Preplanned Studies

Effectiveness and Acceptability of a Comprehensive Mobile Health-Based Modality for Smoking Cessation — Beijing Municipality, China, 2022

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Summary

What is already known on this topic?

Mobile health interventions have been demonstrated to be effective in aiding smoking cessation among smokers. Nevertheless, research on this topic remains limited in China.

What is added by this report?

Following two months of utilizing the services of a comprehensive mobile health (mHealth)-based modality ("Way to Quit" modality) which integrated three online interventions through the WeChat application, 29.1% of participating smokers successfully quit smoking. Participants who used a greater number of online services were more likely to cease smoking. All services were scored highly for satisfaction among smokers.

What are the implications for public health practice?

This study presents a practical and feasible method to assist Chinese smokers in quitting smoking. The results of this research suggest a promising direction for enhancing the accessibility and utilization of smoking cessation services. Additionally, these findings serve as a critical reference for addressing the obstacles faced by smoking cessation services in China.

China has a high prevalence of tobacco use, yet smoking cessation services are insufficient. However, mobile health (mHealth) can provide smoking cessation assistance. We developed and refined a comprehensive mHealth-based smoking cessation modality called the "Way to Quit" modality (WQ modality), comprising three interventions and using the WeChat app based on multiple behavior change theories. To assess the effectiveness and acceptability of the optimized WQ modality, we conducted a prospective cohort study from May to September 2022 in Beijing Municipality, China, as part of a large public welfare program. Eligible smokers were recruited using online advertisements and received WQ modality-based interventions for two months, followed by phone or online follow-up at 1-month, 2-month, and 3-month. Usage data was downloaded from the WeChat platform for each service. We included 392 eligible participants who completed at least one follow-up in the final analysis. The self-reported 7-day point prevalence of abstinence (PPA) at 1-month, 2-month, and 3-month was 27.0%, 29.1%, and 22.7%, respectively. Participants who used more online services were more likely to quit smoking [using all services: adjusted odds ratio (*OR*)=9.08, 95% confidence interval (*CI*): 4.36–18.94, *P*-trend<0.001]. The satisfaction score for each service was on average 9 out of 10 points [interquartile range (IQR): 8–9]. This study provided an effective and accessible smoking cessation approach for Chinese smokers.

An initial study in western China discovered that the WQ modality was efficacious in encouraging smoking cessation (*1*). To augment the effectiveness of this modality, we further refined it by integrating various theories of behavior change, such as developing interventions that are matched to the stage of development and customized in the WeChat group, organizing guidance on utilizing the WeChat mini-program, and fortifying referrals between various services. In 2022, we implemented the optimized WQ modality in a public welfare program, namely the Online Quit Program — an online smoking cessation public welfare program designed for citizens of Beijing Municipality, China. The program aimed to provide cessation assistance to more than 500 smokers.

A prospective cohort study was carried out in Beijing Municipality from May to September 2022. Individuals who were current smokers, 18 years or older, planned to quit within a month, and possessed a WeChat account were eligible to participate. Recruitment took place from May 31 to June 6, 2022 through an online advertisement on the WeChat

official account. Individuals with mental and psychological illnesses were excluded.

Those who were interested in participating underwent a screening process by scanning a Quick Response code on the advertisement to determine eligibility. Online consent forms were provided for eligible individuals. Out of the 729 participants who underwent screening, 604 were found eligible. Among those eligible individuals, 112 did not complete the baseline survey, and 100 lost all three follow-ups; they were excluded. Ultimately, 392 eligible participants who completed the baseline survey and at least one follow-up were included in the final analysis. Approval for this study was granted by the Institutional Review Board of Beijing Chao-Yang Hospital, Capital Medical University (IRB# 2022-ke-394).

We provided two months of comprehensive cessation services to participants, based on the WQ modality. Participants who used any of the WQ modality services during the program were included in the exposed group, while those who did not use any WQ modality services were included in the non-exposed group. The WQ modality was developed based on three behavior change theories: the capability, opportunity, motivation, and behavior (COM-B) model (*2*), Transtheoretical Model (TTM) (*3*), Ecological Systems Theory (EST) (*4*), and clinical practice guideline (*5*). To integrate the WQ modality, we developed a WeChat mini program (QUIT WMP), a WeChat group (QUIT WG), and a WeChat official account (QUIT WOA). The QUIT WMP was designed to help smokers build their capacity to quit smoking and was based on behavior change techniques (BCTs) (*6*) and clinical guideline for smoking cessation treatment (*5*). Detailed functions have been published elsewhere (*7*). Participants were encouraged to use the QUIT WMP at least five days per week. The QUIT WG provided real-time online counseling, stage-matched group interventions, and interactive activities to foster long-lasting and supportive relationships to promote smoking cessation. Weekly topics and examples of group interventions and interactive activities are provided in Table 1. Participants were divided into ten subgroups (30–40 per subgroup) to facilitate discussion. To promote interaction among smokers, ten participants were selected as team leaders. The QUIT WOA provided smoking cessation materials electronically and offered information about group interventions and interactive activities for smokers to download at their convenience. Additionally, smoking cessation physicians provided online professional counseling for at least one hour through WeChat group or Tencent video conferences every weekday during the program. Furthermore, a series of popular science lectures were conducted by eight smoking cessation experts once a week for two months. While the program did not provide any cessation medications to participants, they were free to use cessation medications or other smoking cessation methods in combination with the WQ modality-based interventions on their own.

The study collected baseline data through an online questionnaire, which included demographic characteristics, smoking and quitting history, and comorbidities. The Fagerström test for nicotine dependence (FTND) was used to measure nicotine dependence. Follow-up data were collected at 1-month, 2-month, and 3-month intervals after baseline,

TABLE 1. The weekly topics and examples of group interventions and interactive activities in the QUIT WeChat Group used in the Online Quit Program in Beijing Municipality, China, 2022.

Week	Stage	Topic	Group intervention	Interactive activity
Week 1	Preparation	Motivating to quit	Health hazards of smoking and benefits of quitting smoking	Discussion: Why do I quit smoking?
Week 2	Action	Setting a quit day	Facilitating a quit plan	Establishing a target date to quit smoking and publicly declaring the intention to quit within the online support community.
Week 3	Action	Coping with craving	Skills to cope with smoking craving	Experience sharing: How did I cope with smoking craving?
Week 4	Action	Developing the capacity for quitting	Effective methods for smoking cessation	Discussion: What are the barriers to quitting smoking for me?
Week 5	Maintenance	Preventing relapse	How to prevent relapse	Experience sharing: My experience of relapse.
Week 6	Maintenance	Establishing new habits.	How to establish a new habit	Experience sharing: My new habit to replace smoking.
Week 7	Maintenance	Refusing the temptation of tobacco	Refuse the first cigarette	Discussion: How do I refuse cigarettes from others.
Week 8	Maintenance	Benefits of quitting	Benefits of quitting	Sharing quitting achievement pictures in the online group.

including changes in smoking behaviors, cessation service usage, and satisfaction with each service. Login information for QUIT WMP and messages sent to QUIT WG were downloaded from the WeChat app platform. The primary effectiveness outcome was self-reported 7-day PPA at the 2-month follow-up. This was defined as the proportion of smokers who reported abstaining from smoking for the past 7 days at the 2-month follow-up (*8*). Secondary effectiveness outcomes included self-reported 7-day PPA at the 1-month and 3-month follow-up, as well as self-reported quit attempt rates at 1-month, 2-month, and 3-month intervals. Participants' willingness to recommend online services to other smokers and their satisfaction scores of each service were used to assess the acceptability of the online service. All statistical analyses were performed using SPSS software (version 22.0; SPSS, Inc., Chicago, IL, USA). Descriptive statistics were presented as means (standard deviation, SD), medians (IQR), and proportions for continuous variables with normal distribution, variables without normal distribution, and categorical variables, respectively. Logistic regression was used to calculate *OR* and 95% *CI* for the relationship between cessation service use and self-reported 7-day PPA at the 2-month follow-up. Participants' smoking status at the lost follow-up was determined to be continuous smoking. A significance level of 0.05 (two-tailed) was used to define statistical significance.

The study included 392 participants, the majority of whom were men (97.2%; *n*=381) with a median age of 41.3±10.0 years. Most participants had a college degree or higher (81.6%; *n*=320) and 44.1% (*n*=173) had comorbid conditions. More than half of the participants had smoked for at least 20 years (57.9%; *n*=227), with 54.1% (*n*=212) smoking more than 20 cigarettes per day. Additionally, 63.0% (*n*=247) were moderately or severely dependent on nicotine (FTND score ≥4) and 61.22% (*n*=240) had attempted to quit smoking in the past. Willpower was the most commonly used cessation method (57.9%; *n*=139) among those who had attempted to quit in the past. The follow-up rates for the 1-month, 2-month, and 3-month follow-up were 53.8% (*n*=211), 77.8% (*n*=305), and 60.7% (*n*=238), respectively.

Based on usage data downloaded from the WeChat app platform, all participants adhered to the QUIT WOA and subsequently joined the QUIT WG, 60.7% (238/392) of participants registered for the QUIT WMP. Among these individuals, only 32.4% (77/238) used the QUIT WMP for more than 20 days while 25.5% (100/392) sent more than 30 messages in the QUIT WG. During the first month of the program, the median daily number of messages sent in the QUIT WG was 1,123 (IQR: 972, 1,451); however, this figure gradually decreased in the second and third months (2-month: Median, IQR=608, 485–651; 3-month: Median, IQR=357, 320–398).

The study assessed self-reported 7-day PPA at 1-month, 2-month, and 3-month post-baseline, as well as self-reported quit attempts. The results showed that 27.0%, 29.1%, and 22.7% reported 7-day PPA at 1-month, 2-month, and 3-month respectively, with an additional 25.0%, 28.8%, and 18.4% reporting quit attempts at those same time points. After controlling for covariates such as age, sex, education, occupation, and use of other cessation services, logistic regression analysis revealed that participants who used any services of the WQ modality were more likely to quit smoking after the intervention (*OR*=1.99, 95% *CI*: 1.15–3.44) compared to those who did not use online cessation services at 2-month follow-up. Furthermore, participants who used more online services were even more likely to quit smoking (using all three services: *OR*=9.08, 95% *CI*: 4.36–18.94, *P*-trend<0.001) (Table 2). The majority of smokers found the WQ modality-based services attractive (198/238, 83.2%) and would recommend it to other smokers (203/238, 85.3%). Participants also rated satisfaction with each service at 9 out of 10 (IQR: 8–9).

DISCUSSION

Following two months of utilizing WQ modality-based services, 29.1% of participants successfully quit smoking. Participants who used a greater number of online services were more likely to cease smoking. All services were scored highly for satisfaction among smokers. The optimized WQ modality was demonstrated to be an efficient, favorable, and convenient means of aiding smokers in quitting smoking. These results may offer promising resolutions to the struggle of delivering smoking cessation services in China.

The rate of abstinence in our study is similar to that found in real-world studies on quitlines and smoking cessation clinics in China. The abstinence rate on quitline was approximately 25% (*9*), and that of the smoking cessation clinic was about 30% (*10*). This finding indicates that mHealth-based cessation services can be used alongside traditional cessation services, especially in areas where cessation resources are limited.

TABLE 2. Association between using the WQ-based services and participants' self-reported 7-day quitting at 2-month follow-up in the Online Quit Program in Beijing Municipality, China, 2022.

Interventions	*n*	%	7-day PPA *n* (%)	adjusted *OR** (95% *CI*)	*P*
Used services					
No (Ref.)	109	27.81	21 (19.27)	1.00	
Yes	283	72.19	93 (32.86)	1.99 (1.15–3.44)	0.014
Number of services					
None (Ref.)	109	27.81	21 (19.27)	1.00	
Used any 1	175	44.64	29 (16.57)	0.81 (0.43–1.52)	0.508
Used any 2	45	11.48	21 (46.67)	3.68 (1.70–7.94)	0.001
Used all 3	63	16.07	43 (68.25)	9.08 (4.36–18.94)	<0.001
P-trend					<0.001
Different combinations of two or more services[†]					
None (Ref.)	109	27.81	21 (19.27)	1.00	
WOA[§]+WMP[¶]	13	3.32	7 (53.85)	5.60 (1.65–19.07)	0.006
WOA+WG[**]	31	7.91	13 (41.94)	2.77 (1.14–6.70)	0.024
WOA+WMP+WG	63	16.07	43 (68.25)	8.68 (4.15–18.17)	<0.001
P-trend					<0.001

Abbreviation: 7-day PPA=7-day point prevalence of abstinence; *OR*=odds ratio; *CI*=confidence interval; WOA=WeChat official account; WMP=WeChat mini program; WG=WeChat Group.

* Adjusted for age, sex, education level, and occupation, as well as incorporating additional interventions such as counseling in smoking cessation clinics and using cessation medications or electronic cigarettes.

† Only one participant used WMP+WG, and he was not included in this analysis section.

§ Self-reported use of QUIT WOA during the program at the 2-month follow-up;

¶ Used the QUIT WMP for more than 20 days from baseline to the 2-month follow-up according to the usage data obtained from the WeChat app platform.

** Sent more than 30 messages to the QUIT WG from baseline to the 2-month follow-up according to the usage data obtained from the WeChat app platform.

Several reasons could account for the positive impact of the WQ modality. First, the WQ modality was developed using behavior change theories (*2*–*4*) and clinical practice guideline (*5*), which ensured that the smoking cessation interventions offered were evidence-based, stage-matched, and personalized. Second, the WQ modality integrated three mHealth-based smoking cessation interventions into one platform, which could lead to increased intervention intensity and improved access to multiple cessation services. Furthermore, the Online Quit Program was part of the 2022 World No Tobacco Day, and the media conducted extensive campaigns on smoking hazards and quitting smoking during this period, which likely boosted participants' motivation and confidence to quit smoking.

The study found the optimized WQ modality to be acceptable. Within just one week of recruitment, over 700 smokers registered through online advertisements on the WeChat app. Participants expressed satisfaction with the services, finding the WQ modality attractive and indicating a willingness to recommend it to other smokers. This may be attributed to the fact that the WQ modality is based on the WeChat app, which is the most popular app in China and more user-friendly. Moreover, the WQ modality enabled participants to access real-time online professional smoking cessation assistance without being limited by time or location, removing barriers to accessing cessation services. Additionally, the WQ modality enabled the professional smoking cessation team to treat hundreds of smokers simultaneously, thereby improving treatment efficiency and expanding services to reach more smokers.

The present study has some limitations. First, our evaluation of the optimized WQ modality was conducted in a prospective cohort study rather than a randomized controlled trial (RCT). Therefore, our conclusions are not definitive. Second, the cessation status information relied on self-reporting, which was not biochemically validated, leading to potential measurement bias. Finally, the study provided a relatively brief two-month intervention for smoking cessation, so the effectiveness of the comprehensive

online interventions for the long-term needs to be further determined by RCT design over at least a one-year follow-up period.

The study findings suggest that utilizing the optimized WQ modality can assist with short-term smoking cessation and is acceptable to the general population. Moreover, it has the potential to attain comprehensive coverage. To further promote the success of this modality and achieve the smoking cessation goal set by Healthy China 2030, there is a need to develop a standardized online smoking cessation intervention toolkit in the near future. This toolkit would enable nationwide dissemination of the WQ modality.

Conflicts of interest: No conflicts of interest.

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