

DEPINVA WeChat Applet for Online Intervention of Depression Based on Accept Cognition Theory

Ronghua Xu (✉ ronghuaxu@zjut.edu.cn)

Zhejiang University of Technology <https://orcid.org/0000-0001-7349-1005>

Qingpeng Zhang

City University of Hong Kong

Honglu Zou

Zhejiang University of Technology

Sidie Tan

Zhejiang University of Technology

Lifan Zhu

East China University of Science and Technology

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Abstract

Background: Studies have shown that the phenomenon of fetal malformations can cause serious psychological problems and even depressive symptoms of pregnant women during their perinatal period. Psychological studies have shown that involving these women into appropriate interventions and treatments can effectively alleviate their depressed symptoms. With the prevalence of mobile technologies and online social networks, practitioners and researchers have been dedicating to move the offline intervention strategies to online platforms for the treatment of depression caused by fetal malformations.

System Design: We design an online DEPression INterVention system (DEPINV), suitable for the online intervention of depressed woman suffering from fetal malformations. There are three main features in the design of DEPINV. First, it intends for the effective coordination and interaction among three types of user roles in order to reach a tripartite synergistic therapy effect. Second, it focuses on the assessment and monitoring of users' psychological state, and the Accept Cognition Theory (ACT) is introduced into the design of the system for the intervention. Third, various communication channels are provided to assist users' coordination and ACT-based intervention.

System Implementation: To make the access easy and flexible, we adopt the WeChat applet as the development and deploying technical framework. Therefore, DEPINV is a WeChat applet that can be accessed by simply scanning the Quick Response (QR) code. It cooperates three types of users, the healthcare providers, depressed women and their family members. That is, DEPINV helps healthcare providers to maintain and manage the psychological states of depressed women with the involvement of their family members. There are six successive stages in the core function of the ACT-based intervention and each target for the accomplishment of one specific psychological state. Through the comprehensive management of treatment procedure, DEPINV applet helps healthcare providers record and monitor the dynamic change of patients' affections. To cope with the negative emotions of depressed women, various channels of information support, social support and emotional support are also provided for instant communication between healthcare providers and family members.

Conclusion: The DEPINV applet provides effective online interventional strategies and treatments for depressed women with the help of both healthcare providers and their family members. When more interventional features and functions are included, it is necessary to extend the applet into a mental health app.

Background

According to the White Paper on Mental Health of Urban Residents in China, 10.3 percent of the country's population have been suffering from some type of mental illnesses[1]. Among them, more than 264 million Chinese people worldwide have been suffering from depression, which is a leading cause of poor health and disability worldwide[2][3]. With the conduct of the "third baby" policy released by the Chinese

government, the type of perinatal depression caused by the fetal malformation during the pregnant period has become prevalent.

Fetal malformation during pregnancy will cause serious adverse psychological reactions to both the mothers and their family members, which will become worse in the late pregnancy, and even cause maternal depression and more severe symptoms[4][5]. With the help of professional healthcare providers, the depressed symptoms can be alleviated with less physical pain, relieved psychological pressure and reduced psychological burden. Therefore, it is very necessary and important to grant appropriate psychological treatments to the maternal women, as has also been proved to be acceptable and effective in clinical practices[6][7].

With the rapid development of Internet technologies, online social networks have exerted higher and higher impact on Chinese people's attitudes toward medical treatment and on changing their health behaviors [8][9]. With the advantages of large volume of audience, high user participation and high retention rate, online social networks have also been widely adopted to promote public health[10]. For instance, compared with offline friends and family members, users would more like to discuss their problems in online social networks (such as WeChat)[11]. And compared to the offline environment, online users are exposed to more sources of positive social influence and fewer sources of negative social influence[12].

WeChat is one of the largest online social networks for instant messaging services[13][14]. The monthly active accounts of WeChat are 1.2 billion, with an increase of 8.2% year-on-year. As a representative form of social networks, WeChat has become an integral part of the daily lives of Chinese people. And it has shown potential impact on changing health behaviors of its users[15]. As WeChat applet is easy to be integrated into WeChat, there is a rapid growth of applet users. Intervening through WeChat applet is not only cost-effective and convenient, but also shortens the treatment time[16][17][18].

Based on the above advantages, we design and implement a WeChat applet, DEPRESSION INterVENTion system (DEPINV) to carry out online intervention for depressed women caused by fetal malformation. As family members should also be involved, DEPINV is designed to coordinate not only the healthcare providers with depressed women, but also the healthcare providers with their family members to reach a tripartite synergistic therapy effect[19]. Healthcare providers distribute online questionnaires to depressed women before and after accepting the intervention. Healthcare providers can get in touch with the family members to provide better treatment and social support. Family members can also follow the treatment procedure of depressed women and ask questions to healthcare providers, in order for instant and better treatment of the depressed women.

Focusing on the assessment and monitoring of users' psychological state, we introduce the Accept Cognition Theory (ACT) into the development of the system and design ACT-based intervention strategies. Therefore, there are six successive modules in the core function of DEPINV and each module targets for the accomplishment of one specific psychological state in the ACT-based intervention strategies. There are six successive stages in the ACT intervention, the acceptance, the cognitive

defusion, the being present, the self as context, the values and committed action. The six units will be carried out in dynamic collaboration among healthcare providers, depressed women and their family members.

Related Therapies

Before introducing the system, we categorize and compare four types of therapies for depression, the anti-depression drugs, the Cognitive Behavioral Therapy (CBT), the Vagus Nerve Therapy (VNS) and the Acceptance and Commitment Therapy (ACT).

Antidepressant drugs, as the main treatment of depression can effectively relieve the symptoms of depression. Since the 1950s, the treatment of depression has mainly relied on antidepressant drugs based on the monoamine hypothesis, such as monoamine oxidase inhibitors, tricyclic drugs and selective serotonin (5 - HT) reuptake inhibitors[20]. There are also many limitations and shortcomings, including relatively low efficiency, multiple side effects and time lag for treatment[21]. For instance, one of the studies have shown that less than one third of the patients responded to the antidepressants for the first treatment[22][23]. Even if patients attained the initial clinical cure, there is still a high risk of depression recurrence up to 50% while the recurrence rate after the second onset is higher[23].

Cognitive behavioral therapy (CBT) is based on the cognitive theory of emotional disorders. It believes that people's thoughts and beliefs are the rooted causes of emotion and behavior, and the dysfunctional cognition leads to emotional disorders and inadaptability[24]. Studies have shown that CBT can help patients adjust their cognition of the reality, reconstruct reasonable, positive and adaptive ideas, and guide patients to correctly evaluate themselves and the outside objective things. CBT also helps patients learn to explore outside resources and seek help to deal with problems in a positive way, thereby improving treatment compliance[25]. However, the current study of CBT intervention for depressive individuals is mostly combined with drug therapy, and the study of CBT alone is less compared with antidepressant drugs[26]. It is unclear which type of depressive patients are more suitable for CBT treatment, which needs further study.

Vagus nerve therapy (VNS) is a kind of invasive treatment, where a pacemaker-like pulse generator is implanted in the chest, and connected to a stimulation electrode located in the cervical vagus nerve. Via electrical stimulation of the vagus nerve and through the solitary tract nucleus, it will finally exit the corresponding cerebral cortex and subcortical structure[27]. In 2005, Food and Drug Administration (FDA) set out to approve VNS for the treatment of chronic or recurrent adult depression[28]. And at present, this treatment method has been applied to the treatment of major depression and drug-resistant epilepsy which has been proved to be effective. However, there are also many shortcomings in the conduct of the VNS treatment such as slow onset, side effects and so on. Studies reported that the response rate of VNS to depression was 31.8%, with an average onset time of more than 9 months[29]. Another study showed that only 35% of the first three months of VNS treatment were effective, while 65% and 50% of these

patients remained effective at 12 and 24 months, respectively[30]. In addition, VNS has many adverse reactions such as pronunciation changes, dyspnea, neck pain and cough[29].

Compared with the above treatment methods, ACT intervention has the advantages of low cost, obvious effect and small side effects. The ACT intervention (Acceptance and Commitment Therapy), includes six core procedures: the acceptance, the cognitive defusion, the being present, the self as context, the values and the committed action. ACT was proposed by the American physician Steven C. Hayes and his colleagues in 1986[31][32]. They advocate that healthcare providers allow the patients to accept pain in a positive manner. People accept the cognition that people cannot be in a state of happiness forever, and re-establish and realize their own values[33]. At present, ACT therapy has been widely used in the intervention treatment of depression and autism with the advantages of good efficacy, low cost and high individual satisfaction[34].

The ACT intervention in this study refers to the professional psychological intervention related to the acceptance and commitment therapy (ACT). That is, the healthcare providers briefly introduce the ACT and the intervention content during the verification period. They then guide the patients to identify the negative emotions and initially experience the mindfulness breathing exercises to concretize the painful emotions. They observe the ideas through the exercises, and guide the patient's cognitive dissociation. In the decision-making period, the healthcare provider makes patients understand that that avoidance and control are ineffective and guides patients to accept via analysis. Via metaphor the healthcare provider can further help patients observe their own inner experience and guide them to be 'self as context'. In the recovery period, metaphor assists to enhance the patients' conscious awareness and mindfulness exercises can help patients clarify values as well as develop goal commitment actions. It is mainly reflected in the medical staff uploading treatment-related audio through the functions in the applet, and 'urge' patients timely review.

Table.1 Review of relevant therapies of depression

The name of therapy	Use-method	Patient participation	Healthcare provider participation	Clinical effect
Antidepressant drugs	<ul style="list-style-type: none"> λ monoamine oxidase inhibitors λ tricyclic drugs λ selective serotonin (5-HT) reuptake inhibitors[20] 	low	low	Limitations include: <ul style="list-style-type: none"> λ relatively low efficiency λ drug resistance λ multiple side effects and time lag for treatment[21].
CBT	<ul style="list-style-type: none"> λ adjust their cognition of reality λ reconstruct reasonable and positive ideas λ guide to correctly evaluate themselves and objective things λ learn to explore resources and seek help to deal with problems in a positive way[25] 	high	high	<ul style="list-style-type: none"> λ combine with drug therapy λ CBT alone is less compared with antidepressant drugs λ unclear the applicability of CBT treatment
VNS	<ul style="list-style-type: none"> λ implant a generator in the chest λ connect it to a stimulation electrode located in the cervical vagus nerve λ stimulate the corresponding cerebral cortex and subcortical structure[27] 	low	low	Adverse reactions [29]: <ul style="list-style-type: none"> λ pronunciation changes λ dyspnea λ neck pain λ cough
ACT	<ul style="list-style-type: none"> λ accept pain in a positive manner λ accept the cognition that people cannot be in a state of happiness forever λ re-establish and realize their own values [31] 	high	high	<ul style="list-style-type: none"> λ good efficacy λ low cost λ high individual satisfaction

Implementation

Design

As one of the most popular online social networks, WeChat has a wide range of users. After logging in WeChat account, users do not need to install WeChat applet. Instead, they can enter the applets directly by scanning QR codes. That is, WeChat applet provides convenient and cost-effective way to get access and conduct depression intervention. Therefore, we intend to implement our intervention system, DEPINV by adopting the development framework of WeChat applets.

To develop a WeChat applet, we first register and obtain the AppID. The overall developing architecture is shown in Fig. 1. According to the B/S framework[35], three layers should be implemented, the front-end customer layer, the intermediate application layer and back-end database layer. In terms of the front-end customer layer, we adopt the technical solution of WeiXin Markup Language (WXML), Wireless Application Protocol Cascading Style Sheet (WCSS) and JavaScript (JS) and use Eclipse as the developing tool. In terms of the intermediate application layer, we rent and deploy our application in the cloud servers. Finally, in terms of the back-end layer, Tomcat has been running in cloud servers and the cloud databases of MySQL(Structure Quest Language) are rented to store the data entered by the users.

DEPINV is designed to coordinate not only the healthcare providers with depressed women, but also the healthcare providers with their family members to reach a tripartite synergistic therapy effect. Therefore, there are three types of users, the healthcare providers, depressed women and their family members. For the effective coordination among three types of user roles, we design the tripartite interaction as is shown in Fig. 2.

In terms of the coordination between healthcare providers and depressed women, when the depressed women join the intervention, the healthcare providers will release the online questionnaires to them. After they complete the questionnaires, healthcare providers shall get feedback, upload the relevant treatment audio of the corresponding unit, and urge the depressed women to review it in time. After the depressed women complete the intervention for a certain time, healthcare providers will issue new online questionnaire to them again and analyze the questionnaire so as to decide whether the depressed women should enter the next stage. In addition, through "Q&A", depressed women can also ask questions so that healthcare providers give answers and suggestions. Healthcare providers can also upload relevant articles for depressed women to learn the relative knowledge and understand their situation better.

In terms of the coordination between healthcare providers and family members, healthcare providers can get the contact information of the family members. They can also know about the comprehensive situation of the depressed women if necessary. Family members can also ask the healthcare providers through "Q&A", and learn the relevant contents through the applet to provide better support for the depressed women.

In terms of the coordination between depressed women and family members, family members can understand the situation of depressed women through the "PROCESS" page, and provides emotional

support for the depressed women offline. To summarize the above interaction, we design the functions of DEPINV as is shown in Fig. 3.

Act-based Intervention

The second and core feature of DEPINV is that, it focuses on the assessment and monitoring of users' psychological state where ACT-based intervention strategies have been implemented. As there are six successive stages in the ACT, the acceptance, the cognitive defusion, the being present, the self as context, the values and committed action. Accordingly, we design and implement six successive units in the series of ACT-based intervention strategies. Each unit targets for the accomplishment of one specific psychological state. Before each stage, healthcare providers use the applet to send questionnaire to the patients. During the intervention stage, patients use the applet to accept the intervention under the supervision of healthcare providers. After the stage, healthcare providers send the questionnaire again to evaluate the change of the psychological state. As a whole, the six units will be carried out in dynamic collaboration among healthcare providers, depressed women and their family members.

To conduct the ACT-based intervention, healthcare providers login in the system and enter the ACT world. They can manage their target depressed woman as their patients, and select one of the patients to conduct the intervention. The overall flowchart conducted by the healthcare providers is shown in Fig. 4. And their corresponding operations in DEPINV are shown in Fig. 5.

When healthcare providers open the corresponding unit, the system shows that the opening is successful. At the meantime, the chosen depressed woman can obtain the audio resources of this unit. Otherwise, the system prompts that the unit is not opened. Each unit displays two functions including 'sending questionnaires' and 'objective drawing'. Healthcare providers click 'sending questionnaires', if they have already sent, the system will prompt 'sending already'. Otherwise, the system will prompt 'sending successfully'. Healthcare providers can also click 'objective drawing' to view the details page of questionnaire filled out by depressed women and analyze their response to give an appropriate comment if the questionnaire has been sent. Otherwise, the system will prompt 'not sent'. When the psychological intervention of the six core units coordinated by healthcare providers, depressed women and family members is implemented, the whole ACT intervention is consequently completed.

Digitized the six stages of the ACT intervention method into six unit modules and moved to online implementation, as is shown in Fig. 5 (A). The specific procedure is reflected in the online questionnaire distributed by healthcare providers to different depressed women through the applet. After the depressed women fill in the questionnaire, the healthcare providers can get feedback. Healthcare providers can also upload therapy-related audio and "urge" depressed women to review it in a timely manner. After the intervention, the healthcare providers sent online questionnaires to the depressed women again, and the questionnaires were fed back to the healthcare providers again, as shown in Fig. 5 (B) (C).

To accept ACT-based intervention, depressed women login in the system and enter the ACT world. They can enter the unit based on their therapy schedule. The overall flowchart conducted by the depressed

women is shown in Fig. 6. And the corresponding operations in DEPINV are shown in Fig. 7.

If the selected unit is open, the corresponding questionnaire and audio resource of this unit are available to get. Otherwise, the system will show “NO”. Then if depressed women are willing to complete the questionnaire, they will receive a feedback by their healthcare provider. Otherwise, the system will stay on the current page. After depressed woman fill out all questionnaires, the system will show “SUCCESS” finally.

After patients logged in to the system, they cooperate with the online ACT intervention provided by the medical staff through the applet, which is six units too (as shown in Fig. 7 (A)). When patients enter each open unit, they can see the questionnaires issued by the attending healthcare provider to themselves (as shown in Fig. 7 (B)). These questionnaires are divided into pre-intervention, post-intervention and “objective drawing” (as shown in Fig. 8(A)(B)(C)). After filling in the questionnaire, patients can see their own answers (as shown in Fig. 8 (D)), and then get feedback from healthcare providers that is whether they will enter the next stage of ACT intervention. In addition, patients can obtain and relish the audio resources of the unit which means further receiving the ACT intervention.

Communication Channel

Finally, the last but not the least important feature of DEPINV is that, various communication channels are provided to assist users’ coordination and ACT-based intervention. Compared to other mental health procedures, the system introduced wide intervention methods, including information support intervention, emotional counseling intervention and social support intervention to assist communication of three sides. Among them, information support intervention is mainly reflected in the uploading of depressed women’s information, links and pages by healthcare providers in the WeChat applet. Emotional counseling intervention and social support intervention both have “Q&A” part, which is mainly reflected in healthcare providers to communicate and interact with depressed women and to provide them with psychological counseling. In terms of family members, healthcare providers can also communicate with them in time through “chat with relatives” part to comprehensively monitor the degree of recovery, so as to realize emotional counseling and social support intervention.

To better support the implementation of intervention strategies, we also design various channels of information support, social support and emotional support. There is a “Q&A” platform between healthcare providers and depressed women, where depressed women can ask healthcare providers questions; then healthcare providers can answer them. Between healthcare providers and family members, healthcare providers can get the contact information of depressed women's family members through the platform. If necessary, healthcare providers can get in touch with the family members to provide better treatment and social support. Family members can also inquire about the treatment process of depressed women through the specific page and ask questions through “Q&A”, so as to jointly assist depressed women with better treatment, as shown in Fig. 10.

At the same time, we also set up an article sharing platform in this applet. Healthcare providers can publish popular science articles on this platform, and depressed women and their families can read. If they like one article, they can give the article likes, as shown in Fig. 11.

Discussion

As one of the most popular online social networks in China, WeChat has obtained a huge number of users and it has shown great potential in changing users' health behaviors. Intervening through WeChat applet has presented many advantages. First, applets are easily accessed by scanning QR codes at any time and at any place, and thus suitable for cultivating user behaviors. As users can reserve time slots of online intervention, reducing the waste of time such as offline transportation, registration and so on. Despite of the advantages, as applets are lightweight with only limited functions, it is necessary to extend DEPINV to mobile applications when complex functions are required.

DEPINV intends to reach a tripartite synergistic therapy effect among healthcare providers, depressed women and their family members. The difference between our applet and other systems is that we not only target healthcare providers and depressed women, but also design the pages of family members. Family members bind the corresponding depressed women through the "BIND" function, view their treatment stage and realize social support intervention. Healthcare providers can get the contact information of family members through the "CHAT" function, which facilitates the communication according to the situation of depressed women. The synergistic effect and information sharing facilities mutual understandings and empathy.

Finally, ACT-based intervention strategies are implemented in DEPINV applet. In recent years, ACT plays a significant role in the treatment of depression, it is not only a unique way of psychological intervention, but also a new technology in the field of psychotherapy. In previous studies, it was found that few applets would be combined with ACT. Therefore, our applet combines with ACT, there are six modules in the core implementation of the DEPINV platform, and each module designs questionnaires and relevant audio, grasps the progress management of intervention implementation, and comprehensively manages the treatment process of depressed women.

In the future work, DEPINV will be used in clinical practices to assist practitioners and healthcare providers conduct the intervention. Our applet has many psychological measurement functions, with the main purpose of auxiliary regulation. In addition, in order to know whether the depressed women's problems are completely cured, we plan to add a three-stage tracking and follow-up function. The healthcare providers will keep in contact with their depressed women and conduct psychological inquiry at three time points of one year, three years and five years. When the depressed women decide to use the applet, we can sign an agreement with them, but the development of this function requires high information maintenance. We need to ensure long-term contact with depressed women and ensure that their information is kept confidential. Of course, in the later development process, as our applet becomes

more and more mature, we also try to use the project in parallel with mental a health app, which can fulfill a wider range of users' needs and retain the advantages of the applet[38][39].

Conclusion

To conclude, the DEPINV applet provides effective online interventional strategies and treatments for depressed women with the help of both healthcare providers and their family members. Healthcare providers use the applet to conduct ACT-based online intervention so that depressed women can participate. Their family members will also be involved into the treatment by scanning the shared information and using the communication channels of the applet. Therefore, DEPINV is intended to reach a tripartite synergistic therapy effect between healthcare providers, depressed women and their family members. When more interventional features and functions are included, it is necessary to extend the applet into a mental health app.

Abbreviations

DEPINV: DEPression INterVention system

ACT: Accept Cognition Theory

CBT: Cognitive Behavioral Therapy

VNS: Vagus Nerve Therapy

FDA: Food and Drug Administration

QR: Quick Response

WXML: WeiXin Markup Language

WCSS: Wireless Application Protocol Cascading Style Sheet

JS: JavaScript

SQL: Structure Quest Language

Declarations

Availability and requirements

Project name: DEPINV DEPression INterVention system

Project home page: refer to the QR code in the right hand

Operating system(s): Platform independent

Programming language: Java, WXML, WXSS, JS, JSON

Other requirements: Java 10.0 or higher, Tomcat 8.0 or higher, WeChat account, WeChat Devtools

License: GNU GPL etc.

Any restrictions to use by non-academics: licence needed, WeChat account needed



胎儿畸形引产女性抑郁干预体验版

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare no conflict of interest.

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Authors' contributions

Xu and Zhang designed the overall framework of the system. Zou, Tan and Zhu implemented the system. All authors wrote and revised the manuscript.

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Figures

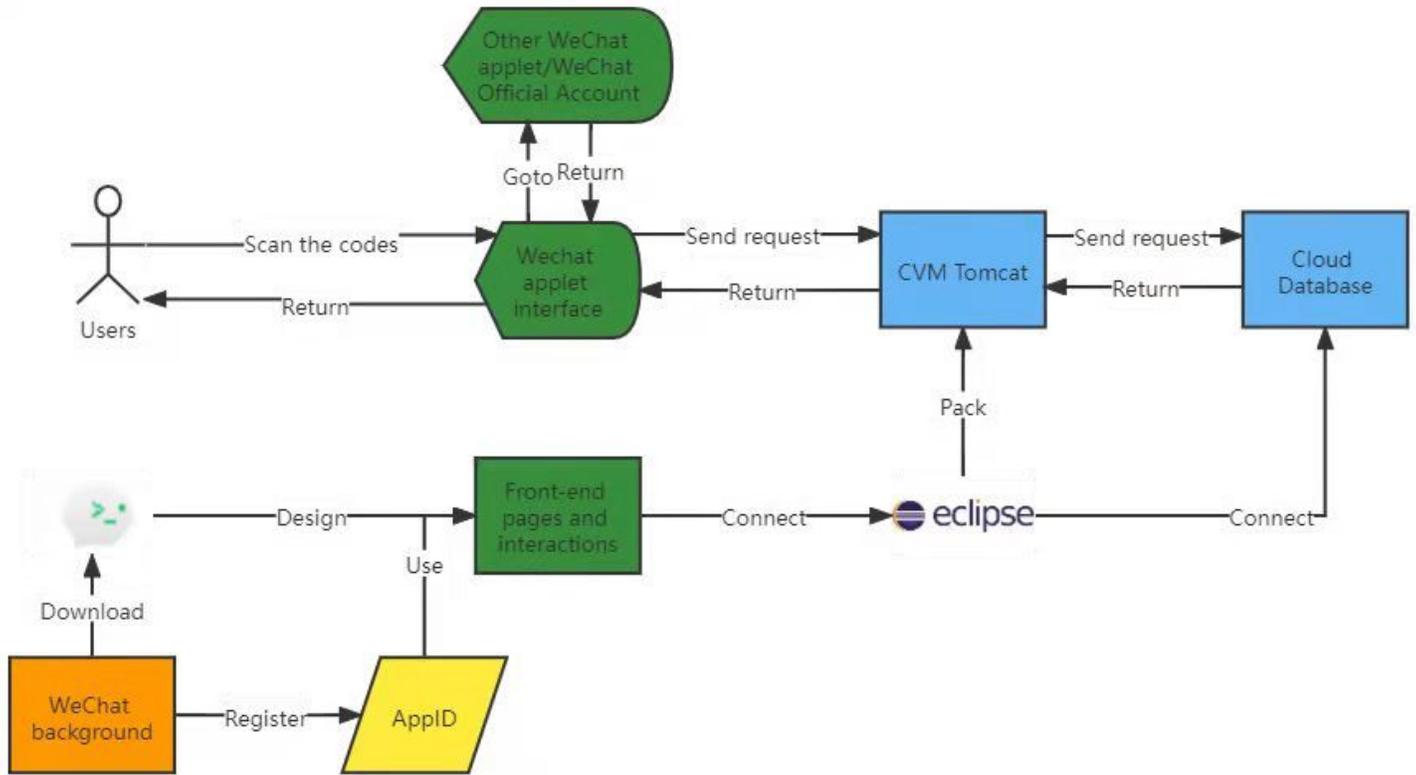


Figure 1

Technical architecture of WeChat applet development

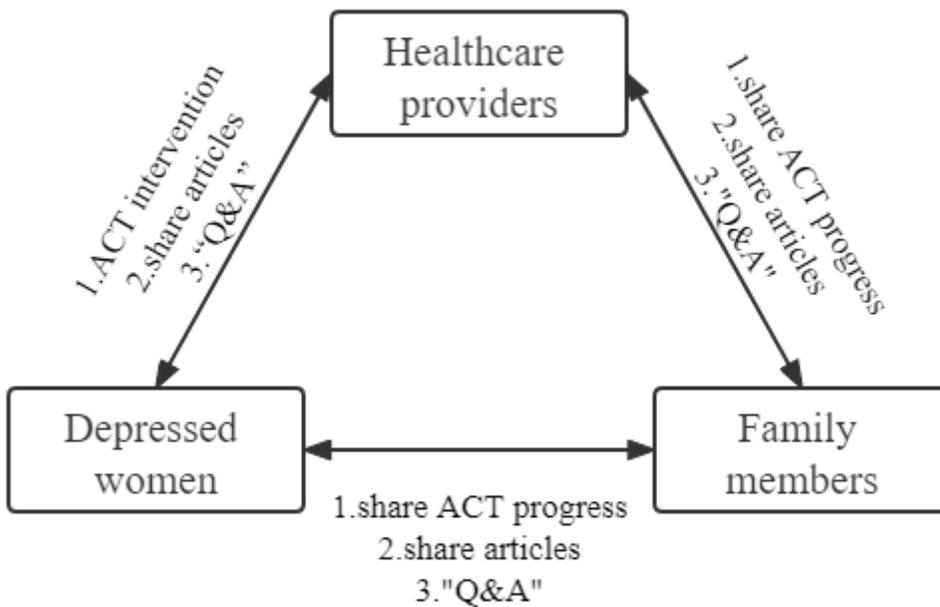


Figure 2

Tripartite cooperation among the three types of users

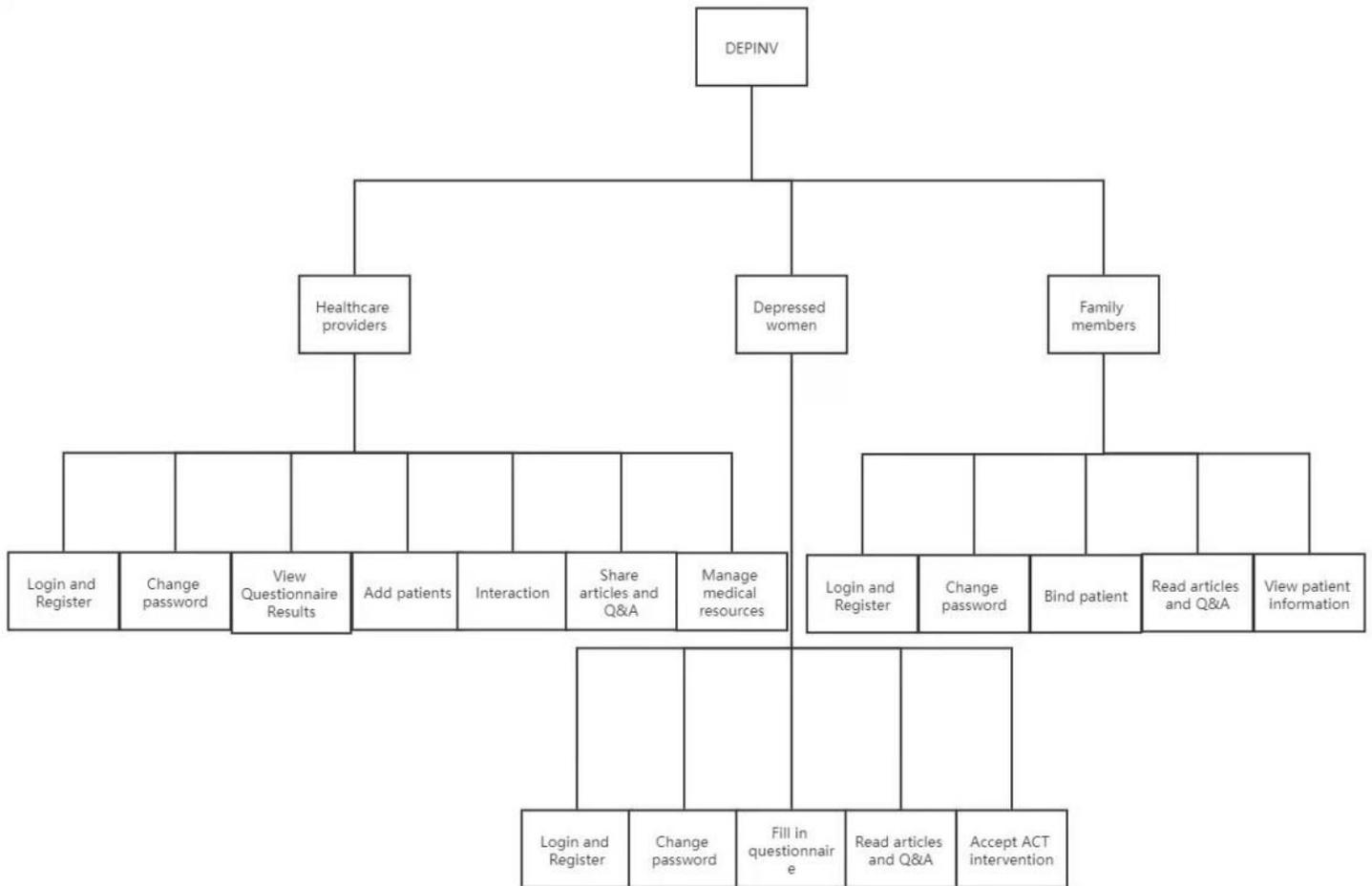


Figure 3

The designed functions of DEPINV

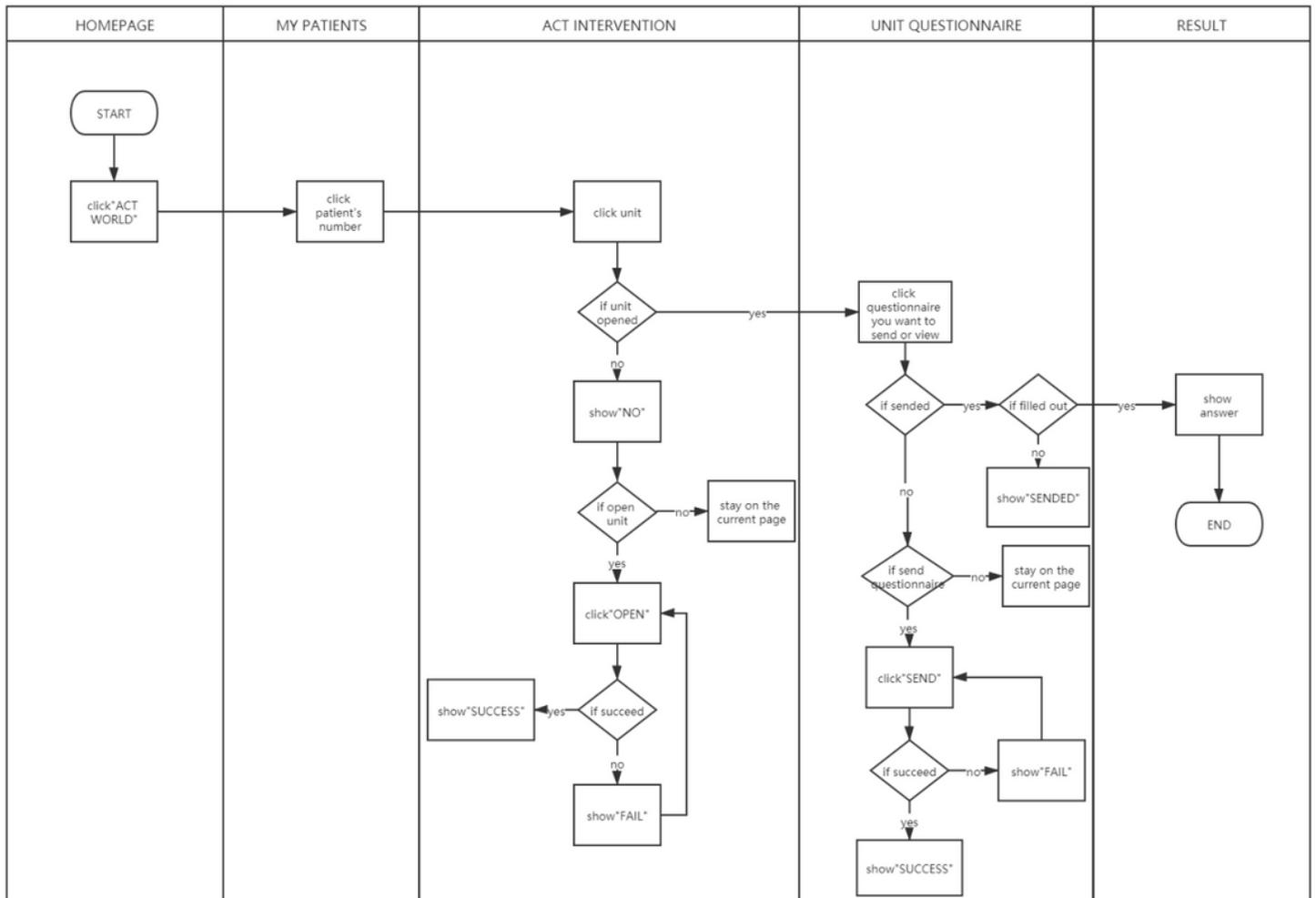


Figure 4

The flowchart of ACT-based intervention for healthcare providers

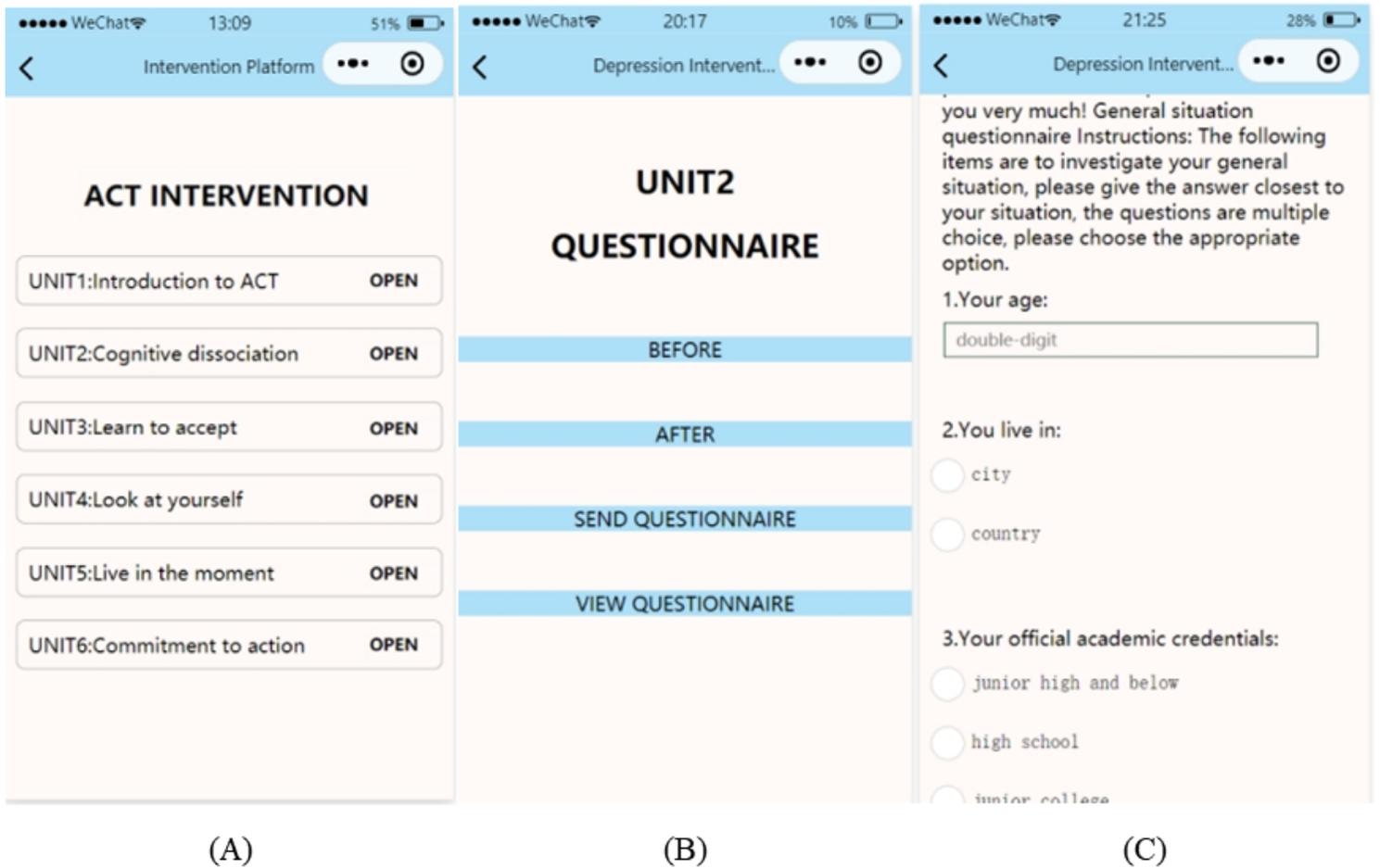


Figure 5

“ACT INTERVENTION” page.(A) Healthcare providers select unit to implement ACT intervention in this page**(B)**Healthcare providers send questionnaires in this page.**(C)**Depressed women answer questionnaires in this page.

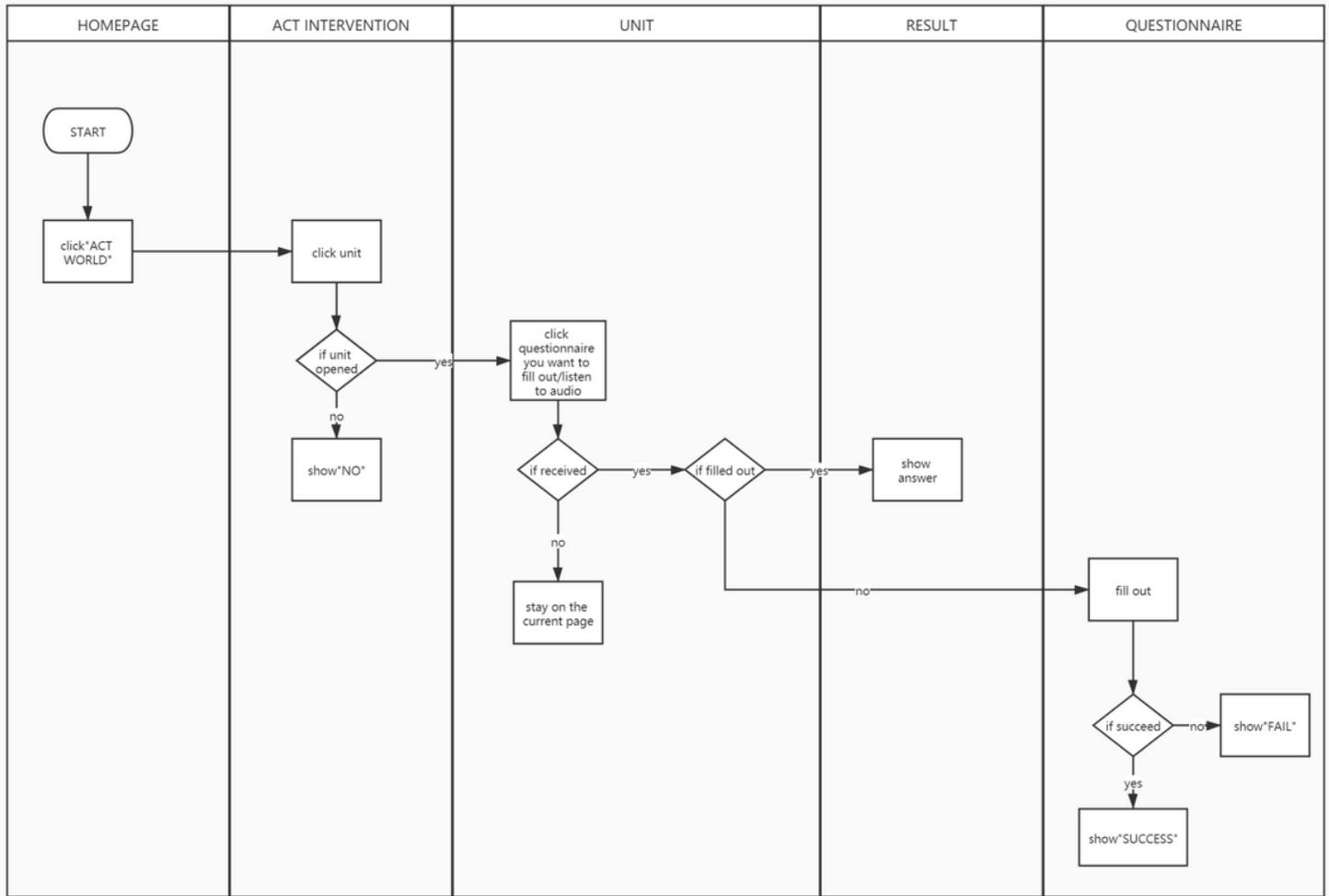
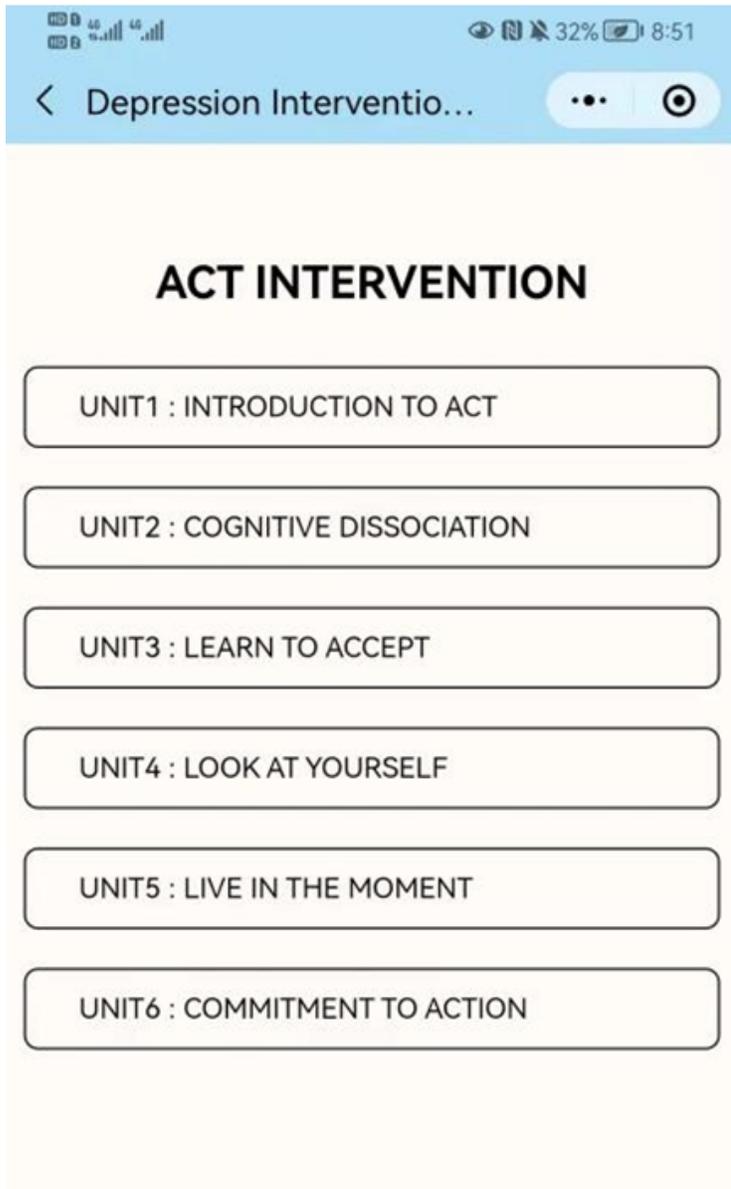
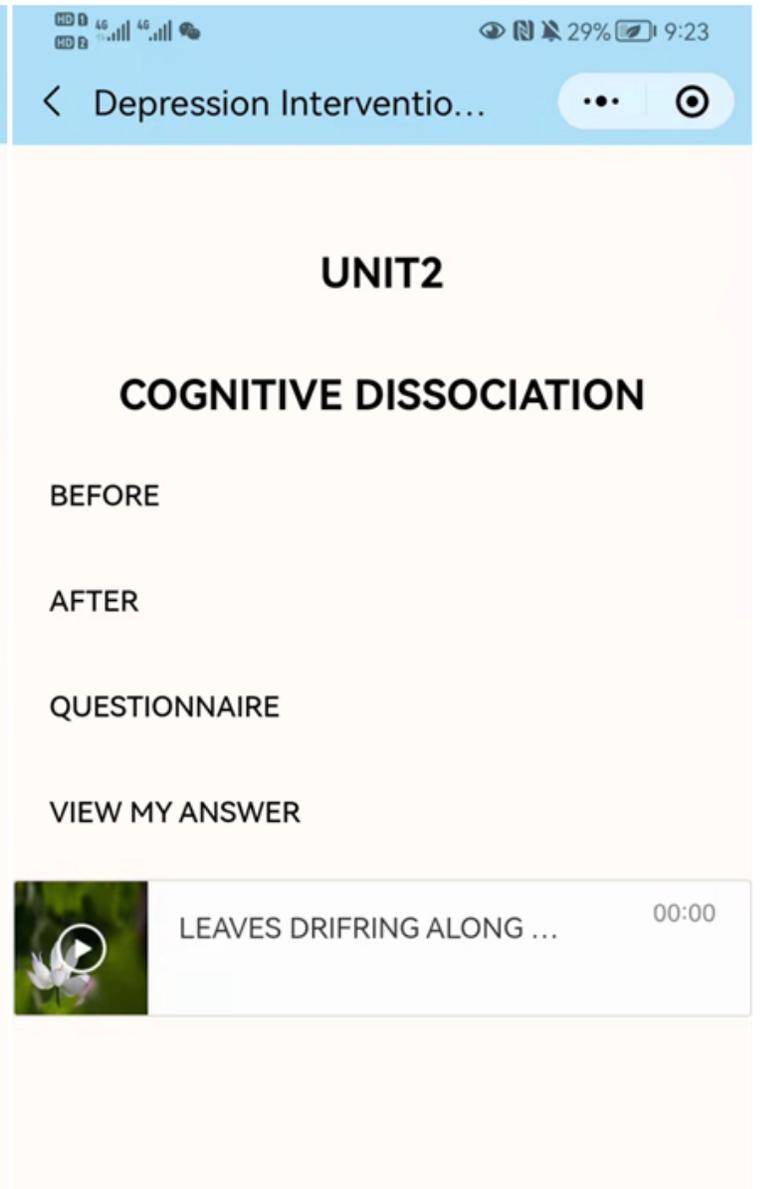


Figure 6

The flowchart of the ACT-based intervention for depressed women



(A)



(B)

Figure 7

“ACT INTERVENTION” page(A) Depressed women select unit to accept ACT intervention in this page.(B) Depressed women accept “UNIT2 COGNITIVE DISSOCIATION” and get audio resources in this page

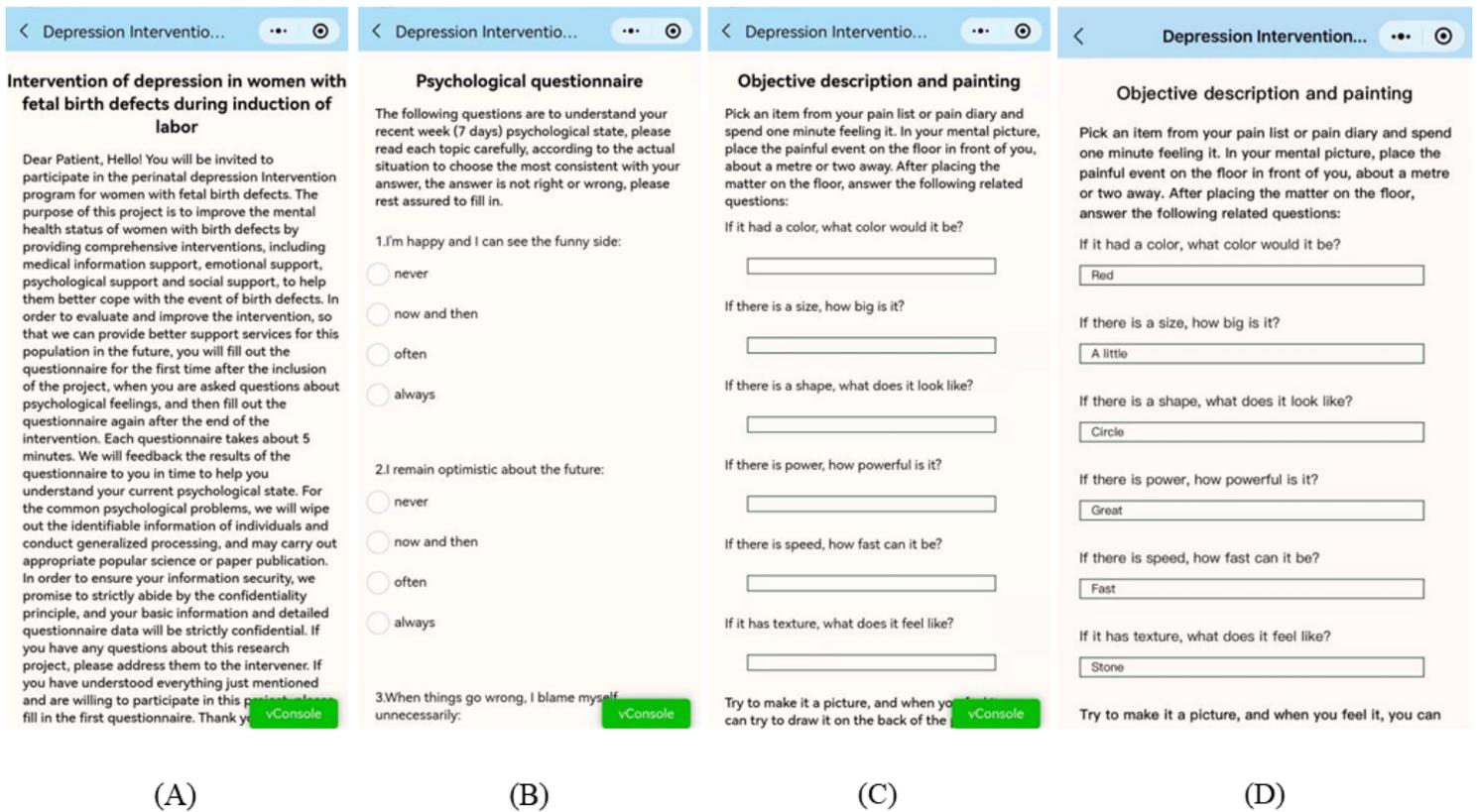


Figure 8

“ACT QUESTIONNAIRE” page. (A) pre-intervention questionnaire. (B) post-intervention questionnaire. (C) “objective drawing” questionnaire. (D) the answer of “objective drawing”.

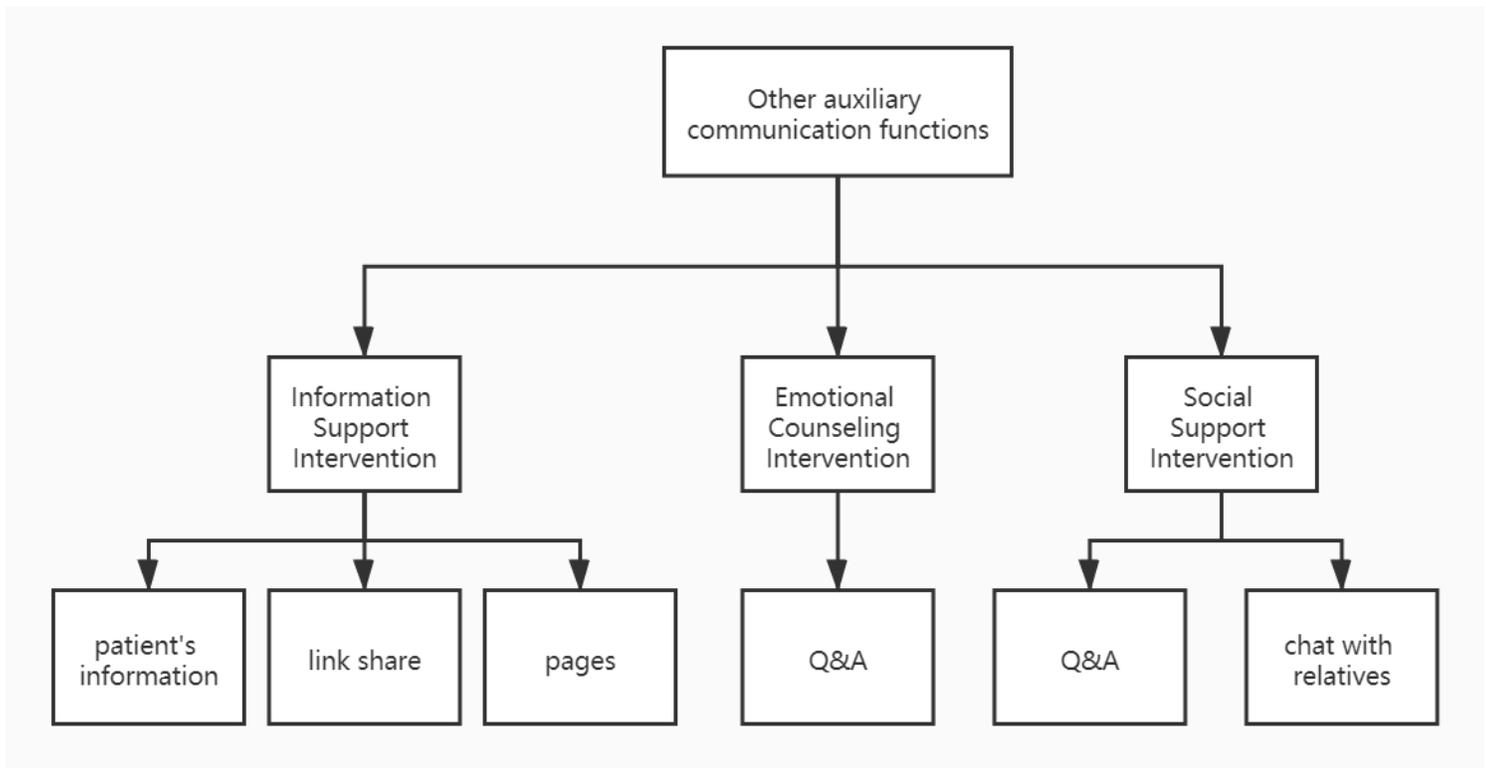
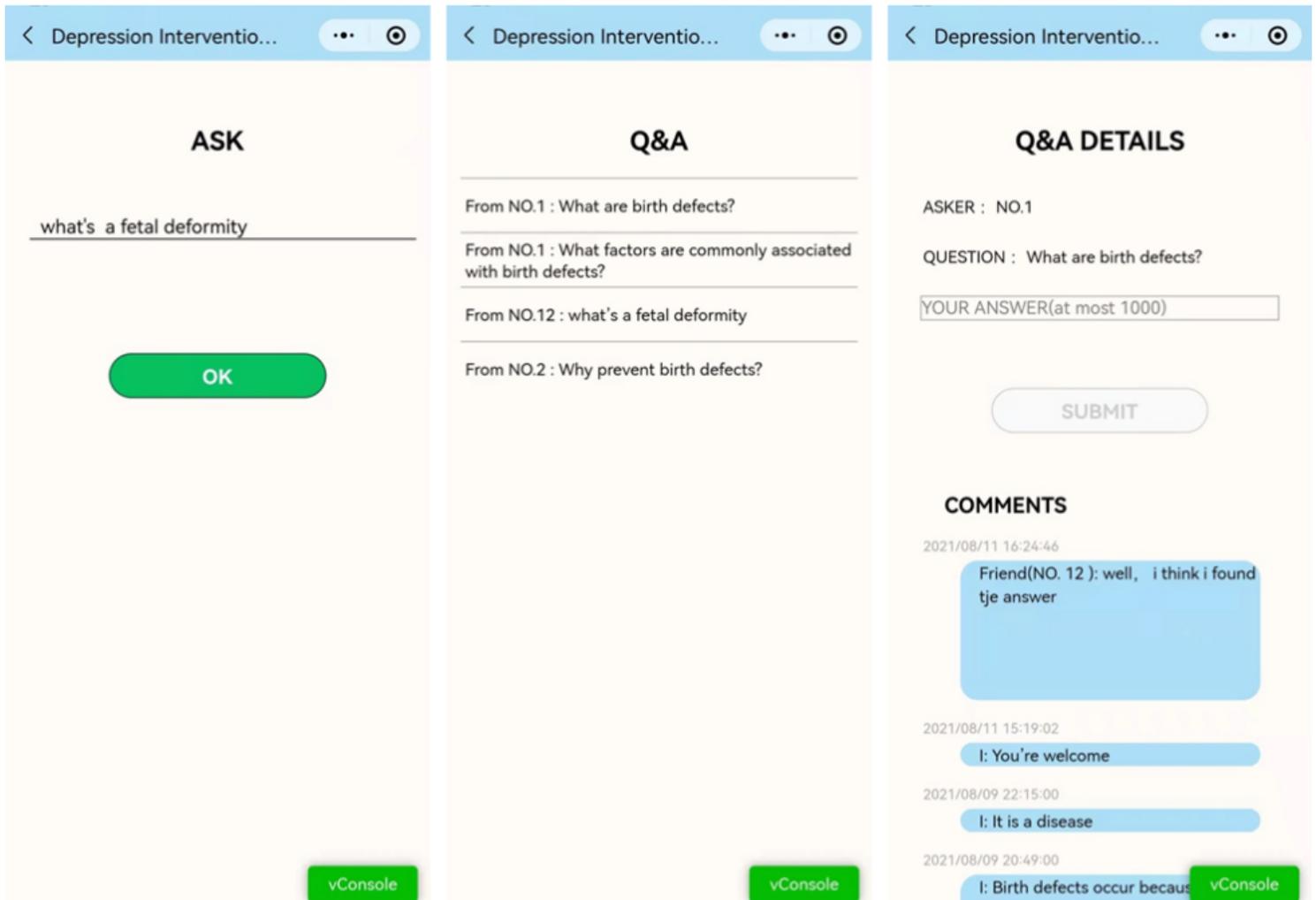


Figure 9

Other functions for auxiliary communications



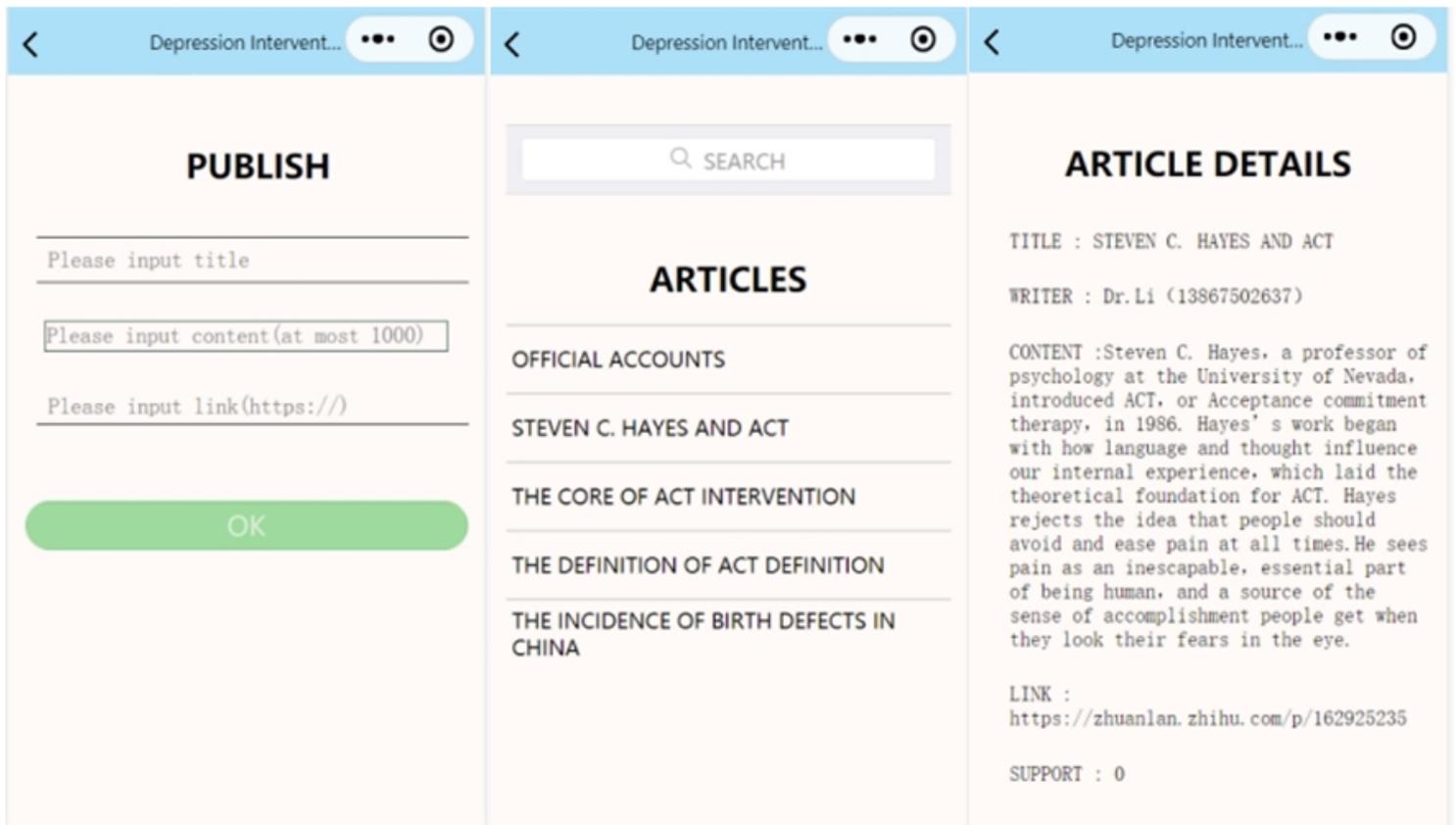
(A)

(B)

(C)

Figure 10

“Q&A” page.(A) Depressed women ask questions in this page.(B) Healthcare providers answer questions in this page.(C) Healthcare providers view the details of questions in this page.



(A)

(B)

(C)

Figure 11

“ ARTICLES” page.(A)Healthcare providers publish articles in this page.(B)Depressed women and relatives read articles in this page(C)Depressed women and relatives read the details of articles in this page.