

ORIGINAL ARTICLE

DEVELOPMENT OF PHARMQUIT: AN INTERACTIVE COMMUNITY PHARMACIST-ASSISTED SMARTPHONE APPLICATION FOR SMOKING CESSATION

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ABSTRACT

Smoking is a major cause of worldwide morbidity and mortality. This study describes the development of an interactive app, PharmQuit, based on a user experience framework in collaboration with pharmacist counseling. There were three phases in the development process. First, clinical practice guidelines were researched together with discussions with experienced counsellors. Second, a diagram was developed to support two-way communication between smokers and pharmacists. Third, user testing was done by conducting a satisfaction survey and a one-month trial. The development of PharmQuit was based on five elements: strategy, scope, structure, skeleton, and surface. The first element was strategy. The aim of the app was to encourage smokers to quit smoking, stay with the program, and stay in contact with a community pharmacist. The second element, scope, included the features of daily encouragement, health status tracking, and community connection. The third element, structure, explained the connections between features. The fourth element, skeleton, showed the arrangement of buttons and fields that made up seven pages of the app. The last element, surface, covered color and cartoon figures. PharmQuit was linked to the web system for clinical information. The highest satisfaction scores were Design (4.3±0.9), Beauty (4.1±1.0), and Objective (4.1±0.9). The one-month trial for PharmQuit showed an average access of 21 times with a continuous abstinence rate of 31 percent. In conclusion, PharmQuit was developed with the needs of smokers and pharmacists in mind. The features and users' testing showed that the app was able to properly function corresponding to its objectives and design.

Keywords: PharmQuit, Smoking Cessation, Mobile App, Community Pharmacist

INTRODUCTION

Smoking is a major cause of premature deaths worldwide¹. The death rate among current smokers was about three times that of those who had never smoked²⁻³. The goal of the Thai government to reduce the prevalence of smoking by 15 percent by the year 2025 is an ongoing challenge².

Pharmacists play a pivotal role in smoking cessation services. Many systematic reviews have shown that pharmacist-led interventions resulted in better abstinence rates in smokers⁴⁻⁷, and may also be cost-effective^{6,8}. However, some studies have not shown clear benefits of pharmacy personnel-delivered Nicotine Replacement Therapy (NRT)

interventions^{6,9}. Medications for cessation showed an abstinence rate of 26.59 percent at 6 months and 19.90 percent at 12 months¹⁰. A smoking cessation service, provided by a hospital, for 94 smokers showed a 6-month quit rate of 31.9 percent and a 12-month quit rate of 17 percent¹¹. The loss to follow-up rate was 75.5 percent¹¹. In a smoking cessation service, which started with 23 community pharmacies, catering for 205 smokers at the start, had only 2 participating community pharmacies after 6 months¹². Pharmacists reported difficulties with follow-up associated with participants' relapse¹³. Clearly, there were issues in communication between community pharmacists and smokers.

Current evidence shows benefits of mobile phone-based smoking cessation interventions on long-term outcomes (RR 1.71, 95% CI 1.47 to 1.99, over 9,000 participants)¹⁴. Various mobile apps are already available to help smokers quit, such as: SmartQuit, DistractMe, mCM, SmokeFree, Craving to Quit, and REQ-Mobile¹⁵. A systematic review showed that only two out of 50 apps had scientific and professional support¹⁶, and most apps omitted referrals to Quitline and recommendations for medicine¹⁷⁻¹⁸. Participants did not stay in the program and over 50% of the study participants dropped out due to a variety of factors, including mobile phone or operating system/app incompatibility and difficulties with quitting¹⁹. The quality of smoking cessation apps according to some studies was poor^{16, 20-21} and most apps were not customized to users' needs¹⁵.

The Community Pharmacy Association Thailand and Community Pharmacy Network for Smoke-free Thai Society support training for community pharmacists to provide smoking cessation services with follow-up on day 0, 7, 14, 30, 60, and 120. Some medications for cessation such as NRT, herbal lozenges/spray, and nortriptyline are also dispensed under the supervision of community pharmacists. However, low smoker retention rates, low quit rates, and the weakness of electronic health interventions were challenges. PharmQuit, a mobile application, was designed to fill these gaps by incorporating pharmacists and User Experience (UX). Using human computer interaction (HCI), PharmQuit focuses on positive emotions to ensure the desired experience²². The purpose of this paper is to describe the development of PharmQuit app, provide a full description of the app and present some preliminary results of its benefits.

METHODS

This study was approved by the Ethical Committee of Mahasarakham University (No 033/2559). Informed consent was obtained from all participants.

Program design

PharmQuit and the web system were carefully designed to protect the smokers' personal information. Each pharmacist had to register on the web system to get a username from the web system administrator, and the password was the 13-digit national ID of the pharmacist.

The pharmacist then entered the smoker's name into the web system to generate a username for the smoker to login to PharmQuit on a smartphone. The smoker's national ID was the initial password for logging into PharmQuit.

A new strategy that included an evidence-based treatment with medications and higher retention rate was developed. Thus, PharmQuit was developed to support both pharmacists and smokers. PharmQuit had two components: the mobile app for smokers and a web-based system for the pharmacists (Smokefreerx.com). The strategy in developing PharmQuit was to aim for an app that was easy to use; attractive to the user; and which provided basic information suited to the individual smoker. According to the user experience framework, PharmQuit, was designed to give a unique experience to its users. The five elements of user experience (strategy, scope, structure, skeleton, and surface) considered in creating user's experience are described in Table 1.

The web system backup for PharmQuit, smokefreerx.com, was developed for the pharmacist to give clinical information, schedule appointments, and communicate with the smoker. The link function between PharmQuit and the web system was designed to merge clinical information evaluated by a pharmacist. Pharmacists evaluated the smokers' willingness to join the program and then identified the smokers' stage of change (TTM model). Smokers who were ready to quit smoking or in the preparation stage, were asked to sign a consent form. Pharmacists then started counseling and recorded information according to the standard protocol of smoking cessation service using a form and then entering the information on smokefreerx.com. The pharmacists generated a username and helped smokers to login to PharmQuit on their phones.

Program description

Study Procedure

The three phases of the study were conducted from December 2016 to October 2017. In the first phase, the content and information were developed. In the second phase, the features of PharmQuit were designed. The last phase consisted of a satisfaction survey of 14 smokers at a college, and a one-month trial with 29 smokers.

Table 1 Five elements of user experience, aims, and functions

UX elements	Aims	Functions
Strategy	To encourage the users to quit smoking and help potential quitters to consistently stick with the cessation program with a community pharmacist	<ul style="list-style-type: none"> • Easy design so that the smoker will consistently use it and will be more likely to be successful in quitting. • Daily updates for the smoker and the pharmacist. • Challenging the smoker to stay abstinent for 6 months with a cartoon avatar. • Attractive to users • Providing basic information to deal with craving and adverse drug reactions. Reminders for follow-ups
Scope	Translates the strategy into functional and content requirements	<ul style="list-style-type: none"> • A main screen with a smoking record, current progress and reminders • Personal information and statistics • Timelines • An inspirational section with a place for a picture to remind them why they are quitting • Daily encouragement • Messages reminding them of their schedule • User health status tracking and stages of improvement • Pharmacist direct messaging • FAQs • Community connection • Achievement and failure sound effects • Credits and other settings.
Structure	Explains the arrangement of features.	<ul style="list-style-type: none"> • order daily activities. • minimize going back and forth between pages and instead maximize the use of the one-click menu button. • highlight important information and ease of use.
Skeleton	The physical interface.	<ul style="list-style-type: none"> • allows users to input commands and navigate. All features are connected by functions and back-forth buttons. • Frequently used features are shown in larger text fonts and pictures.
Surface	Accounts for the overall attractiveness and aesthetics of PharmQuit.	<ul style="list-style-type: none"> • The color red was chosen for its visibility and energy. • Cartoon figures (avatars) reflect the current stage of the user and challenge him to reach the next stage.

Phase 1: Content and information on the design

Content and information for smoking cessation services were retrieved from 3 existing guidelines for smoking cessation services. Data was collected by a community pharmacist. The data included demographic information, smoking behavior, previous attempts to quit, current stage of change (TTM Model), and Fagerström test results. The clinical data which covered the amount of carbon monoxide exhaled (measured by a picolyzer), number of cigarettes smoked per day, amount of money saved by not smoking, blood pressure, and weight were recorded. Medications used for assisting in smoking cessation were recorded. According to the drug laws and the Smoking Cessation Practice Guideline in Thailand,

community pharmacists can prescribe proper medicines (nicotine replacement therapy, nortriptyline, and ironweed (a Thai herbal medicine pill) for individual patients²³.

Practical counseling techniques for smoking cessation were discussed with three pharmacists and one nurse, all of whom had clinical experience in smoking cessation counseling. The language used was Thai. Short sentences, phrases, techniques for generating encouraging messages, and a linkage between the web system and app was developed to ease the pharmacists' work.

When a smoker wanted to quit smoking, the pharmacist followed a 6-month plan using the 5As: ask, advise, assess, assist, and arrange follow-up. The pharmacist provided

systematic approaches for smoking cessation following the STAR and 5Ds techniques. STAR stands for: S--setting a quit date within 2 weeks, T--telling other people that you are in a cessation program. A--anticipating and planning for the challenges that will be faced while quitting, and R--removing cigarettes from your environment. The 5 Ds were: delaying smoking, deep breathing, drinking water, doing something else, and discussing the urge to smoke with someone else. In order to refine the practical steps of counseling for PharmQuit, a data mapping feature was made in the app design for effective practical counseling²³⁻²⁴.

Phase 2: Smartphone app and web system development

Five discussion sessions between the researchers and three IT personnel took place to anticipate what smokers would want from a smoking cessation service and an app. All information was incorporated into an interface design for PharmQuit. For example, a smoker must be prepared for potential symptoms of nicotine withdrawal. The smoker must know some techniques to resist the temptation to smoke and must know how to use the medications. The smoker must also be willing to share their desire to quit so that others can encourage them. User preference and smoking patterns were reviewed by two pharmacists.

The diagram was initially drafted to cover login/logout, ethical information, daily record with a cartoon face in each step, self-encouragement by pictures and words, clinical data (weight, carbon monoxide, blood pressure), money saved, profile management, timeline for self-sharing, connecting with a pharmacist, and line @ (an app similar to WhatsApp) for group discussion. The diagram was evaluated by two smokers for the required functions, the smokers' preferences, and ease of use.

Phase 3: Testing

Testing was performed in two groups of smokers. The first group was to assess satisfaction with PharmQuit. A 25-item questionnaire was developed for the satisfaction assessment. Each question was measured by a 5-point Likert scale (very satisfied, quite satisfied, somewhat satisfied,

slightly satisfied, and not at all satisfied). The questionnaire had six parts: objective, scope, interactive features, design, beauty, and self-efficacy. Content validity testing was performed by three experts in smoking cessation counseling. The questionnaire was modified according to the experts' suggestions. A purposive sampling was designed for college students in Chiyaphum province. A letter seeking permission was sent to the director of the college where the questionnaires were distributed. In a meeting of 78 students, there were only 14 students who were eligible for the study (at least 18 years old and smokers). The reliability test showed Cronbach's alpha of 0.923. Descriptive statistics were used.

The second group was to evaluate the efficacy of PharmQuit using a month data from the main study of a randomized controlled trial performed between 2017-2019. It was registered retrospectively in Thai Clinical Trials Registry: TCTR20200925004. A month's use of PharmQuit was analyzed in 29 smokers, who fulfilled the criteria of being at least 18 years old, smoked at least one cigarette per day, had signed a consent form, was able to complete self-recording, and had a smartphone. They received smoking cessation services from seven community pharmacies in 4 provinces. Pharmacists were trained to use PharmQuit and the web system. The access to the app and quit rate were evaluated after a month. Data from the web system was retrieved and analyzed. Descriptive statistics were used.

RESULTS

PharmQuit, designed to help smokers quit smoking in collaboration with community pharmacists' counseling, provided a connection to pharmacists and automated support amongst its features.

After phase 1 and phase 2 were complete, the functions of PharmQuit were developed according to the diagram as shown in Figure 1. Encouraging messages were developed to send to the PharmQuit user every day in the morning and evening as shown in Table 2. PharmQuit was developed for iOS and android systems.

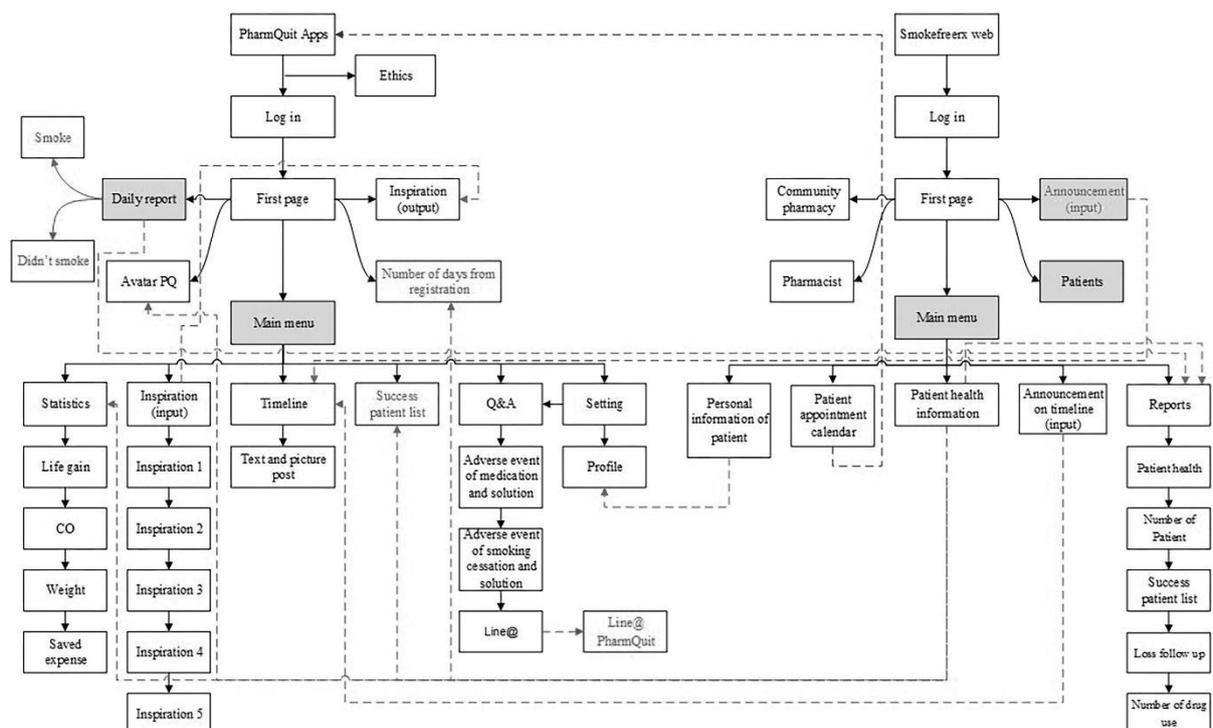


Figure 1 Functions of PharmQuit and web system

Registration and scope of the PharmQuit app features

When a pharmacist introduces PharmQuit to a smoker, the web-based program generates a login username. The smoker uses the username given by a pharmacist and ID number to login to PharmQuit. The screens of PharmQuit contain seven pages, some of which are shown in Figure 2.

There are five features on the first page. Two pictorial buttons, one for smoking and one for not smoking, are shown at the top of the page for users to record their daily activity. When a user presses either button, an encouraging message will pop up. The smokers can input pictures and messages to encourage themselves. The number of days since enrollment is tracked by PharmQuit and displayed with an avatar face. A different face is displayed on days: 0, 7, 14, 30, 60, 120, and 180.

The second page provides different bits of information. The Life gain window shows seven minutes gained when one cigarette per day is given up. This information is computed from the users' interaction on the first page. The smoker's latest weight and carbon monoxide levels are shown on this page.

Monetary savings are calculated using an average cost of cigarettes at 4.8 baht per cigarette.

The third page is for motivation. Pictures and messages are input here by the user for personal use. This function can be added or deleted by the user. This motivation page is linked to the first page of daily use information.

The fourth page is a timeline for the smoker to share their opinions and ideas. Users can share ideas with others and read others' opinions and ideas. Announcements sent by the pharmacist in the web-based program are linked to this page and can be seen by clicking on the bell icon.

The fifth page lists the names of users who have quit smoking within the last 6 months. It shows that others had succeeded in quitting and is an encouragement to the user.

The sixth page has frequently asked questions pertaining to cravings and adverse reactions to medications. On the top right of the screen, there is a Line @ button to be connected to a pharmacist in real time for help.

Table 2 Encouraging text messages to quit smoking

Morning messages	Evening messages	Messages of encouragement in a day with no cigarettes	Messages of encouragement in a day with one or more cigarettes
<ul style="list-style-type: none"> • Congrats on quitting, cheers! • We've got your back! Keep fighting! • Be strong! You will get through this! • Find some other activities, keep yourself busy. • You can do it, keep going! • Great job! You're getting there! • I'm behind you! Keep fighting! 	<ul style="list-style-type: none"> • Don't forget to keep records! • Have you tracked your progress today? • Remember to keep records. (We want to see your progress too!) • You got through another day! Great job! • Have you finished your homework for tomorrow? 	<ul style="list-style-type: none"> • You're doing great! • Congratulations!! • Celebrate your victories! • Excellent! • Well done! • Fantastic! • Great! • Keep going! • That's superb! • Terrific • Proud of you! • You are doing great! • Two thumbs up! • Like!! • You are doing a great job!!! 	<ul style="list-style-type: none"> • Keep trying! Fight on! • Hang it there! • Don't give up! • Keep fighting! • You have done your best, keep going! • Don't worry about it--keep pushing forward! • Try again! You'll do it this time!



Figure 2 Screenshots of PharmQuit: login, a page of daily report, encouraging picture and avatar, a page of clinical data, and Timeline (a forum for smokers to share)

The seventh page is the settings page showing the user profile and copyright and ownership information.

Registration and scope of web (smokefreerx.com)

The registration process for a community pharmacist was done by the web administrator. The web system for the administrator has seven features: (i) A pie chart on the first page of the web based

program showed the number of providers (community pharmacies and primary care units/hospitals, smokers who enrolled in the cessation program, number of pharmacies, hospitals, pharmacists, smokers, and the number of encouraging messages; (ii) Adding and deleting community pharmacies and hospitals; (iii) A list of pharmacists registered on this web; (iv) Editing patient information during each visit; (v) Adding and deleting messages to be sent to PharmQuit; (vi) Adding

and deleting Q&A to be sent to PharmQuit;
 (vii) Reports of the number of patients, health information, quitters, lost follow-up,

medicines used, accessibility to the app and frequency of accessing Q&A to deal with cravings, and adverse drug reactions.

Table 3 Satisfaction score to PharmQuit presenting in each question and six dimensions

Survey questions	Mean \pm SD (n=14)
Dimension 1: Objective to quit smoking	4.1\pm0.9
1. You are satisfied with PharmQuit in helping you to keep service schedules.	4.3 \pm 1.0
2. You are satisfied with the progress feature.	4.1 \pm 1.2
3. You are satisfied with the encouragement received.	4.1 \pm 0.9
4. You are satisfied with question-and-answer section.	4.2 \pm 0.9
5. You are satisfied that PharmQuit has helped you quit or reduce the number of cigarettes smoked.	3.9 \pm 1.1
Dimension 2: Scope of application	4.0\pm0.9
6. You are satisfied with the number of functions.	3.9 \pm 1.0
7. You are satisfied with interactive functions between a pharmacist and other smokers.	4.2 \pm 1.0
8. You are satisfied with the ease of inputting your personal information.	3.9 \pm 1.2
9. You are satisfied with the privacy of your information.	4.0 \pm 1.0
Dimension 3: Format and interactive between PharmQuit and the user	4.0\pm1.0
10. You are satisfied with the daily encouraging messages and reminders.	4.1 \pm 1.2
11. You are satisfied with the response speed of the application.	4.1 \pm 0.9
12. You are satisfied with funny and interesting features.	3.8 \pm 1.1
13. You are satisfied with the challenging and attractive interactive features.	3.7 \pm 1.3
Dimension 4: Design	4.3\pm0.9
14. You are satisfied with characteristics of the app.	4.1 \pm 1.1
15. You are satisfied with the amount of information on each screen.	4.4 \pm 0.9
16. You are satisfied with the order of each group of functions.	4.2 \pm 0.8
17. You are satisfied with the convenience and ease of use of PharmQuit.	4.2 \pm 0.8
Dimension 5: Beauty	4.1\pm1.0
18. You are satisfied with beauty and usability of the app.	4.1 \pm 1.0
19. You are satisfied with the font and background color.	4.1 \pm 1.1
20. You are satisfied with the font and font size.	4.4 \pm 0.8
21. You are satisfied with beautiful and attractive pictures used.	4.0 \pm 1.2
Dimension 6: Perceived self-efficacy	4.0\pm0.8
22. You are satisfied with your ability to reduce or stop smoking.	4.2 \pm 1.0
23. You are satisfied with the respect given you by other people for quitting.	3.9 \pm 1.2
24. You are satisfied that you have quit and don't plan on starting again.	4.1 \pm 1.0
25. You are satisfied with using the app to help you quit smoking.	3.9 \pm 1.0

The web system for pharmacists covers six main features: (i) A comparison pie chart that showed comparisons between the number of pharmacists and smokers who enrolled in the cessation program, the number of pharmacists, smokers' contact information and announcements. ; (ii) Reviewing and editing patient information from previous visits; (iii) Scheduling of appointments in the calendar; (iv) Inputting patient information for the current visit; (v) Reports of health information, smokers, quitters, lost follow-ups, and medicines used.

A users' test with PharmQuit

A satisfaction questionnaire was administered to 14 college students who smoked. All were males (average age 18.8 years), 13 were

current smokers and 1 was a former smoker. The three highest scores were for question 15 (Design Dimension), question 20 (Beauty Dimension), and question 1 (Objective Dimension). The lowest score was for question 13 (Format Dimension). All questions are shown in Table 3.

One month after the launch of PharmQuit, a study that evaluated the efficacy of PharmQuit with 29 smokers was carried out. Most of the respondents were male (93.1%), with no underlying disease (69.0%), and low levels of nicotine addiction (62.1%) as shown in Table 4. Only 10.3 percent of smokers received medication for smoking cessation as shown in Table 4. Of the 29 smokers who used PharmQuit, the average access to the app was

20.6± 2.2 times per person per month (excluding the outlier smoker number 25). The blue bars represent the smokers who had not quit by day 30 and the green bars represent

the smokers who had quit by day 30 as shown in Figure 3. The continuous abstinence rate was 31.0 percent after one month (9 quitters out of 29 smokers).

Table 4 Characteristics of smokers who registered with PharmQuit

Characteristics	Number (n = 29)	%
Age (years, mean ± SD)	31.5 ± 14.0	
Gender: male	27	93.1
Occupation		
Student	11	37.9
Official/ State enterprise	4	13.8
Business	4	13.8
Employee	9	31.0
Other (e.g., monk)	1	3.5
Underlying disease		
No	20	69.0
Yes	9	31.0
Diabetes	2	22.2
Hypertension	2	22.2
Asthma	1	11.1
Allergy	3	33.3
Herniated disk	1	11.1
Length of time as a smoker (month) (mean±SD)	156.0±147.7	
Number of cigarettes smoked per day (mean±SD)	10.6±6.4	
Fagerström test for Nicotine Dependence (FGST) (mean±SD)		
Score 7-10: High nicotine addiction 3	6	20.7
Score 4-6: Moderate nicotine addiction 2	5	17.2
Score <4: Low nicotine addiction 1	18	62.1
Use of smoking cessation medications		
No	26	89.7
Yes	3	10.3

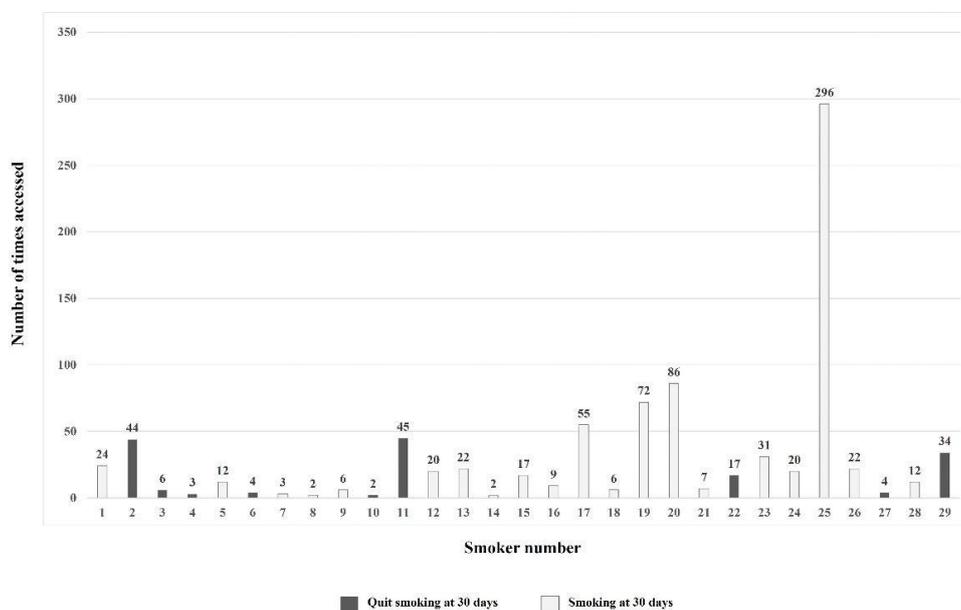


Figure 3 Smokers and Numbers of times PharmQuit was accessed within 30 days after registration

DISCUSSION

The strategy of PharmQuit is to help smokers quit smoking with the help of their own pharmacist. PharmQuit was developed using a user experience framework and thus counselors' and smokers' reviews were considered in the process of development. PharmQuit is used by smokers and a web system is used by pharmacists with linkages between web and app for two-way communication. All smokers who were surveyed were highly satisfied with PharmQuit.

To our knowledge, PharmQuit is uniquely designed to fulfill users' needs by taking into consideration the views of IT professionals, pharmacists, nurses, and smokers. The smoking cessation service by pharmacists in Thailand, allows medications (e.g., nicotine gum, nortriptyline) to be prescribed by law but must follow the Thai Smoking Cessation Practice Guideline supported by the Thai Health Promotion Foundation²³. Moreover, community pharmacies are easily accessible when compared to other health care facilities (e.g., hospitals). Thus, a novel intervention with PharmQuit by community pharmacists could fulfill an evidence gap of face-to-face intervention and attrition from other smoking cessation apps. PharmQuit bridges the gap to provide a platform for self-understanding and patient-provider relationships. Most mHealth apps on the market are in English, and they may not be understood by low to middle income segments of society. PharmQuit is an example of an app developed in a local language as suggested by one study¹⁴.

Other mobile apps have been developed based on various frameworks and theories by researchers. For example, See Me Smoke-Free™ and SmokeFree Baby™ focused on feasibility, usability, and potential impact^{19,25}. However, the retention of smokers in those studies was a challenge^{19,25}. Other available apps are also interactive, but they are limited in that they cannot help smokers get counseling or the needed medications^{18,26}. PharmQuit fulfills a need to provide services with a community pharmacist who can also provide medications¹⁹⁻²⁰. Technology continues to improve rapidly and there is now an app which has similar functions and features but includes more options, such as a CO-exhaled checker, which can be connected to the phone²⁷.

PharmQuit helps smokers and pharmacists to communicate with each other through features of line@, announcement to smokers, encouraging messages, and smokers' feedback in the timeline feature. Construct-based UX helps to clarify the needs of both the pharmacists and the smokers²⁸ so PharmQuit has new features like two-way communication between them. PharmQuit was accessed an average of 30 times in the month-long test which is higher than in the study by Herbec et al (10.2±15.8 logged in during 8 weeks). The abstinence rate was also higher with PharmQuit (31% in one month) versus NRT2Quit (25% in 8 weeks)²⁹.

The limitations of the study were, firstly, time constraints in the usability test. Secondly, the participants often forgot their username because it was automatically generated by the system and not a username of their own choosing. This may have created a barrier for users to access the app and should be improved before launching the app for more users. Thirdly, the app required internet connectivity to function. So, users who had limited internet access could not update self-recording information. Fourthly, the users' testing in phase 3 was developed from the perspective of college/university students, so the features of the app might not appeal to other age groups. Since the 29 participants in the trial were of various ages, this might be the reason why they did not access the app every day (average access was 21 times/month). Fifthly, in a busy pharmacy, the pharmacist might not have been able to help a participant to fully understand the app at the time of registration.

Since PharmQuit uses the systematic approach to smoking cessation counseling, health care providers trained in smoking cessation counseling can use the app. The next stage is to evaluate the effectiveness of PharmQuit in a larger population and for a longer duration.

We believe this app will help smokers successfully quit smoking with the help of a health care professional. People still rely on health care systems in prevention and treatment, so health care professionals are still important to reach out and provide accessibility for smokers to quit smoking. However, as newer technology becomes available, the app will need upgrading to respond to the users' needs.

CONCLUSIONS

PharmQuit was aimed to help smokers quit smoking in collaboration with counseling by community pharmacists. The features and users' testing showed that the app was able to properly function corresponding to its objectives and design. With a small number of participants in the trial, further usability testing should be performed with more participants. Further development of the app is encouraged especially in registration, offline function, and in making it more interactive.

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Conflict of interest

The authors declare no potential conflict of interest.

REFERENCES

1. Taylor AL, Bettcher DW. WHO Framework Conventional on Tobacco Control: a global "good" for public health. *Bull World Health Organ* 2000; 78:920-9.
2. Jha P, Ramasundarahettige C, Landsman V, et al. 21st-Century Hazards of Smoking and Benefits of Cessation in the United States. *N Engl J Med* 2013; 368:341-350.
3. Thun MJ, Carter BD, Feskanich D, et al. 50-Year Trends in Smoking-Related Mortality in the United States. *N Engl J Med* 2013; 368:351-364.
4. Saba M, Diep J, Saini B, et al. Meta-analysis of the effectiveness of smoking cessation interventions in community pharmacy. *J Clin Pharm Ther* 2014; 39:240-247.
5. Brown TJ, Todd A, O'Malley C, et al. Community pharmacy-delivered interventions for public health priorities: A systematic review of interventions for alcohol reduction, smoking cessation and weight management, including meta-analysis for smoking cessation. *BMJ open* 2016; 6:e009828.
6. Brett K, Yenug SST, Ford C. Pharmacist-led interventions for tobacco smoking cessation: a review of clinical effectiveness and cost-effectiveness. <https://europepmc.org/article/NBK/NBK549529> (accessed 13 April 2021).
7. O'Reilly E, Frederick E, Palmer E. Models for pharmacist-delivered tobacco cessation services: a systematic review. *Journal of the American Pharmacists Association* 2019; 59:42-752.
8. Cantor SB, Deshmukh AA, Luca NS, et al. Cost-effectiveness analysis of smoking-cessation counseling training for physicians and pharmacists. *Addict Behav* 2015; 45:79-86.
9. Mdege ND, Chindove S. Effectiveness of tobacco use cessation interventions delivered by pharmacy personnel: a systematic review. *Res Social Adm Pharm* 2014; 10:21-44.
10. Rosen LJ, Galili T, Kott J, et al. Diminishing benefit of smoking cessation medications during the first year: a meta-analysis of randomized controlled trials. *Addiction* 2018; 113:805-816.
11. Bussaratid S, Siripaiboonkij A. Study of Smoking Cessation Rate at Smoking Cessation Clinic, Siriraj Hospital, Thailand. *J Psychiatr Assoc Thailand* 2012; 57:305-312.
12. Bunditanukul K, Bunditanukul W, Chalongsuk, R. Effectiveness of smoking cessation program by the community pharmacist in BANGKOK. *Thai Bull of Pharm Sci* 2014; 9:1-17.

13. Shen X, Bachyrycz A, Anderson JR, et al. Improving the effectiveness of pharmacist-assisted tobacco cessation: a study of participant- and pharmacy-specific differences in quit rates. *Ann Phar* 2015; 49:303-310.
14. Whittaker R, McRobbie H, Bullen C, et al. Mobile phone-based interventions for smoking cessation. *Cochrane Database Syst Rev* 2012;11: CD006611. doi: 10.1002/14651858.CD006611.pub3.
15. Hoepfner BB, Hoepfner SS, Seaboyer L, et al. How smart are smartphone apps for smoking cessation? A content analysis. *Nicotine Tob Res* 2015; 18:1025-1031.
16. Haskins BL, Lesperance D, Gibbons P, et al. A systematic review of smartphone applications for smoking cessation. *TBM* 2017; 7:292-299.
17. Abroms LC, Westmaas JL, Bontemps-Joanes J, et al. A content analysis of popular smartphone apps for smoking cessation. *AM J Prev Med* 2013; 45:732-736.
18. Ubhi HK, Michie S, Kotz D, et al. Characterising smoking cessation smartphone applications in terms of behavior change techniques, engagement and ease-of-use features. *TBM* 2016; 6:410-417.
19. Godon JS, Armin J, Hingle MD, et al. Development and evaluation of the See Me Smoke-Free multi-behavioral mHealth app for women smokers. *TBM* 2017; 7:172-184.
20. Abroms LC, Padmanabhan N, Thaweethai L, et al. iPhone apps for smoking cessation: a content analysis. *Am J Prev Med* 2011; 40:279-285.
21. Jacobs MA, Cobb CO, Abroms L, et al. Facebook apps for smoking cessation: a review of content and adherence to evidence-based guidelines. *JMIR* 2014; 16:e205.
22. Hassenzahl M, Tractinsky N. User experience - a research agenda. *Behav Inf Technol* 2006; 25:91-97.
23. Rungruanghiranya S, Suntorntham S. *Clinical Practice Guideline for smoking cessation in Thailand (Revised edition 2012)*. Bangkok: Health Professional Alliance for Smoke-Free Thai Society, 2012.
24. Prochaska JO, Velicer WF. The transtheoretical model of health behavior change. *Am J Health Promot* 1997;12(1):38-48.
25. Tombor I, Shahab L, Brown J, et al. Development of SmokeFree Baby: a smoking cessation smartphone app for pregnant smokers. *TBM* 2016; 6:533-545.
26. Heffner JL, Vilardaga R, Mercer LD, et al. Feature-level analysis of a novel smartphone application for smoking cessation. *Am J Drug Alcohol Abuse* 2015; 41:68-73.
27. Masaki K, Tateno H, Nomura A, et al. A randomized controlled trial of a smoking cessation smartphone application with a carbon monoxide checker. *Npj Digital Medicine* 2020;3 :35.
28. Lemon C, Huckvale K, Carswell K, et al. A narrative review of methods for applying user experience in the design and assessment of mental health smartphone interventions. *In J of Tech Assessment in Health Care*. 2020;36: 64-70.
29. Herbec A, Brown J, Shahab L, et al. Pragmatic randomized trial of a smartphone app (NRT2Quit) to improve effectiveness of nicotine replacement therapy in a quit attempt by improving medication adherence: results of a prematurely terminated study. *Trials*. 2019; 20:547.