Apps for smoking cessation through Cognitive Behavioural Therapy. A review

Apps para dejar de fumar mediante Terapia Cognitivo Conductual. Una revisión sistemática

Patricia García-Pazo*,**, Joana Fornés-Vives*,**, Albert Sesé**,***, Francisco Javier Pérez-Pareja***.

* Departamento de Enfermería y Fisioterapia. Universitat de les Illes Balears, Palma. Spain.
** Institut d'Investigació Sanitària Illes Balears (IdISBa), Palma. Spain.
*** Departamento de Psicología. Universitat de les Illes Balears, Palma. Spain.

Abstract

Smoking is a health and economic problem that is difficult to eradicate. Nicotine addicts also often suffer from psychological problems such as depression and anxiety. The recommended treatment according to clinical practice guidelines (CPG) is Cognitive Behavioural therapy (CBT), alone or combined with medication. Currently, health-related apps (m Health) enable wider availability and access to this treatment. The objectives of this study are to carry out a review of the smoking cessation apps that apply CBT and to describe the techniques used by them. Following the PRISMA framework, the databases EBSCOhost, Cochrane, Web of Science and Scopus were searched for publications between 2010-2019. Four hundred fifteen studies were found and, after applying the inclusion and exclusion criteria, only five articles were eligible for systematic review. Only three apps were identified as using CBT, and the techniques most commonly used were the recording of smoking history, progress visualised through graphics, psycho-educational videos, motivation, social support through social media, and elements of gamification to reinforce adherence and abstinence behaviour. The results recommend the inclusion of smoking behaviour analysis in these types of apps, as not all of them do so, as well as an interface between the health professionals and the users to provide a personalised treatment.

Key Words: Smoking cessation; Cognitive Behavioural Therapy; mobile applications.

Resumen

El tabaquismo constituye un problema sanitario y económico de difícil erradicación. Las personas más dependientes a la nicotina suelen presentar, además, problemas psicopatológicos como depresión y ansiedad. Según las Guías de Práctica Clínica (GPC), el tratamiento recomendado para abandonar el hábito es la Terapia Cognitivo Conductual (TCC), sola o combinada con medicación. Actualmente, las aplicaciones móviles (*App*) en salud (*mHealth*) permiten un acceso masivo y económico a este tratamiento. El objetivo de este trabajo consiste en llevar a cabo una revisión bibliográfica de las *Apps* para dejar de fumar que apliquen TCC y describir las técnicas implementadas. En el marco del protocolo PRISMA, la búsqueda se ciñó al periodo 2010-19 y se realizó en las bases de datos: EBSCOhost, Cochrane, Web of Science y Scopus. Se hallaron un total de 415 trabajos, de los cuales, tras aplicar los criterios de inclusión/exclusión, solo 5 artículos fueron objeto de revisión. Únicamente se identificaron 3 *Apps* (en inglés) que incluyeran TCC y, las técnicas más utilizadas fueron: el registro de cigarrillos, la visualización del progreso mediante gráficas, videos psicoeducativos, la motivación, el apoyo social mediante redes sociales y elementos de gamificación para reforzar la adherencia y la conducta de abstinencia. Los resultados sugieren incluir en este tipo de *Apps* el análisis de la conducta de fumar, ya que no todas lo hacen, así como una interfaz que comunique el personal sanitario con el usuario y pueda proporcionar un tratamiento personalizado.

Palabas clave: Dejar de fumar; Terapia Cognitivo Conductual; aplicaciones móviles.

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Send correspondence to: Patricia García-Pazo. Edificio Guillem Cifre de Colonya, Despatx C204. Campus de la Univesitat de les Illes Balears. Ctra. de Valldemossa, km 7.5, 07122 Palma de Mallorca. Tel.: 971259943.
E-mail: patricia.garcia@uib.es

According to the World Health Organization (WHO), tobacco causes the death of half of its users. It is estimated that in 2030 there will be more than 7 million tobacco-related deaths per year (OMS, 2019). In Spain, the percentage of daily smokers over the age of 15 is over 22% of the population (ENSE, 2017). The adolescent population aged aged between 17 and 18 has seen an increase in smoking (Leal-López, Sánchez-Queija & Moreno, 2019). Moreover, tobacco is one of the few drugs that harms not only smokers but also the people around them.

In economic terms, smoking imposes a heavy financial burden worldwide, especially in Europe and North America, where the tobacco epidemic is more advanced. In the United Kingdom, the British national health system (NHS) estimated annual health costs generated by smoking at £2.6 billion (UK Government, 2015). Globally, the cost of smoking-related health problems in 2012 rose by 5.7%, excluding indirect costs due to lost productivity (Goodchild, Nargis & Tursan d'Espaignet, 2018). Nor does this figure include the cost of passive smoking, responsible for about 600,000 deaths per year (Öberg, Jaakkola, Woodward, Peruga & Prüss-Ustün, 2011).

In addition to being a serious health and economic problem, smoking is a difficult addiction to eradicate given dependence it generates at physiological, psychological and social levels. Withdrawal also has several consequences: craving symptoms despite the desire and attempts not to smoke, psychoactive effects of the substance on the brain and behavioural impairment due to nicotine reinforcement (Camarelles et al., 2009). Regarding the above effects, it should be noted that people with greater nicotine dependence frequently present psychopathological problems (anxiety, depression, stress, etc.), a fact that makes detoxification treatments more complex (Becoña et al., 2014). In the case of depression, a linear relationship has been found between the severity of use and the severity of depression symptoms (Jiménez-Treviño et al., 2019).

Treatments included in the Clinical Practice Guidelines (CPG) for smoking cessation include the pharmacological (Nicotine Substitute Therapy, Bupropion or Varenicline), the behavioural (Cognitive Behavioural Therapy, CBT) or a combination of both in more complex cases (Fiore et al., 2008; NICE, 2018).

The CBT described in these programs focuses primarily on the analysis of smoking behaviour in order to develop alternative behaviours to help the smoker deal more effectively with risk situations related to the habit; this has proven effective in maintaining abstinence (Deiches, Baker, Lanza & Piper, 2013). CBT programs are described as multicomponent therapies since they incorporate different techniques, such as psychoeducation, cognitive restructuring, problem solving, relaxation and social support, among others, around a cessation strategy (Alonso-Pérez et al., 2014; Becoña, Míguez, Fernandez del Río & López, 2010; Raich et al., 2015). The need to attend to a large population and the expense generated by this health problem mean that treatments which have proven effective have to be provided not only face-to-face but also in a different format, for example, through the use of information and communication technologies (ICT). ICTs and specifically mobile phone health applications, mHealth, can offer low-cost alternatives. In addition, such apps offer their users a series of benefits missing in other formats, such as accessibility to treatments, immediate and real-time attention to smoking behaviour and withdrawal symptoms, flexibility with regard to time, progress monitoring, personalized feedback, motivational support and complementarity regarding improved communication with health professionals (Kazdin, 2015; Kreps & Neuhauser, 2010; Do et al., 2018; Whittaker, McRobbie, Bullen, Rodgers & Gu, 2016. These advantages are reflected in the growth of these applications on the market (Haskins, Lesperance, Gibbons & Boudreaux, 2017) and the number of monthly downloads to quit smoking (Hartmann-Boyce, Stead, Cahill & Lancaster, 2013). However, there are also some drawbacks to consider: technical problems (app software issues), data security, patient privacy, handling of the device by the healthcare professional, or user distrust of this type of method (Luxton, Mccann, Bush, Mishkind & Reger, 2011).

Despite the large number of apps and downloads, the scientific community reports that it is necessary to study the effectiveness of the treatments they offer because the vast majority of mHealth apps do not follow the guidelines set by the CPG (Abroms, Lee Westmaas, Bontemps-Jones, Ramani & Mellerson, 2013; Gulati & Hinds, 2018; Haskins et al., 2017; Thomas, Abramson, Bonevski & George, 2017)the most popular apps were identified (n=47 for the iPhone and n=51 for the Android), nor do they incorporate therapies of proven efficacy, such as CBT (Heather, Haffe, Peele & Rho, 2016; Nijhof, Bleijenberg, Uiterwaal, Kimpen & Putte, 2012).

Given the above, we ask whether there are mobile applications for quitting smoking which include CBT as a treatment. To answer this question, our aims are the following: 1) Identify mobile phone smoking cessation applications which include CBT, and 2) Describe the CBT techniques used by these applications.

Method

A literature review was performed using the keywords: *Smoking Cessation, mHealth, mobile application, Smartphone, Cognitive Behavioural Therapy*, which were combined with the classic Boolean operators (OR, AND) and phrase search using (") and truncation (*). Articles were selected which contained the descriptors in key terms in the title,

abstract and keyword fields in the period between 2010 and August 2019. The databases consulted were: EBscohost (PsycINFO, CINAHL, Psycarticles, Psychology and Behavioural Sciences Collection), Cochrane (PubMed, EMBASE), Web Of Science (Medline, Scielo) and Scopus. The entire review process followed the PRISMA protocol recommendations (Liberati, Altman, Tetzlaff & Al, 2009).

The inclusion criteria were: 1) appearance of any of the search terms in the title, abstract or keyword, 2) study participants aged over 18 and 3) publications in English or Spanish. Studies carried out on samples with mental pathology or pregnant women, and studies dealing with simultaneous addictions (e.g., alcohol and tobacco, marijuana and tobacco...) were excluded.

The Mendeley reference manager was used to eliminate duplicates. The title and abstract were read to verify that they met the inclusion criteria, and those that did not were discarded. The full texts of those selected were subsequently obtained to be evaluated in their entirety.

Results

A total of 415 studies were found in the search: 16 in Scopus, 5 in EBSCOhost, 316 in Cochrane Library and 78 Web of Science. Figure 1 shows the article selection flowchart. After eliminating those that did not meet the inclusion criteria, a total of 6 studies remained, which were subjected to exhaustive analysis. A further study was finally eliminated because it did not describe a specific app but only a CBT technique.

One of the main observations in this review is the existence of a large number of mobile applications aiming to help smokers to quit, with at least 400 available apps identified for both Android and iPhone operating systems (Regmi, Kassim, Ahmad & Tuah, 2017). However, examples of mHealth found to incorporate CBT are scarce. Moreover, it is important to note that, despite the large number of applications available (Apps Store and Play Store) to treat smoking, none have been proven effective in studies, nor are they supported by health workers (Haskins et al., 2017).

Three smoking cessation apps incorporating CBT are mentioned in the five articles selected: *SmartQuit* (Heffner, Vilardaga, Mercer, Kientz & Bricker, 2015), *Smoke Mind* (Alsharif & Philip, 2015a, 2015b) and *Quit Genius* (Lin et al., 2018; Tudor-Sfetea et al., 2018) are extracted. Following an exhaustive analysis of the studies selected, useful information in line with our research aims was extracted from each (Table 1).

The first study presents the *SmartQuit* app (Heffner et al., 2015), designed in Seattle by one of the co-authors Dr.

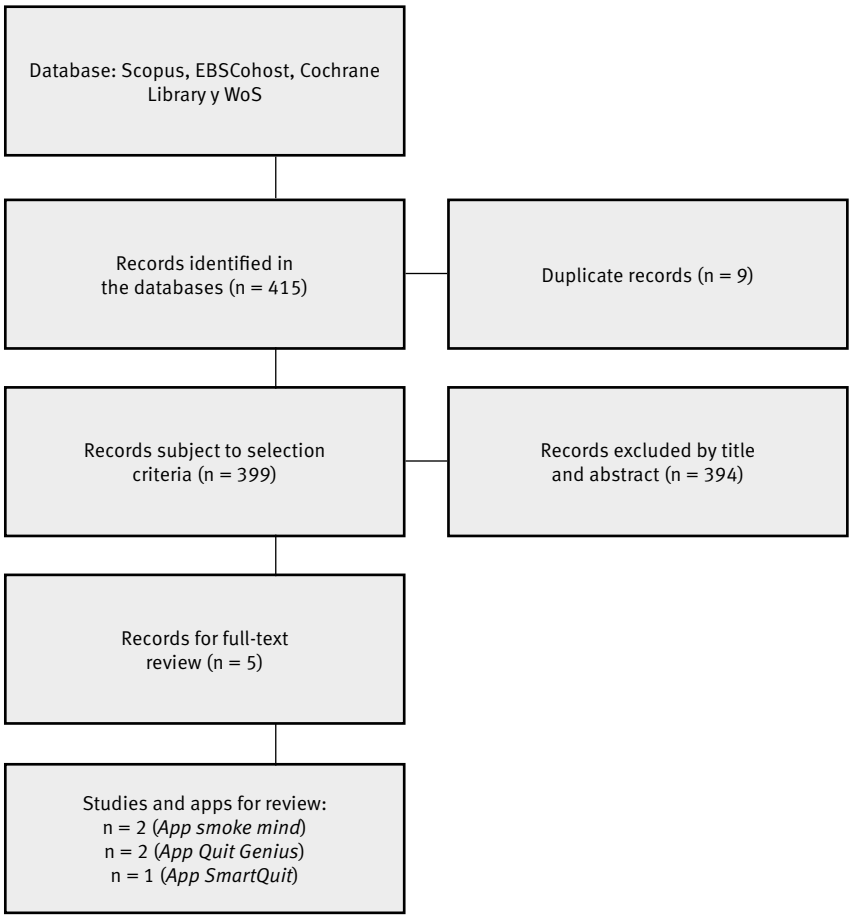

Figure 1. Flowchart of the study selection.

Bricker (Fred Hutchinson Cancer Research Center). It is limited to English-speaking users with Apple-type devices and involves an 8-week treatment based on Acceptance and Commitment Therapy (ACT), combined with CBT techniques. Sixty days after using the app, of a total of 41 available functions the ten most used were assessed. Results indicate that eight were CBT (see Table 1), with a statistically significant relationship found between the function "viewing the quit plan" and smoking cessation. This function prompts activities such as: set quit date, give reasons why you want to quit smoking (supported by images), agree on the behavioural strategy to reduce smoking and indicate whether medication will be used for support. Users can also check their smoking habits, monthly costs and select people in their circle who will support them during the process of quitting.

The two studies focussing on the *Smoke Mind* app were published in 2015 by the same authors, Alsharif and Philip. The first study presents a proposal to design an application on a treatment model which combines CBT with *mHealth* (Alsharif & Philip, 2015a). The app has 3 modules: smoking cessation management module, interactive module (with an interface for professionals to intervene in the treatment) and CBT module. The CBT functions focus on identifying risk situations (situations in which the user smoked and in which he or she must now abstain) and working on them to modify behaviour. To this end, they incorporate techniques such as: cognitive restructuring, problem solving, training in coping skills and relaxation among others (see Table 1). These techniques are explained in educational videos, tutorials and/or messages. In addition, *Smoke Mind* has a daily record of the user's carbon monoxide (CO), measured using a cooximeter provided for the patients. After taking the measurement, they record it manually on the app, which sends the information to the centre. If CO increases, the CBT therapist asks the user for a behaviour analysis (I think, feel and act) and offers immediate feedback.

Table 1. *Results of the articles analysed.*

Author (Year)	Objetives	Design/Sample/ Measures	App name/ Characteristics	CBT components	Results
Heffner, et al. (2015)	(1) Specify the 10 most used functions of the app to quit smoking. (2) Determine which are the predictors of tobacco cessation.	Descriptive analysis (post hoc). N =76 Sex =54%(M) Age (m/sd) = (41.8/11.9) Online questionnaire about online app aspects.	*App*: *Smart Quit* Characteristics: Combines ACT and CBT.	- Self-report of behaviour with feedback (follow-ups and progress). - Goal setting (quit plan). - Positive reinforcement (gamification elements). - Social support (sharing progress).	(1) Only 8 of the 10 functions are CBT; see quit plan, smoking behaviour follow-up, see progress calendar, see sharing page, see progress table, see places follow-ups, see badges earned and notepad. (2) Best predictor of smoking cessation, see quit plan ($p = 0.03$). OR = 11.1, 95% CI = 1.3-94.2. Predictor of failure, see follow-up $p<0.04$, OR = 0.11, 95% CI (0.1-0.9).
Alsharif & Philip (2015)	Propose a model that includes CBT and mobile smoking cessation technology.	Describing contents with regard to the objectives set.	App: *Smoke Mind* Characteristics: Web portal for healthcare professionals. Remote monitoring Communication channel with CBT therapist.	Direct and personal feedback from health professionals. - Behaviour graphics. - Emotional support. - Behaviour analysis (thinking, feeling, acting). - Psychoeducation (videos). - Train skills. - Relaxation. - Problem solving. - Motivational messages. - Social support.	The proposed model consists of: - mHealth platform. - Support system based on data mining techniques to provide optimal information management.
Alsharif & Philip (2015)	Discover opinions regarding the preferences of smokers and health professionals in the use of the smoking cessation app and its functions.	Descriptive study. N = 52 Sex = 71%(M) Women = 29% Age = 18-54 Questionnaire based on concepts of use of the app and semi-structured interview.	App: *Smoke Mind* (same characteristics as previous study)	(same characteristics as previous study)	User Preferences: - Progress graphics (90%). - Alerts, notifications (57.6%). - Informative videos, educational material, feedback from doctors and ex-smokers (88.4%). - Telephone helpline (77%). - Continue using the app after treatment (73%). Preferences of the professionals: - Interaction with hospital. - Ability to update follow-ups. - Ability to attend to individual problems.

The second study involving the *Smoke Mind* application (Alsharif & Philip, 2015b) aims to assess the opinions of users and health professionals regarding the app as a method of quitting smoking, as well as its functions. For this purpose, a sample of 52 users was interviewed, mostly university and health personnel (3 doctors and 5 social workers). The results indicate that 100% of users value getting the smoking cessation treatment through the app positively, highlighting some preferences (see Table 1). In addition, the healthcare staff see the ability to intervene in the treatment and interact with the patient to address the problems individually as an important benefit.

Table 1 (cont.). *Results of the articles analysed.*

Author (Year)	Objetives	Design/Sample/ Measures	App name/ Characteristics	CBT components	Results
Tudor-Sfetea et al. (2018)	(1) Identify opinions regarding two apps as a method to quit smoking and their functions: (*Smokefree* (no CBT) and *Quit Genius* (with CBT)). (2) Identify the opinions of the users of the apps regarding the results.	Short-term qualitative longitudinal study. Semi-structured interview. N = 15 university students. Sex = 13(M). Age(m) = 25.07	App: *Quit Genius* (TCC) Treatment duration = 8 weeks (4 stages and 39 steps). Assessment aspects, after 1 week of use: - App functions. General functions - App design. - Interactivity. - Information contents (information style, commitment, quality). - App usability. - Effects of the app. - Improvements of the app.	- Log behaviour (cigarette log). - Motivational messages. - Educational information (about consequences of smoking). - Psychoeducation (on CBT). - Personalized relationship. - Help identify triggers of smoking behaviour. - Imagined exposure (critical situations). - Relaxation. - Problem solving. - Gamification elements. - Social support (peer community).	(1) Report positively regarding the app as a method, as well as its functions and design. (2) Regarding their opinions of results: - Reduced the number of cigarettes per day (53%). - Increased motivation to quit smoking (53%). - Expressed their desire to continue using the app (67%). - Would recommend the app to others (73%).
Lin et al. (2018)	(1) Explore the progress function of the CBT program. (2) Examine the gamification elements of the app design, regarding the constructs empowerment, well-being and inspiration. (3) Explore the association of the constructs empowerment, well-being and inspiration with quitting smoking or reducing the number of cigarettes smoked. (4) Identify and describe the possible facilitators and barriers arising from the app's design elements.	Qualitative longitudinal study. N =190 Age(m) =36 Sex = 52.6%(F) Online interview Scales adapted to measure items: Hedonic wellbeing, empowerment, inspiration and anxiety.	*App*: *Quit Genius* (same characteristics as previous study)	(same characteristics as previous study)	(1) 69 quit smoking, 121 did not quit smoking (59.6% reduced the number of cigarettes). - Completing the treatment is predictive of: High empowerment ($p < 0.01$; beta = 0.27), inspiration ($p = 0.02$; beta = 0.18) and well-being ($p = 0.06$; beta = 0.14). - Finishing the program is not a predictor of smoking cesssation. (2) The gamification elements of the app increase empowerment and are predictors of smoking cesssation. (3) Predictors of smoking cessation probability with app: -Wellness ($p = 0.01$; beta = 0.54), -Empowerment ($p < 0.05$: beta = 0.47) and -Inspiration ($p = 0.05$; beta = -0.48). - The improvements in well-being increase the probability of smoking cessation by 1.72. - Predictors of reducing the number of cigarettes: - Empowerment ($p < 0.01$; beta = 0.18) - Inspiration ($p < 0.05$; beta = 0.11) Positive correlation between: - Empowerment - well-being 75% ($p < 0.01$), inspiration - empowerment 79% ($p < 0.01$), inspiration - Well-being 66% ($p < 0.01$). (4) Impact of design variables on psychological variables.

The last two articles reviewed analyze *Quit Genius* (Lin et al., 2018; Tudor-Sfetea et al., 2018), in which the CBT treatment is spread across 4 stages and divided into 39 steps. In addition, it features a personalized application involving self-reflection on smoking behaviour, recording the number of cigarettes smoked, psychoeducation (video and audio format), the development of coping strategies, interactive exercises (motivation, relaxation, fun and stress management) and troubleshooting techniques. It also has gamification elements to reinforce tobacco abstinence behaviour in an imagined journey with achievements, progress bars, monitoring, achievement badges and a calculator that shows financial savings by cutting down on smoking. The first study by Lin et al. (2018) sets out to explore in the app the role of CBT treatment and the elements of gamification on psychological components such as empowerment (intrinsic motivation), well-being and inspiration, among others. They also evaluate the effectiveness of these elements on smoking cessation or reduction of cigarettes. The data under study are collected through the application itself and an online interview with the user at the end of the treatment. Results indicate that performing the complete CBT treatment is a predictor of improvements in the constructs of well-being, inspiration and empowerment. A regression analysis shows well-being to be a predictor of smoking cessation, while the increase in inspiration is a predictor of remaining a smoker but with a 34% probability of reducing the number of cigarettes per day. Empowerment is also linked to a decrease in the number of cigarettes. The impact of the app's design elements on the increase in these variables is highlighted, and the elements of gamification are seen to increase the user's empowerment, predicting the ability to quit.

The study by Tudor-Sfetea et al. (2018) assessed users' opinions regarding the app, evaluating the application and the method to help quit smoking, as well as its functions and its possible influence on behavioural changes. Data were obtained through interviews with 15 university students, who offered a positive assessment both of functions and use of the app as a method to quit smoking. The results of this study show that the smoking behaviour diary is valued positively and understood as a technique which increases motivation for quitting and decreasing cigarette consumption. The elements of gamification were also assessed very positively.

All five studies describe the CBT techniques implemented by the apps, but only one of them details the development of the application and its operation (Alsharif & Philip, 2015a). Table 2 summarizes the basic techniques of CBT interventions and those described in the studies of the apps reviewed. The main CBT techniques implemented by the three applications are: cigarette log, visualization of progress through graphics, psychoeducation (through educational videos, tutorials and/or text), motivation (through videos, motivational messages), social support (through the use of social networks), the possibility of a combined treatment with medication, and adding gamification elements to reinforce abstinence behaviour and/or use of the app.

Discussion

The main objective of this study was to investigate the existence of possible mobile applications to quit smoking and describe their main functions, especially those involving techniques and/or procedures implicit in CBT. Three applications were found: *SmartQuit, Smoke Mind* and *Quit Genius*, although none of the studies analysing their use fully describe the techniques and information included in the apps. To bridge this gap, we tried downloading the applications, consulting the websites and even contacting the authors of the studies reviewed, but even so, it was difficult to resolve some of the questions regarding functionality and information offered by the applications.

Furthermore, the studies reviewed are based on small and non-representative samples of the general population, making it difficult to extrapolate the results. The sample in the study by Tudor-Sfetea et al. (2018) consisted of 15 university students, and in that of Alsharif and Philip (2015b) 52 smokers, mostly also university students. Both studies were of a descriptive and observational design, while the two on the *Quit Genius* app were qualitative longitudinal studies. These types of design do not allow causal associations to be made between the variables studied in the treatment and the results obtained (quitting smoking or reducing the number of cigarettes). Likewise, in terms of the scientific rigor of the published sources, it is noteworthy that while the studies on the *Quit Genius* app came from journals of high scientific impact, the same is not true of the studies involving the other two apps; one of them (*Smoke Mind*), was even published in proceedings of congresses.

Although CBT is reasonably well applied in the three apps, *SmartQuit* and *Quit Genius* combine it with other therapeutic approaches, such as ACT, considered a third-generation therapy, and mindfulness techniques, respectively. Face-to-face studies incorporating other techniques into CBT programs, such as behavioural activation, have evidenced improvements in the depressive symptoms related to smoking relapse (Martínez-Vispo et al., 2019). However, no evidence is available to assess the combined effect of these therapies or techniques in the apps reviewed. On the other hand, the analysis of smoking behaviour (thinking, feeling, acting) as an essential technique in CBT is well represented in the *Smoke Mind* and *Quit Genius Apps*, but it cannot be firmly stated that it is applied in the case of *SmartQuit*. In the latter, the objective of which is to develop skills to accept the triggers of smoking behaviour, the ACT approach carries more weight.

Table 2. *CBT components used in the mobile apps reviewed.*

CBT	*SmartQuit*	*Smoke Mind*	*Quit Genius*
Questionnaire assessment: Nicotine dependence		x	
Questionnaire assessment: Motivation to quit smoking			x
Interview regarding history of smoking (habits)	x	x	x
Psychoeducation about addictive behaviour and CBT		x	X*
Information about tobacco, craving, health consequences		X*	x
Self-report of the number of cigarettes smoked	x	x	x
Analysis of smoking behaviour: (I think, feel and do)		x	x
Quit plan: Reduction techniques. Gradual reduction of nicotine and tar intake	x	x	x
Quit plan: Quit date (eliminate all cigarettes on that date)			
Motivational exercises: Advantages and disadvantages of quitting smoking, reasons to quit	x	X*	x
Feedback on efforts: Graphic representation of consumption	x	x	x
Control of anxiety, stress: Training in relaxation techniques and deep breathing		x	x
Control triggers: Places, people and activities where user smoked and will now remain abstinent		x	x
Social support: Exercise of social commitment with people nearby or peers	x	x	x
Coping strategies to generate alternative behaviours to maintain abstinence and to deal with nicotine withdrawal symptoms		x	x
Problem solving technique		x	
Cognitive restructuring: Information on identifying and changing thinking		x	x
Self-instructions			
Behavioural test: Expose yourself to situations where you used to smoke without smoking			
Development of cigarette rejection techniques: Fog bank technique, broken record			
Cooximetry (measuring CO in exhaled air)		x	x
Considers combined treatment with medication	x	x	x

Note. CBT: Cognitive-Behavioural Therapy, CO: Carbon Monoxide. X *: The type of information is not clearly specified.

Knowing that CBT treatment must include smokers' awareness and information in the behaviour analysis of situations in which they smoke or smoked, understood as critical situations for relapse, we believe that *mHealth* can help identify and record these. It is even recommended that the apps themselves notify the user of this function to make sure smokers are attentive to their progress (Naughton, 2016) but evidence is lacking in how these strategies can be effectively promoted. Unlike most traditional methods of delivering behavioral support, mobile phones can in principle deliver automated support, including lapse prevention strategy recommendations, Just-In-Time (JIT. From this perspective, we consider that *Smoke Mind* provides the user with most control over this analysis. An interface for healthcare staff provides the CBT therapist with the ability to help the smoker perform the analysis in real time, thereby receiving personalized attention. Thus, the interface can facilitate app-based CBT, and furthermore enables interaction with the assigned health personnel, better monitoring, and access to the health system for smokers who want to quit smoking.

Contacts with health personnel, such as *"Quitlines"*, in distance therapies have proven effective, albeit with the drawback, according to some authors (Stead, Koilpillai & Lancaster, 2015), that they are underused by smokers. This problem matches the results of the study by Alsharif and Philip (2015b) especially in the Arabian Gulf region. However, very few studies to date have addressed the use of smart mobile health technologies for smoking cessation in the region. This paper proposes a smart mobile health solution tailored to assist with smoking cessation in the Arabian Gulf, and in particular in the Kingdom of Saudi Arabia (KSA, in which they report that despite the possibility of contacting health professionals through the mobile application, more than 70% of the sample never did so. The study on *SmartQuit* (Heffner et al., 2015) also refers to problems of underutilization of the app's available functions. In order to solve the above problems and achieve a more active user response, it is advisable to incorporate the notifications or warnings of the device itself (Naughton, 2016) and include gamification elements in *mHealth* (Edwards et al., 2016) because adherence to treatment and follow-up after cessation can be strengthened through play (Andújar-Espinosa, Salinero-González, Castilla-Martínez, Castillo-Quintanilla, Ibañez-Meléndez & Hu-Yang, 2018). Both strategies are included in the apps reviewed and were positively valued by their users. (Lin et al., 2018; Tudor-Sfetea et al., 2018).

Despite the scientific and applied importance of measuring the efficacy of smoking treatment through

assessments which may be made objective, such as the reduction of depressive symptoms, anxiety symptoms, craving, and the number of cigarettes, and of course quitting smoking, most of these studies employ semi-structured interviews about the opinions regarding app use, either by users or health staff. Thus, the studies base their assessments on a) the opinions of users and professionals (Alsharif & Philip, 2015a, 2015b), b) the app functions most commonly used as cessation predictors in the study by Heffner et al. (2015), or c) the prediction of quitting given the strengthening of psychological constructs (empowerment, well-being and inspiration) (Lin et al., 2018). In order to improve the quality of evidence, several additional sources would be necessary: assessments before and after use of the app, objective tests (co-oximetry, nicotine in saliva...) and/or information that may be provided by people close to the user or by health personnel; none of the above sources of objectivity and triangulation were included in any of the studies reviewed.

A further important limitation found in the studies reviewed is related to the fact that the opinions recorded are assessed very shortly after the use of the app: either before finishing the treatment (Alsharif & Philip, 2015b; Heffner et al., 2015; Tudor-Sfetea et al. 2018) or right at the end of the treatment (Lin et al., 2018). There is scientific evidence that relapse percentages of smokers are high, from the first month after withdrawal, decreasing at 3 months, 6 months and 12 months of follow-up in smoking cessation treatments (Minami et al., 2018)few outpatient mental health treatment facilities offer smoking cessation services. In this paper, we describe the development of a smartphone-assisted mindfulness smoking cessation intervention with contingency management (SMI-CM. Given this issue, follow-ups should be carried out with longer-term objective assessments in smokers who maintain abstinence after app use.

In conclusion, the review has highlighted the existence of a small number of smoking cessation applications which include CBT. The apps identified have important limitations: they offer low levels of detail as to the information regarding the techniques they perform in their CBT program; although they explain some of the procedures they use, they should detail how, and the sequence and the frequency with which they are used. This would facilitate the standardization of the program. Moreover, they do not focus the study on analysing smoking behaviour, and in general they do not refer to achieved levels of abstinence by not including sufficiently efficient procedures to measure the effectiveness of the tool. Given the above, and in order to construct new smoking cessation apps, the use of notifications and warnings is recommended, as well as gamification elements which reinforce the performance of the proposed activities, so that treatment adherence and subsequent change of behaviour can be strengthened. For functions requiring more interaction, such as behaviour analysis, the inclusion of an interface to facilitate this is recommended, in addition to customizing treatments. In this way, the app would become an instrument of support for the smoker. The inclusion of objective measurement procedures such as the use of a cooximeter and/or information regarding the user's social network would be necessary to increase the reliability of both the process and the result of the instrument's application. Finally, it is recommended that applications are developed which allow the user to choose their language to participate in *mHealth*, and which, through simplicity of design, present a user-friendly and straightforward procedure, so that neither cultural level nor the technological skills required generate a user gap.

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Conflict of interests

The authors declare no conflict of interest in any aspect of this investigation.

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