A Community Pharmacist-led Smoking Cessation Intervention Using a Smartphone App (PharmQuit): A Randomized Controlled Trial

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Abstract

Background: WHO supports the harnessing of mobile technologies to improve access to smoking cessation services. PharmQuit, a smartphone app, was developed to support smoking cessation efforts by pharmacists taking into consideration the design of the app according to the needs of smokers. This study evaluated the effectiveness of smoking cessation services conducted by community pharmacists using PharmQuit compared with standard care.

Methods: An open-label prospective, randomized, controlled trial was conducted. Stratified random sampling by sex, age, and nicotine addiction was used to allocate participants to either the intervention group or control group. Eligible participants were smokers 18 years old or older who smoked at least one cigarette daily for a month, were ready to quit, willing to participate, and had a smartphone. The study was performed at seven community pharmacies situated in three provinces in Thailand. In the intervention group, participants received smoking cessation services by community pharmacists using PharmQuit. The control group received standard care delivered by community pharmacists. Both groups were scheduled follow-ups at day 7, 14, 30, 60, 120, and 180. The primary outcomes were quit rate and number of cigarettes smoked per day. Secondary outcomes were exhaled carbon monoxide levels, adherence rate to the program, and satisfaction with PharmQuit. Analysis using the intent-to-treat principle was carried out.

Results: A total of 156 smokers were randomly assigned to either the intervention (n=78) or control (n=78) group. Smoking cessation rates and the number of cigarettes smoked per day were significantly better over the follow-up visits in both groups ($p<0.05$). However, there were no statistically significant differences between the two groups. Adherence rate to the smoking cessation program was higher in the intervention group than the control group (74 days vs 60 days, $p>0.05$). Relapse rate was found to be lower in the intervention group as compared to the control group (28.6% vs 71.4%).

Conclusions: The results showed obvious benefits of the community pharmacist's contribution in helping smokers quit smoking. PharmQuit was not better than just pharmacist's counselling but it might help to obtain better adherence to smoking cessation programs, and have less likelihood of relapse.

Trial registration: Thai Clinical Trials Registry: TCTR20200925004. Registration date September 25, 2020 – Retrospectively registered, http://www.clinicaltrials.in.th/index.php?tp=regtrials&menu=trialsearch&smenu=fulltext&task=search&task2=view1&id=6841

Background

Tobacco smoking is a major cause of premature death worldwide [1]. Tobacco prematurely kills up to half of its users. In 2017, smoking was the second leading risk globally (following hypertension) for premature death and disability ranked by disability adjusted life years (DALYs) [2]. WHO has a global action plan to reduce the prevalence of tobacco use in persons aged 15 years and older by 30% by the year 2025 [3]. In Thailand the smoking prevalence among the general population in 2010 was 42%. The

benchmark of a 30% relative reduction requires that the smoking prevalence in Thailand be reduced to 30% by 2025. With the combination of tobacco control policies and rate of smoking cessation, the relative prevalence is predicted to be 34% in 2025 which, however, is still higher than the WHO target [4]. Increased efforts to control tobacco use are essential for reducing the burden of non-communicable diseases in Thailand [4].

Counselling for smoking cessation is effective in helping smokers quit. Lancaster and Stead showed that different models of counselling provided benefits to participants [5]. Nicotine replacement therapy (NRT) increased the rate of quitting by 50–60% for people who made an attempt to quit—regardless of setting [6]. A combination of pharmacotherapy plus high-intensity behavioral treatment is better than the high-intensity behavioral treatment alone [7]. Health professionals, such as pharmacists, are in a unique position to help smokers quit. Several systematic reviews have shown that pharmacist-led interventions result in better abstinence rates in smokers [8–11], and may also be cost-effective [11–12]. However, pharmacy counselling programme still has a high drop-out rate [13].

Although various mobile apps are available to help smokers quit, studies have shown that only two out of 50 apps were accompanied with scientific and professional support [14] and most apps were not customized to the users' needs [15]. The aims of this study were to help smokers to adhere to a smoking cessation program, in which pharmacists assisted and provided information and support for smokers. Developed for iOS and android phones, PharmQuit aims to help "ready-to-quit" smokers with the help of community pharmacists. PharmQuit was developed using the five user experience framework with perspectives from smokers and pharmacists and was designed to deliver easy access to users. PharmQuit sends encouraging messages to the users' phone every day to remind them to keep a daily record of smoking and encourage them to be abstinent. It gives them information about cravings and adverse drug reactions from medications. Users can see clinical data screened by their pharmacists in PharmQuit and they are also able to send messages directly to their pharmacists through Line@ in PharmQuit. They can see the status of how well they are doing in the program depicted by an avatar. They also can share their status with others in the PharmQuit community.

Current evidence shows benefits of mobile phone-based smoking cessation interventions on long-term outcomes [16]. A few studies of smoking cessation apps have been conducted in community pharmacies and evaluated for short term (8 weeks) outcomes [17–18].

Aim Of The Study

To evaluate the effectiveness of pharmacist-led quit-smoking smartphone app, PharmQuit, on abstinence rate, number of cigarettes smoked per day, carbon monoxide level, adherence to the smoking cessation program, and satisfaction with the app.

Method

Design

This study was an open-label randomized trial with a control group. Stratified random sampling was used for both the control and intervention groups and was based on age, gender and nicotine dependence. This study adheres to CONSORT guideline [19] and includes a completed CONSORT checklist as additional file 1. Cash compensation of 1.50 US dollars per visit were given to each smoker and 16.7 US dollars per smoker was given to each community pharmacist who worked with a smoker.

The satisfaction questionnaire for PharmQuit was specifically developed for this study using the 5-Likert scale (additional file 2). The Cronbach's alpha was 0.923. User's experience theory was used as a framework for developing the questionnaire. Validity was verified by 3 experts in questionnaire development and research. There were 21 questions in 5 dimensions: objectives in quitting smoking, scope of application, format and interaction, design, and appearance. Online and paper-based questionnaires were administered to participants in the intervention group.

Participants

The recruitment was through invitation by pharmacy students, community pharmacists, health care providers, and health care volunteers. Seven community pharmacies in 3 provinces participated in this study. The recruitment period was from July 30, 2017 to August 28, 2018. The study completed in January 2019.

Eligible participants were smokers who were (1) aged 18 years or older, (2) smoking at least one cigarette per day for a month or more, (3) ready to quit smoking or in the preparation stage, (4) willing to participate in the study, (5) able to complete self-recording, and (6) had a smartphone. Exclusion criteria were women who were pregnant or breast feeding, individuals with cardiovascular disease, and individuals currently enrolled in another smoking cessation program. The calculated sample size was 69 people per group (with alpha = 0.05, two-tailed) and with a 80% power to reject the null hypothesis in quit rate at the 6 month follow-up. A dropout rate of 15% was estimated and so the sample size was increased to be about 80 smokers per group.

Randomization

Stratified random allocation was used to achieve equal assignment to the two groups. Stratification was done according to 3 factors: gender, nicotine dependence level as determined by Fagerstorm test (FTND) score, [20] and age. A computer-generated random sequence was used to assign participants to the intervention and control groups. The pharmacists enrolled the participants and then used a randomized table provided by the researcher to allocate participants to either the intervention group or the control group.

Intervention group

Smokers assigned to the intervention group met one-on-one with a community pharmacist at the community pharmacy.

The duration of the first visit was around 30 minutes. The pharmacists asked if the participants were willing to quit smoking; if they agreed to join the study, and to complete a consent form. The pharmacists reassured the participants that choosing to quit was the best decision and emphasized the benefits of quitting. The pharmacists interviewed the participants for general information, intention to quit, struggles in quitting, history of attempting to quit, smoking habits, and nicotine dependence as determined by a Fagerstorm test (FTND). Blood pressure, weight, and exhaled carbon monoxide (CO), measured by a smokerlyzer, were measured by the pharmacists. The pharmacists then followed the treatment plans. The pharmacist checked the randomized table to see if the participant was in the intervention group and then registered their name to the web system, http://www.smokefreerx.com/, to get a username for the participant to login to the app. PharmQuit was then introduced and registered to the participant's mobile phone. At the end of the service, the pharmacist scheduled the next visit at the community pharmacy.

Nicotine gum, nortriptyline, sodium nitrate 0.5% mouth wash, *Vernonia cinerea* lozenges, and herbal medicine were options for participants who had FTND scores of at least 4, were smoking at least 10 cigarettes per day, or had a history of failure to quit smoking. Contraindications were checked before dispensing. The pharmacists counseled the participants on how to use the medication: drug name, dose, regimen, administration, duration of therapy, adverse effects, and disposal of nicotine gum. Pharmacists dispensed the medications following the smoking cessation practice guidelines of Thailand [21].

Follow-up visits were scheduled for Day 7, 14, 30, 60, 120, and 180. If participants were not able to keep to the schedule, the pharmacists followed-up by telephone, line, or Facebook messenger. Each follow-up visit took around 10 to 20 minutes. The pharmacists assessed smoking status, adherence to medication, adverse drug reactions, PharmQuit use, and their overall status to evaluate obstacles and provide encouragement. The pharmacists encouraged the participants to continue in the cessation program and did not blame them if progress had not been made. Blood pressure, weight, and exhaled CO were recorded by the pharmacists. At the end of the appointment, the pharmacists refilled medications and arranged for the next appointment.

Control group

Smokers assigned to the control group met one-on-one with a community pharmacist at the community pharmacy. Participants received usual pharmacy services on smoking cessation and medications, but had no access to PharmQuit.

Measurements

Pharmacists assessed outcomes at every visit. The baseline information assessed by pharmacists included socio-demographic characteristics, months of smoking, number of cigarettes smoked per day, FTND scores, quitting history, reasons for joining the study, and medications used for smoking cessation. Primary outcomes were quit rate, and number of cigarettes smoked per day. Secondary outcomes were adherence rate to the follow-up schedule, exhaled CO level, and satisfaction with PharmQuit. Quit rate was determined by counting the number of visits with the pharmacist since quitting. Exhaled CO was

used to confirm the quit rate. Primary and secondary outcomes were measured at Day 0, 7, 14, 30, 60, 120, and 180. Satisfaction with PharmQuit was evaluated only in the intervention group at Day 180.

Data analysis

Intention-to-treat was applied in this analysis. Descriptive statistics were presented for baseline. Categorical variables were compared by using the chi-squared test, and continuous data using the independent t test for normally distributed data and the Mann-Whitney U test for data that were not normally distributed. Estimates of effect and confidence intervals were analysed by using logistic regression. Data for participants with missing data were assumed to be the same as their last visit information. All test were two-sided and alpha was set to 5%.

Results

We randomized a total of 156 participants to the intervention group or the control group. Completion on Day 180 was 30.8% (24/78) for the intervention group and 23.1% (18/78) for the control group (Fig. 1).

Participant characteristics

More medications were used by participants in the control group than in the intervention group. FTND in the control group was lower in the high nicotine addiction group than in the intervention group. Nevertheless, there were no significant differences in all baseline characteristics between the two groups as shown in Table 1.

Table 1
Baseline characteristics of participants in the intervention and control groups.

Characteristics	Intervention group No (%) (n = 78)	Control group No (%) (n = 78)	p-value
Gender: male	71 (91.0)	72 (92.3)	0.772[b]
Age (years, mean ± SD)	33.5 ± 14.3	35.0 ± 16.5	0.533[a]
Weight (Kg.) (mean ± SD)	69.1 ± 14.3	68.9 ± 13.1	0.947[a]
Blood pressure (mmHg) (ni/nc = 72/68) SBP (mean ± SD) DBP (mean ± SD)	125.0 ± 15.0 77.3 ± 9.9	129.8 ± 16.3 79.4 ± 11.0	0.070[a] 0.234[a]
Underlying disease: yes	24 (30.8)	25 (32.1)	0.908[b]
Length of time as a smoker (months) (mean ± SD)	182.5 ± 165.0	196.5 ± 175.5	0.621[a]
Number of cigarettes smoked per day (mean ± SD)	12.0 ± 6.8	12.4 ± 8.2	0.775[a]
Fagerstrom test nicotine dependence (FTND) score (mean ± SD) - Score 7–10: high nicotine addiction 3 - Score 4–6: moderate nicotine addiction 2 - Score < 4: low nicotine addiction 1	3.7 ± 2.4 13 (16.7) 28 (35.9) 37 (47.4)	3.46 ± 2.6 11 (14.1) 28 (35.9) 39 (50.0)	0.589[a] 0.896[b]
Use of smoking cessation medications: Yes	40 (51.3)	44 (56.4)	0.521[b]
Close friends/family who smoke: yes (n_i/n_c =53/50)	50 (75.8)	45 (71.4)	0.577[b]
Quit attempt in the past: yes (n_i/n_c = 60/57)	61 (81.3)	64 (87.7)	0.287[b]
Longest period of abstinence in the past (days; mean ± SD) (n_i/n_c=71/69)	117.0 ± 328.8	123.3 ± 209.6	0.892[b]

[a] Independent t-test, [b] Chi-square

Characteristics	Intervention group No (%) (n = 78)	Control group No (%) (n = 78)	p-value
Smoking behaviors (n_i/n_c = 76/75)	53 (69.7)	50(66.8)	0.095 [b]
- After meals	30 (39.5)	20 (26.7)	
- When drinking coffee	56 (73.7)	49 (65.3)	0.685 [b]
- When drinking alcohol			0.265 [b]
Psychological dependence (n_i/n_c = 76/75)	44(57.9)	36 (40.0)	0.223 [b]
- Free time	32 (42.1)	25 (33.3)	
- Working time	48 (63.2)	47 (62.7)	0.266 [b]
- Stressful time			0.950 [b]
Reasons for wanting to quit smoking (n_i/n_c =76/75)	27 (35.5)	27 (36.0)	0.952 [b]
- Family	52 (68.4)	47 (62.7)	
- Health	6 (7.9)	11 (14.7)	0.457 [b]
- Socially unacceptable	6 (7.9)	12 (10.0)	0.188 [b]
- Economic issue	10 (13.2)	7 (9.3)	
- Others (partners, stress)			0.124 [b]
			0.457 [b]

[a] Independent t-test, [b] Chi-square

Clinical outcomes

The number of cigarettes smoked per day was not significantly different between the intervention and control groups at each follow up visit. However, the number of cigarettes smoked per day at Day 180 decreased significantly when compared with Day 0 in both groups ($p < 0.05$) as shown in Table 2.

Table 2
Comparisons of number of cigarettes smoked per day between the intervention and control groups at Day 0,7, 14, 30, 60, 120 and 180

Visit	Intervention group (n=78)		Control group (n=78)		p-value[a]
	Number of cigarettes smoked per day Mean±SD	Mean difference	Number of cigarettes smoked per day Mean±SD	Mean difference	
Day 0	11.8±6. 8		13.2±8.5		0.775
Day 7	7.3±6.8	4.4±7.1**	6.8±7.9	6.2±9.0**	0.479
Day 14	5.0±5.8	6.7±7.9 **	5.2±7.1	7.8±9.2**	0.948
Day 30	4.5±5.3	7.2±7.8 **	3.1±3.8	10.0±9.4**	0.188
Day 60	4.4±5.6	7.3±7.7 **	3.1±4.1	9.9±9.5 **	0.235
Day 120	3.7±5.0	8.0±7.7 **	2.9±3.9	10.2±9.3 **	0.407
Day 180	3.5±5.0	8.2±7.6 **	2.9±4.0	10.2±9.4 **	0.513

[a] Comparing the number of cigarettes smoked per day between groups by using the Independent t-test

** p<0.001, within group comparison using Day 0 as a reference by pair t-test

There was no significant difference in quit rate between both groups in all visits. Both groups showed significant improvement in abstinence rates compared with their respective Day 0 ($p < 0.05$) as shown in Table 3. There were a total of 7 participants who relapsed after quitting. Two participants (28.6%) in the intervention group relapsed at Day 14 and Day 30. Five participants (71.4%) in the control group relapsed at Day 14 (2 participants), Day 30 (2 participants), and Day 60 (1 participant). The proportion of participants who exhaled CO lower than 7 ppm significantly increased compared with Day 0 in both groups ($p < 0.05$). Nevertheless, there was no significant difference when comparing between groups as shown in Table 4. Of the 29 participants in the intervention group who accessed PharmQuit continuously, 12 were (41.3%) were successful in quitting and 17 (58.6%) failed to quit smoking.

Table 3
Comparisons of quit rate between the intervention and control groups at Day 0, 7, 14, 30, 60, 120, and 180

Visit	Intervention group (n = 78)	Control group (n = 78)	OR	95%CI	p-value[b]
	Quit rate No (%)	Quit rate No (%)			
Day 0	0(0.0)	0(0.0)	n/a	n/a	n/a
Day 7	14 (18.0)	15 (19.2)	0.93	0.44–1.97	0.848
Day 14	18 (23.1)	20 (25.6)	0.83	0.41–1.67	0.591
Day 30	18 (23.1)	20 (25.6)	0.88	0.43–1.78	0.718
Day 60	23 (29.5)[#]	25 (32.1) [#]	0.94	0.48–1.85	0.863
Day 120	25 (32.1) [#]	25 (32.1) [#]	1.00	0.51–1.96	1.000
Day 180	25 (32.1) [#]	27 (34.6) [#]	1.00	0.51–1.95	1.000

[b] Comparing the quit rate between groups by using the logistic regression

[#] $p < 0.05$, within group comparison using Day 7 as a reference by using the McNemar test

n/a stands for not applicable

Table 4
Comparisons of carbon monoxide (CO) levels between the intervention and control groups at Day 0, 7, 14,30, 60, 120 and 180

Visit	Intervention group (n=74)	Control group (n=76)	OR	95%CI	p-value[c]
	CO <7 ppm No (%)	CO <7 ppm No (%)			
Day 0	24 (32.4)	24 (31.6)	1.04	0.52-2.07	0.911
Day 7	30 (40.5)	32 (42.1) *	0.94	0.49-1.80	0.846
Day 14	29 (39.2)	36 (47.4) *	0.72	0.37-1.37	0.313
Day 30	33 (44.6) *	38 (50.0) *	0.81	0.42-1.53	0.508
Day 60	36 (48.7) *	38 (50.0) *	0.95	0.50-1.80	0.869
Day 120	32 (43.2)	38 (50.0) *	0.76	0.40-1.45	0.407
Day 180	36 (48.7) *	40 (52.6) *	0.85	0.45-1.62	0.626

CO stands for exhaled carbon monoxide, ppm stands for part per million

[c] Comparing exhaled CO between groups by using the logistic regression

* $p<0.05$, within group comparison using Day 0 as a reference by using the McNemar test

Adherence to the smoking cessation program

Adherence to the smoking cessation program in both the intervention and control groups was assessed. Table 5 shows that adherence rate decreased over time, and adherence was higher in the intervention group than the control group. The number of days in the cessation program was analyzed and there was no significant difference between the intervention (73.4 ± 76.1 days) and control groups (60.1 ± 70.8 days) ($p = 0.232$).

Table 5
The adherence rate to the smoking cessation program in the intervention and control groups

Day	Adherence rate		OR	95%CI	p-value[d]
	Intervention group (n = 78) No (%)	Control group (n = 78) No (%)			
1 day	78 (17.95)	78 (23.08)	n/a	n/a	n/a
7 days	64 (82.05)	60 (76.92)	1.37	0.63-3.00	0.429
14 days	54 (69.23)	55 (70.51)	0.94	0.48–1.87	0.861
30 days	47 (60.26)	43 (55.13)	1.23	0.65–2.33	0.517
60 days	36 (46.15)	28 (35.90)	1.53	0.81–2.91	0.194
120 days	28 (35.90)	21 (26.92)	1.52	0.77-3.00	0.228
180 days	24 (30.77)	18 (23.08)	1.39	0.68–2.86	0.364

[d] Comparing adherence rate between groups by using the logistic regression

Of the 78 participants in the intervention group, 37.2% were using PharmQuit at month 1. After six months, only 2.6% were using PharmQuit as shown in Fig. 2. The number of times PharmQuit was accessed was highest during the 1st month, and then decreased over time. At day 180, 14 out of 78 participants (response rate 17.9%) returned the PharmQuit satisfaction questionnaire. They rated it the highest for design, appearance, and the objective of PharmQuit. The overall satisfaction with PharmQuit was high in all questions. The top three highest scores on individual questions were satisfaction with the amount of information on each screen, satisfaction with the font and font size, and the help to keep service schedules. The lowest score was humorous and interesting features, and challenging and attractive interactive features as shown in Table 6.

Table 6
Satisfaction score (on a scale of 1–5) to PharmQuit

Application PharmQuit	**Mean ± SD (n = 14)**
Dimension 1: Objective to quit smoking	4.1 ± 09
1. You are satisfied with PharmQuit in helping you to keep service schedules.	*4.3 ± 1.0*
2. You are satisfied with the progress feature.	*4.1 ± 1.1*
3. You are satisfied with the encouragement received	*4.1 ± 0.9*
4. You are satisfied with question and answer section.	*4.2 ± 0.9*
5. You are satisfied that PharmQuit has helped you quit or reduce the number of cigarettes smoked.	*3.9 ± 1.1*
Dimension 2: Scope of application	4.0 ± 0.9
6. You are satisfied with the number of functions.	*3.9 ± 1.1*
7. You are satisfied with interactive functions between a pharmacist and other smokers.	*4.2 ± 1.0*
8. You are satisfied with the ease of inputting your personal information.	*3.9 ± 1.2*
9. You are satisfied with the privacy of your information.	*4.0 ± 1.0*
Dimension 3: Format and interactive between PharmQuit and the user	4.0 ± 1.0
10. You are satisfied with the daily encouraging messages and reminders.	*4.1 ± 1.2*
11. You are satisfied with the response speed of the application.	*4.1 ± 0.9*
12. You are satisfied with humorous and interesting features.	*3.8 ± 1.1*
13. You are satisfied with the challenging and attractive interactive features.	*3.7 ± 1.3*
Dimension 4: Design	4.2 ± 0.9
14. You are satisfied with characteristics of the app.	*4.1 ± 1.1*
15. You are satisfied with the amount of information on each screen.	*4.4 ± 0.9*
16. You are satisfied with the sequence of each group of functions.	*4.2 ± 0.8*
17. You are satisfied with the convenience and ease of use of PharmQuit.	*4.2 ± 0.8*
Dimension 5: Appearance	4.1 ± 1.0
18. You are satisfied with attractiveness and usability of the app.	*4.1 ± 1.0*
19. You are satisfied with the font and background color.	*4.1 ± 1.1*
20. You are satisfied with the font and font size.	*4.4 ± 0.9*

Application PharmQuit	Mean ± SD (n = 14)
21. You are satisfied with beautiful and attractive pictures used.	*4.0 + 1.2*

Discussion

Participants in both groups significantly benefited from the smoking cessation program provided by community pharmacists. Although there were no significant differences between the intervention and control groups, participants in both groups showed improvement in quit rate, number of cigarettes smoked per day, exhaled CO, and adherence to the cessation program. Adherence to the cessation program was higher in the intervention group (74 days) than the control group (60 days). Also, the relapse rate in the intervention group was lower than the control group. This good probably be due to the motivation provided through PharmQuit as the participants in the intervention group were highly satisfied with PharmQuit.

In this study, the quit rates in the intervention group tended to be lower than the control group in most of follow-up visits, but this difference was not statistically significant. The findings from other studies using different mobile apps are not consistent. For example, in a study by Herbec et al, carried out in 300 community pharmacies in the UK, the results after 8 weeks showed a quit rate of 25% in the intervention group (using the NRT2Quit app) and 8% in the control group ($p = 0.19$) [17]. A study by Nomura et al in Japan showed no significant difference in continuous abstinence rates between telemedicine counselling plus CureApp and face-to-face clinical visits plus CureApp (81.0% vs 78.9%) [22]. Another double-blind RCT study by Bricker et al compared two apps (SmartQuit and QuitGuide) over two months. This study showed quit rates of 13% in SmartQuit and 8% in QuitGuide ($p > 0.05$) [23]. However, a study on physicians and CureApp by Masaki et al in Japan showed a significant difference between the intervention group using CureApp and a control group using a control-app (63.9% vs 50.5%) [24].

The magnitude of the quit rates in this study are similar to those of other pharmacist-led smoking cessation programs conducted elsewhere. One randomized controlled trial (RCT) study in Qatar by Hajj et al evaluated smoking cessation rates provided by pharmacists at 6 months and found a quit rate of 27.0% [25]. Gong et al did an RCT study with participants who received pharmacist-provided telephone counseling and medications showed a 42.3% 1-week point abstinence rate at week 12 which was higher than the usual care rate of 38.2% ($p > 0.05$) [26]. When compared with the PharmQuit study, these cessation rates are similar or better than two studies that evaluated the effectiveness of the apps without services from health professionals. The first was a single arm study by Iacoviello et al in the US using the Clickotine app for 8 weeks, which showed a self-reported abstinence rate of 26.2% [18]. However, the other study by Bricker et al, showed a lower quit rate (13% in SmartQuit and 8% in QuitGuide) when compared to our study [23].

Although most participants in the intervention group liked PharmQuit, participants accessed it less frequently over time. Some explained that they had limited internet access. One participant complained that there were too many messages being sent (twice per day). Frequent messages may be counterproductive because Do et al showed that daily texts were less effective than weekly texts [27]. One participant uninstalled PharmQuit due to limited memory on his phone. One participant forgot to do the daily record on PharmQuit because there was no feedback from his pharmacist. Some participants who were able to quit smoking stopped using PharmQuit after quitting. At the start of recruitment of participants, the login feature was not functioning and this delayed recruitment by a week. This might not have left a good impression on the particpants in the intervention group. These factors may explain the low rate of active users of PharmQuit even though all participants in the intervention group were trained to use PharmQuit by their pharmacists at the start of the program. However, when considering that the aim of PharmQuit was to help participants adhere to the program using an easy-to-use app, the aims was achieved.

Another explanation for the results was high loss to follow-up rate in both groups. Although the pharmacists reminded the participants about the appointments and made calls, most of them could not be reached by phone. This may have reduced the power of the study to show significant differences in smoking cessation rates between the two groups. One participant in the intervention group was diagnosed with cancer and decided to stop using this app. Other studies have shown that special characteristics such as swearing to complete the study [22], much better compensation (90 US dollars per visit) [24], and effective medications (such as varenicline, bupropion, nicotine patch) [22, 24–26] helped to increase app engagement and quit rate. Our study was performed ethically and the participants could choose to leave the study at any time. A small compensation was given and any needed medications were provided free of charge. The most effective medication for smoking cessation in our study was nicotine gum which has been shown to be less effective than some other medications in other studies [28]. As only 51–56% of participants received medications, participants who did not get medications may have thought it was not necessary or worthwhile to come and talk to the community pharmacists.

The study had some limitations. A substantial number of participants had missing data during the follow-up visits. The low compensation may not have been a sufficient incentive to convince people to join the study and to complete the study. Although participants who were participating in other cessation programs during recruitment were excluded, no follow-up was done to find out if they had started another cessation program during the study. PharmQuit was developed for this study only in Thai, so the use of PharmQuit outside of Thailand would be limited to countries where reading Thai is common, such as Lao P.D.R.

The strength of the study was that it was a multicenter study that used a randomized control design, and had a long follow-up duration. Some of the community pharmacists in this study had experience serving at a university with a smoke-free campus policy [29].

Conclusion

The results showed benefit that community pharmacist provide in helping smokers quit smoking. PharmQuit was not more effective than just pharmacist counselling. Nevertheless, it may help pharmacists get better adherence to a smoking cessation program. The use of a mobile app is thus one option for smokers in larger clinical trials looking at smoking cessation.

Declarations

Acknowledgements

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Availability of data and materials

The datasets used and/or analyzed during this study are available from the corresponding author on request.

Authors’ contributions

NA was the principal investigator in the study. He was responsible for the initial concept of the study, literature review, drafting the plan of the study, application development, data collection, analysis and interpretation of the data, and writing the first draft of the manuscript. PO was responsible for the research funding, the initial concept and design of the study, assisting with application development, data collection, analysis and interpretation of data, finalizing and approving the manuscript, and submitting it to the journal. JK was responsible for the initial concept and design of the study, and assisted with the development of the app, interpretation of data, and approving the manuscript. PT and BS were responsible for the initial concept of the study and design—mainly for application development, and

approving the manuscript. CS and SS were responsible for the initial concept and design of the study, data collection, and approving the manuscript.

Competing interest

We undersigned confirm that we do not have any competing interests which would influence the study.

Consent for publication

Not applicable. The manuscript does not report individual data.

Ethical approval and consent to participant

The study protocol, consent forms, and tools received ethical approval by Mahasarakham University (ID: 033/2559). The participants provided written and informed consent to participate in this study.

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Figures

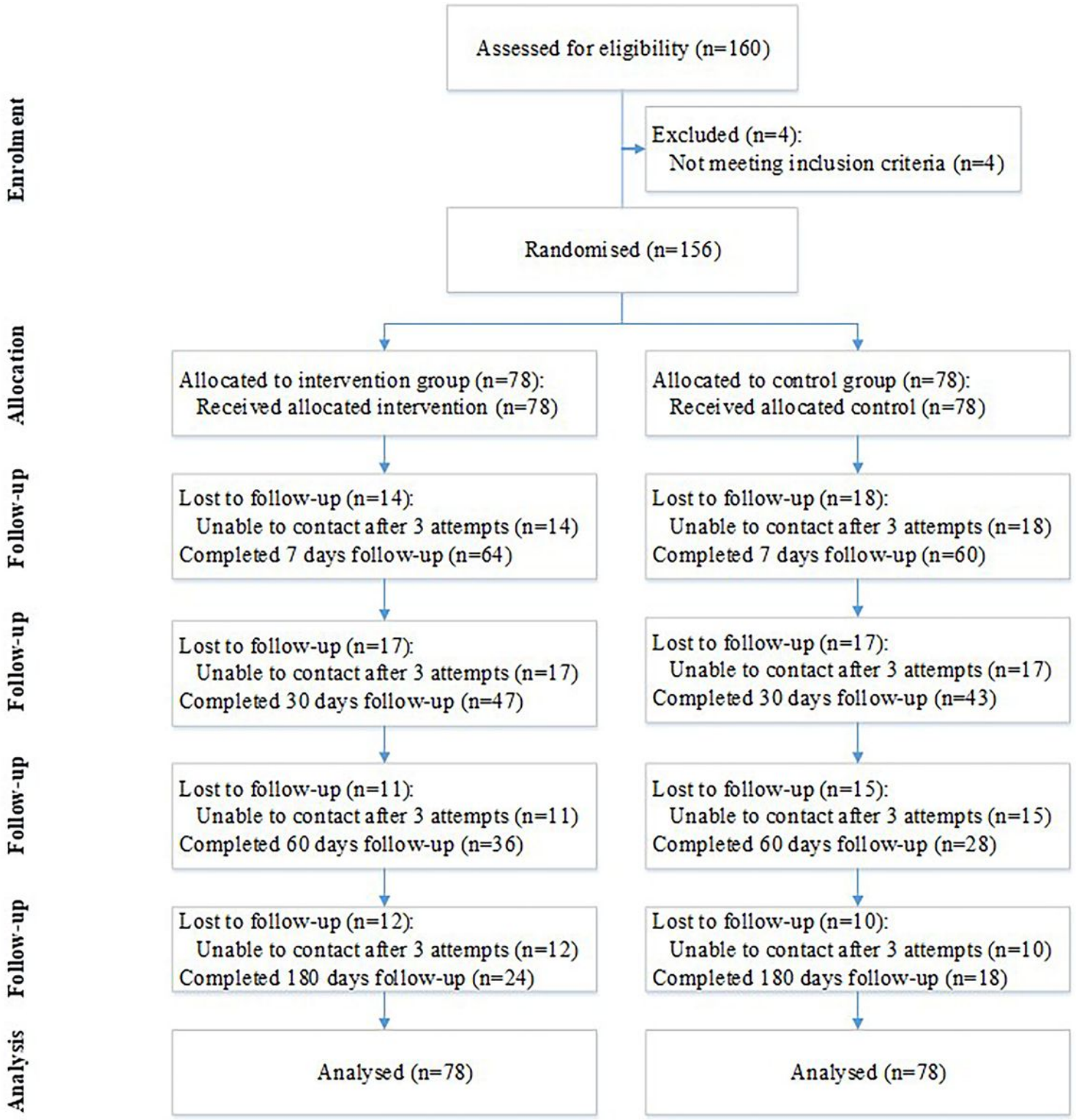

Figure 1

Participant flowchart

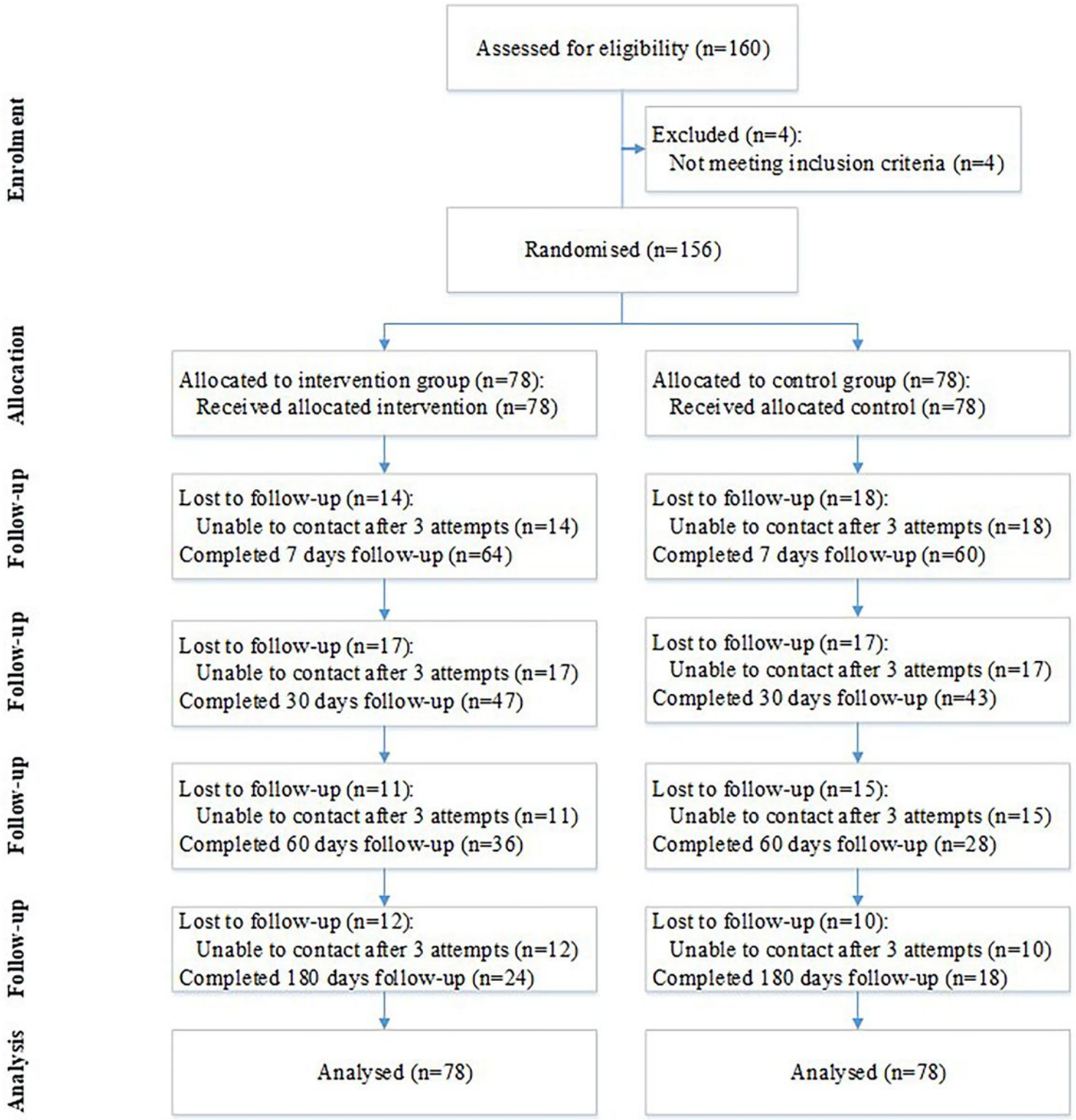

Figure 1

Participant flowchart

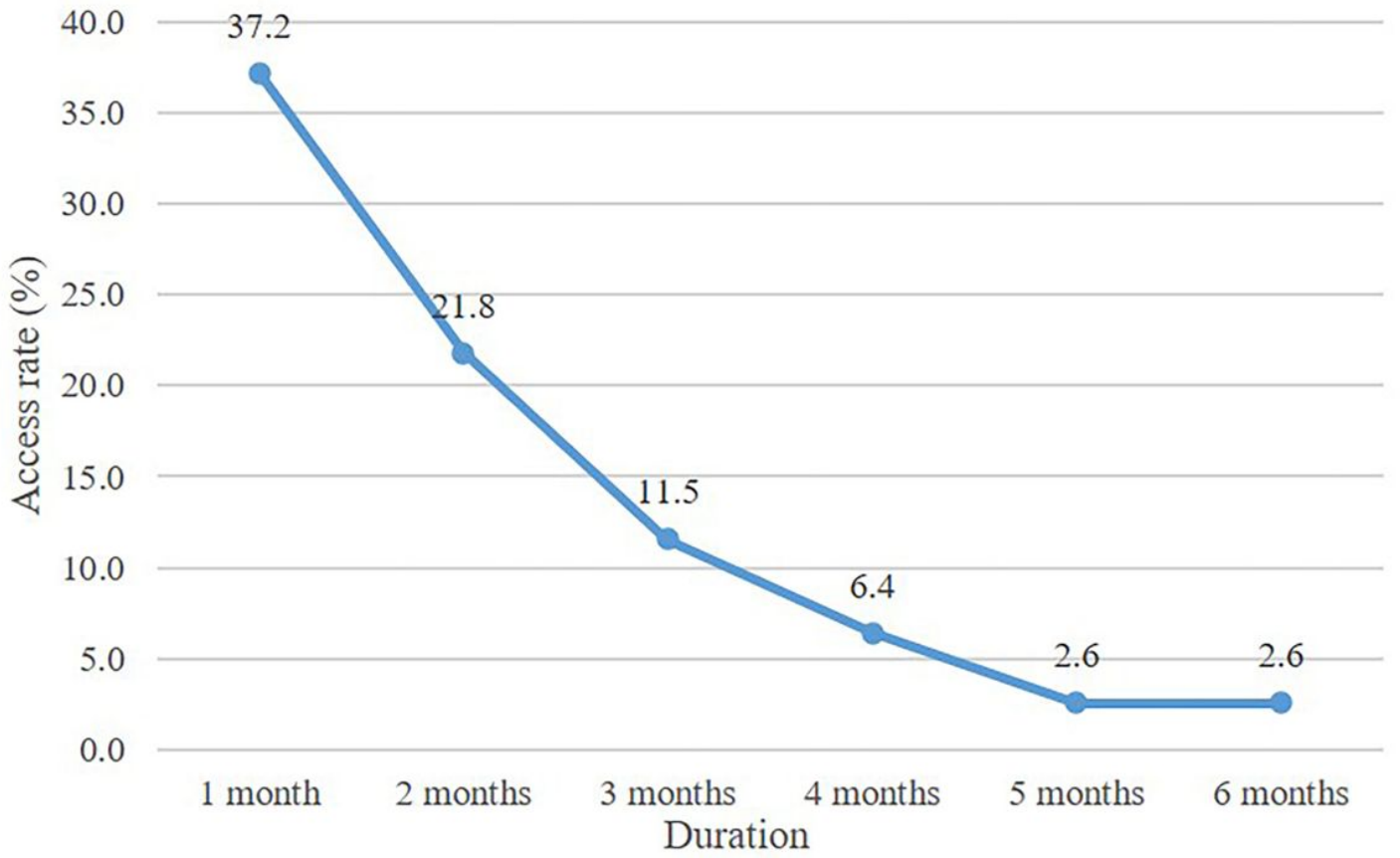

Figure 2

The access rate to PharmQuit in the intervention group within the 6 month follow-up (n=78)

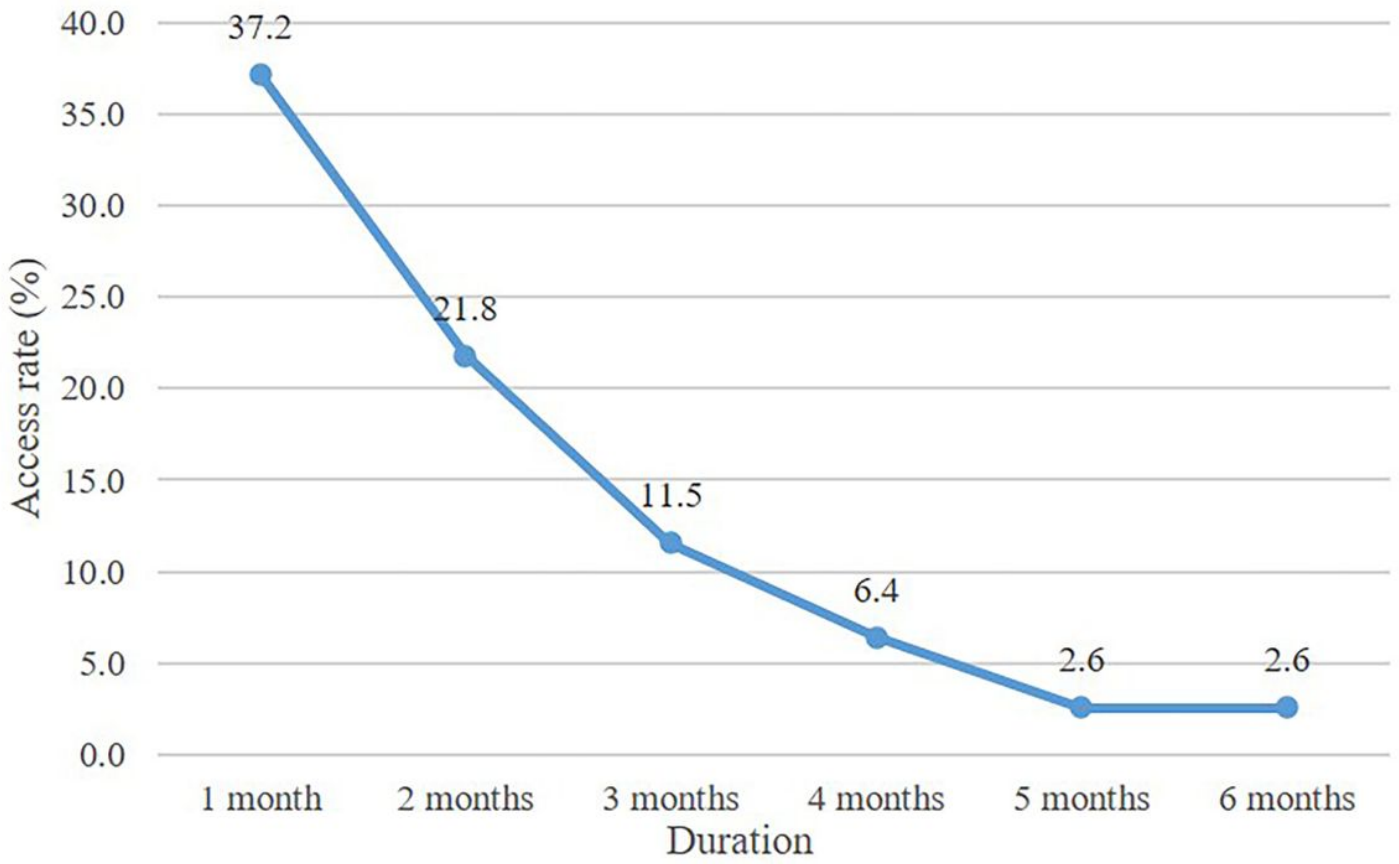

Figure 2

The access rate to PharmQuit in the intervention group within the 6 month follow-up (n=78)

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