Designing and evaluating of smartphone-based cognitive behavioral therapy to control anxiety and depression

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Article Info	ABSTRACT
  * Corresponding author: *Amirabbas Azizi* *PhD, Department of Health Information Technology, School of Allied Medical Sciences, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran* *Email: amirabbasazizi@gmail.com* 	**Introduction:** Depression and anxiety are prevailing mental health disorders. The presence of several barriers in face-to-face approaches for treating these diseases and the emergence of numerous post-pharmacotherapy complications have made researchers embark on removing barriers in treating these diseases. The research on mental healthcare aiming to develop non-pharmaceutical treatments has presented and evaluated many approaches. One of these approaches is cognitive-behavioral therapy (CBT), which is effective in depression and anxiety treatment. This study aimed to design and evaluate a psychological program based on CBT and smartphones to control and alleviate the symptoms of anxiety and depression. **Material and Methods:** This study was framed into a 10-session randomized control trial with the assistance of psychologists and valid scientific books. It was designed and implemented in the form of an applied smartphone-based program. After selecting 45 samples and assigning them to intervention and control groups, the researchers examined the effect of the application-based CBT on patients' depression and anxiety, then analyzed the results with statistical tests with SPSS software. **Results:** After the intervention, the data normality was confirmed by statistical analyses. Then, the paired T-test was used to analyze the pre-intervention and post-intervention data on anxiety and depression and the results were obtained with (P=0.001) and (P=0.002) respectively. According to the results, there was a significant difference between the results of the intervention group before and after using the software, while the control group manifested no significant differences. **Conclusion:** With its user-centered approach, this software develops a mobile health (mHealth) program that improves and controls anxiety and depression by providing an efficient therapeutic method within a self-care program and removing spatial and temporal barriers.

INTRODUCTION

The World Health Organization (WHO) defines health as a condition in which individuals not only lack any disease or defects but also possess full physical, mental, and social welfare. According to this definition, mental health is introduced as an undeniable dimension of individuals' health [1]. Today, the prevalence of mental disorders is one of the biggest challenges of modern healthcare [2]. WHO predicts that mental disorders will be the main reason for the disease burden all over the world by 2030 [3].

Among mental health disorders, depression and anxiety are prevalent cases that often co-occur, cause considerable pain, and reduce the quality of life [4-6]. According to the WHO report, over 300 million

patients in the world suffer from depression, and over 284 million struggles with anxiety disorders [4, 7]. For example, the annual per capita of patients with anxiety disorders is 40 million in America, and this rate reaches 16 million for depressed individuals [8, 9]. In Iran, one person, out of five adults, experiences mental disorders in his life. Reports reveal that anxiety and depression symptoms influence 21% and 20.8% of the adult population, respectively [10].

However, minimally half of the patients are not treated for various reasons, e.g., not perceiving the need for treatment and self-reliance [11, 12], fear of stigma [13], and difficulty in accessing specialized care [14-16]. On the other hand, the dispersion of mental healthcare systems [17], high costs of treatments [18], and not accessing clinical psychologists and psychiatrists, are among the treatment challenges of mental disorders. It has been confirmed that untreated mental disorders have negative impacts on mental health, healthcare costs, productivity, and welfare [19-21].

The permanence of mental problems and traumas extensively impacts the daily and routine social, occupational, and familial performance of individuals [22, 23] and imposes heavy financial burdens on society and healthcare services [24, 25]. Concerning the long-term effect of these disorders on individuals and societies, early treatments can noticeably be influential. Depression and anxiety treatment approaches mainly involve pharmacotherapies and psychotherapies. Pharmacotherapy can alleviate patients' symptoms, while medications lack strong tolerance and prognosis.

On the other side, psychotherapy can compensate for this deficiency and make the treatment more effective. The main approaches to psychotherapy include behavior therapy, cognitive therapy, and hypnotism therapy, and among psychotherapy approaches, cognitive-behavioral therapy (CBT) is an effective method for anxiety and depression disorders [26] and considered a golden standard for treating many mental health problems [27]. CBT is an evidence-based intervention for depression and anxiety and is provided by therapists in conventional face-to-face interventions [28-31].

Studies show that CBT can be as effective as pharmacotherapy [32]. However, conventional face-to-face CBTs are time-consuming and costly and depend on the availability of trained therapists [16]. However, individual CBTs can improve the patient's quality of life, reduce mental distresses during crises, and bring about long-term positive impacts [33-37]. Many approaches, such as bibliotherapy, are employed in individual CBTs, and these self-regulatory mental health interventions have long revealed their efficiencies [38]. Concerning the structured nature of CBT, program can provide patients with predesigned content and enable them

to access it at any time and place they wish. Therefore, healthcare-provision time and cost are saved, and the care capacity is enhanced [38-46]. CBT-based interventions are suitable for application in mobile health (mHealth) programs due to their robust empirical bases and clear and specific structures and frameworks [2].

According to respective studies, self-regulated CBT can be used as an intervention with minimum direct contact. It enjoys many benefits as a self-regulatory treatment-access platform for those patients that need CBT and face barriers that prevent them from meeting psychotherapists [47]. Studies about self-regulatory CBT can motivate patients, maintain their clinical progresses considerably, influence the non-use of mental health services, shorten long waiting lists, circumvent the barriers to using services, and effectively reduce the care and welfare facility costs [47, 48].

With the surge of the treatment demand, mental healthcare systems are pressurized throughout the world and look for accessible, cost-effective, and time-fit solutions [49]. For this reason, the aim was to present a self-care application that could present cognitive-behavioral therapy within a framework of CBT approaches and characteristics to users and pave the way for attaining mental health and getting rid of mental traumas.

MATERIAL AND METHODS

According to previous studies, treating anxiety and depression by CBT needs approximately eight to twelve sessions [50, 51]. Since this program was designed for patients with mild to moderate levels of anxiety and depression, it was implemented in ten sessions on average. To homogenize temporal conditions, users were asked to finish every session in a day and examined the effect of the intervention during these ten days concerning the pre- and post-assessments. In this analysis, the users were compared in terms of their depression and anxiety levels with their pre-intervention time.

Ethical approval

This was a 10-session, mobile-based, unblinded randomized controlled trial, with a control group. This study, registered on Iranian Registry of Clinical Trials (IRCT), received approval from the Research Review Committee and the Regional Ethics Committee (Approval ID: IR.AJUMS.REC.1400.437).

Characteristics of the target population and research location

The statistical population consisted of clients referring to the social mental health center affiliated with the Lorestan university of medical sciences, Lorestan-Iran.

Sample size

The purpose was to attract 30 to 50 participants. This sample size is considered sufficient for identifying employment-associated problems, providing interventions, and running assessments [52]. Out of 45 patients who participated in this study, 25 were assigned to the intervention group and 20 to the control group. To control the conditions and reduce the risk of sample attrition a larger sample size was considered for the intervention group.

Data collection instruments

Patients' conditions were evaluated by Beck's anxiety and depression scales. These questionnaires examine and assess all moods and mentalities of individuals with 21 items. The validity and reliability of these tests have been confirmed [53].

Randomization

After acquiring the informed consent of the patients, they assigned into two intervention and control groups randomly.

Research design

Patients in the intervention group accessed the self-care content in the application, while their counterparts in the control group followed their conventional treatments and only filled out the anxiety and depression questionnaires.

Inclusion criteria

- Men and women with depression and anxiety histories
- Patients aged between 15 and 50
- Possessing Android smartphones
- Knowing how to work with smartphones completely
- Patients willing to participate in the study with complete satisfaction

Exclusion criteria

- Patients' disinclination to continue their cooperation
- Patients' non-active participation
- Patients' critical conditions and inability to participate in the project
- Patients' hospitalization
- Patients' entrance to other research projects

Developing the self-care application (Monji)

At first, the researchers developed the initial concepts of the program by studying several psychology books, extracting the main subjects, with a psychologist's confirmation. These subjects were separated and categorized into ten sessions to be presented to the users. The subjects were a combination of texts, a space for the users' replies, and tables. The users were first to read the subjects and then answer the questions raised immediately or at the end. After a few days, the users were asked some questions about the presented subjects. If it was found that they did not predominate the previously-presented topics, they were encouraged to re-study and try to perceive the subjects profoundly. The software was implemented by a research team using the Kotlin programming language in the android platform.

The merits of the Monji application

This program is written with the help of cross-platform and advanced Kotlin programming language for the Android platform. In this program, MySQL database is used to collect user information and store it in the user's mobile phone. In addition, app was designed offline in order to gain more user's trust and satisfaction. The main components of this software are examined in the following:

The self-care plans

This section is the main component of this software and encompasses a ten-session program that is extracted from several psychology books. The users are obliged to fill out the anxiety and depression tests in the first and tenth days, and their information is examined and evaluated on the seventh to ninth days with regard to the subjects they have been provided with until then.

Daily thought records

Considering the CBT procedure, app consisted a phase where individuals reached better feelings or tried to improve or alter their thoughts after mentioning their senses and reflections following several approaches. All pieces of information users entered in the past days were easily accessible in the Results section, and they could review them completely.

Fig 1: The scheme of the self-care plan section and the plan for third day respectively
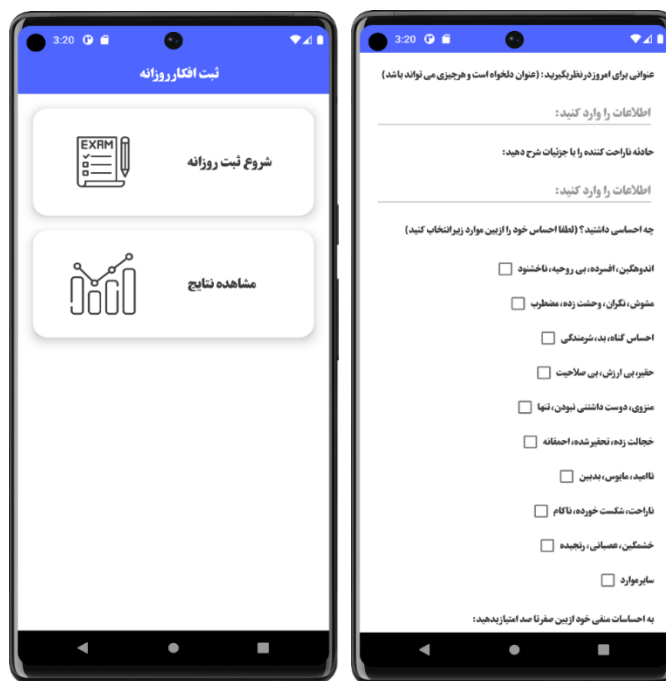

Fig 2: Screenshots of the daily thought records section

Tests

This phase included Beck's anxiety and depression scales, whose validity and reliability were confirmed [53]. Every test encompasses 21 items that measure the mental and physical conditions of individuals in the past several days. Beck's depression inventory assesses sadness, pessimism, sense of failure, loss of pleasure, guilt, the expectation of punishment, dislike of self, self-accusation, suicidal thoughts, crying, agitation, irritability, social withdrawal, indecisiveness, worthlessness, loss of energy, insomnia, loss of appetite, preoccupation, fatigue, and loss of interest in sex.

Beck's anxiety inventory also examines mental, physical, and fear by considering the following factors: feeling hot, wobbliness in legs, heart pounding, numbness or tingling, unable to relax, fear of worst happening, dizzy or lightheaded, unsteady, terrified, nervousness, feeling of choking, hands trembling, shaky/unsteady, fear of losing control, difficulty in breathing, fear of dying, scared, indigestion, feeling of fainting, flushed face, hot/cold sweats.

In both inventories, there are four alternatives, each of which is scored between zero and three. The final score of the test ranges from zero to 63, where 0-7 indicates a minimal level, 8-15 shows mild that necessitates reference to therapists, 16-25 indicates moderate for which individuals would better visit a therapist, and 26-63 signals severe that refers to therapists' imperative.

After every test, the users were informed of their anxiety and depression scores and provided with appropriate advice. The users could access their scores in the *See the Results* section and gain knowledge of variations in their depression and anxiety degrees by comparing them with past results.

Methods

This phase was designed for users' access to CBT approaches. All methods applied in the software were included in this part together with several new approaches, and the users were enabled to study the respective explanations of every method and employ it if necessary.

Fig 3: Screenshots of the test section

Fig 4: Screenshots of the methods section

Data analysis

The SPSS 26 software was used to analyze the quantitative data descriptively (frequency, percentage, and mean) at the confidence and significance levels of 95% and 0.05%, respectively.

RESULTS

The descriptive analysis of the control and intervention groups was run separately via frequency and percentage parameters for qualitative variables and the mean factor for quantitative variables. Twenty-five subjects constituted the intervention group, 14 (56%) females, and 11 (44%) males, with an average age of 31.9 years. Unfortunately, five participants left the study, and the intervention group was reduced to 20 samples, including 14 females (60%) and six males (30%). The average age of the group also changed to 32.45. The control group also consisted of 20 samples, 15 (60%) females and 8 (40%) males, with an average age of 31.6.

Table 1: The demographics of the respondents and their distribution differences in both intervention and control groups

Property		Number (%)		P-value
		Control Group (N=20)	Intervention Group (N=20)	
Gender	Male	12(60)	6(30)	0.550
	Female	8(40)	14(70)	
Age	<20	1(1)	1(5)	0.364
	20-35	13(65)	11(55)	
	>35	6(30)	8(40)	
Education	Associate degree or less	3(15)	1(5)	0.001
	Bachelor's degree	11(55)	7(35)	
	Above bachelor's degree	6(30)	12(60)	

The Chi-square test was used to ensure the normality of the distribution of some variables, such as gender, age, and education, which were supposed to have confounding effects. The results showed that the groups were significantly different in their educational levels, and the intervention group possessed higher educational levels. However, they were not significantly different in the other variables.

At first examined the normality of the depression and anxiety scores in both intervention and control groups for comparison purposes with Shapiro-Wilk test. The results showed that the distribution of the test scores was normal. Then, the paired T-test was employed to investigate the baseline and post-intervention results in the intervention group. According to the results, there was a significant difference (P-value = 0.001) in the pretest and post-test anxiety scores, as well as a significant difference (P-value = 0.002) in the depression scores after the using of application.

Finally, the pretest and post-test scores of the control group were also examined by the Paired T-test. It was found that the control group did not reveal any significant difference in their anxiety scores (P=0.140) and no significant difference after the program (P=0.683).

Considering the obtained results, the effectiveness of the program on the intervention-group participants' mentalities, and no significant changes in the control group, it could be concluding that the program improve anxiety and depression.

DISCUSSION

With regard to the high prevalence of mental diseases and their growing spread, it is imperative to present treatment approaches according to patients' conditions. Since conventional methods, like face-to-face treatments, are accompanied by various problems, like high costs, fewness of expert therapists, stigma, long waiting times, etc. [54], it can benefit from IT technology to remove these problems. The use of CBT is one of the best methods for treating psychological disorders. Integrating this therapeutic approach with IT technology can overcome many common problems in treatment and provide suitable conditions for improving and treating psychological disorders such as anxiety and depression.

Prior to this, research has been conducted in this field, and significant results have also been achieved. One of these studies is the research conducted by Newton et al, titled "A Mobile Phone-Based App for Use During Cognitive Behavioral Therapy for Adolescents with Anxiety (MindClimb): User-Centered Design and Usability Study". The evaluation of using this program showed that young adults and therapists usually feel that using software to practice CBT outside therapy sessions is useful and easy. Having CBT skills and tools on their phones at all times enables teens to practice their skills more between sessions. They recommend integrating the use of the program into the CBT treatment manual [55].

Another study by McCloud et al., titled "Effectiveness of a Mobile App Intervention for Anxiety and Depression Symptoms in University Students: Randomized Controlled Trial" evaluated the mobile application called "Feel Stress Free" for treating anxiety and depression symptoms. This study was

conducted on 168 students, who were divided into two groups of 84, one for intervention and one for control. After necessary evaluations, researchers concluded that the application is a promising mobile intervention for treating anxiety and depression symptoms in students and overcomes many of the obstacles of traditional CBT [56].

In addition to the mentioned cases, another study by Venkatesan et al., titled "Digital Cognitive Behavior Therapy Intervention for Depression and Anxiety: Retrospective Study" examined the effectiveness of a cognitive-behavioral program called Vida. After conducting a study on the results and based on the significant decrease in symptoms of anxiety and depression in the participants, researchers concluded that digital interventions can support sustainable and significant clinical improvements in depression and anxiety symptoms. It also appears that initial digital intervention in the area of mental health may facilitate this matter [57].

Subsequently, in view of the points discussed above and inspired by the research [58-67] done on this topic, the application was designed.

To this end, the application was designed and examined for ten sessions based on one of the most credible psychological techniques (CBT). After the trial and patients' program evaluations, the results were analyzed. In this regard, the Chi-square test was used to determine confounding factors. This test revealed that among the patients' variables, i.e., gender, age, and education, the educational level was higher in the intervention group than in the control group and could be considered confounding.

Then, the normality of the data was confirmed by the Shapiro-Wilk test. Also, the pre-intervention and post-intervention scores of the patients were compared by the Paired T-test. The founding showed that the posttest scores of the intervention group were significantly different from their baseline scores, while the control group revealed no significant differences in the primary and secondary outcomes.

CONCLUSION

The results showed that the depression and anxiety levels of the intervention and control groups were significantly different due to using the Monji CBT application, such that the mean anxiety and depression scores of the intervention group were lower than the mean scores of the control group. This issue reflects the effectiveness of the program on individuals' mental health.

To evaluate the program, future studies are suggested to consider longer intervals, larger samples, and broader geographical scopes since individuals' mentalities depend on the culture and members of the society they are interacting, especially in culture-influenced countries like Iran. Concerning the structure of the application, with using gamification techniques can implement more attractive and efficient programs that make individuals more adhered to using the application. Besides, the employment of artificial intelligence to present and propose the existing approaches and techniques of the program in a customized way commensurate with individuals' abilities can provide patients with a program with fitter using experiences.

Limitations of the study

The present study has the following limitations:

- Access to mobile phones was a limiting factor.
- Farsi language used in the app.
- Individuals aged above 50 years did not attend the study.
- Low-literate or illiterate patients did not participate in the study.
- A short period was considered for the assessment of the program.
- The size of the samples in the intervention and control groups was few.
- The program was examined in a very small geographical scope, and the generalization of the results seems illogical.

AUTHOR'S CONTRIBUTION

All authors contributed to the literature review, design, data collection and analysis, drafting the manuscript, read and approved the final manuscript.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest regarding the publication of this study.

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