

Efficacy of the QuitSure App for Smoking Cessation in Adult Smokers: a Cross-Sectional Web Survey

Gregory M. Goldgof, Shweta Mishra, Kriti Bajaj

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Efficacy of the QuitSure App for Smoking Cessation in Adult Smokers: a Cross-Sectional Web Survey

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Abstract

Background: Cigarette smoking remains one of the leading causes of preventable death worldwide [1]. A worldwide study by the WHO concluded that more than 8 million people die every year from smoking, tobacco consumption, and second-hand smoke [2]. Meanwhile, the annual economic burden attributable to smoking was found to be more than \$600 billion in the U.S. alone in 2018 as reported by the CDC [3]. The most effective tobacco cessation programs require personalized human intervention combined with costly pharmaceutical supplementation, making them unaffordable and/or inaccessible to most tobacco users [3]. Thus, digital interventions, delivered through smartphones, offer a promising alternative to these traditional methods. However, the leading smartphone applications available in the market today have either not been studied in a clinical setting or are unable to match the smoking cessation success rates of their expensive offline counterparts. We would like to understand whether QuitSure, a novel smoking cessation application, is able to bridge this efficacy gap and deliver affordable and effective smoking cessation at scale.

Objective: Our objective was to do an initial exploration into the engagement, efficacy, and safety of QuitSure based on the self-reported experiences of its users. Outcomes measured were program completion, the effect of program completion on smoking behavior, including self-reported cessation outcomes, and negative health events from using the application.

Methods: All QuitSure registered users who created their accounts on the QuitSure application between 1 April 2021 and 28 Feb 2022 were sent an anonymised web-based survey. The survey results were added to their engagement data on the app to evaluate the feasibility and efficacy of the app as a smoking cessation intervention. The data was analyzed using descriptive statistics (frequencies and percentages) and chi-square test of independence.

Results: A total of 13,237 users who had completed the QuitSure program were sent the survey, of which a final 1,299 participated in the study. App engagement and pre-program smoking behavior data between those who filled out the survey versus those who did not were not significantly different. Of the study participants, 1,286 had completed the program more than 30 days ago and 80.87% (1040) of them had maintained continuous smoking abstinence (c.s.a.) 30-days post program completion. 1,002 of the total participants had completed the program more than 6 months ago, of which 72.36% (725) had maintained c.s.a. 6-months post program completion. Only 13.13% of participants who reported abstinence for at least 1 day experienced known severe nicotine withdrawal symptoms. No additional adverse events outside of these known nicotine withdrawal symptoms were reported.

Conclusions: The nature of the web-based survey and cohort selection allows for extensive unknown biases. However, the efficacy rates of survey respondents who completed the program are high and provide a case for further investigation in the form of randomized controlled trials on the QuitSure tobacco cessation program.

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Background

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Our objective was to do an initial exploration into the engagement, efficacy, and safety of QuitSure based on the self-reported experiences of its users. Outcomes measured were program completion, the effect of program completion on smoking behavior, including self-reported cessation outcomes, and negative health events from using the application.

Methods

All QuitSure registered users who created their accounts on the QuitSure application between 1 April 2021 and 28 Feb 2022 were sent an anonymised web-based survey. The survey results were added to their engagement data on the app to evaluate the feasibility and efficacy of the app as a smoking cessation intervention. The data was analyzed using descriptive statistics (frequencies and percentages) and chi-square test of independence.

Results

1,299 users who had completed the QuitSure program submitted the survey and satisfied the inclusion criteria of the study. App engagement and pre-program smoking behavior data between those who filled out the survey versus those who did not were not significantly different. Of the study participants, 1,286 had completed the program more than 30 days ago and 80.1% (1040/1286; 95% C.I at 79.1% - 82.6%) of them had maintained prolonged abstinence (p.a.) 30-days post program completion. 86.4% of participants who reported abstinence for at least 1 day did not experience any severe nicotine withdrawal symptoms, while 41.9% experienced no mild withdrawal symptoms either. Smoking quantity prior to doing the program significantly affected quit rates ($X^2_{(2,1)} = 20.3253$, $P < .001$), with heavy smokers (>20 cigarettes per day) having a lower 30-day prolonged abstinence rate (relative risk = .91) compared to lighter smokers. No additional adverse events outside of known nicotine withdrawal symptoms were reported.

Conclusions

The nature of the web-based survey and cohort selection allows for extensive unknown biases. However, the efficacy rates of survey respondents who completed the program are high and provide a case for further investigation in the form of randomized controlled trials on the QuitSure tobacco cessation program.

Keywords

Smoking; Quit smoking; Smoking cessation; Smoking App; QuitSure; Smoke Free; Quit vaping

Introduction

Cigarette smoking remains one of the leading causes for many premature deaths worldwide. According to the World Health Organization (WHO), more than 8 million people around the world die every year, either directly or indirectly (via second-hand smoke) because of tobacco consumption. Hence, the WHO has identified the tobacco epidemic as one of the world's biggest public health threats [2]. Beyond the burden of mortality, lies the burden of disease as a result of tobacco consumption. For every one individual who dies because of smoking, at least 30 of them live with a serious illness caused by smoking. Smoking causes many health issues like cardiovascular diseases, chronic obstructive pulmonary disease (COPD), and 12 types of cancer [3]. More than 67% of smokers face debilitating, and eventually fatal, health issues at some point in their smoking lives [4]. Health risks, as well as death risks for smokers compared to non-smokers, have worsened, due to the deadly spread of Coronavirus across the world [5]. Meanwhile the estimated economic costs attributable to smoking and exposure to tobacco smoke globally has been estimated to be \$1436 per smoker globally, which is equivalent to around 1.8% of world's GDP [6].

In 2015, 68.0% of adult smokers (22.7 million) said that they wanted to quit smoking. In 2018, 55.1% of adult smokers (21.5 million) said that they had made a quit attempt in the past year. In 2020, 62.5% of youth (middle and high school students) who currently used tobacco products wished to quit all tobacco products, and 65.4% of youth who currently used tobacco products reported that they had stopped using all tobacco products for one day or longer in the past year because they were trying to quit [7]. But on the other side of the coin, a report by the National Institute of Cancer, US, found that in 2020, of the 53.9% of smokers who attempted to quit smoking, only 8.5% of them were successful in doing so [8]. In fact, research has found that it takes about 30 quitting attempts for a smoker to successfully quit [9]. The WHO, in 2022 said that without cessation support, only 4% of smokers will be able to successfully quit.

Smoking cessation

There are several smoking cessation methods available across the world, including unassisted methods, nicotine replacement therapy, prescribed medicine (bupropion/varenicline) use, behavioral counseling, quitlines, use of mobile apps and websites for smoking cessation [10]. Financial incentives have gained popularity as a cessation method recently [11]. Nicotine Replacement Therapy (NRT), like nicotine patches, gums, nasal sprays; medications such as Bupropion, Varenicline; and non-pharmacological interventions [12] are the most common smoking cessation interventions. However, NRT has shown to have success rates of only 6-8% [13], while pharmacological interventions, despite their somewhat higher success rates of 14-20% [14] come with the risk of side effects such as skin irritation or more serious seizures and also are very expensive [15]. Combined interventions for smokers such as behavioral interventions and long term assistance or social support are the most effective when it comes to smoking cessation [15]. However, they tend to be expensive, highly variable depending on the quality of each individual provider, accessible to only small hyperlocal communities, and cannot be scaled up to achieve population level impact.

Smartphone apps for smoking cessation

In response to the COVID-19 pandemic, the rate of smoking cessation increased from 23% to 31 % [16] which creates the opportunity to encourage and support smokers to quit smoking through different smoking cessation methods. Unconventional methods such as smartphone-based apps can be more useful to increase the odds of quitting success over conventional methods because smartphone usage is highly prevalent, available 24x7, cost-effective, requires zero-minimal human intervention and can provide instant and constant support. Seo et al (2022) found a total of 603 apps designed for smoking cessation which were available in the US, UK, Australian, and Asian markets [17]. Apps designed for smoking cessation have been downloaded 33 million times globally according to a study done by SensorTower in April 2020 (R Nelson, SensorTower.com, personal communication, April 15, 2020). Users

who have high engagement with smoking cessation apps have been found to be more likely to be successful in quitting [18, 19].

However, literature reviews suggest that only a few apps follow the guidelines for treating tobacco dependence and most apps use only very simple tools like calculators (41%), calendars (36%), trackers (18%), hypnosis apps (21%) and distractors (10%) [20, 21]. According to the WHO any primary care provider needs to follow the 5As (Ask, Advise, Assess, Assist and Arrange) to help a tobacco user [22]. One content analysis study suggested that 96% of the cessation apps addressed "Assist" but less frequently addressed the other four A's [21]. Another review demonstrated that only 11 (6.1%) of the 180 smoking cessation apps available in 2022 have any scientific support [56]. The review also discovered that very few apps offered evidence-based interventions such as mindfulness (18%), or cognitive behavior therapy (2.2%). Other reviews indicated that 88.46% of smoking cessation apps have not been updated by the developers in over a year and 33.67% of apps have low acceptance by the market with <10,000 downloads [17, 21]. Thus, the development of additional smartphone apps which have good user acceptance and are using empirically supported behavior change techniques to deliver smoking cessation interventions appears to be warranted.

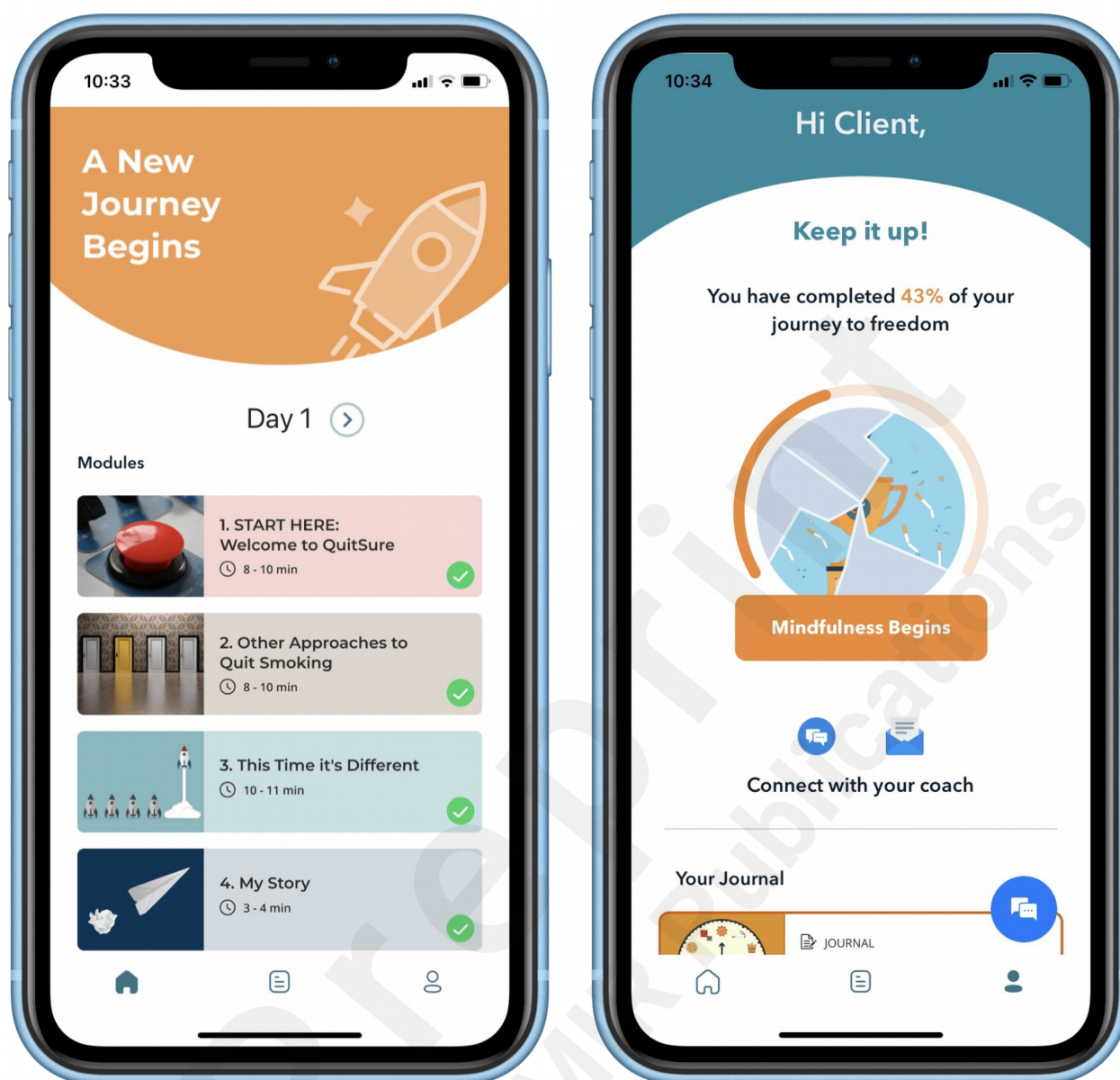
The QuitSure Smoking Cessation Program

The QuitSure Program has been identified as one such program, which incorporates behavior change techniques like positive psychology, cognitive behavioral therapy (CBT), and mindfulness that have been shown to be effective in smoking cessation interventions [22, 27], and is customized to the smoking habits and psychological needs of the user. It does not include or recommend the use of any pharmaceutical interventions, like oral supplements, medications, or nicotine replacement therapies.

The program follows the 5A's recommended by the WHO (2014a) [22]: It first asks the users about their smoking history like quantity, patterns, past quitting attempts, relapse reasons etc. This also helps the user internalize their smoking behavior. Then it assesses if they are ready to quit and asks them about their inhibitions to quit. Unless it is a medical condition, it then advises in a clear, strong manner to quit smoking alongside a summary the program and how it actually works. After understanding the program, willing users are then progressed to the next level where the app provides the main content on psychological, CBT, and mindfulness [27].

CBT is incorporated by helping users question their beliefs around the positive aspects of smoking and remove them. The app does not demand any lifestyle modification. It simply helps the user accept their smoking triggers and change their response to these triggers. Under mindfulness, the app provides video exercises to teach users how to smoke mindfully by focusing on every aspect of the smoking experience. This exposes to the user the real effects of cigarettes, both while smoking and after, on their bodies and minds. All the content is delivered using empathy and without administering any guilt or blame to the user, to keep the user's mind in a more calm, and receptive state.

Figure 1: Screenshots of the home page (left) and profile page (right) of the QuitSure App.



Users are required to do the program in a very specific way with a predefined sequence of content and video exercises. The program requires around 6-10 hours over 6-12 days to complete. During the whole process, the app has an interactive journal for users to record their quitting journey and 24*7 chat-based support from trained counselors for users who have additional questions or concerns which are not addressed by the program itself. Once the user has completed the program and quit smoking, the app has post-quit tools and chat support available to prevent them from relapsing. Around 12% of all users reach out to the counselors for support during and after the program.

The program is priced at USD 10 , and should be affordable to most daily smokers, as the average global retail price of a pack of 20 cigarettes is ~\$5 [28, 29]. Users only have to pay on Day-2 of the 6 day program. This is done so they can understand how the program is structured and what techniques it uses before committing to it. At the end of the program, user's are asked to perform a guided smoking exercise where they smoke their last cigarette and then quit cold-turkey. The timestamp when they mark having performed this exercise in the app is considered as their quit date and as their program completion date. The Quitsure app has been updated an average of once every 3 weeks since its launch.

In this paper, we report the results of a retrospective cross sectional study on users who completed the

program between 1 April 2021 and 28 Feb 2022. Participants who started the QuitSure program, but then dropped out before completing it were also surveyed to evaluate potential areas of improvement for QuitSure. The aim of this study is to evaluate the effectiveness of the QuitSure Smoking Cessation Program to enable smoking cessation amongst daily smokers. We will also examine the program's usability, feasibility, and acceptance by the market.

Methods

Design

This was a retrospective cross-sectional study to understand, through a web-based survey, smoking cessation outcomes of users who completed the QuitSure program via the QuitSure smartphone application. The survey was conducted in April 2022.

Recruitment

Users who downloaded and registered for the QuitSure quit smoking application between dates 1 April 2021 and 28 Feb 2022 and satisfied all the following inclusion criteria, were sent the web surveys.

The Inclusion criteria for the study included: (i) were daily smokers as defined by the US CDC - smoked at least 1 cigarette per day before they did the program and had smoked at least 100 cigarettes before doing the program [6]; (ii) are adults over 18 yrs of age (self-reported); (iii) are, at minimum, proficient in the English Language (since the program content is solely available in English); (iv) had completed the entire QuitSure program; (v) and had a valid email address.

All registered users of the QuitSure application give consent to be contacted for the purpose of research studies at the time of registration.

Web-Based Survey

The surveys were created on the web based 'Jotform' tool built by Jotform Inc. The forms were set up with Jotform's HIPAA compliant mode, and no personally identifiable data was collected, thus protecting the confidentiality and privacy of the participants. The survey details have been reported in accordance with the CHERRIES checklist guidelines [55].

The survey was sent via an automated email from the QuitSure server to all users who fit the inclusion criteria above. The email included the relevant details for participation in the study, including length of the survey, the aim of the study, benefits for the participant, as well as the link to the survey itself. They were encouraged to contact the investigators if they had any questions or concerns. Participation in the survey was voluntary. Participants were granted entry into a lucky draw for a \$50 dollar Amazon voucher. This amount was chosen as being 5 times the price of the QuitSure program and the email specified that winning the \$50 voucher did not depend on whether their experience with the QuitSure Program was positive or negative.

To prevent duplication of data, each email included a hidden, unique, non-personally-identifiable, id number which appeared in the survey results. For duplicate submissions, the more recent entry was kept. All questions seen by the participant, depending on the conditions, were mandatory. As a result, incomplete surveys were not recorded or used for analysis. No statistical correction methods, such as weighting of items or propensity scores, were applied to adjust for sample non-representativeness.

The first part of the surveys confirmed the participants demographic data and satisfaction of the inclusion criteria. It also explicitly requested informed consent for participation in the study. Participants were only shown the remaining sections in the survey if they consented to participate in the study and met the inclusion criteria defined above. The second and third parts of each survey are described in the individual sections below. Prior to launching the survey, we conducted usability and technical functionality testing to ensure that participants could easily navigate and complete the electronic questionnaire. In both surveys, the questions were primarily multiple-choice, with the rest requiring integer number entries. All multiple choice questions included the option for free form "other" entries, as

well as the option for “none” or “choose not to share” as relevant for that question.

Survey for Program Completers

This survey, referred to as S-Completers, was sent to all users who satisfied the inclusion criteria above and had also completed the QuitSure program on the QuitSure App as defined in the introduction.

The second section of this survey identified the participants' smoking history, including the outcome of their completion of the QuitSure program. The 3rd section was conditional. Each participant saw a different set of questions depending on their smoking cessation/reduction/relapse outcome post program completion. The number of questions in each section ranged from 4 to 9 depending on the responses of the participant.

Survey for Non-Completers of the Program

This survey, referred to as the S-Incompleters survey, was sent to all users who satisfied the inclusion criteria above who had started the program, but then not completed it, to get a qualitative understanding of the feasibility of the program at scale.

The S-Incompleters survey also took the participants' explicit consent for participation in the study and the same demographic data and smoking history questions. The rest of the survey was to understand their reasons for leaving the program midway. The number of questions in each section ranged from 4 to 9 depending on the responses of the participant.

The copy of both survey questionnaires are provided in Multimedia Appendices 1 and 2.

Study Variables

The data collected in the first part of both surveys included demographic information about the participants including gender, age, country of residence, and English proficiency.

The second part of both surveys, regarding smoking history and behavior, asked what form(s) they consumed nicotine in before doing the program; how much and how long they had smoked; and whether they had previously tried to quit smoking using other methods. Those who had completed the QuitSure program were asked for the outcome of their most recent attempt at doing the QuitSure program; and if they used any other quit smoking tools, programs, or medications/supplements during or after doing the QuitSure program.

The questions in the third part of the S-Completers survey were dependent on their outcome of doing the QuitSure program. Those who were able to quit 100% since completing the program were asked whether they experienced any mild or severe withdrawal symptoms, and weight gain. They were also asked for their current level of cravings to smoke via a Likert scale ranging from 1 (none) to 5 (unbearable). Those who quit for some time, but then relapsed, were asked how long they were able to stay quit, and their reason(s) for relapse. Those who were only able to cut down their smoking level were asked for their new smoking rates and the reason(s) the program did not help them quit completely. Lastly, those for whom the program had no impact, were asked why the program did not work for them. All participants who said they are still smoking were asked their current level of motivation to quit smoking on the Likert scale and whether they would use QuitSure again for their next quitting attempt.

The S-Incompleters survey asked participants why they did not complete the program and whether they were able to quit using a different method since. If they have quit since, then how they quit and what their level of cravings to smoke are. If not, then what their level of motivation to quit is, and whether they will use QuitSure as their method of choice.

Ethical Considerations

This study was approved by the IRB board of the University of California, San Francisco. The email sent

to the users described the study's aims and procedures, as well as the security and confidentiality of their data. It also clearly stated that participation was voluntary and they could decline to participate. The participants were given a consent form with all the details of the study including the purpose of the study. Participants younger than 18 years old were not included in the study. The study observed data protection laws in effect at the time it was conducted. Participants were entered in a lucky draw to win a \$50 gift voucher for Amazon.

Statistical Analysis

Data was collected from 1,299 participants from over 25 countries. The survey responses were available in excel format. The data analysis tools used were descriptive statistics (frequencies and percentages), pivot tables, as well as chi-square tests of independence.

Results

Survey for Program Completers

Out of the 13,585 users who were sent the S-Completers survey email, 853 (6.3% of the total) emails bounced. Of the 12,732 delivered emails, 5,365 (42.1% of the delivered emails) were opened. QuitSure or smoking were not mentioned in the sender or subject lines of the emails, only in the body of the email, to reduce bias based on user perception of the QuitSure program before opening the email. Therefore, we will use this number of email openers as the baseline number of users who were aware of this Study. 1,906 (35.5% of those who opened the email) clicked on the survey link, and a final 1,332 (24.8% of email openers, and 69.9% of those who initiated the survey) consented to participate in the study and completed the survey. These values are all either equal to or greater than expected opening (21.5%) and click (8%) rates based on global industry standards [31, 32]. Of this set of submitters, 11 were excluded for completing the program <7 days before submitting the survey. An additional 22 were excluded for submitting false data that was significantly different from actual app engagement. A final set of 1,299 participants were included in the data analysis for the study. App engagement and pre-program smoking behavior data between those who filled out the survey versus those who did not were not significantly different. A Flowchart representing the participant funnel for the S-Completers survey is available in Multimedia Appendix 3.

Table 1 shows the baseline characteristics of the participants, while Multimedia Appendix 4 shows their global distribution. The ratio of male : female participants was found to be 1:1.17. The most common age range of participants was found to be 25-34 years (33.2%; 431/1,299). 97.2% (1,262/1,299) of participants were cigarette smokers, while the remaining 2.6% (37/1,299) only consumed other forms of nicotine. 5 countries, USA, UK, India, Canada, and Australia, had 71.8% (933/1,299) of the participants.

Smoking behavior of participants prior to doing the program was grouped into 4 categories defined as Very Light (<5 cigarettes/day), Light (5-10 cigarettes/day), Average (11-20 cigarettes/day), and Heavy (>20 cigarettes/day) [33]. The participants smoked an average of 13.66 ± 8.83 cigarettes per day.

Table 1: Demographic details of participants.

Male	Female	Others	All
(n=587)	(n=699)	(n=13)	(n=1,299)

Age (years), mean (SD) ^a	35.8 (11.74)	41.83 (12.55)	27.11 (6.82)	39.5 (12.56)
Cigarettes smoked/day, mean (SD)	12.57 (8.02)	14.57 (8.56)	13.30 (5.51)	13.66 (8.83)
Median (smoking category)	10 (Light)	14 (Average)	13 (Average)	12 (Average)
No. of years Smoked, mean (SD)	15.28 (11.40)	21.13 (12.87)	10.15 (9.69)	18.59 (12.62)
Smoking Categories				
Very Light (<5), n (%)	75 (12.8%)	47 (6.7%)	0 (0%)	122 (9.4%)
Light (5-10), n (%)	119 (20.2%)	109 (15.6%)	3 (25%)	231 (17.8%)
Average (11-20), n (%)	233 (39.6%)	301 (43.1%)	8 (61.5%)	542 (41.7%)
Heavy (>20), n (%)	160 (27.2%)	242 (34.6%)	2 (15.4%)	404 (31.1%)

^aIn order to calculate the mean, the midpoints of each age group was considered (calculated as upper limit + lower limit/2 (i.e. 25+35/2 and so on.)

Effectiveness of the smartphone app for smoking cessation

Participants were divided into 4 overlapping subsets based on the duration between completing the program and submitting the survey. The 4 durations chosen were the 7 days, 30 days, 3 months, and 6 months which are the 4 commonly used smoking cessation milestones [34]. Table 2 shows the self-reported outcome of completing the program for each of these groups. Overall, 88.0% (1144/1299), 80.9% (1040/1286), 82.4% (991/1203), and 72.4% (725/1002) of participants had maintained prolonged abstinence (*p.a.*) for 7 days, 30 days, 3 months, and 6 months respectively. 35 of the 1203 participants (2.9%) were able to cut down on their smoking level 30-days post the completion of the program and 1.9% (19/1002) were able to sustain it for over 6 months post program completion.

Table 2: Prolonged abstinence post program completion.

	7-day p.a.	30-day p.a.	3-mo p.a.	6-mo p.a.
Overall	88.0%(1144/1,299)	80.9% (1040/1,286)	82.4% (991/1,203)	72.4% (725/1,002)
Confidence Interval (C.I) at 95%	86.8% - 89.7%	79.4% - 82.3%	80.0% - 84.6%	69.8% - 75.8%
Based on Smoking Behavior				
Very Light (<5)	87.7% (107/122)	78.5% (95/121)	83.2% (84/101)	65.5% (57/87)
Light (5-10)	90.5% (209/231)	86.0% (196/228)	88.4% (183/207)	76.3% (132/173)
Average (11-20)	90.6% (491/542)	83.4% (446/535)	86.9% (405/466)	75.1% (319/425)
Heavy (>20)	82.4% (333/404)	75.1% (301/401)	79.7% (271/340)	68.% (215/316)
Countries with most participants				
United States	89.3% (351/393)	83.5% (324/388)	77.9% (278/357)	76.8% (242/315)
United Kingdom	84.6% (88/104)	70.9% (73/103)	69% (67/97)	65% (56/86)
India	84.6% (226/266)	74.7% (195/261)	68.4% (158/231)	64.5% (129/200)
Canada	90% (78/87)	83% (72/86)	77% (58/75)	76% (51/67)
Australia	91% (68/75)	87% (65/75)	81% (54/67)	85% (50/59)

The participants who were able to quit smoking as a result of the program and had maintained prolonged cessation at the time of filling out the survey (n=891) experienced varying degrees of withdrawal symptoms as shown in Figures 2 and 3. Overall, 41.9% (373/891) experienced no mild withdrawal symptoms, and 86.4% (770/891) experienced no severe withdrawal symptoms. 41.9%

(373/891) experienced no weight gain after quitting with the QuitSure app; 39.6% (353/891) gained <5 kgs while 18.5% (165/891) gained >5 kgs post quitting.

Figure 2: Mild Withdrawal Symptoms Reported by Participants.

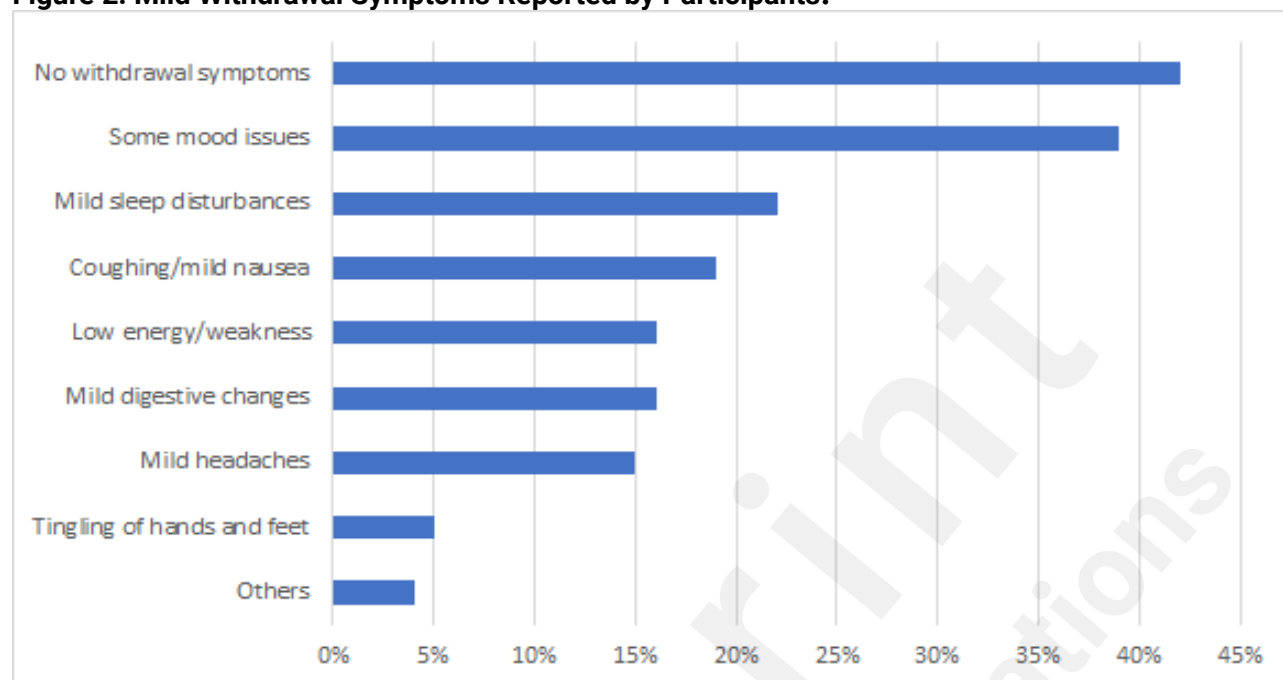
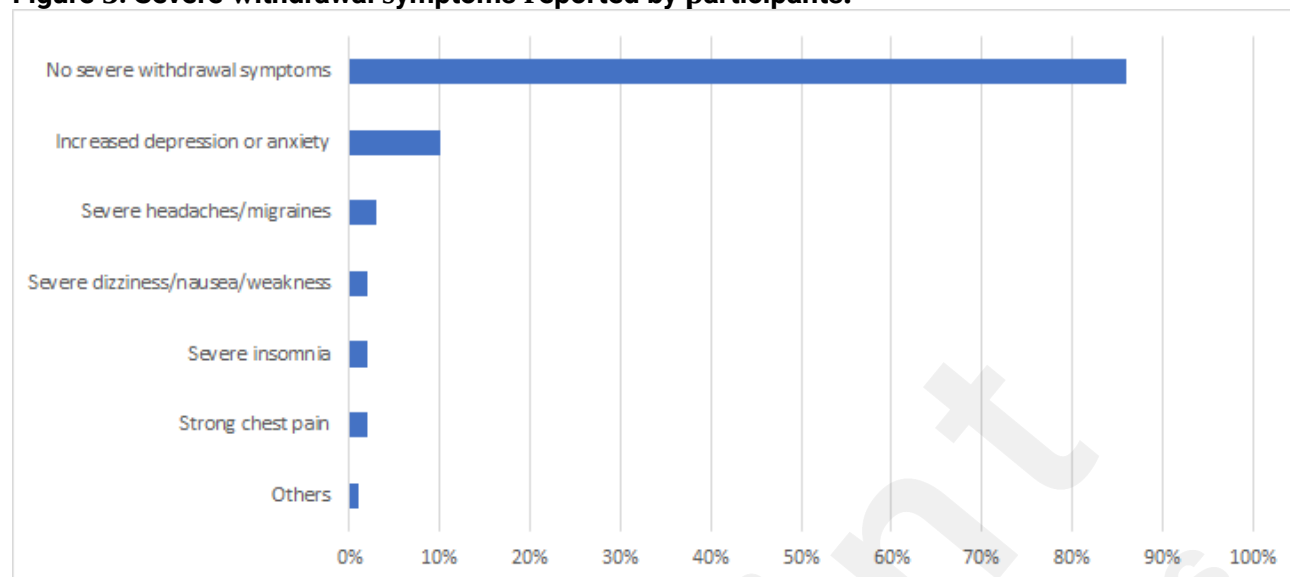


Figure 3: Severe withdrawal symptoms reported by participants.

Factors contributing to success

To assess whether quitting smoking via QuitSure is independent of demographic variables, two chi-square tests of independence were conducted as shown in Table 3. The $X^2_{(2,1)}$ value for the impact of gender and age on the efficacy of the program was found to be 3.8135 ($P=.09$) and 5.9438 ($P=.20$) respectively. This indicates that smoking cessation via QuitSure was *not* dependent on the gender or age of the participants. Smoking behavior prior to starting the program, however, did affect the program's efficacy. The $X^2_{(2,1)}$ value was found to be 20.3253 ($P<.001$), indicating a significant impact of smoking behavior on the quit rate. The 30-day prolonged abstinence of heavy smokers was significantly lower than that of those who smoked <20 cigarettes a day (relative risk = 0.91). Country of residence also had a significant impact on program effectiveness with a $X^2_{(4,1)}$ value of 9.8152 ($P=.04$) when comparing the 5 countries with the most participants. Residents of Australia had the highest 30-day p.a. rates (relative risk compared to all other participants = 1.08) while residents of the United Kingdom had the lowest (relative risk for 30-day p.a. compared to all other participants = 0.87).

Table 3: Factors affecting smoking cessation rates:

	<i>Chi-Square Value</i>	<i>P-value</i>
<i>Gender</i>	3.8135	.09
<i>Age Groups</i>	5.9438	.20
<i>Smoking Behavior</i>	20.3253	<.001
<i>Country of Residence</i>	9.8512	.04

Factors contributing to failure and relapse

Figure 4 shows the reasons given for failure amongst participants for whom the program did not work at all (n=112), with fear of quitting (13.4%; 15/112) and lack of belief (10.7%; 12/112) being the most common reasons given. Figure 5 shows the major reasons for relapse amongst participants who quit successfully at first but then relapsed at some point before filling out the survey (n=297). The most likely reasons for relapse were cravings for cigarettes (35.0%; 104/297) and alcohol consumption (31.0%; 92/297).

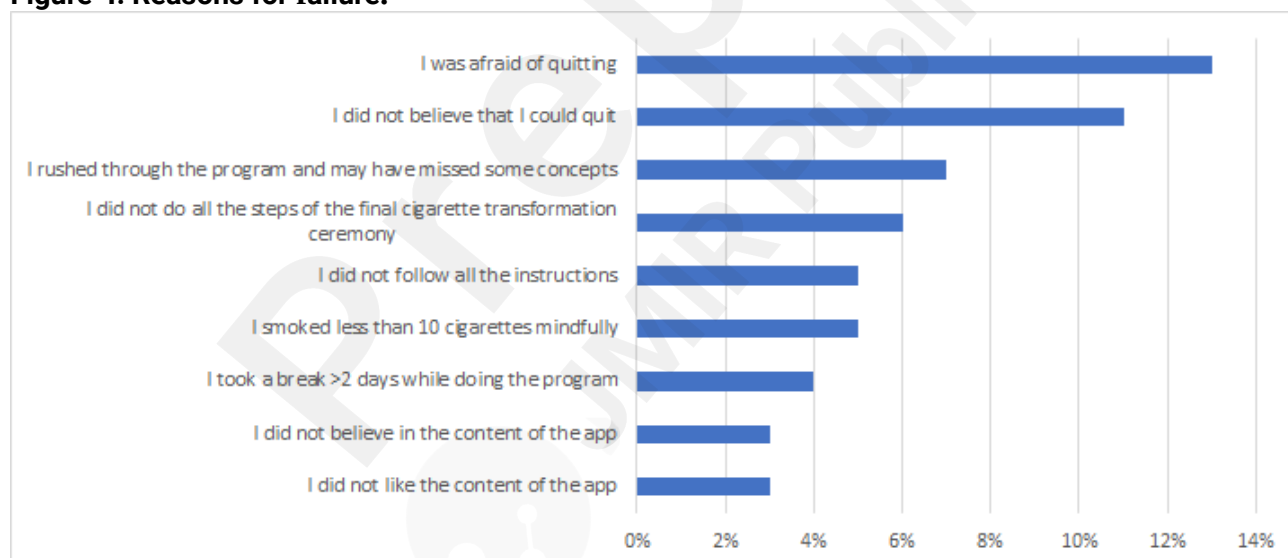
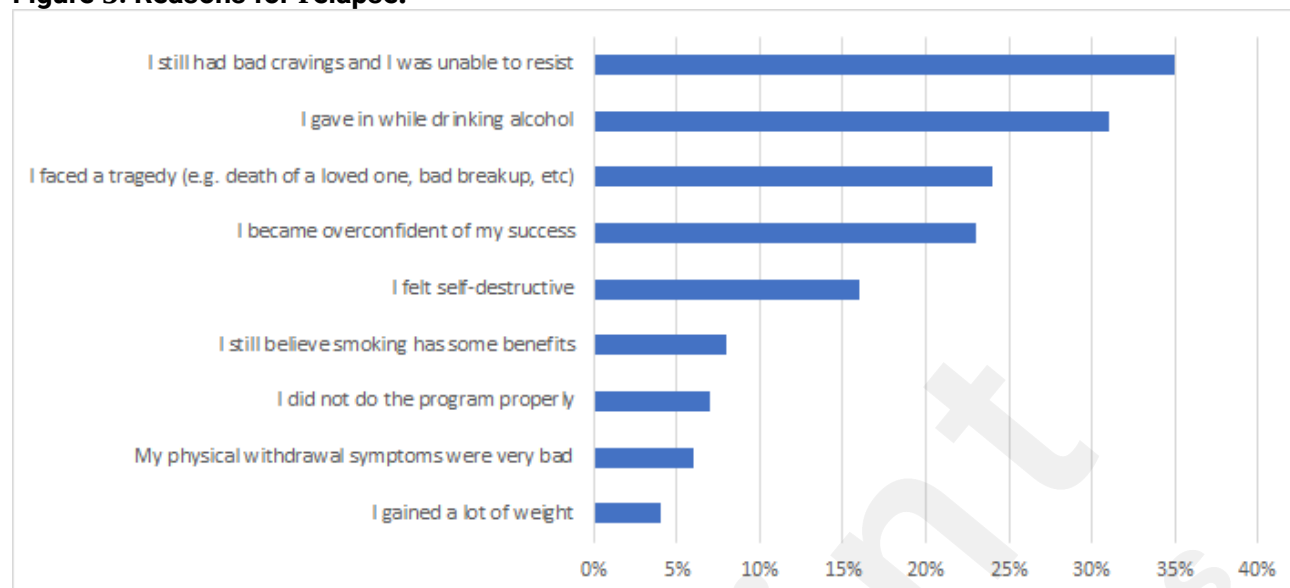
Figure 4: Reasons for failure.

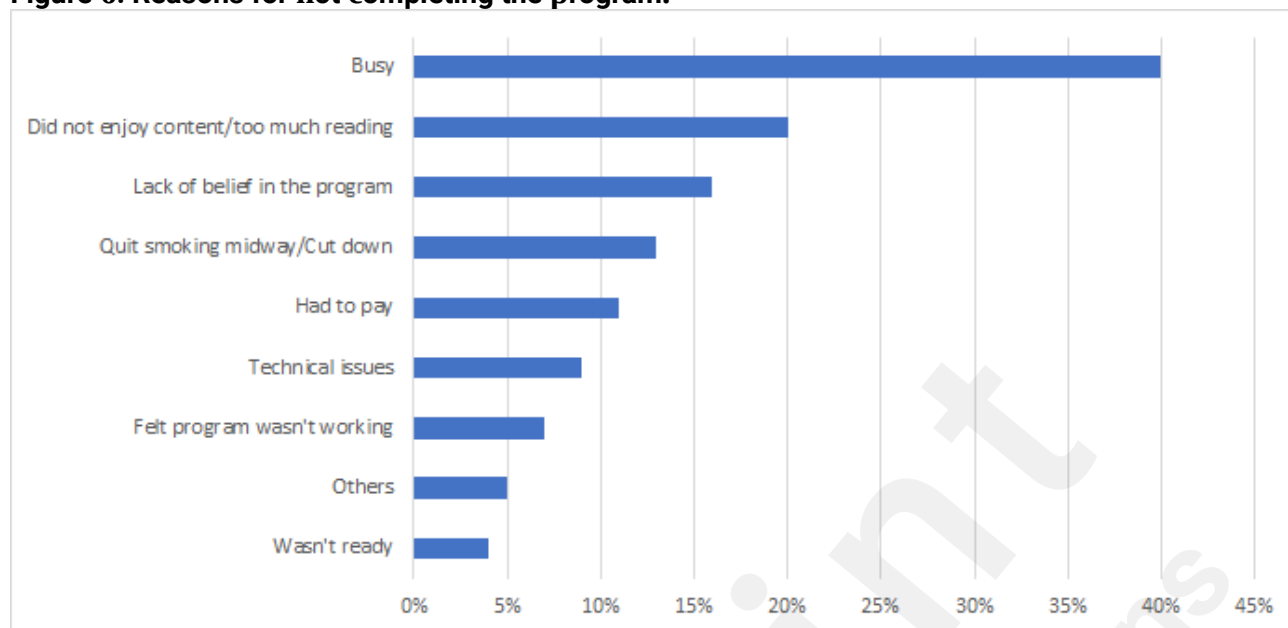
Figure 5: Reasons for relapse.

Amongst those who relapsed or were unable to quit after completing the program, 80.7% (331/410) had a moderate-to-high motivation to quit at the time of submitting the survey. 91% (377/410) said that they would consider using QuitSure for their next quitting attempt while 46.1% (189/410) said that they will definitely use QuitSure to quit in the future.

Survey for Non-Completers of the Program

19,873 users had dropped off after starting the program and were sent the S-incompleters survey, of which only 126 (0.6% of the total) consented to participate in the study and submitted the survey.

Figure 6 shows the reasons submitted for not completing the program. The most common reasons given for dropping off midway were a busy schedule (40.5%; 51/126), not enjoying the content of the program or having too much to read (19.8%; 25/126), and lack of belief that the program will work (15.9%; 20/126)

Figure 6: Reasons for not completing the program.

Discussion

Principal Findings

The purpose of the study was to understand whether the QuitSure program is an effective intervention for smoking cessation, and can be implemented at scale to counteract the health and economic consequences of the tobacco epidemic. It was conducted via 2 web-based surveys. 1,299 participants submitted the S-completers survey for program completers. 80.9% maintained prolonged abstinence (p.a.) for 30 days post program completion, and 72.4% maintained 6-month p.a. after program completion. 86.4% participants reported no severe withdrawal symptoms, while 41.9% reported no withdrawal symptoms at all. Only 18.5% experienced > 5 kg weight gain post completing the program. Demographic variables such as gender and age did not significantly impact the program's success, but smoking quantity prior to doing the program and country of residence did have a significant impact on program efficacy. For those who relapsed, cravings and alcohol consumption were major factors, while program non-completion was attributed to busy schedules or lack of belief in the program by the participants.

The program was able to achieve extended cessation for every category of smoker, from light to heavy with high efficacy rates, and low withdrawal symptoms post quitting. It is easy to navigate, and uses simple language. The low price makes it affordable for smokers across most socio-economic strata and the easy to understand content makes it usable by anyone with a basic understanding of English. The fact that most participants who relapsed, or for whom the program did not work, continue believing in the program's potential is also a point in its favor. The difference in cessation rates in different countries indicates that the program requires some adaptations to be contextually and culturally relevant to the residents of certain countries.

When it comes to the feasibility of the program to be distributed to the population at large, the dropout rates of the program, at 59.4% did not show improved program adherence and engagement compared to other healthcare apps [48]. While the very short 6-day length of the program likely increases completion rates, it requires ~1 hour of daily use. This high engagement requirement could be the reason why 40.5% of participants who dropped off the program midway state being busy as the reason for non-completion. The other major reason for dropping off the program was the length and style of the content. QuitSure could break down the program into a 30-day version with just 10-15 minutes of content per day for people who are busy or for whom the content seems too much. They could also add more graphics, videos, and design elements in the content to make it more appealing to users than plain, simple, text. Lack of belief in the program's techniques was also shared as a reason for dropout. The makers of the

app can thus focus on informing the users about the scientific underpinnings of the techniques used in the program as well as include relevant references for their claims throughout the program.

The app is attempting to standardize and replicate an in-person de-addiction counseling program into a do-it-yourself app and uses many of these same psychological tools to achieve success for its users as in-person counseling [35, 49, 50]. The efficacy for those who completed the program and participated in the study seems high, indicating some degree of success. However the do-it-yourself nature and length of the program require significant self-motivation and high intent-to-quit to start and then complete the program. We do not have data on how many people dropped off even before starting because of the quantity of self-driven work required. A pre-post study analyzing drop-out rates at every stage in the user journey will be required to evaluate the true feasibility of the app.

Limitations

The study had several limitations. A selection bias was created because the base sample selected was solely those who had already signed up for and completed the program, creating a closed cohort, and a higher than normal intent to quit. Another limitation was the low response rate. Only 24.8% of those who opened the email chose to submit the survey, allowing for a significant bias towards those for whom the program was successful. If we consider the program to have failed for all those who opened the email but did not submit the survey, the quit-rate of QuitSure at the 30-day post-program time-point becomes just 19.4%. A recall bias may have resulted in false memories of withdrawal symptoms during the initial post program phase. The single measurement taken eliminates long-term cessation data of participants who only recently completed the program. Lastly, the reward for filling out the survey may have motivated participants to give a false positive response, based on an assumption that it would increase their likelihood of receiving the reward.

Ultimately, the obtained sample is not representative of the smoker population at large. To be able to understand the true feasibility and efficacy of the QuitSure program, and counteract the above limitations, we would need to conduct a randomized controlled trial where the self-reported cessation of participants is confirmed via biochemical verification.

Comparison with Prior Work

Studies have shown that 46.3% of smokers who quit experience significant withdrawal symptoms ranging from anxiety, depression, irritability, and other physical symptoms [38, 39]. The biggest strength of the QuitSure program is that only 21.2% of the study participants faced severe withdrawal symptoms. Of the remaining participants, only around half faced even the milder withdrawal symptoms like coughing, and mild sleep disturbance, which are usually seen amongst all smokers upon quitting [36]. This could be a reflection of the program's focus on the psychological aspect of nicotine addiction via mindfulness, cognitive behavioral therapy, and reframing mental sets and beliefs, which have previously shown to reduce withdrawal symptoms post-quit [37, 51]. Withdrawal symptoms are known to be a key contributor to relapse [38, 39]. Therefore, it is likely that the increased effectiveness of the program, and higher prolonged cessation rates are a result of these reduced withdrawal symptoms. However, QuitSure does not include any sort of nicotine replacement therapy (NRT) in its protocol. NRT is recommended by the WHO, US CDC, as well as NICE, UK [22, 43, 44] as an important complement to counseling and has been shown to significantly increase the success rates in psychology based smoking cessation programs [49, 53, 54]. The hypothesis given is that NRT reduces withdrawal symptoms and cravings levels. QuitSure could include a phased out nicotine replacement regimen post-program to further increase its efficacy. This is especially important for Heavy smokers, for whom the program was less effective.

The primary reason for relapse was due to still experiencing strong cravings for smoking. In fact, 75% of participants who experienced greater than moderate levels of cravings after completing the program, eventually relapsed. Currently, the QuitSure program does not address cravings management in any specific way post program completion, relying on the program itself, to prevent the appearance of cravings at all. To address them, and prevent their relapse, QuitSure can monitor craving levels post-program, with additional content and counseling for those who are struggling.

The second reason for relapse was alongside alcohol consumption. The app already recommends users not to drink any alcohol for the first week after quitting. It can extend this further and also give more guidelines on how to handle cravings when drinking alcohol.

Weight gain after quitting is another big concern amongst smokers, as there is evidence that nicotine reduces appetite, increases metabolism, and reduces food cravings [40, 41]. Previous studies have shown that post-quitting smoking 35.4% of quitters had a weight gain over 5% of their body weight. [42]. Of the study participants who were able to quit for even a brief period, 58.1% had some weight gain. The QuitSure program should do more to specifically address the maladaptive thought patterns and beliefs connecting food, hunger, and smoking.

Previous studies have found that the higher an individual's app engagement is, the more they are likely to be able to quit smoking [19]. Thus, the QuitSure app needs to improve its engagement rates to increase program completion rates. Some tools the app developers can use to increase engagement that have previously demonstrated success are (i) gamification techniques like leaderboards, progress bars, and levels [19, 45, 46]; (ii) small rewards to participants for every engagement milestone [45], (iii) personalizing notifications and reminders [46], as well as (iv) inclusion of a peer support group to improve program adherence and navigate post-quitting withdrawal symptoms and cravings [52].

Overall, within the limitations of the study, the program shows high smoking cessation rates, low rates of withdrawal symptoms and cravings, and a generally positive experience for its users.

Conclusion

80.9% of the survey respondents were able to achieve 30-day prolonged abstinence from smoking post program completion. The program also adheres to the WHO's 5As guideline for smoking cessation and includes psychological tools used in evidence-based in-person counseling protocols. However, there are many improvements in app engagement, program adherence, and post-program support that can be made by the app developers. The high success rates, including prolonged cessation rates, amongst study participants are an indicator that QuitSure could be a useful tool for achieving smoking cessation at scale. Despite the severe limitations and selection biases of the study, the results make the QuitSure program a strong contender for further investigation. Healthcare institutions should consider and study the programs feasibility and efficacy in a more controlled setting.

Acknowledgements

We thank the users of the QuitSure app, whose participation and feedback played a pivotal role in this study. Their willingness to engage with the program and share their experiences provided valuable insights and enriched the findings.

Conflicts of Interest

GMG has no conflicts of interest. KB is a co-founder and equity holder in QuitSure. SM is an employee of QuitSure.

Multimedia Appendix 1: S-Completers survey questions

Multimedia Appendix 2: S-Incompleters survey questions

Multimedia Appendix 3: Participant funnel for the S-Completers survey

Multimedia Appendix 4: Global distribution of participants

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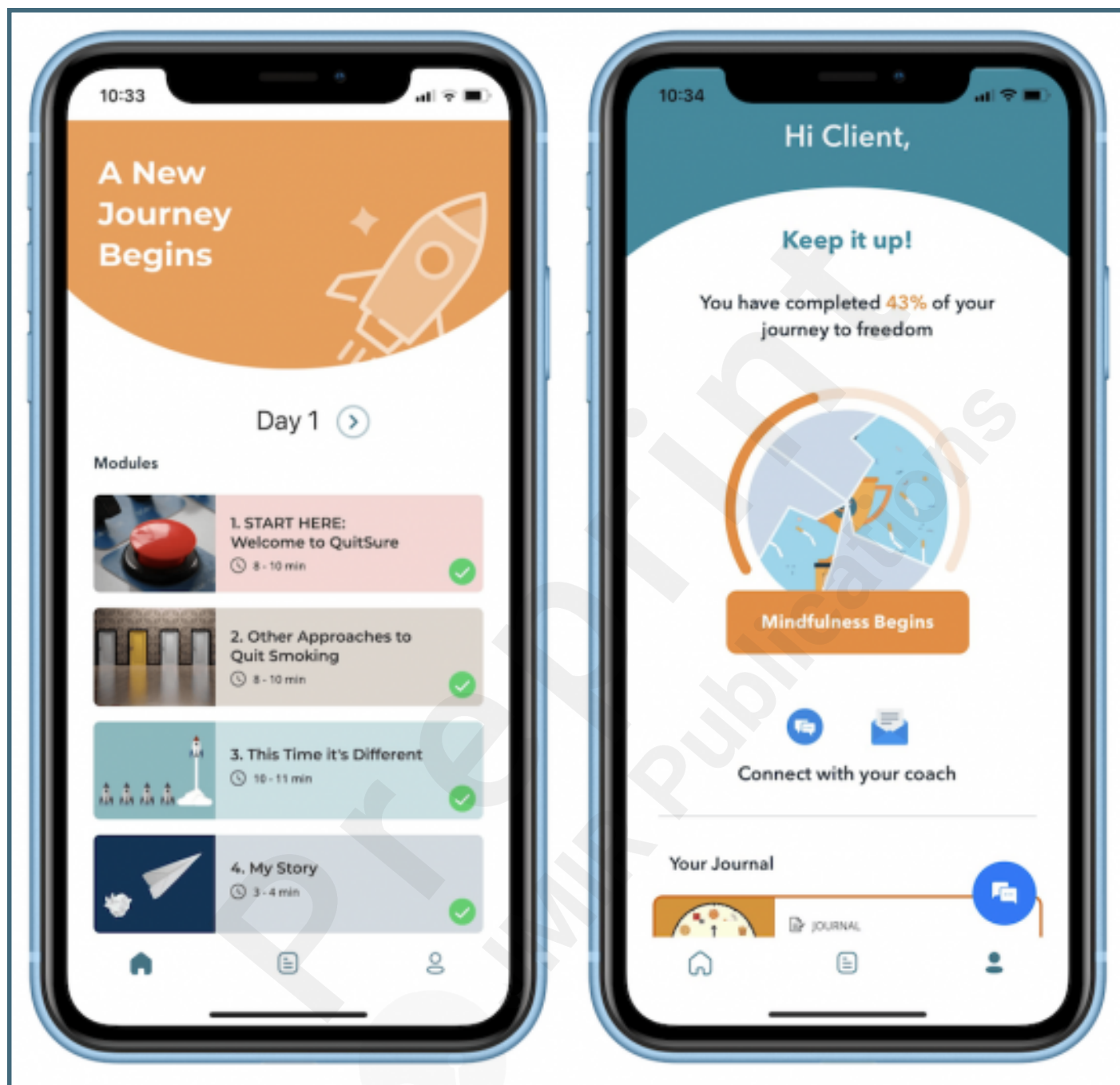
Supplementary Files

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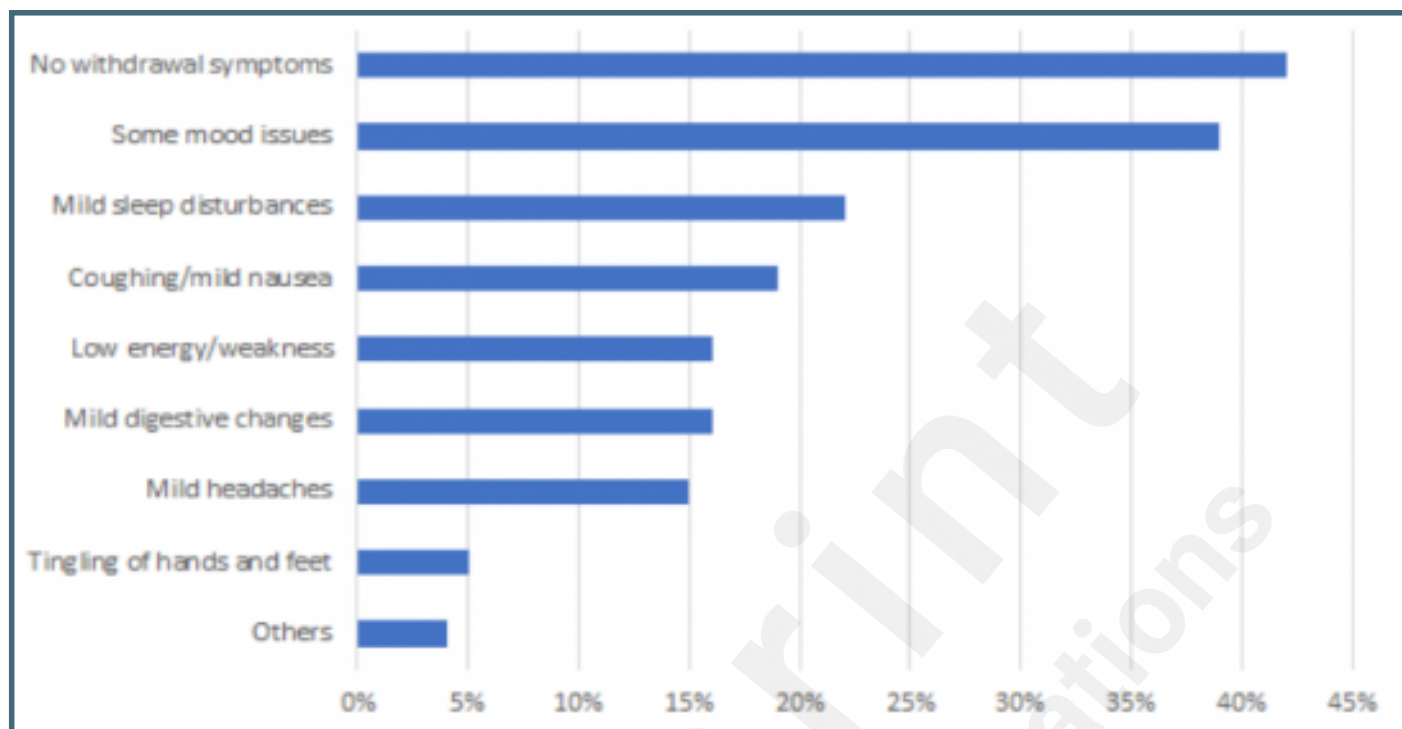
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Figures

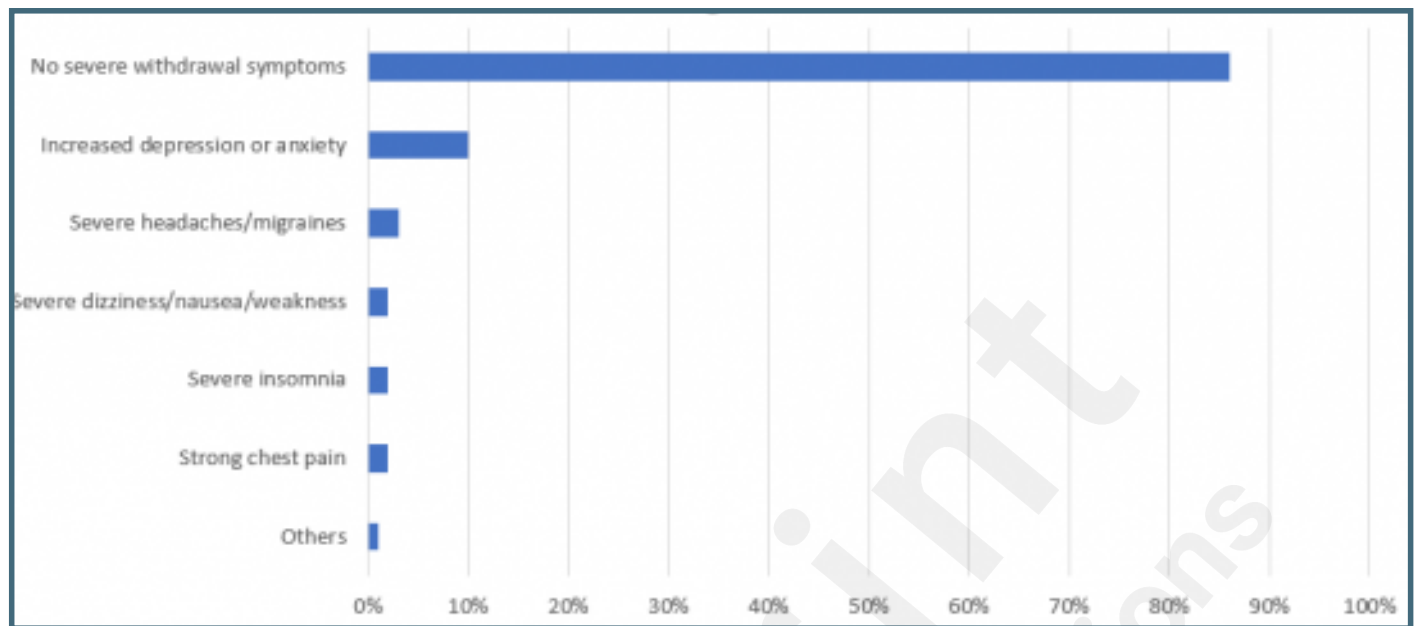
Screenshots of the home page (left) and profile page (right) of the QuitSure App.



Mild withdrawal symptoms reported by participants.



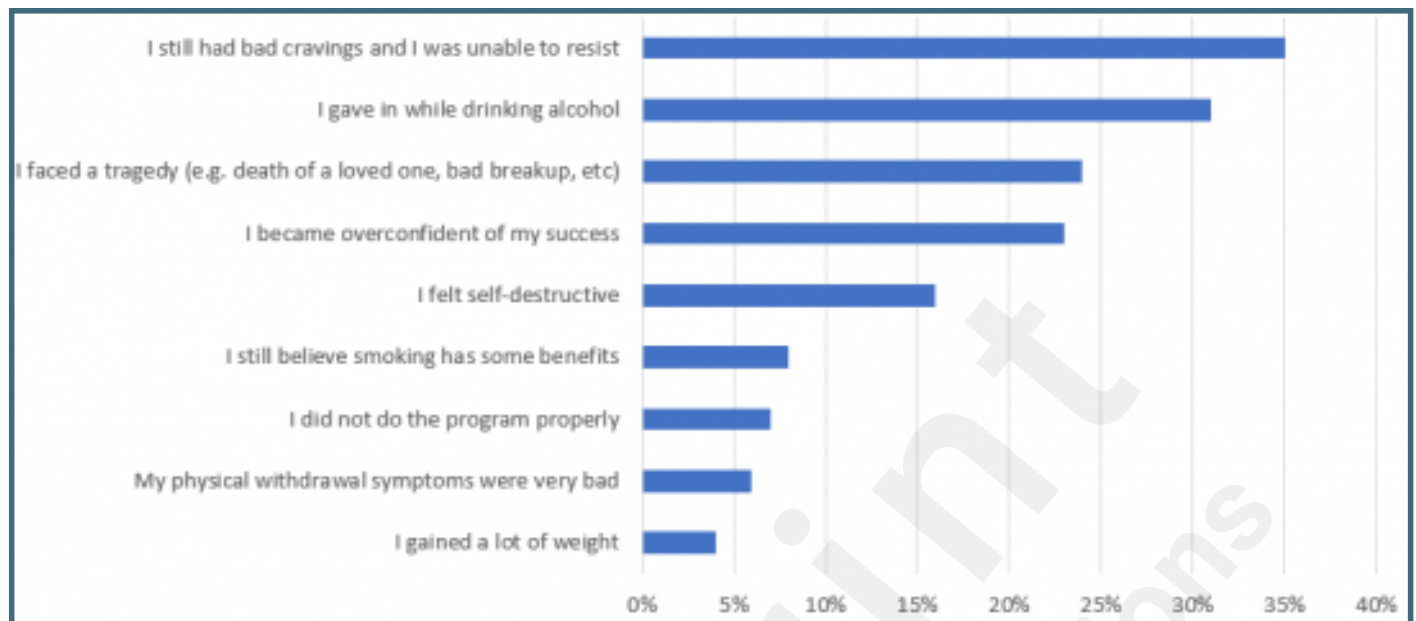
Severe withdrawal symptoms reported by participants.



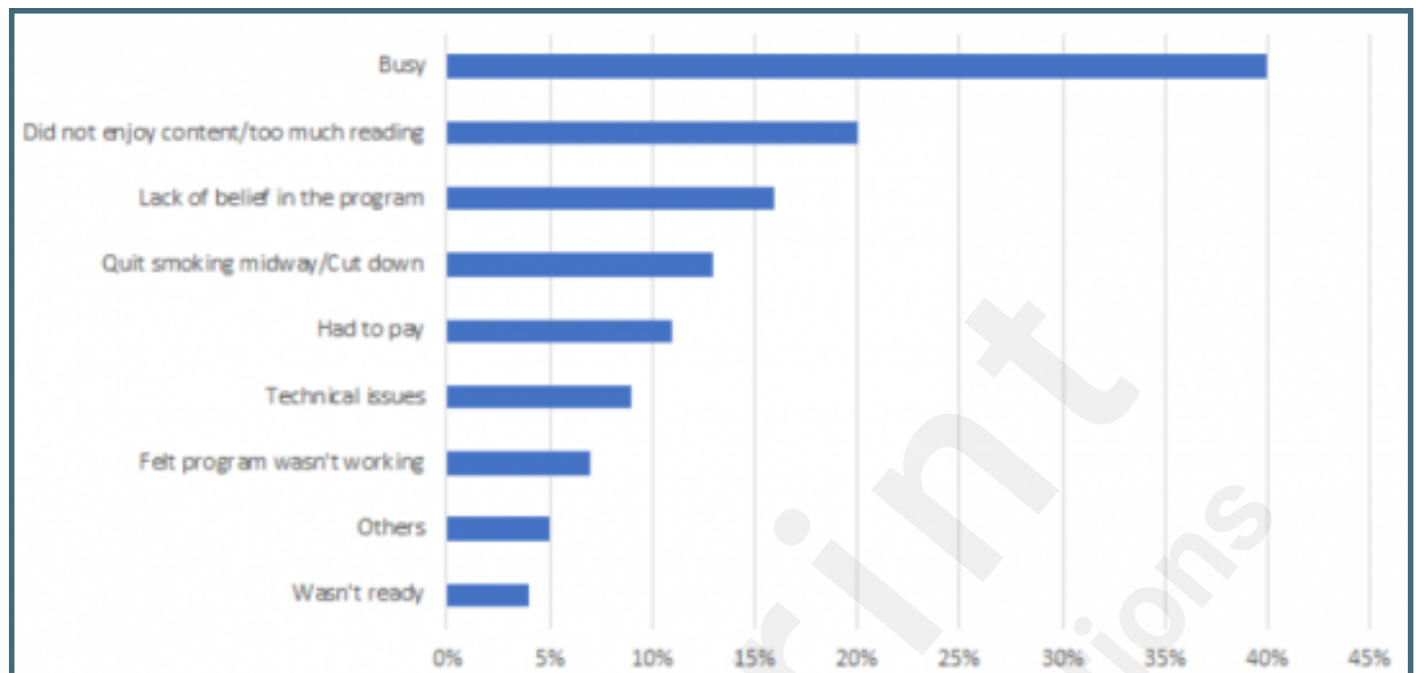
Reasons for failure.



Reasons for relapse.



Reasons for not completing the program.



Multimedia Appendixes

S-Completers Survey Questions.

URL: <http://asset.jmir.pub/assets/36288572b9dbe54e142e995fd9253709.pdf>

S-Incompleters Survey Questions.

URL: <http://asset.jmir.pub/assets/91a8a1c0b85e92800764ddca7c0b000f.pdf>

Participant funnel for the S-Completers survey.

URL: <http://asset.jmir.pub/assets/dd24fac3a5ca9feac80513a33df7eb2b.pdf>

Global distribution of participants.

URL: <http://asset.jmir.pub/assets/c373b8180e19ba40ebae48237ebfe2dc.pdf>



TOC/Feature image for homepages

Screenshots of the home page (left) and profile page (right) of the QuitSure App.

