Journal of Network and Innovative Computing
ISSN 2160-2174 Volume 4 (2016) pp. 062-075

Smoke Mind System: The Design and Development of a Integrated CBT Mobile Health Management System for Smoking Cessation Program in Saudi Arabia

Abdullah H. Alsharif[1], Nada Philip[2]

Faculty of Science, Engineering and, Computing, Kingston University,
Penrhyn Rd, Kingston upon Thames, Surrey KT1 2EE, UK
[1]a.alsharif@mu.edu.sa, [2] N.Philip@kingston.ac.uk

***Abstract*—Smoking cessation programs are widely implemented to assist smokers in the process of quitting smoking. Cognitive Behavioral Therapy (CBT) is a psychological approach which is increasingly used in smoking cessation programs. On the other hand, the recent advancements in smartphone technologies have been widely explored to develop smoking cessation apps as a tool to assist with quitting smoking. However, most of the existing smartphone apps lack follow-up and adherence to clinical guidelines for treatment. Therefore, there is a need to implement behavioral change mechanisms in smoking cessation apps to help smokers quit effectively. The impacts of using integrated CBT mobile applications in Saudi Arabia, where the prevalence of smoking is very high and has been increasing in recent years, remain unexplored. Considering the urgent need for effective smoking cessation programs in the region, this paper analyzes the benefits of CBT and mobile technologies, and proposes a CBT integrated mobile application for achieving smoking cessation in Saudi Arabia. In this process, different studies concerned with CBT and m-health technologies are reviewed to develop an effective and updated model suitable for current situations. The requirements for designing and developing the mobile application are derived from a recent survey focusing on the needs of smokers in Saudi Arabia. Currently the proposed system is in the implementation stage and the results are expected very soon.**

Keywords— Cognitive Behavioral Therapy, m-health, smartphones for health, smoking cessation, mobile health, e-health.

I. Introduction

Tobacco smoking is one of the leading causes of deaths across the globe. Usually when smokers inhale smoke by burning tobacco, they inhale carbon monoxide (CO) along with other gases. CO reacts with hemoglobin in red blood cells 230 times faster than oxygen-forming carboxyhemoglobin (COHb), which is released from red blood cells much more slowly than oxygen. As a result, oxygen availability reduces in the blood and the heart has to work harder to supply the required oxygen to the various parts of the body. Therefore the high level of carbon monoxide in the blood of smokers is one of the main factors causing smokers to have increased rates of cardiovascular diseases. Table 1 shows the COHb levels and their corresponding effects on health [1].

Blood Saturation levels of COHb	Health Effects
<1%	Normal range
1% - 5%	Reduction of oxygen supply in the blood; increase in heart rate
5% - 15%	Exercise tolerance reduced
15% - 20%	Headache; visual distortions

TABLE I. *COHb effects on health*

According to the World Health Organization`s (WHO) estimates in 2014, tobacco smoking kills around 5 million people every year. It is also estimated that 80% of the world`s one billion smokers are in low- and middle-income countries [2]. Economically, it is estimated that direct healthcare costs due to smoking are at least $133 billion per year in the USA [3]. Apart from the deaths caused, smoking also decreases the quality of life of smokers by directly or indirectly causing damage to their health. Surveys have repeatedly shown that a large proportion of smokers are aware of the ill-effects of smoking and want to give up their smoking habits. Around 70% of smokers want to quit smoking. The process of overcoming smoking addiction or "quitting smoking" is often referred to as smoking cessation and several programs have been designed using various technologies over the years. These smoking cessation programs help smokers to overcome their smoking addiction, in order to improve their health, and thereby increase their life expectancy, which would have been severely impacted had they continued to smoke [4]. There are different types of smoking cessation interventions. In [5], smoking cessation interventions are broadly classified into two categories:

Pharmacotherapies – the intervention here is mainly through drugs which can be both nicotine and non-nicotine based.

Behavioral therapies – the intervention here is mainly through non-medication methods such as partner support, self-

help books, professional advice, telephone counselling, and others.

Behavioral therapy, also referred to as psychotherapy, is a branch of study that focuses on analyzing various behavioral aspects of an individual and modifying them in order to help the individual to lead a healthier lifestyle [6]. Behavioral therapy encompasses three main disciplines: applied behavior analysis, social learning theory, and Cognitive Behaviour Therapy (CBT). Of these, CBT is a widely popular discipline of psychotherapy [7].

CBT is an approach of psychotherapy in which the dysfunctional beliefs, thoughts and behaviors of individuals are modified by techniques such as psycho-education, mind training, behavioral reaction, etc. [8]. CBT has been widely used for the treatment and management of various diseases such as depression, anxiety, diabetes, smoking, and others [9, 10, 11]. CBT has also been implemented for smoking cessation programs and has been successful in helping smokers to quit smoking. On the other hand, Mobile-Health (mHealth) is a technological domain which in the last decade has seen tremendous advancements in developing applications for various disease interventions. mHealth can be defined as the use of mobile computing devices, medical sensors, and wireless communication technologies for providing various healthcare services [12]. It has recently been extensively implemented in smoking cessation programs, especially in developing smartphone based "apps" for smoking cessation. Further, there has been a rapid increase in smartphone penetration in both developed and developing countries [13] which has also led to the increasing popularity of smoking cessation apps.

There is a need to combine mHealth app technology and CBT modules in order to develop more effective smoking cessation programs. The integration of mHealth and CBT technologies can make smoking cessation programs more readily accessible to users, increase their motivation and awareness, and allow medical professionals to intervene more quickly. More importantly, it can provide CBT-based education to the users which can be a more effective approach than traditional approaches for smoking cessation.

Although there are different studies focusing on the use of CBT with mobile technologies in different regions, mostly in developed countries, there have been no studies conducted in the region of Saudi Arabia, where the prevalence of smoking is very high and increasing rapidly. Recent studies about smoking levels in Saudi Arabia have shown a rapid increase and suggest that there is a need for in-depth research and RCTs for achieving smoking cessation in the region. In Saudi Arabia, more than 71 males and 21 females are killed by diseases caused by tobacco smoking every week, and more than 116,000 and 2,889,000 adults continue to smoke everyday [14]. Among adults, around 22.2% more men and 2.2% more females than on average in developed countries are addicted to tobacco smoking. Among children, around 13% more boys and 5% more girls than on average in developed countries are addicted to tobacco smoking. It is alarming to identify that the prevalence of smoking in Saudi Arabia is increasing, although it is still slightly less than in other parts of the world. While the smoking prevalence among males is increasing, the smoking prevalence among women has remained the same [15, 16].

As for smoking cessation programs, there have been several attempts to adopt a generic nationwide program. Over the past 20 years, there have been over 30 antismoking clinics established across the country for providing pharmacological and behavioral treatments for smokers. The success rate for smoking cessation has been around 13% on average. The prevalence of current smoking ranges from 12-29.8% among school children, 2.4-37% among university students, 11.6-52.3% among adults, and 25% among the elderly [17]. There have been few studies concerned with smoking in Saudi Arabia [18, 19, 20] and these mostly focus on smoking patterns and the ill effects of smoking. There have been no studies focusing on implementing advanced solutions like integrating CBT and mobile technologies for controlling the rapid increase in smoking in the region. In spite of increasing concerns over rising rates of chronic diseases and the increasing number of smokers, there are no m-health systems that help smokers to quit or create an awareness of the ill effects of smoking. Therefore, there is an urgent need to start effective smoking cessation activities through different technologies, especially through m-health technologies, given the increasing number of mobile phone users and the lower availability of healthcare services in remote areas of the country.

Considering the advantages of integrating behavioral therapies and mobile technologies, this paper focuses on developing an effective and efficient smoking cessation system designed according to the needs and requirements of the smokers in Saudi Arabia. Accordingly, the rest of the paper is organized in the following sections.

- An overview of m-health technologies, areas of application and benefits.
- A systematic review and analysis of the studies focusing on using mobile technologies in achieving smoking cessation.
- Investigating and reviewing the recent mobile applications and their features used for smoking cessation.
- A detailed discussion about CBT and its benefits in smoking cessation programs.
- The design specifications and feature analysis of the Smoke Mind system.

II. M-Health overview

M-health involves the use of mobile technologies in delivering and managing the healthcare services. M-health can be defined and understood in different ways based on the areas of application, services involved and technologies used. It is defined as "emerging mobile communications and network technologies for healthcare systems" [21]. It can also be understood as a method of integration of mobile computing, communication technologies and medical sensors in order to provide mobile healthcare applications [22]. The concept and applications of m-health are expected to prosper in the near

future as mobile phones become increasingly integrated into peoples' lives, and almost all the relevant services can be delivered through mobile phones. A few authors have stated that m-health systems will have a significant impact on the delivery of healthcare and that such systems are yet to be exploited in daily practice [23, 24].

M-health applications can be useful in all regions, including developed, developing and under-developed countries. Especially in developing and under-developed countries, where the access to the healthcare is limited and there are few healthcare resources including clinics, physicians, and medicines, m-health technology solutions can be very useful in managing and delivering healthcare services.

M-health applications can provide different services depending on which services are required, or the number of service receivers etc. For example, the m-health application developed for the population of Croatia provides various services such as e-prescribing (137,000 prescriptions daily), e-referrals (8,483 issued monthly), e-booking operations in all hospitals, e-waiting lists for all practitioners and specialists, and labs with national interconnectivity. The state has reported an increase in chronic diseases such as obesity, diabetes and an aging population. Therefore, in order to effectively manage all healthcare services, and to minimize costs, the health system is integrated at a national level through m-health technologies, where all the healthcare operators are integrated in to a single system [25]. M-health applications can also be small and unique with dedicated services. For example, Endomondo is an m-health mobile application that allows users to track things such as time, speed, calories burned and heart rate for a variety of activities, and also allows them to share the results on social networking platforms like Facebook. Such applications motivate the users to effectively engage in their healthcare management. Similarly, there are applications for tracking illness, diagnosis, and disease management. The iBGStar iPhone Glucose meter is such example; it is approved by the FDA, and used for monitoring blood glucose levels [26]. Therefore, m-health is a concept where mobile technologies are integrated with healthcare services in order to reduce operational costs and deliver healthcare services effectively.

Even the simple services on mobiles like SMS, text messaging and voice calls can be very useful for managing healthcare services. They allow the delivery of healthcare services to remote locations where people have no access to health clinics. Additionally, with the growing number of smartphone users, there is a good scope for developing mobile phone applications intended for specific healthcare services. Using such applications, regular healthcare services can be managed remotely. In addition to mobiles and smartphones, other m-health technologies may be required. These can include patient monitoring devices, for example glucose readers or carbon monoxide (CO) monitors; mobile telemedicine devices; audio devices for learning; data collection software; operating systems and mobile applications. The operating system (OS) forms a base on which all the applications work, therefore it is essential to use an effective OS in order to maintain confidentiality, integrity, and availability. Mobile devices such as Apple iPads or Samsung mobiles use operating systems on which different applications can function. However, it is essential to ensure that the OS is agile enough to be able to modify the applications according to the changing needs of the users and healthcare services, so that new technologies like Bluetooth, Wi-Fi, and sensor devices can be easily integrated.

III. Related WOrk

Mobile devices have managed to provide promising results with regard to helping people to quit smoking and to modify other health behavior. In a study focusing on the available apps for the iPhone that aim at smoking cessation, the authors asserted that most of the downloaded apps tracked users for only a limited time after their quitting. It was pointed out that these apps did not adhere to any proven strategies for smoking cessation, and that only a few apps referred the user for treatment. In addition, almost none of them supported the use of authorized medications or the combination of medication and counselling [27]. These apps did not provide links for users to any outside resources such as a clinical support, or provide social support. The exclusion of important multi-component aspects like creating awareness, education, motivation etc., represented serious shortcomings in smoking cessation apps [27]. Hence it was concluded that these apps did not actually help smokers to quit, but rather they acted as supporting apps to hypnosis apps, which smokers believed to be helpful. Another study focusing on the use of m-health for smoking cessation through text messaging and obtaining feedback was successful in improving the system, as the system was modified according to feedback received, thus ensuring that the needs of the users were met. However, the study tracked only the crave pattern feedback of subscribers, and may have excluded other significant information that would be necessary to improve the system [28]. Based on the above, developing mobile apps that bypass the frames of the classic alerting of smokers, and instead link smokers to clinics and social support, should be a primary aim.

For smoking cessation, CBT approaches have been widely implemented and tested. Several research publications have demonstrated that CBT procedures can significantly increase the success rate of smoking cessation programs [29, 30, 31]. CBT methods are also used in combination with pharmacotherapy methods, where intervention drugs are administered to the smokers to help them overcome their smoking addiction. For instance, in [32], the authors used a combination of CBT techniques with nicotine patches as a smoking cessation treatment. Other drugs such as Nortriptyline and Bupropion were tested along with CBT techniques in works such as [33, 34]. The outcomes of these studies have shown that CBT techniques can enhance the success rate of smoking cessation programs.

An advantage of CBT is that it can be combined with different tools and technologies and hence made to deliver effective health intervention programs. Email and internet technologies have been used to deliver interventions for various disorders such as anxiety, obsessive compulsive disorder, panic disorders, etc. [35, 36]. In [37], the authors used the internet and mobile phones for smoking cessation. In their program, they delivered therapy based on CBT principles via web pages, text messages, and interactive voice responses. The outcomes

of their trial showed that CBT, delivered using the internet and mobile phone technologies, is an effective approach to smoking cessation.

The reviewed intervention studies that used text messaging outlined different results, with wide disparities in the abstinence rates achieved. Text messaging combined with video messaging and emails [38, 39, 40] achieved high abstinence rates compared to the simple text messaging interventions [41, 42, 43]. These studies have been conducted in different regions, and it is evident that using the same techniques in different regions yielded different results. For example, a study in China achieved 66% reduction rates in smoking [44], while using the same techniques in another study [66] achieved only 40% reduction rates.

These studies reflect the fact that the same techniques may not provide the same results in different regions. The techniques have to be modified with new interventions, therapies and technologies, and adjusted according to the lifestyles, culture and needs of the smokers in the different regions [45]. A summary of studies focusing on text messaging interventions is presented in Table 2.

TABLE II. Summary of studies focusing on text messaging interventions.

Study	Description	RCT	Duration	No. of participants	Outcomes
Bramley et al. [41]	Text messages in Maori language vs. non-Maori	X	26 weeks	- 355 Maori -1350 non-Maori	-26% abstinence achieved - no significant difference between Maori & non-Maori
Brendrey et al. [38]	Text messages combined with emails and voice messages	X	54 weeks	400	22% abstinence achieved
Ybarra et al. [42]	MySmoking program in USA		12 weeks	164	39% abstinence achieved
Abroms et al. [39]	Text messages with emails	X	6 months	503	11% abstinence achieved
Naughton et al. [43]	For pregnant smokers	X	11 weeks + 3 month follow up	207	12.5% abstinence achieved
Whittaker et al. [40]	Text and video message	X	6 months	226	26.4% abstinence achieved
Haug et al. [62]	Acceptance for text interventions	X	3 months	174	No significant difference between control and intervention group
Rodgers et al. [63]	Intervention in New Zealand	X	6 months	1705	28% abstinence achieved
Shi et al. [44]	Adolescents in China	X	12 weeks	179	66% reduction in smoking

Smartphone applications, popularly called apps, have become extremely popular in recent times and are used for a variety of functions and applications. Apps for smoking cessation are being extensively developed and deployed on various smartphone operating systems such as Android, iOS, and Windows. However, there has been very little research work available in the literature about smoking cessation apps. Three of the reviewed studies conducted RCTs on smoking cessation apps. For instance, in [46], the authors conducted dual RCTs between a smoking cessation app designed by the authors and an app recommended by the US Clinical Practice Guidelines. The results of the RCT study showed that the proposed app was successful in making 13% of the participants quit smoking. Despite the lack of RCTs on smoking cessation apps, there have been a few published works that have analyzed different aspects of these apps. For instance, in [39], content analysis of 400 smoking cessation apps was presented. The outcomes showed that the apps have low adherence to clinical guidelines, despite their popularity, with most apps failing to recommend approved medications. A similar study conducted in South Korea showed that most apps have few adherences to guidelines and hence may not provide significant motivation for smoking cessation. However, the claim is not supported by a clinical trial [47]. Other studies include a content analysis of 47 iPhone apps for smoking cessation which again demonstrated the low adherence of apps to guidelines [24].

IV. Smoking Cessation Mobile Applications

Presently, there are different applications for smoking cessation, using different interventions and technologies, which can be easily downloaded and used by the public for relatively inexpensive prices. Some of the most popular smoking cessation apps are considered for review here, since to the best of our knowledge, no studies have performed a feature analysis of the popular apps. For the analysis, the popularity of the apps was based on medical review, the list of the best quit smoking apps of the year in 2015 [67], and also their ratings and the number of downloads from the App Stores.

The app features analyzed are coded into three main categories. Fig. 1 illustrates the feature classification followed in our analysis. A description of the features analyzed and their classification is given below.

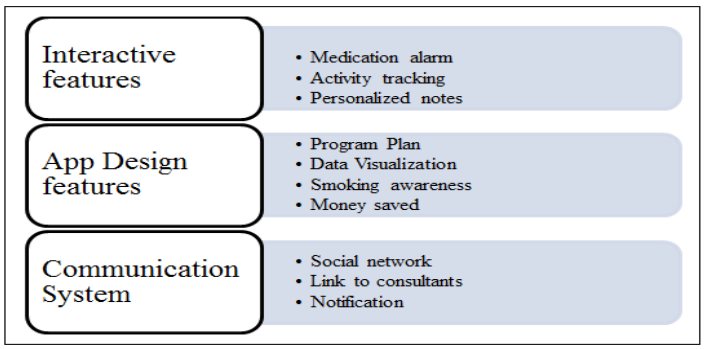

Fig1. APP Feature Classification

Interactive features: A desirable feature of an mHealth app is that it must be interactive so that the users are encouraged and would be interested in using the app more frequently, analyzing their information and receiving feedback [48]. Interactivity is one of the important aspects of the mobile application, as the overall experience of the user depends on it. A recent survey conducted by the Consumer Health Information Corporation (CHIC) found that 80% of the respondents desired better interactive mHealth apps [49]. Therefore, the interactive features of the smoking cessation apps were analyzed in our study. The following features were classified under the “Interaction” category.

- Medication Alarm – The National Tobacco Cessation Collaborative (NTCC) suggests the "combination method" as the most effective approach for smoking cessation, where phone-based support is combined with medication to quit smoking [50].
- Activity tracking – A desirable feature of an mHealth app is to track the activities of the users related to the intervention in order to measure their progress. Activity tracking is a feature known to be used in most m-Health applications such as weight loss, diabetes, smoking cessation etc. [24, 51, 52].
- Personalized notes – This is a feature that provides the user with personalized notes or messages at regular intervals in order to remind them about their program and to keep them motivated.
- App Design Features – Various design specifications are considered in the different applications reviewed. The main requirements include the sensitivity of the apps, data visualizations, information dissemination and engagement with the users [53, 54, 55]. Considering the various contexts of feature analysis, the following features were investigated in the apps:
- Program plan – The users must be aware of the program so that the expectations of the users from the applications will be in line with the design.
- Data visualization – An effective way of representing the data not only helps the users to clearly understand the information, but it also helps to analyze the data from different perspectives. This helps to track progress and keep people motivated.
- Smoking awareness – Information dissemination is important and hence it is also considered during the reviews. Note is made of whether the app possesses any smoking awareness features such as providing the user with information about benefits of quitting, the ill effects of smoking, etc.
- Money saved – Monetary benefits can be a great motivational factor to many people and presenting the financial gains of giving up cigarettes can be an attractive feature in an app.

Communication system: Another important aspect of an effective mHealth app is the communication system embedded in the design. The focus is on the approach to the communication process between the different stakeholders or users of the app. This encompasses aspects such as how the app communicates with the user, and the mode of communication between the user and other stakeholders such as family or healthcare providers. Notifications, social networking features, links to consultants, and modes of sharing information from apps are a few of the aspects considered in the communication systems while reviewing the applications.

With these features in mind, 10 mobile applications for smoking cessation were reviewed. The feature analysis of these smartphone applications can be seen in Table 3. It is observed that most of these applications are either available for free or at very low prices; using mobile applications is therefore a cost-effective method for smoking cessation intervention. Reviewing the interactive features of these applications, it can be seen that none of them provide a medication alarm, which is an important feature. Most of the applications (80%) provide an activity tracking feature, and 70% of the applications provide personalized notes, which can be used by the app to send personalized messages or notifications according to the progress made by the users.

In reviewing the app design features, it was found that only 3 apps (30%) provide the program plan feature, which updates the users about the program. Data visualization is an important feature of the mobile application, as it allows the users to view their data in different graphical presentations, and it helps them to keep track of their progress. 8 apps (80%) included this feature. On the other hand, 5 apps (50%) did not include a smoking awareness program to disseminate information about the effects of smoking. They also did not include an accessible overall description of the plan for smoking cessation provided by the app. The majority of the applications reviewed (80%) provided a 'money saved' feature, which uses financial gains as a motivational factor for quitting smoking.

The review has indicated that 80% of the apps included a social networking feature as part of their communication features. Using this feature, the users can interact with other users, participate in discussions, and motivate each other. A vast majority of the apps reviewed (90%) had a notification feature to notify the users through alerts or messages, or to provide details of their progress via different mechanisms such as text messages, daily reminders or app notifications. However, it was observed that none of the apps reviewed provided a link to a consultant in the case of an emergency or as a part of a consultation.

All of these apps have been reviewed by Healthline Networks [64] and are considered to be the best applications for quitting smoking in 2015. The prices of the applications shown in the table may vary as the price fluctuates depending on the demand, the number of users and the number of downloads. From the apps reviewed, it can be clearly observed that the medical community has no involvement in the design, development and implementation process. While some of the reviewed applications follow regulated clinical guidelines, others do not. Several important features, such as providing a link to consultants, a medication alarm, a program plan etc., are not included in most of the applications, and this makes these applications less effective.

TABLE III. *Feature analysis of Mobile applications for smoking Cessation*

Feature type	Features	LIVESTRONG MyQuit Coach	Smoke Free	Kwit	Craving to quit	Stop Smoking Cigarettes Now (Butt Out - Quit Smoking Forever)	Quit smoking - QuitNow!	Cessat-ion Nation	QuitPro	Quit smoking Andrew Johnson	Quit it lite
App overview	**Price**	Free	Free	$2.16	Free	$3.99	Free	Free	Free	$2.99	Free
	Ratings	4.5	4.5	4.5	3	4.5	4	4.5	4	4	4.5
	iOS	X	X	X	X	X	X		X	X	X
	Android	--	X	X	X	--	X	X	--	X	--
Interactive features	**Medication alarm**	--	--	--	--	--	--	--	--	--	--
	Activity tracking	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	--	--
	Personalized notes	**X**	**X**	**X**	**X**	**X**	**X**	**X**	--	--	--
App design features	**Program plan**	**X**	--	--	**X**	--	--	--	--	**X**	--
	Data Visualization	**X**	X	X	X	X	X	X	X	--	--
	Smoking Awareness	X	X	--	X	X	--	X	--	--	--
	Money saved	--	X	X	X	X	X	X	X	--	X
Communication system	**Social network**	X	--	X	X	X	X	X	X	--	X
	Link to consultants	--	--	--	--	--	--	--	--	--	--
	Notification	**notification**	**---**	**Gams**	**Daily remind-er**	**App notification**	**App notificat-ion**	**App notificat-ion**	**Messag-es**	**Daily reminder**	**App notifica-tion**

COGNITIVE BEHAVIOURAL THERAPY (CBT) FOR SMOKING CESSATION

Cognitive Behavioral Therapy (CBT) is an approach that

relies on three factors: thoughts, feelings, and behaviors. These three factors are interconnected and are mainly responsible for the consequences of an individual's actions, as shown in Fig. 2.

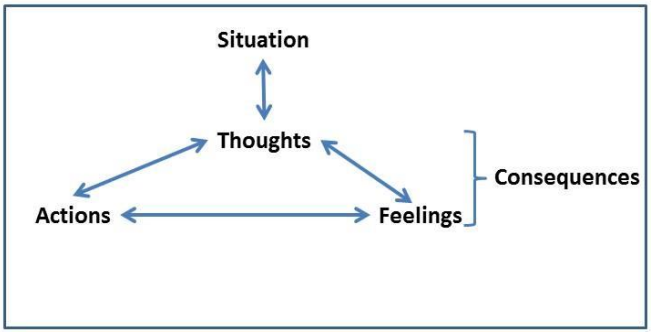

Fig2. A Typical CBT Approach.

It is a psychotherapeutic approach that addresses problems such as maladaptive behaviors, psychological disorders, and stress. How people think (cognitive) and what they do (behavior) are the two aspects that can be changed by using different approaches such as talking, motivating, skills training, and relaxing. This is the major idea behind the use of CBT; it helps patients to change their behavior according to their medical and psychological condition for their own good. It analyzes the patients' thoughts, feelings and actions in particular situations, and then analyzes the consequences. Based on this analysis, the therapy, which includes different aspects such as motivation, education, training etc., can be used to change the patients' behavior. By analyzing the CBT data and by providing effective support, patients' self-efficacy can be improved, which in turn can help them to achieve the desired objectives. The CBT functionality to be used in the proposed system is presented in Fig 3.

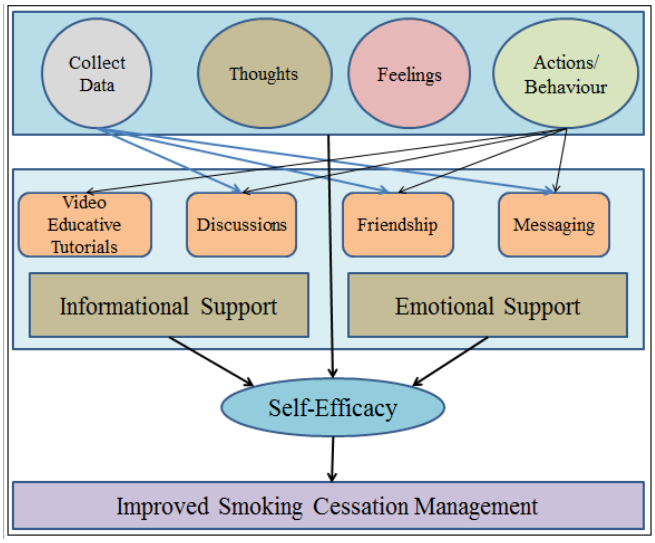

Fig3. CBT In Achieving Smoking Cessation

The CBT can be manually adopted by the CBT therapist, or a computerized CBT can also be used, depending on the situation and the patients' needs. Computerized CBT (CCBT) uses software programs that enable individuals to manage their problems by changing the ways they think and behave [56]. There are different CBT models and approaches used for different health conditions. Through psycho-education in the CBT approach, individuals can develop the necessary skills to manage their thoughts, feelings, and behaviours and how they interact or influence each other. CBT uses several methods such as cognitive restructuring, skills training, problem solving and relaxation to enable the individual to develop the strengths and skills to manage their actions and the subsequent consequences [57].

The recent advent of smartphones has allowed researchers to explore smartphone apps for delivering CBT-based interventions. Though mHealth apps and CBT combined interventions have been designed for many other health problems, we could not find any work that has implemented CBT for smoking cessation via smartphone apps. However, there is no shortage of non-CBT-based smartphone apps for smoking cessation today in smartphone app stores.

As discussed earlier, there are various applications for smoking cessation available on the market, with different features, therapies and technologies. These apps provide various features such as a program plan, smoking awareness messages, expenditure tracking, medication reminders, etc. to motivate and monitor the smoking cessation process of the users. A Randomized Controlled Trial for smoking cessation using a smartphone app showed that the tested app was successful in making 13% of the participants quit smoking [46]. Apart from this publication, we could not find any other research work that has implemented a clinical trial process on app-based smoking cessation programs. Further, it must also be noted that the authors in [58] and [27] showed that most apps for smoking cessation do not adhere to clinical guidelines or recommendations.

The lack of research into CBT procedures delivered via a smartphone app for smoking cessation is a research gap that needs to be addressed. The combined benefits of CBT procedures and smartphone apps can potentially produce an effective tool for smoking cessation. The literature review in this study suggests that both mHealth technologies and CBT have shown good results separately in various studies. Therefore, the concept of m-health technologies has been used to develop smartphone applications with different technological features [59, 58, 27]. These include measuring CO levels through a CO monitor, providing a platform for interaction between the physician and smokers through messaging, a graphical representation of CO levels, and graphs to show the smoker's progress towards achieving smoking cessation. Various CBT features [35, 36, 60] have also been employed, such as requesting the smokers to fill a multiple choice questionnaire, focusing on their behavioral aspects such as thoughts, feelings, mood, and actions at that time. Thus, the proposed system integrates both mHealth technologies and CBT in order to help users to quit smoking [65].

V. Perception study for the smoke mind system

In our earlier study [61], a survey was conducted on smokers' perceptions of using smart mobile phone technologies for smoking cessation in a community setting in Saudi Arabia. The outcome of this study suggested that the system architecture needs to include the m-health platform, CBT module, and a decision support system based on data mining techniques to provide an optimized information management process to the smokers in the KSA community. Based on these results, the requirements (functional and non-functional) were obtained and published. These requirements were used to design the architecture, features, and functionalities of the Smoke Mind System.

VI. Smoke Mind System

The Smoke Mind Management System is a proposed tool for improving smoking cessation management systems. Its aim is to overcome some of the smoking cessation challenges that currently exist. The Smoke Mind system has been designed to provide the following features:

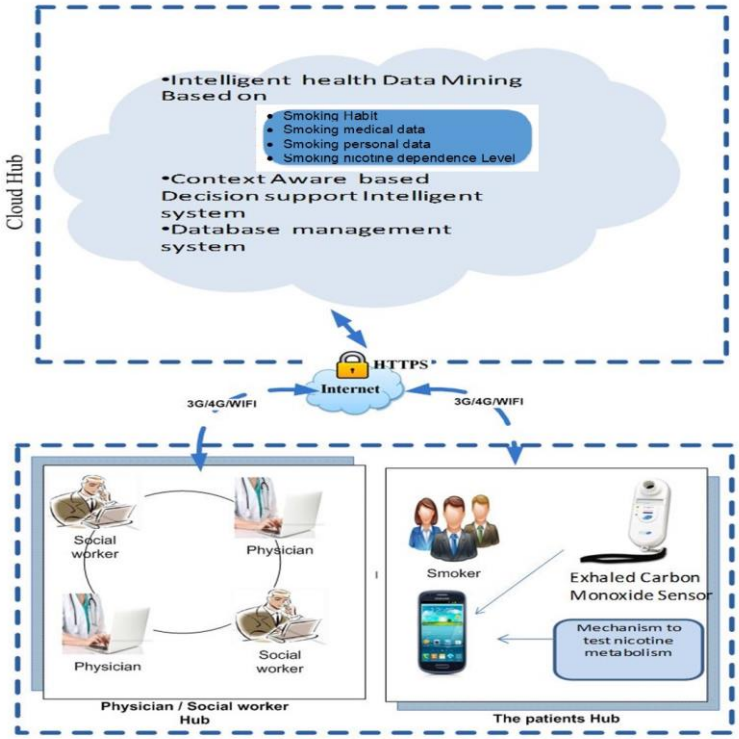

Fig5. The General Architecture of Smart-Phone Based Smoking Cessation System for KSA User.

A. The Patient Hub

The smoker will be equipped with a mobile app (designed for Android and iOS platforms) as their point of connection to the proposed system. The smoker's app is used as an interactive platform that allows the smoker to receive the services of the smoking cessation program. This hub has an important component called the Exhaled Carbon Monoxide sensor which performs the pharmacotherapy function of the smoking therapy. This sensor measures the carbon monoxide levels of patients' breath on a daily basis and collects the data. This information tests the nicotine metabolism of the smoker. The CO levels recorded need to be manually entered by the smoker into the mobile application, and this data will then be automatically updated in the server. The patient hub also includes an interface for entering the CBT data of the smoker which includes their thoughts, actions, and feelings. This data has to be entered by the smoker if the CO levels recorded are more than the normal range outlined. The smokers need to select an option from the multiple options outlined in the app. The CBT data will be automatically transferred to the server by the app. Apart from this major feature, our proposed architecture includes other features mainly derived from the findings of our survey in the previous study [61], which include:

- A data visualization tool in the form of charts and graphics to show the smoker`s progress.
- An interaction system to communicate with the professionals.
- Daily reminders and push notifications to follow the program instructions and keep motivated.
- Videos and text messages that provide awareness of smoking hazards and the benefits of quitting.
- A direct connection to a helpline feature for urgent consultations in cases of emergency.
- A behavioral change module that allows users to record their thoughts, actions, and feelings. Based on this data, the users receive advice and treatment suiting their needs.
- An education interface for the users to increase their awareness about smoking, its ill effects and the benefits of quitting smoking.

B. Physician/Social Worker Hub

The physician/social worker will have access to the system through a website dedicated to maintaining communication with the smokers through the application. The website will also provide the physicians with information about the smoker, their previous track record and the current progress being made. The healthcare professionals can monitor the CO levels of the smokers and can change the treatment accordingly if the levels are high. They can also analyze the smokers' CBT data, define changes in the treatment, and send notifications to keep the smokers motivated and focused on achieving smoking cessation. The professionals will be able to monitor and analyze the smokers' progress closely, and use this information to modify and adapt the program, thus enhancing the quitting progress. They will also be able to interact with the smokers through their interface and provide required feedback.

C. *Cloud Hub*

The cloud hub is where all the data generated in the system is stored and retrieved from. It acts as an intermediary between the Patient Hub and the Physician/Social Worker hub. The server shall host the data generated from the patient hub such as the carbon monoxide readings, and other interactions with the system. The nicotine metabolites data collected from the sensor at the patient hub will be stored on the server.

Further, the contents related to smoking awareness are stored on the server, and these will be automatically sent to the smokers at predetermined regular intervals. The physicians will be able to access the database and retrieve individual smokers' data in order to analyze their progress. Additionally, the CBT data entered by the smokers is also stored on the servers and can be retrieved whenever necessary to analyze the behavioral aspects of the smokers, and to adjust or redefine the treatment of the individual smokers according to their CBT data.

Finally, an important component hosted on the server is the decision support system. This is an intelligent decision-making system that analyzes the patient data and recommends to physicians specific consultations with the individual smoker. This component can help the physicians to make clinical decisions quicker and thereby help to increase the speed and accuracy of the consultations for smoking cessation.

The proposed architecture of our smoking cessation system is designed based on the findings of our survey and literature research. The system is currently at the stage of development and implementation. This will be immediately followed by a pilot study in KSA.

VII. Internet & Mobile Technologies

There is a wide range of software tools and technologies that can be used to develop effective and efficient information systems. However, there is one major challenge that usually results in system failures; i.e. change management. The aspect of change management can be seen in the changing requirements during the system design and development and during the system usage. It is important that the system should adopt the changing requirements without this affecting its functionality and efficiency. However, in most cases, it is very hard to achieve such an outcome as there are various types of issues or risks that might develop, depending on the type and the extent of change. To avoid such instances, the proposed approach would follow the waterfall model, where the complete set of requirements is gathered before designing and developing the system. However, care would be taken to increase the non-functional aspects, for example the adaptability and flexibility of the system. The prototype screens of the system can be found in Fig. 5. This process of effective and efficient system development is supported by the use of the following tools and technologies.

A. *Smartphone application & Web portal*

Software that can be installed on mobile phones, tabs, smartphones and other similar devices is usually referred to as a smartphone/mobile application. Similarly, a web portal is a web interface application that runs on different devices on different website browsers, where users can perform different functions like read/edit/delete/update data, and interact with other users. The proposed Smoke Mind system would use a mobile application that would be installed on the smokers' mobile phones, and a web portal that would be accessed by the healthcare staff and CBT staff at healthcare centers in order to view the smokers' readings and to interact with them. Different tools and technologies would be used to develop both the mobile application and the web portal.

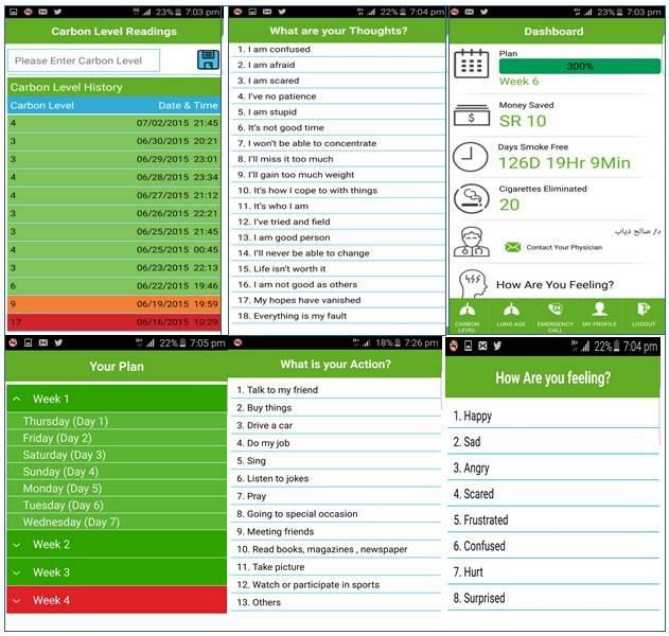

Fig6. Prototype Screenshots of The Proposed System (SMOKE MIND APPLICATION)

They mainly include PHP, SQL database, Android OS, Java SDK, Platform eclipse, SMS text local, Polymap wireless, Java, HTML 5, XML, CO Monitor, Java script, CSS3 etc. The prototype screens of the web interface can be found in Fig. 6.

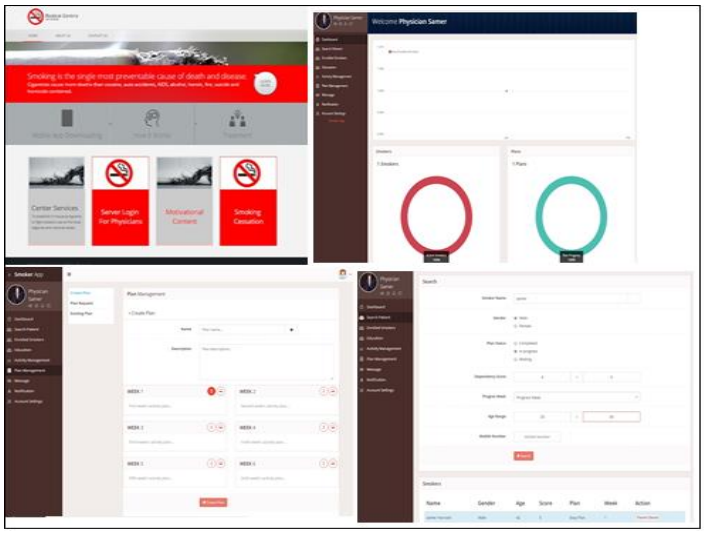

Fig7. Prototype Screenshots of Health Portal Service access Interface.

The web interface is systematically designed so that the healthcare practitioners can easily access the smokers' information, analyze it using GUI tools, and update the patient records regarding changes in treatment. They can also update the plans, notifications and other features that are part of the treatment.

B. Classification Algorithm

A classification algorithm is a program that is set in the Smoke Mind system to trigger the CBT therapy module and automated messaging if the specified criterion is met. The criterion to trigger a notification is based on the CO levels of the smoker. A notification is triggered when the CO levels are outside the normal range. In addition, a k-means clustering algorithm is used to detect the smokers' possibility of quitting, and to determine the kind of treatment that they should be given, based on their data. It is also used to identify the best course of treatment for the smokers, and can be used by the medical staff and CBT therapists to recommend better treatment and decisions.

C. Database Module

An SQL database server is used in the Smoke Mind system. The database is designed using tables with different attributes. The data is stored in these tables and can be retrieved, updated, edited, and inserted according to the requirements of the users while using the system.

VIII. Integrated mobile cbt-based smoking cessation system

The proposed integrated Mobile CBT-based smoking cessation system is illustrated in Fig. 7. The overall functioning scheme of the proposed system can be described as follows. The smoker measures his carbon monoxide (CO) levels every day and manually updates the smoking cessation application. There is a reminder that alerts the smokers in case they forget to upload the readings. The updated data from the application is then transferred via a wireless communication channel such as 4G to the server. If the CO data obtained is within the normal range, then an automated educational or motivational message will be sent to the user. If it is above the normal rate, then the smoker is required to submit CBT-related information. The smoking cessation professionals involved monitor the updated data on a daily basis and send appropriate feedback to the users accordingly.

It can be noted that the proposed system uses different approaches to interact with the user, based on the progress that they have made. For instance, if the user has maintained their CO level below the target rate, then the user is congratulated on their progress and provided with more motivational and educational messages. In the event that the smoker has not made progress, then the user would be asked to provide CBT-related information through the application. The information collected is then analyzed by the CBT therapist who would then interact with the smoker, understanding their issues and providing appropriate feedback. The CBT information collected is crucial for providing effective intervention, and it is based on three main elements: thoughts, feelings, and actions. The choice of CBT-related information to be collected was developed from detailed consultations with relevant medical and non-medical professionals.

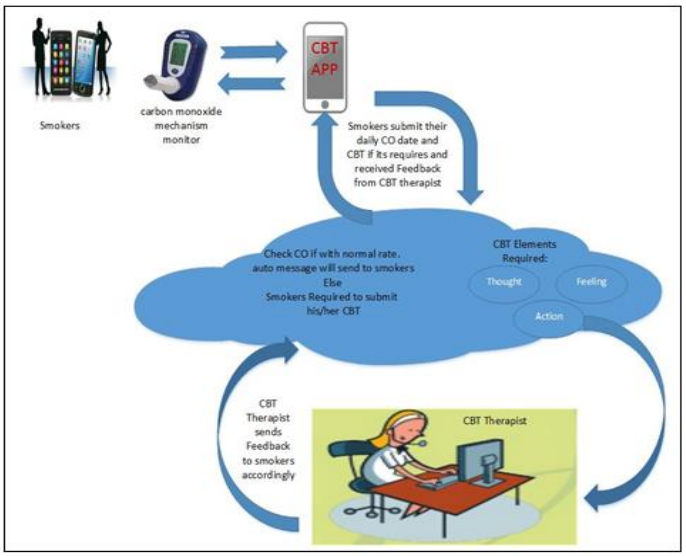

Fig8. Functional Scheme of the Proposed System.

The technical aspects of the proposed system can be discussed using the following service models.

A. Smoking Cessation Management Module Services

The services in this module can be explained through two components, which include a CO management component and a communication component. The key function of the first component is to provide the mobility for the Smoke Mind building blocks. This component includes the functionality at the smokers' end, which assists smokers with measuring their CO levels and manually submitting the readings using the mobile application. The application in turn transfers the readings to the central database using 3G/4G services. The smokers can view their readings over a period of time using charts or graphs. The smokers' data stored in the database can be accessed by the medical staff to schedule the reading time and date, send feedback and observe the readings of the smokers remotely. The key function of the second component is the communication process. An effective communication process is achieved by using Bluetooth technology to transmit the lung age readings to the mobile device; it is also used by the mobile data network to transmit the readings from the mobiles to the server. However, CO levels have to be manually entered in to the application by the smokers as the CO monitoring device does not support Bluetooth technology. In addition to these, text messaging is also used to improve the smoking cessation management, by acting as a medium of communication.

B. Interactive Module Services

The key function of this module is to provide the necessary information to all the users of the Smoke Mind system. The services include information sharing, educational support, and

providing emotional support to the users. This module consists of a messaging feature which supports all these services.

C. CBT Module Services

The key function of this module is to provide the behavioral change component to the Smoke Mind system. This module consists of the smokers' mobile CBT end, which will assist them with sending their CBT data remotely via the smartphone, and a web portal at the CBT specialist's end, which will assist the therapist with sending feedback and observing the state of the patients' behavioral change remotely. Both smokers and CBT therapists can view the CBT (thoughts, feelings and actions) in graphical representations such as tables and charts. This module will aid CBT intervention by applying a logic (when CO levels are more than the normal range) to decide whether to trigger an intervention notification, asking the smokers to submit CBT data.

The CBT cycle starts from when the CO levels of the patients are recorded and are higher than the normal range. If such an event occurs, the smokers will automatically receive a notification requesting them to submit their CBT data. Then, the patients are supposed to submit the CBT data, which comprises of thoughts, moods and actions through the mobile application. The patients are required to select the appropriate options which define their thoughts, mood, and action at that point of time from the list displayed on their mobile's screens. These are discussed in detail in the following points.

D. Thoughts

The thoughts of the user are essential in the CBT process since they enable the therapist to understand the state of mind of the smoker and to use this to design an atmosphere that would help to reduce any negative thought patterns in the smoker. The thoughts used in our system are derived from a research review and from consultations with professionals. Table 4 lists some of the thoughts used in our system.

Thoughts
I am confused
I am afraid
I am scared
I've no patience
I am stupid
It's not a good time
I won't be able to concentrate
I'll miss it too much

TABLE IV. *List of some thoughts*

E. Feelings

It is important for the therapist to know how the smokers feel about themselves during the cessation program, in order to understand how the progress in the cessation program is affecting the smokers' mood and feelings. The smokers in our designed system will be asked to identify their mood from a set of options as shown in Table 5.

Feelings
Happy
Sad
Scared
Angry
Frustrated
Confused
Surprised
Hurt

TABLE V. *List of some feelings*

F. Actions

The users of our system are asked to provide information about their actions as this will help the therapist to analyze their success or failure during the course of the program in the context of their activities. For instance, if the smoker is able to abstain from smoking by diverting his attention onto certain activities, then the therapist can identify them based on the information collected from the smoking cessation application. Some typical examples provided in the application are listed in Table 6.

Actions
Talk to my friend
Buy things
Drive a car
Do my job
Sing
Listen to jokes
Go to a special occasion
Meet friends
Read books, magazines, etc.

TABLE VI. *List of some actions*

The CBT data collected will enable the therapist to understand the users' actions and behaviour and use them as a context to modify the smoking cessation program.

In addition to the CBT, the proposed system also embodies other functional features that are interlinked with CBT. The smokers can interact with the physicians through messaging and can clear any doubts or receive feedback from the CBT therapists. The users can view their progress through graphs and receive educational materials and motivational messages tailored specifically to each participant, based on their CBT data and CO levels. In the case of an emergency, the smokers can directly contact the physicians over the phone, for which purpose an emergency contact number is presented in the application. The smokers' data and the measured CO levels are stored in the cloud hub, from where the physicians and smokers can access the current and historical data. An important component hosted on the server is the decision support system. This is an intelligent decision-making system that analyzes the patient's data, and based on the analysis, it recommends that the physicians provide specific consultations to the individual smoker. This component can help the physicians to make clinical decisions quicker and help to increase the speed and accuracy of the consultations for smoking cessation. In addition it also sends the educational and motivational messages to the smokers at regular intervals. However, the functional features such as messaging and feedback etc. are mainly based on the CBT data.

IX. Conclusion and future work

The proposed system presents a new approach of combining mobile health technology and CBT methods to provide an effective smoking cessation program. The ubiquitous presence of smartphones and the various communication benefits they provide are utilized by our proposed system to provide a CBT paradigm in smoking cessation application systems and hence enhance their success potential. Currently, the proposed system is at the clinical trial stage to study the impact of this system on smoking cessation.

References

[1] J. Foulds, "Carbon monoxide in cigarette smoke", Healthline.com, 2015. [Online]. Available: http://www.healthline.com/health-blogs/freedom-smoking/carbon-monoxide-cigarette-smoke. [Accessed: 31- Aug- 2015].

[2] WHO, Tobacco - fact sheet, World Health Organization, 2014.

[3] U. D. o. H. a. H. Services, The Health Consequences of Smoking - 50 Years of Progress: A Report of the Surgeon General, U.S. Department of Health and Human Servicesq, Atlanta, 2014.

[4] U. S. General, The Health Benefits of Smoking Cessation, Washington: Department of Health and Human Services, 1990.

[5] J. P. Ruger, and C. M. Lazar, "Economic evaluation of pharmaco-and behavioral therapies for smoking cessation: a critical and systematic review of empirical research," Annual Review of Public Health, vol. 33, p. 279, 2012.

[6] K. Glanz, B. K. Rimer, and K. Viswanath, Health behavior and health education: theory, research, and practice. John Wiley & Sons, 2008, San Francisco.

[7] K. E. Ferguson and W. O'Donohue, "Behavior Therapy: The Second and Third Waves," International Encyclopedia of the Social & Behavioral Sciences, pp. 431-436, 2015.

[8] R. F. Cima et al., "Specialised treatment based on cognitive behaviour therapy versus usual care for tinnitus: a randomised controlled trial," The Lancet, vol. 379, pp. 1951-1959, 2012.

[9] B. Paxling et al., "Therapist behaviours in internet-delivered cognitive behaviour therapy: analyses of e-mail correspondence in the treatment of generalized anxiety disorder," Behavioural and Cognitive Psychotherapy, vol. 41, no. 3, pp. 280-289, 2013.

[10] G. R. Dalle, S. Calugi, H. A. Doll, and C. G. Fairburn, "Enhanced cognitive behaviour therapy for adolescents with anorexia nervosa: An alternative to family therapy?" Behaviour Research and Therapy, vol. 51, no. 1, pp. 9-12, 2013.

[11] S. A. Safren et al., "A randomized controlled trial of cognitive behavioral therapy for adherence and depression (CBT-AD) in patients with uncontrolled type 2 diabetes," Diabetes Care, vol. 37, no. 3, pp. 625-633, 2014.

[12] R. S. H. Istepanian, E. Jovanov and Y. T. Zhang, "Guest editorial introduction to the special section on m-health: Beyond seamless mobility and global wireless health-care connectivity," Information Technology in Biomedicine, IEEE Transactions on, vol. 8, 4, pp. 405-414, 2004.

[13] Google Report, "Our Mobile Planet," Google, 2013.

[14] World Lung Foundation, "Country Fact Sheet: Saudi Arabia", 2015. [Online]. Available: http://www.tobaccoatlas.org/country-data/saudi-arabia/. [Accessed: 21- Jan- 2016].

[15] The World Bank Group, "Smoking prevalence, males (% of adults)", 2015. [online]. Available: http://data.worldbank.org/indicator/SH.PRV.SMOK.MA/countries/1W-SA?display=graph [Accessed: 03- Dec- 2015].

[16] The World Bank Group, "Smoking prevalence, females (% of adults)", 2015. [online]. Available: http://data.worldbank.org/indicator/SH.PRV.SMOK.FE/countries/1W-SA?display=graph [Accessed: 03- Dec- 2015].

[17] M.M. Bassiony, 2009. "Smoking in Saudi Arabia". Saudi Medical Journal, 2009 Jul; vol. 30, pp. 876-81. PMID: 19617999.

[18] R. Salama, 2012. "Challenges facing smokers in Saudi Arabia". International Journal of Health Sciences (Qassim). 2012 Jun, vol. 6, pp. V–VI. PMCID: PMC3616952.

[19] J. Jarallah, K. Al-Rubeaan, A. Al-Nuaim, A. Al-Ruhaily and K. Kalantan, "Prevalence and determinants of smoking in three regions of Saudi Arabia", Tobacco Control, vol. 8, pp. 53-56, 1999.

[20] K.A. Al-Turki, N.A. Al-Baghli, A.J. Al-Ghamdi, A.G. El-Zubaier, R. Al-Ghamdi, M.M. Alameer, "Prevalence of current smoking in Eastern province, Saudi Arabia", Tobacco Control, vol. 16, pp. 6-671, 2010.

[21] Robert S. H. Istepanian, Swamy Laxminarayan, Constantinos S. Pattichis, 2006. 'M-Health: Emerging Mobile Health Systems', Springer Link Publications. ISBN: 978-0-387-26558-2

[22] E. Jovanov, 2006. "Wireless technology and system integration in body area networks for m-health applications", Engineering in Medicine and Biology Society, 2005. IEEE-EMBS 2005. 27th Annual International Conference.

[23] N. Herscovici et al., "m-Health e-Emergency Systems: Current Status and Future Directions - [Wireless corner]", IEEE Antennas and Propagation Magazine, vol. 49, pp. 216-231, 2007.

[24] E. Kyriacou, C. Pattichis and M. Pattichis, "An overview of recent health care support systems for eEmergency and mHealth applications", 2009 Annual International Conference of the IEEE Engineering in Medicine and Biology Society, 2009.

[25] A. Guerrero, 2013. “There’s An App for That: How mHealth Technologies Are Benefitting Patients”. [online]. Available: http://medcitynews.com/2013/04/theres-an-app-for-that-how-mhealth-technologies-are-benefitting-patients/?rf=1 [Accessed: 03- Jan- 2016]

[26] World Lung Foundation, “Country Fact Sheet: Saudi Arabia”, 2015. [Online]. Available: http://www.tobaccoatlas.org/country-data/saudi-arabia/. [Accessed: 02- Jan- 2016].

[27] L. C. Abroms, N. Padmanabhan, L. Thaweethai and T. Phillips, “iPhone apps for smoking cessation: a content analysis,” American Journal of Preventive Medicine, vol. 40, pp. 279-285, 2011.

[28] K. Ghorai, S. Akter, F. Khatun and P. Ray, "mHealth for Smoking Cessation Programs: A Systematic Review", Journal of Personalized Medicine, vol. 4, pp. 412-423, 2014.

[29] H. S. Kapson and D. A. Haaga, “Depression vulnerability moderates the effects of cognitive behavior therapy in a randomized controlled trial for smoking cessation,” Behavior Therapy, vol. 41, pp. 447-460, 2010.

[30] R. Hiscock, S. Murray, L.S. Brose, A. McEwen, and J. L. Bee, “Behavioural therapy for smoking cessation: the effectiveness of different intervention types for disadvantaged and affluent smokers,” Addictive Behaviors, vol. 38, pp.2787-2796, 2013.

[31] R. A. Brown et al., “Cognitive-behavioral treatment for depression in smoking cessation,” Journal of Consulting and Clinical Psychology, vol. 69, p. 471, 2001.

[32] G. Vera, and M. Paz, “Clinical utility of the combination of cognitive-behavioral techniques with nicotine patches as a smoking-cessation treatment: five-year results of the “Ex-Moker” program,” Journal of Substance Abuse Treatment, vol. 27, pp. 325-333, 2004.

[33] Hall, S. M. et al., “Nortriptyline and cognitive-behavioral therapy in the treatment of cigarette smoking,” Archives of General Psychiatry, vol. 55, pp. 683-690, 1998.

[34] A. E Evins et al., “A pilot trial of bupropion added to cognitive behavioral therapy for smoking cessation in schizophrenia,” Nicotine & Tobacco Research, vol. 3, pp. 397-403, 2001.

[35] E. Andersson et al., 2012. “Internet-based cognitive behaviour therapy for obsessive--compulsive disorder: a randomized controlled trial,” Psychological Medicine, vol. 42, pp. 2193-2203, 2012.

[36] G. Andersson et al., “Internet-based psychodynamic versus cognitive behavioral guided self-help for generalized anxiety disorder: a randomized controlled trial,” Psychotherapy and Psychosomatics, vol. 81, 6, 2012.

[37] H. Brendryen, F. Drozd, and P. Kraft, “A digital smoking cessation program delivered through internet and cell phone without nicotine replacement (happy ending): randomized controlled trial,” Journal of Medical Internet Research, vol. 10, 5, 2008.

[38] H. Brendryen and P. Kraft, “Happy Ending: A randomized controlled trial of a digital multi-media smoking cessation intervention,” Addiction, vol. 103, pp. 478-484, 2008.

[39] L. C. Abroms, A. L. Boal, S. J. Simmens, J. A. Mendel and R. A. Windsor, “A randomized trial of Text2Quit: a text messaging program for smoking cessation,” American Journal of Preventive Medicine, vol. 47, pp. 242-250, 2014.

[40] R. Whittaker et al., “A theory-based video messaging mobile phone intervention for smoking cessation: randomized controlled trial,” Journal of Medical Internet Research, vol. 13, 2011.

[41] D. Bramley et al., “Smoking cessation using mobile phone text messaging is as effective in Maori as non-Maori,” The New Zealand Medical Journal, vol. 118, pp. 1-10, 2005.

[42] M. L. Ybarra, J. S. Holtrop, T. L. Prescott, M. H. Rahbar and D. Strong, “Pilot RCT results of stop my smoking USA: a text messaging--based smoking cessation program for young adults,” Nicotine & Tobacco Research, vol. 15, pp. 1388-1399, 2013.

[43] F. Naughton, A. T. Prevost, H. Gilbert and S. Sutton, “Randomized controlled trial evaluation of a tailored leaflet and SMS text message self-help intervention for pregnant smokers (MiQuit),” Nicotine & Tobacco Research, p.ntr254, 2012

[44] H.-J. Shi, X.-X. Jiang, C.-Y. Yu and Y. Zhang, “Use of mobile phone text messaging to deliver an individualized smoking behaviour intervention in Chinese adolescents,” Journal of telemedicine and telecare, vol. 19, no. 5, pp. 282-287, 2013.

[45] C. Free, G. Phillips, L. Galli, L. Watson, L. Felix, P. Edwards, V. Patel and A. Haines, "The Effectiveness of Mobile-Health Technology-Based Health Behaviour Change or Disease Management Interventions for Health Care Consumers: A Systematic Review", PLoS Med, vol. 10, no. 1, p. e1001362, 2013.

[46] J. B. Bricker, K. E. Mull, J. A. Kientz, R. Vilardaga, L. D. Mercer, K. J. Akioka and J. L. Heffner, “Randomized, controlled pilot trial of a smartphone app for smoking cessation using acceptance and commitment therapy,” Drug and alcohol dependence, vol. 143, pp. 87-94, 2014.

[47] J. Choi, G.-Y. Noh and D.-J. Park, “Smoking cessation apps for smartphones: content analysis with the self-determination theory,” Journal of medical Internet research, vol. 16, no. 2, 2014.

[48] N. Lewis, 2011. “Mobile Health App Users Want Intelligent, Interactive Features,” InformationWeek. [Online]. Available: http://www.informationweek.com/mobile/mobile-health-app-users-want-intelligent-interactive-features-/d/d-id/1097543?. [Accessed: 28- Dec- 2015].

[49] CHIC, 2010. “Motivating Patients to Use Smartphone Health Apps,” Consumer Health Information Corporation, 2010

[50] NTCC, 2010. “A Guide to Quit Smoking,” National Tobacco Cessation Collaborative, 2010.
[51] J. A. Cafazzo, M. Casselman, N. Hamming, D. K. Katzman and M. R. Palmert, “Design of an mHealth app for the self-management of adolescent type 1 diabetes: a pilot study,” Journal of medical Internet research, vol. 14, no. 3, 2012.
[52] E. R. Breton, B. F. Fuemmeler and L. C. Abroms, “Weight loss—there is an app for that! But does it adhere to evidence-informed practices?,” Translational behavioral medicine}, vol. 1, no. 4, pp. 523-529, 2011.
[53] C. Liu, Q. Zhu, K. A. Holroyd and E. K. Seng, “Status and trends of mobile-health applications for iOS devices: A developer's perspective,” Journal of Systems and Software, vol. 84, no. 11, pp. 2022-2033, 2011.
[54] E. Årsand, D. H. Frøisland, S. S. O. T. Chomutare, N. Tatara, G. Hartvigsen and J. T. Tufano, “Mobile health applications to assist patients with diabetes: lessons learned and design implications,” Journal of diabetes Science and Technology, vol. 6, pp. 1197-1206, 2012.
[55] T. McCurdie et al., “The case for user-centered design,” Horizons, 2012.
[56] S. Rachman, 'The evolution of behaviour therapy and cognitive behaviour therapy', Behaviour Research and Therapy, vol. 64, pp. 1-8, 2015.
[57] D. Meichenbaum, J. Carlson and D. Kjos, 2009. Cognitive-behavioral therapy, Psychotherapy.net.
[58] L. C. Abroms, J. L. Westmaas, J. Bontemps-Jones, R. Ramani and J. Mellerson, “A content analysis of popular smartphone apps for smoking cessation,” American Journal of Preventive Medicine, vol. 45, pp. 732-736, 2013.
[59] HSCIC, “Statistics on Smoking: England, 2013,” Health & Social Care Information Centre, 2014.
[60] S. L. Nijhof, G. Bleijenberg, C. S. Uiterwaal, and J. L. Kimpen, “Effectiveness of internet-based cognitive behavioural treatment for adolescents with chronic fatigue syndrome (FITNET): a randomised controlled trial,” The Lancet, vol. 379, pp. 1412-1418, 2012.
[61] A.H. Alsharif, and N.Y. Philip, "A framework for smoking cessation in the Kingdom Of Saudi Arabia using smart mobile phone technologies (Smoke Mind)." Computer Science, Computer Engineering, and Social Media (CSCESM), 2015 Second International Conference on. IEEE, 2015.
[62] S. Haug, C. Meyer, G. Schorr, S. Bauer and U. John, “Continuous individual support of smoking cessation using text messaging: a pilot experimental study,” Nicotine & Tobacco Research, 2009.
[63] A. Rodgers et al., “Do u smoke after txt? Results of a randomised trial of smoking cessation using mobile phone text messaging,” Tobacco Control, vol. 14, pp. 255-261, 2005.
[64] Healthline Networks Inc., “The Best Quit Smoking iPhone and Android Apps of the Year”, [online]. Available at: http://www.healthline.com/health/quit-smoking/top-iphone-android-apps#2 [Accessed: 25-Jan-16]
[65] A.H. Alsharif, and N. Y. Philip. "Cognitive Behavioural Therapy embedding smoking cessation program using smart phone Technologies." Information and Communication Technologies (WICT), 2015 fifth World Congress on. IEEE, 2015.
[66] Ybarra ML, Holtrop JS, Prescott TL, Rahbar MH, Strong D. Pilot RCT results of stop my smoking USA: a text messaging-based smoking cessation program for young adults. Nicotine Tob Res. 2013;15:1388–1399. doi: 10.1093/ntr/nts339.
[67] Erica, R. and Rena G., ‘The Best Quit Smoking iPhone and Android Apps of the Year’. [online] Available at: http://www.healthline.com/health/quit-smoking/top-iphone-android-apps#2 [Accessed: 29-Jan-16]

Author Biographies

Abdullah H. Alsharif Passed his BEng degree in Computer Systems Engineering from Bedfordshire in 2011. He won the National Instruments prize for the most innovative project in BEng. He also passed his MSc in Business Information Systems from Bedfordshire in 2012. Presently, he is a PhD Researcher at Kingston University, London studying Information Systems. His research interest includes Management Information Systems, Bio-Informatics, Mobile Health, Data Mining, Decision Support Systems, System Analysis and Design.

Nada Philip is a Senior Lecturer in the field of Mobile health (mhealth) at Kingston University London. She is the founder of the research group Digital Media for Health. She was the co-director of the Medical Information and Network Technologies (MINT) research centre for the period of 2013-2015. She obtained her PhD in Mobile Healthcare (mhealth) with the thesis title 'Medical Quality of Service for Optimised Ultrasound Streaming in Wireless Robotic Tele-ultrasonography System' from the Faculty of Science, Engineering and Computing at Kingston University, UK in 2008.

Her research interests are mainly in the areas of Data and Multimedia Communication, Networking and Information Technology in healthcare and medical applications. She has more than 10 years of experience in mobile healthcare (mhealth).