using G*Power version 3.1.9.4. An effect size of 0.80, a one-tailed test with a significance level of 0.05, and a power of 0.95 were used to determine a required sample size of 70 participants; with an additional 20 percent to compensate for possible dropouts. The total number of participants was 84. Simple random sampling was used to select the participants. Using a non-replacement drawing, the participants (n=42) were allocated equally into the experimental and control groups.

Measurements

The following research instruments were used for collecting the study data:

1. The instrument used for the intervention was the smartphone application "Kin Ya Kan Na" (Let's Take Medications). The researchers designed this application platform to incorporate certain features, including (a) in-built features to enhance the patients' self-regulation. An access code was included for security reasons and to ensure privacy. Once entering the main page, the application displayed all the patient's medication information and the goals for everyday medication intake. In addition, the patients are informed about the pre-set goals to be achieved in completing their daily medication intake. The system notified the user about their medication use and allowed them to specify their medication-taking behaviors. This strategy encouraged adherence behaviors and gave the patients the freedom to make choices depending on their actions according to their intended goals. As a result, patients evaluated themselves based on system feedback and could compare actual to expected behaviors. (b) To act as an extrinsic factor contributing to a patient's' continuous self-regulation, the application included the following features: 1) notification reminder, 2) notification alert, and (3) the function of social support, which included online and offline support. Offline support was focused on providing informational support on prescribed medications and self-care, leading to a better understanding of medication management, while the online support helped the patient connect directly with the researchers when encountering any problems or having queries about their medication intake or application usage. After consulting experts in informatics, the researchers built application features to cover the functional structures of 1) registration and data confidentiality, 2) a "My Medications List" icon in the screen display, 3) searching and addition to the medications list from the available hospital databases, 4) addition to the medications list apart from the available database, 5) medication notification and confirmation, 6) a medication calendar screen, 7) a "My knowledge resource" screen, and 8) "assisting resource", and a user manual to guide each step (Figure 1).

2. The instruments for data collection comprised three parts:

Part 1: Characteristics of the participants. The questionnaire was developed by the researchers to gather data regarding the patient's gender, age, marital status, education level, occupation, duration of psychiatric illness, and number of hospitalizations for relapse.

Part 2: Medication Adherence Scale in Thai (MAST), which consisted of 8 items with six choices per item that reflected the patient's non-medication behaviors according to the treatment plan of the patients. The responses were rated on a 5-point scale ranging from 0 (never) to 5 (very often). A score of more than 34 or higher indicated high medication adherence. The Cronbach coefficient was 0.94[18].

Part 3: A satisfaction towards application usability' scale was developed by the Health Care Information and Management Systems Society (HIMSS), which was adapted in Thai for assessing the usability of mHealth[13]. This tool measured the satisfaction level with the usability of the smartphone application "Kin Ya Kan Na". This scale comprised 25 items with four components: 1) system usability, 2) efficiency, 3) effectiveness, and 4) user satisfaction. The Cronbach's alpha coefficient was 0.86. The responses were rated on a 5-point Likert scale. Patients that scored between 1.00-1.50 were categorized as least satisfied, 1.51-2.50 were less satisfied, 2.51-3.50 were moderately satisfied, 3.51-4.50 were very satisfied, and 4.51-5.00 were mostly satisfied[13].

Three experts evaluated the application to ensure its validity and verify the application's infrastructure and completeness: a psychiatrist, an engineering instructor with competence in designing mobile applications, and a nursing instructor who had expertise in digital technology and innovation. The overall satisfaction towards application's function was 4.31 (S.D.=0.28) from a total score of 5. However, the experts suggested re-configuring some of the application's features such as accessibility via notification alerts in the phone's display, increasing the medication

Figure 1 The user interface of the "Kin Ya Kan Na" mobile application

database system's capacity by adding medication pictures and drug information and changing the font size and style to improve the legibility of the system. Then the researchers tested the feasibility of the revised application by trying it out on ten patients with schizophrenia who were not included in the actual study sample for one month. At the end of the trial period, the retention rate was 100%. They reported a high usability satisfaction level with a mean score of 4.59 (S.D.=0.24). Focus group interviews were also conducted to examine the application's validity based on the users' experience. The participants were informed about the medication reminders via a notification system that could help them take the right drug and dose at the right time. This application also provided knowledge resources to help promote self-care abilities in medication administration, such as providing advice on managing or relieving the side effects of psychiatric drugs. Finally, this developed application was in line with the objectives, needs, and medication problems that needed to be solved for the target patients.

Data collection procedure

After obtaining ethical approval, the researchers met the head of the psychiatric outpatient department and explained the study. The researchers explained the purpose of the study, data collection procedures, risks, and human rights subject protection in the participating patients. Patients who volunteered to participate in the study were asked to sign an informed consent form. The Research Assistant (RA), a registered nurse at the outpatient psychiatric department, met the participants to collect pretest data. This study employed a double-blinded approach in which neither the patient nor the research assistant were aware of the participant's group assignment. The data were collected via google forms (Line application) to prevent data contamination. After collecting the pretest data, the researchers installed the application in the smartphones of the patients in the experimental group and demonstrated its usage. These participants had access to the study application from weeks one to four, along with their usual care. The app was set up to send pop-up alerts about the patient's prescribed medication intake time. The pop-up alert had a picture of the medications, the amount of each medicine to be taken specific to that patient, and options for the patient to fill out their actual medication-taking behaviors. Then the system displayed the consistency of the taking of the prescribed medications daily in the medication adherence calendar, which took one minute to access each time. The control group received their usual care only, including vital signs assessment, blood tests, physical and mental assessments, and, if necessary individualized health education. At week five, the posttest period, the research assistant provided a QR code for the participant to access and answer a posttest questionnaire. And finally, the researcher conducted a focus group to assess the use of this application, their satisfaction, and suggestions using a semi-structured interview via a line meeting system.

Data analysis

Descriptive statistics were used to describe the characteristics of the participants. Analysis of covariance (ANCOVA) was used to compare the mean medication adherence scores between the experimental and control groups. The level of significance was set at 0.05 with a power of 0.95.

Ethical considerations

This study was approved by the Institutional Review Board of Burapha University (Code IRB1-070/2565). This study was also registered with the Thai Clinical Trials Registry (Code TCTR2022110800). The study process was explained to the participants before asking for their informed consent. Human subject protection was also ensured and addressed in this study.

Results

The research results can be divided into 3 parts as follows:

Part 1: Demographic characteristics of the participants

The participants in the experimental group were over half female (n=23, 54.8%), with an average age of 37.38 years (S.D.=12.75). They most were married (59.5%) and half had completed secondary education, and did their own business (57.1%). The mean duration of psychiatric illness was 6.10 years (S.D.=6.61), and the average number of relapse hospitalizations was 2.17 (S.D.=2.20). In the control group, most participants were males (n=23; 54.8%) with an average age of 34.07 years (S.D.=8.63) and were single (66.7%). Half of them (52.4%) had completed their high school education, and 47.6% were self-employed. The mean duration of psychiatric illness was 6.93 years (S.D.=7.60), and the average number of relapse hospitalizations was 1.95. (S.D.=2.10).

The participants' characteristics between the experimental and the control groups were compared using the Pearson Chi-square test and t-test. No significant differences were found in the individual characteristics between the two groups (Table 1).

Part 2: Effectiveness of the new smartphone application "Kin Ya Kan Na"

Prior to data analysis, the medication adherence and application usability scales were tested and had a normal distribution. At the pretest, the experimental group had medication an adherence behaviors mean score of

Table 1 The demographic characteristics of the patients with schizophrenia in the experimental and the control groups (n=84)

Characteristic	Experimental (n=42)		Control (n=42)		X^2/t	p-value
	n	%	n	%		
Gender						
Male	19	45.2	23	54.8	0.762[a]	0.383
Female	23	54.8	19	45.2		
Age (years)	M=37.38, S.D.= 12.75		M=34.07, S.D.= 8.63		1.393[b]	0.167
Marital status						
Single	17	40.5	28	66.7	7.175[a]	0.127
Married	17	40.5	11	26.2		
Widowed	2	4.8	-	-		
Divorced	6	14.2	3	7.2		
Education level						
Uneducated	3	7.1	-	-	4.775[a]	0.311
Primary school	4	9.5	7	16.7		
High school	21	50.0	22	52.4		
Vocational school	5	11.9	7	16.7		
Bachelor	9	21.4	6	14.3		
Occupational status						
Hired employee	8	19.0	17	40.5	12.302[a]	0.443
Self-employed	24	57.1	20	47.6		
Other	10	23.9	5	11.9		
Duration of illness (years)	M=6.10, S.D.=6.61		M=6.93, S.D.=7.60		0.537[b]	0.593
Hospitalizations (times)	M=2.17, S.D.=2.20		M=1.95, S.D.=2.10		0.458[b]	0.649

[a]=chi-square test, [b]=t-test, M=mean

21.62 (S.D.=7.03), while the control group had a medication adherence behaviors mean score of 32.38 (S.D.=8.05). The control group had statistically significantly higher medication adherence behavior score than the experimental group ($F_{1,81}$=38.521, p-value<0.001), as shown in Table 2.

The difference in mean scores of medication adherence behaviors as shown by the posttest was compared by using analysis of covariance (ANCOVA) using the medication adherence behavior scores from the pretest as a covariate. The experimental group had a statistically significantly higher mean medication adherence behaviors score than the control group ($F_{1,81}$=65.225, p-value<0.001). The distribution of medication adherence behavior scores of these two groups using a box-plot is presented in Figure 2

Part 3: Satisfaction with the smartphone application use

From Table 4, the overall satisfaction with the usability of the smartphone application, the results showed that the participants had a high satisfaction level with an average score of 4.51 (S.D.=0.38). And the satisfaction level in the application components was categorized from highest to lowest order and were as follows: users' satisfaction was 4.69 (S.D.=0.41), effectiveness was 4.50 (S.D.=0.47), efficiency was 4.44 (S.D.=0.51), and system usability was 4.42 (S.D.=0.44), respectively.

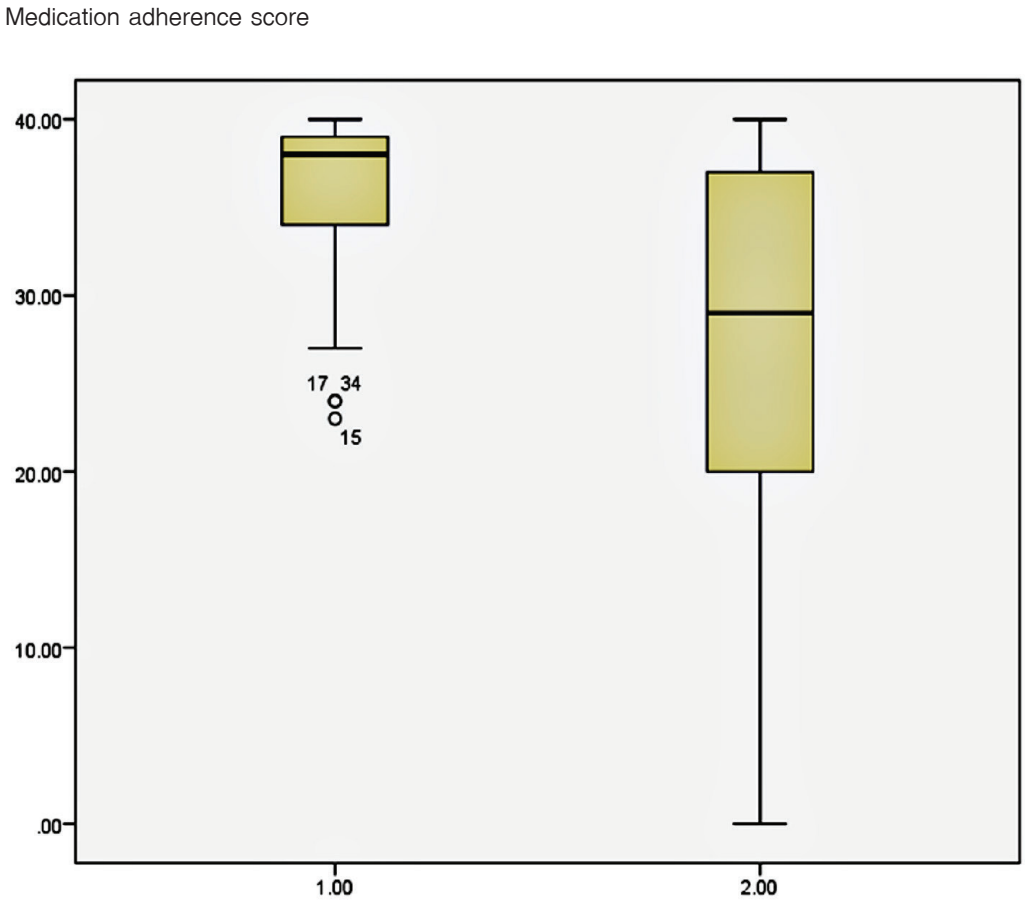

Figure 2 Box plots showing distributions of medication adherence behavior scores between the experimental group and the control group at post-intervention (n=84)

Table 2 Comparison of the mean differences in scores of medication adherence (MA) at pretest among the experimental group and the control group by t-test (n=84)

Variable	Experiment (n=42)				Control (n=42)			
	Possible range	Min-max	M	S.D.	Min-max	M	S.D.	t
MA	0-40	7-35	21.62	7.03	15-40	32.38	8.05	6.523*

* p-value<0.001

Table 3 Comparison of the mean scores of medication adherence behavior at posttest between two groups by ANCOVA (n=84)

Source of variance	Sum of square	df	Mean square	F	p-value
Covariate (MAPre-test*)	1794.84	1	1794.84	38.521	<0.001
Between groups (group)	3039.10	1	3039.10	65.225	<0.001
Within groups (error)	3774.136	81	46.594		
Total	91901.000	84			

Note: *Medication adherence behavior scores at Pre-test

Table 4 Satisfaction with the smartphone application use (n=42)

	Means*	S.D.
Overall usability satisfaction	4.51	0.38
System usability	4.42	0.44
Efficiency	4.44	0.51
Effectiveness	4.50	0.47
User satisfaction	4.69	0.41

S.D=standard deviation, *Higher scores indicate a higher level of satisfaction

In addition, the participants in the experimental group also provided data during the focus group sessions that addressed the advantages of this application, for instance, "The notification system on the phone screen is very good, it helped me not to forget to take my pills and guided me take medications on time", "The information resource feature provided comprehensive contents, about caring for myself when medication side-effects occurred", "The medication calendar screen motivated me to continue taking medications as I could see the progression of my goal behaviors", "The registration system was highly secure because it had to be re-encrypted', "The application had simple features and did not take a long time to update my medication taking behaviors", "This application did not violate the users' privacy as only my medication information was requested, and no other personal information was needed". In addition, some suggestions were also provided, for example, it would be better to have medication names in the Thai language along with the English names", "The notification system should be developed to be more stable", "Sometimes the notification message just displays the medications' picture without sound and it doesn't notify for every medication", "A reminder system can be added before the doctor's appointment date," "Should develop an additional feature to monitor the access history and pre-recorded medication-intake behaviors on the server, to track more efficiently."

Discussion

Patients with schizophrenia in the experimental group had significantly higher scores toward medication adherence behaviors than those in the control group at post-intervention. This study results indicated that patients in the experimental group had improved medication-taking behaviors according to the treatment plan, while the participants in the control group gradually exhibited declining medication adherence behaviors, which was consistent with previous studies in which significant factors contributing to non-medication adherence included patients' forgetfulness and negligence[19,20]. The use this innovative nursing approach by monitoring and promoting medication adherence behaviors will lead to better patient health outcomes.

Earlier studies suggested a smartphone application would be useful for motivating patients adhere to medication. This study used a smartphone application to encourage and monitor the patients to maintain medication adherence behaviors. In this study, the experimental group had better medication adherence behaviors scores after using the application than the non-intervention group which was in line with the previous studies[21,22]. To improve nonadherence medication behaviors among patients with schizophrenia, we developed a smartphone application by integrating the concepts of self-regulation[15]. The feature of medication reminders was also included. Of the three types of reminder applications, Simple Medication Reminders (SMR), Advanced Medication Reminders (AMR), and Medication Management Applications (MMA), the MMA was used in this study due to its comprehensiveness, feasibility, and medication tracking system, increasing users' utility to manage their medications independently. This application includes a medication list system, medication calendar system, and knowledge information system. This smartphone application provided any features that correspond to the users' needs[23]. For instance, the user can use the medication calendar and reminders if they have problems with forgetfulness or ignorance in taking medications. Also, at times of discomfort resulting from a medication's side effects, they could seek information about self-care knowledge by searching for available information in the application (offline mode) or choose to consult the researchers directly (online mode). Providing fruitful information for users offline or online could help them solve medication management problems[24]. Furthermore, these strategies could promote medication intake sustainability. Several studies have found that medication reminder applications improved medication adherence behaviors regardless of age group, such as adolescents, adults, and the elderly[12,17]. However, the design of functions used in the application should be tailored specifically for those using it.

Several empirical studies have found that medication reminder applications are suitable for focusing on medication self-administration. Such applications should also include other useful functions such as user registration data, a notification system, a health assistance system, medication tracking, and appointment systems[25]. These options were included in this current application, thereby motivating and enhancing the medication adherence behaviors of schizophrenic patients continuously. Some studies have suggested that a person develops and retains behaviors when achieving positive outcomes. Also, applications that track real-time medication-taking behavioral patterns, such as pill-count graphs and medication calendars, stimulate and strengthen one's motivation to take medications continuously[26,27]. Hence, this study application included an option allowing patients to include their medications' names in the existing list. Doing so would help them take all medications. In addition, once the patient took the medication following notification and recorded the medication-taking behaviors, the medication calendar system automatically changed the medication's symbol each time from "red" to "green," indicating successful medication adherence. This would give a proud feeling to the patient for their accomplishment of set goals. This application

was built by integrating the social support concept,[16] to provide informational support to the patient to maintain healthy behaviors, such as advice about medications, their side effects, and self-care. This application is an alternative tool that patients voluntarily use to take care of their health for free. It supports the patients by providing feedback about medication-taking behaviors through the medication calendar system and emotional support by posting compliments when they meet their medication goals. This study's findings shed light on utilizing smartphone applications to promote medication adherence along with usability in patients with chronic illnesses[28,29].

Regarding the participants' satisfaction with the application usage, the schizophrenic patients had high satisfaction using the "Kin Ya Kan Na" application. The users were satisfied since this application helped solve the patient's problems directly. This is in line with a systematic review of 7 studies which found that the patients who used a medication reminder application were highly satisfied with the applications[17]. These applications promote adherence to psychiatric medication treatment plans by helping remind patients how to take their medications and motivate them. The applications are successful in helping patients from taking medications continuously to control psychiatric symptoms and live independently.

Limitations

This study had some limitations: Firstly, since this study designed the application for a specific group of patients who had an insight into their illness but had unintentional non-adherence to medications, it cannot be used alone in patients with intentional medication nonadherence behaviors. For this group, the application should be used in conjunction with other nursing interventions, such as psychoeducation and counseling, to tailor individual programs and strengthen the patient's motivation for sustainable medication adherence behaviors. Secondly, this application was developed to promote medication adherence specifically for patients with schizophrenia with unintentional nonadherence medication behaviors and can be run only on the android operating system. Thirdly, the study had only a small sample size, as the effect size in previous studies was not clearly identified. In addition, it was limited by the number of patients who met the study inclusion criteria. Therefore, this study used a large effect size (0.8) from a previous article that recommended how to estimate sample size which can be generalized to the population[30].

Conclusion

The study found that the smartphone application "Kin Ya Kan Na" usage could increase medication adherence behaviors according to the treatment plan as its features help to solve the problems of medication non-compliance. Also, this applications' notification system aided in reducing and preventing medication withdrawal problems such as forgetfulness, poor attention etc. Additionally, the application's features motivated the patients to take their medications continuously through an in-built tracking system or medication calendar to monitor their medication-taking behaviors that reflected their desired behaviors every day. Finally, providing informational support to the patients emphasized the need for self-care during psychiatric drug intake that, in turn, could lessen the problems of tapering off or abstaining from medications on their own. This application also responded to the user's issues, needs, and goals as reflected by their satisfaction feedback.

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Conflict of interest

The authors declare no actual or potential conflicts of interest.

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