Digital Interventions for Mental Health Problems

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Abstract: *With the rapid development of computer technology, the application of digital technology in the field of mental health came into being. Based on the theoretical analysis of the connotation definition, characteristics and types of digital interventions, this paper systematically introduces the main digital interventions means for mental health problems, including websites, software, APP, big data technology, virtual reality technology and wearable devices, machine learning, etc. The above attempts of digital interventions technology for mental health problems have achieved good interventions results. The above attempts of digital interventions technology for mental health problems have achieved good intervention effects, and there is no doubt that digital interventions technology will play a greater role in the future in the process of mental health problem assessment and counseling.*

Keywords: *mental health; mental health problems; digital psychology; virtual technology; digital interventions*

1. INTRODUCTION

The mental health problems of all kinds of people are becoming more and more serious. The American Mental Health Association survey shows that about 45 million Americans suffer from mental illness every year, which means that about one-fifth of adults suffer from some form of mental illness. According to the World Health Organization (WHO), about 1 billion people around the world are suffering from mental disorders, and one person loses his or her life every 40 seconds due to suicide, while low-income and middle-income countries account for 77% of global suicides. The **2022 College Students Mental Health Survey Report** shows that college students have poor depression level, anxiety level, sleep quality and self-rated mental health status. About 21.48% of college students have the risk of depression, and 45.28% of college students have the risk of anxiety. The **Chinese National Mental Health Development Report (2021-2022)** shows that more than 80% of adults have good self-rated mental health, and the detection rate of depression risk among adults is 10.6%. The **2022 National Depression Blue Book** of the Chinese Mental Health Association shows that the lifetime prevalence of depressive disorders in Chinese adults is 6.8%, of which depression is 3.4%.

Since the 21st century, the emergence of mobile devices and smartphones has led to the rapid popularization of digital technology. Emerging technologies such as big data, cloud computing, artificial intelligence, Internet of Things, blockchain, etc., have gradually penetrated into various industries, and the combination of these emerging technologies with psychology makes digital interventions of mental health problems possible and feasible, and makes every item in the intervention process more efficient and convenient (JIAXIN, Z., et al., 2020). The solution of mental health problems is based on the combination of traditional consulting methods and computer intelligence technology in an all-round and multi-level way such as the application of virtual reality technology in psychotherapy (Hoffman et al., 2006). In China, YiXinLi is an early online psychological service platform, including psychological science knowledge popularization, psychological assessment, psychological counseling and other sections; YiDianLing is also committed to the full implementation of various psychological services on the Internet, and the target number will develop itself into a psychological "Taobao". In short, the development of digital interventions in mental health problems is an irresistible trend.

2. DEFINITION OF DIGITAL INTERVENTIONS

Digital interventions, also known as digital health interventions, have a history of more than 30 years (I Moshe et al., 2021), but the rapid development of digital interventions is mainly in the past 10 years, thanks to the new development of computer intelligence technology, especially the popularization and application of smart phones. At the same time, the new coronavirus epidemic in the last three years has also promoted the development of remote online intervention.

2.1. Digital Interventions

Digital interventions mainly use digital technologies such as virtual reality technology and 3D printing technology to intervene in the consultation and medical treatment process of visitors with equipment as the carrier, so that the relevant clinical work can be more optimized (Xiao-qian, L. and C. Min，2020). Visitors to digital interventions usually need to log into a software, website or application, listen, speak, read, write, interact with a series of modules or courses. After that, individuals will receive module-related tasks. After the completion of the stage task, the visitor can see the effect of the intervention, and clinicians can understand and monitor the visitor's condition and development online. Digital interventions is different from teletherapy, which is a one-to-one treatment through video conference or telephone service. Teletherapy has played an important role during the novel coronavirus epidemic.

The World Health Organization clearly stated in **Global Strategy for Digital Health (2020-2024)** that digital health technology can improve health-related knowledge and practice. Digital interventions technology is also applicable to the intervention of mental health problems. Studies have shown that digital interventions technology can effectively intervene in psychological disorders such as depression (I Moshe et al., 2021).

2.2. Advantages of Digital Interventions

First of all, digital interventions break through the limitation of time and space, and can be carried out anytime and anywhere, which is very convenient and fast. For example, AI therapists can serve patients 24 hours a day, and are not limited by time and place (Bickman Leonard, 2020), and they can contact people who cannot obtain mental health services in real life in a virtual way, use a simple and intuitive interface, interact with them in a familiar way, and provide mental health support in a pleasant form where people are located, so that more people can obtain mental health services(Alyson Gamble, 2020).

Secondly, digital interventions can reduce the stigma of psychological problems to a certain extent. Digital interventions for mental health do not require direct personal contact, and it is easier to seek counseling for Internet therapy than face-to-face intervention, so that people at different stages of change can investigate treatment options without experiencing shame or guilt that may be related to the presence of disclosure disorders, missing assessment meetings or giving up treatment (Prochaska, J. O. , & Diclemente, C. C., 1982) which can also reduce stigma to a certain extent. Studies have shown that when people think they are talking to a computer rather than a real clinician, they have less fear of self-disclosure, less impression management behavior, are more likely to express the severity of their emotions, and are more willing to self-disclosure (Le Glaz Aziliz et al., 2021).

Third, digital interventions can use big data, Internet of things and other technologies to make mental health intervention have more abundant available resources. Digital mental health intervention has played an important role during the COVID-19 pandemic. A study shows that during the COVID-19 pandemic, digital medical services were more favored by patients and their families than emergency and inpatient treatment, and patients ' views on digital mental health services were generally positive (Chew Alton Ming Kai et al., 2020). A research has demonstrated the effectiveness of digital mental health, including cloud-based big data systems, AI-based chatbots, online health communities, and telemedicine platforms in a variety of mental health services (Blcombe Luke and De Leo Diego., 2021).

Fourth, digital interventions can ease the pressure on health care and medical care. AI can reduce the cost of tasks for many mental health workers and increase productivity, while in terms of manpower, it can simplify daily work, reduce monotonous and repetitive tasks, and allow professionals to engage in more complex and interesting work (Bickman Leonard, 2020).Studies have shown that the cost-

effectiveness of Internet intervention is more advantageous than face-to-face intervention when the therapist invests the least (Crone, P. et al., 2004; Klein, B. et al., 2006;Mihalopoulos, C. et al., 2005). There are also researchers who combine robot technology with psychological counseling. The developed social robots are used in the treatment of health care, elderly care, autistic children and depression patients, and have achieved quite good results (Dawe Julia et al., 2019; Russell Fulmer., 2019; Prochaska Judith J et al., 2021). Artificial intelligence chat robots can help reduce negative emotions such as anxiety and depression in cancer patients (Alemi,M. et al., 2014), and can also be used in nursing homes to reduce the loneliness of the elderly and the job burnout of nurses(Wada, K. et al., 2004). In addition, in terms of education, it can also broaden the knowledge coverage of mental health education for college students, upgrade the teaching methods of mental health education for college students, and accurately improve the quality of mental health education for college students (Limei, L., 2021).

3. TYPES OF DIGITAL INTERVENTIONS

From different perspectives, digital interventions can be divided into different types.

3.1. Synchronous and Asynchronous Interactions

Digital interventions can be divided into synchronous interaction and asynchronous interaction from the perspective of interaction. Synchronous interaction refers to the real-time online communication between users and other participants, including the use of text input, video, voice and so on for instant communication. The interaction of information occurs and completes in a short time, and the use of synchronous communication can be used for role playing, cognitive reconstruction and other asynchronous communication is difficult to achieve treatment technology (Zhongkai, H. and L. Ning, 2013). Asynchronous interaction refers to the use of e-mail, bulletin boards, forums and other technologies by users and other participants to communicate over a longer period of time, an information exchange cycle is completed within a predetermined or uncertain time, more inclined to dialogue in written language (Zhongkai, H. and L. Ning, 2013). One of the advantages of asynchronous interaction is that both sides of the communication have sufficient time to organize the language to express their own ideas and feelings. On the one hand, it gives professionals the opportunity to check and correct their own expressions and intervention ideas. On the other hand, it also provides users with the opportunity of " writing therapy" (Tate et al., 2003).Through the sense of existence generated by being with a person in real time, the interaction may be more spontaneous, resulting in more exposure of customers.

3.2. Intelligent Interaction and Human Interaction

Digital interventions is divided into intelligent interaction and human interaction from the perspective of interactive personnel. Intelligent interactions such as the UK 's Beating the Blues (BTB, 2012) program provide a large number of forms for users to fill out online. After the program analysis, the results and feedback are generated on the web page for users to print and download. It can also provide voice response or present relevant treatment information according to each operation of the user. For example, the Drinker's Check Up (DCU, 2012) program provides individualized test results feedback based on user test information and uses it as an important part of motivational stimulation. These feedback work is completely completed by the computer, forming a human-computer interaction, to achieve automatic intervention of mental health problems. Real-life interactions such as PTSD Online (2012) provide 10 modules of computerized cognitive behavioral therapy for PTSD patients diagnosed by DSM-IV. While users receive intelligent feedback from computers, professionals provide personalized therapeutic support and feedback through various forms such as e-mail, telephone, etc.

4. SEVERAL MAJOR DIGITAL INTERVENTIONS FOR MENTAL HEALTH PROBLEMS

Digital interventions are gradually being applied to solve mental health problems, such as collecting data through smart devices for evaluation, scene simulation through virtual technology to further achieve intervention, using big data for information collection to achieve simple and efficient purposes, and developing available platforms for intervention or treatment through computer equipment.

4.1. Website, Software and APP Application Development of Mental Health Intervention

Digital interventions have potential advantages in substance addictions such as alcohol, tobacco, illicit drugs and non-substance addictions such as problem and pathological gambling withdrawal (Sally Gainsbury and Alex Blaszczynski, 2011). According to the preferences and needs of addicts, digital interventions can provide targeted intervention content to help addicts abstain and prevent relapse. This form of intervention can be used as an auxiliary treatment for traditional intervention or as an independent treatment (Erika B. Litvin et al., 2013). Some researchers have also designed and developed a remote non-contact college students' Internet addiction prevention mechanism and intervention system. Based on the theoretical model of Internet addiction, multi-stage change psychology theory, user portrait, artificial intelligence AI, visual voice communication, big data mining and software development, a series of prevention and intervention function modules for Internet addicts have been developed to realize remote visual communication between students and experts. Under the premise of ensuring the online intervention effect of college students ' Internet addiction, it can effectively avoid personnel contact and reduce the risk of cross-infection during the epidemic (Ye, O., 2022). EndeavorRX, developed by Akili Interactive, was approved by the FDA as the first digital prescription for the treatment of attention deficit and hyperactivity disorder (ADHD) in children aged 8-12 years based on video games (Valerie A. Canady., 2020).

Based on ASP and back-end database technology, researchers have established an intervention website for the Healthy Internet Self-help Center, which is accessed remotely through a web browser (Wenliang, S. and F. Xiaoyi, 2012). The Student Space network platform supported by Overseas Family School (OFS) provides learning materials and service information for students to cope with the psychological pressure caused by COVID-19, as well as the website of the Student Health Alliance led by student organizations. It aims to improve mental health awareness, reduce the stigma of mental illness, and provide practical help and emotional support for college students (Lei, F., 2022). The Effective Child Treatment Network, sponsored by the Association for Clinical Psychology of Children and Adolescents of the American Psychological Association, focuses on the mental health of children and adolescents, and combines the Internet with evidence-based treatment to provide treatment manuals and practice programs for 11 common types of psychological and behavioral disorders (Ke-sheng, L., et al., 2019). The I CAN App developed by Chinese scholars for college students integrates the functions of psychological science popularization, decompression game, psychological FM, psychological test and so on. It integrates the functions of science popularization, media and entertainment, and meets the needs of users for psychological counseling and psychological decompression. Some researchers have developed a mental health intelligent evaluation system based on k-means clustering algorithm and deep neural network algorithm, which can effectively improve the application effect of the system(JIAXIN, Z., et al., 2022; Lingzhi, J., 2022).

For postpartum women with drug addiction, researchers have developed a motivation enhancement system software that includes two parts : intervention and evaluation (Steven J. Ondersma et al., 2005). What's more, researchers have developed and systematically evaluated a multimedia project called HeadOn, which aims at drug abuse prevention for adolescents in the junior middle school age. It provides effective drug abuse prevention science to adolescents through computer-based educational technology, and effectively promotes the learning of key skills and information (Zhi, Z., 2015). The Behavior self-control program for windows (BSCPWIN) is the first intelligent interactive CPTI program to be put into clinical trials. The purpose is to teach users the skills of moderate drinking. The DCU is similar to BSCPWIN, which is a shorter program for alcohol-dependent patients. The case assessment report using DCU intervention published by Squires et al. (2004) believes that DCU is an effective way to intervene in problem drinkers of all degrees.

4.2. Big Data Technologies for Mental Health Interventions

Digital interventions have been developed and applied to all aspects of mental health and mental health, and an important role is to monitor and feedback psychological intervention and treatment (Jun, Z. & Y. Yanchun, 2007). Starting from the structural analysis of the psychological early warning system, Juan, L., et al.(2017) proposed the construction path of the psychological early warning system based on the characteristics of big data. Through the analysis of big data mining methods in the psychological early warning system of college students, the results show that the psychological characteristics of anxiety, depression and suicidal tendency are strongly correlated (Juan, L. & L.

Haiiu, 2018). In terms of suicide risk prediction, AI has achieved remarkable results in helping to identify and prevent suicide cases and through the early identification of dangerous signals, the cases that need urgent attention are pushed to human consultants (Jun, Z. & Y. Yanchun, 2007). Digital detection system can also help clinicians timely and effectively identify the early symptoms of mental disorders (Ammar Nariman & ShabanNejad Arash., 2020).

4.3. Virtual Reality Technology and Wearable Devices for Mental Health Interventions

At present, the application of virtual reality technology in social psychology research, perceptual-motor research, visual-spatial cognitive field, psychotherapy research and other aspects is more and more (Mingyang, Z., et al., 2017). For example, Malbos et al. used VR technology to treat 6 patients with claustrophobia and found that it had a significant effect on post-traumatic stress disorder. A.Fleming Seay et al. developed a virtual reality meditation room system, which consists of a virtual helmet, a biofeedback device and a high-performance computer system, including scenes such as sun rise or fall. The virtual world is controlled by muscle relaxation, skin electrical response and respiratory meditation to achieve the purpose of meditation relaxation.

Psious in Spain has developed a VR device app for the treatment of acrophobia. The therapist can use this app to perform virtual reality treatment for patients, which is expected to expand to provide intervention treatment for patients with obsessive-compulsive disorder or post-traumatic stress disorder. Psychologists and computer scientists from University College London, University of Barcelona in Spain and University of Derby in the United Kingdom have proposed a new method of psychotherapy called " avatar experiment ", using virtual reality technology to improve the level of self-acceptance. The results show that this technology can effectively reduce the degree of self-criticism and improve the ability of self-compassion.

The Montreal research team in Canada has developed a virtual reality system for the treatment of sexual dysfunction (Zhi-song, Z. and L. Fu-hua, 2018) Some researchers have also developed a system called " super clinician. " The virtual psychological consultant of the system can capture the clinical information such as the facial expression, blink and sound characteristics of the visitor through artificial intelligence technology, and use VR technology to simulate the expression and movement of the consultant to complete the interaction and dialogue with the visitor (Veling Wim. et al., 2014).

Chinese researchers have developed a virtual reality psychological relaxation training system called VRPsyRIS   to explore the effectiveness and possibility of virtual reality technology to intervene in the negative emotions of college students, and to seek new ways and means of psychological intervention for college students. It can better improve the negative emotions of college students and has promotional value in the mental health education of college students (Zhi-song, Z. and L. Fu-hua, 2018).

In addition, researchers have developed a virtual reality helmet system called HTC VIVE based on HTC and Valve, which combines virtual reality technology with psychological sandplay theory. It can be used across regions and time, not only in psychological counseling, but also in the training and education of psychological sandplay counselors (Gong Wenfei., 2016). On the basis of cognitive theory and chaos theory, some scholars have designed the theoretical framework of psychotherapy by using OpenGL and VC++ virtual reality technology, hoping to explore a new way to treat college students' psychological diseases, depression and obsessive-compulsive disorder (Hedong, Y. and D. Yongfeng, 2011). In terms of education, some scholars have also proposed that the application of VR mental health education games based on embodied cognition will provide an effective teaching aid for mental health education in colleges and universities, so that teaching can achieve the coexistence of knowledge and interest (Qiaofang, L., 2020).

Scientists continue to develop various data-driven applications as eHealth tools, including smartphones, wearable or handheld biosensors, social media, and other web-based activities (Zidaru, T. et al., 2021). Through the collection of diverse health data, such as sensory data, smart wearable devices can capture the behavioral and psychological status of patients with schizophrenia in real time, helping to intervene in the early stages of their relapse (Roessner, Veit. et al., 2021).

4.4. Machine Learning for Mental Health Problem Intervention

Researchers have focused on the combination of cognitive behavior and computers. For example, cognitive behavior therapy (CBT) is the most common intervention. Four studies have claimed to use CBT (Abroms, L. et al., 2008; Brendryen, H. et al., 2008; Carlbring, P., & Smit, F., 2008; Japuntich, S. J. et al., 2006). Carroll has developed a computerized cognitive behavioral therapy program that focuses on the realization of individual cognitive and behavioral management skills and strategies. Through the computer interface, the principles and procedures of CBT are expressed in clear operation steps and highly structured multi-media interaction methods such as web pages, cartoons, videos, sounds, etc. (Titov, Nickolai., 2007). Wolfling et al.(2019) developed and tested the short-term treatment for internet and computer game addiction (STICA), a manual CBT that combines group and individual interventions. In the study of the clinical application and effect of computer-assisted psychotherapy intervention (Zhongkai, H. and L. Ning, 2013), cognitive psychology therapy (CPT) was applied to the intervention of depression and anxiety disorders. In 2006, the British National Health Service (NHS) certified the Beating the Blues (BTB, Proudfoot, J. et al., 2003), and the Fear Fighter computer-assisted treatment project (MacGregor et al., 2009), and incorporated it into the national health care system. In addition, CPTI projects such as health knowledge education (Lo, R. et al., 1996), computer-aided self-management program (Glasgow, Russell E. et al., 2003) and real-time monitoring of blood glucose levels (Selecky, C., 2001) play a good role in controlling blood glucose levels, weight management and delaying the occurrence of complications of type II diabetes (Chandra L. Jackson et al., 2006). What's more, Motivational Enhancement Therapy (MET) is often combined with computer networks to increase the interest and engagement of addicts in changing their behavior, emphasizing the decisive role of addicts themselves in withdrawal, and actively encouraging addicts to abstain (Ling, Y., et al., 2017). Contingency management (CM) is based on the principle that strengthening a certain behavior will increase its frequency of occurrence, and can provide specific and immediate reinforcement in competition with drug reinforcement to promote withdrawal and non-drug-related behaviors (Ling, Y., et al., 2017).

Some scholars have used the advantages of computers to integrate psychology into machine learning and give full play to the advantages of discipline integration to a greater extent. They discussed the research on computer psychological dynamic test methods and psychological evaluation systems and found that computer psychological dynamic test methods mainly use computers to set up corresponding program response modes and high imitativeness to simulate some virtual tests and tasks (Lei, L. and Z. Dongbo, 2014). For example, in order to accurately detect students' negative emotions and carry out targeted psychological intervention treatment, a student psychological intervention treatment and behavior monitoring system based on machine vision (Xuedong, G. and H. Xiaoke, 2020) and a psychological detection and guidance system based on C/S mode (Lili, Z., et al., 2015)are designed. With the help of the traditional management model Plan-Do-Check-Act, namely PDCA model, based on the Internet platform, some researchers have constructed a set of mental health counseling system to help college students carry out psychological test and psychological counseling conveniently and quickly, so as to improve the efficiency and effect of psychological counseling (Dongwei, Z, 2021). In addition, in order to explore the mental health assessment based on social media data, the researchers also tried to use the writing and comment data on the students' online learning platform to construct a prediction model for the psychological characteristics of primary school students (Fang, L., et al., 2021; Han, Z., et al., 2021). Because big data can predict related behaviors, some researchers have designed a psychological evaluation system through ID3 algorithm and Apriori algorithm (Xuan, W. and P. Lique, 2011). By analyzing the linguistic features of social media content including text, volume, tone, and speed of speech, etc., it is possible to generate machine learning models to infer an individual 's mental health status earlier (Simon D'Alfonso, 2020).

Machine learning has great potential to establish and mine models through a large number of patient history, medical images, epidemiological statistics and other detailed data such as natural language data. By using Bayesian networks to collect large-scale survey data and conduct association analysis, a predictive model can be established to provide scientific evidence for the interpretation of mental disorders (Jha, I. et al., 2021). As with social media data, studies have shown that anxiety, depression, bipolar disorder, and suicidal intent can all be observed and measured through naturally occurring

data in everyday linguistic forms, such as posts or comments posted on social media platforms (Zidaru et al., 2021). Ive et al.(2018) used recurrent neural networks (RNN) for the first time in their research to predict mental health issues involved in posts on social media.

5. EFFECTIVENESS OF DIGITAL INTERVENTIONS FOR MENTAL HEALTH

The intervention of mental health problems through digital and computer technologies has achieved results. Some studies and experiments also show that the method of integrating subject output has certain effectiveness and practicability. For example, Ziqiang,W (2007) retrieved and analyzed 63 articles, and found that the digital psychological interventions of 29 studies mainly through online chat groups, e-mails, CDs, software programs for online or offline status of computers, websites, platforms, smartphone applications and artificial intelligence to prevent and intervene in adolescent depression. The theoretical basis of 13 studies was cognitive behavioral therapy, 8 studies were based on multiple theoretical basis, 2 studies were based on mindfulness, 1 study was problem-solving therapy, 1 study was short-term solution-focused therapy, 1 study was psychodynamic psychotherapy, 1 study was about growth mentality, gratitude and value affirmation, and 1 study was explanation bias correction training. In terms of intervention efficacy, 22 studies reported that digital psychological interventions had preventive effects on adolescent depression, but 5 studies reported no effect, and the remaining 2 did not report effectiveness. In addition, some studies reported that participants in Internet intervention had significantly increased self-reported smoking cessation rates or withdrawal rates at the end of treatment trials (Abroms, L. et al., 2008; Brendryen, H. et al., 2008; Mermelstein, R., & Turner, L., 2006;Zbikowski, S. M. et al., 2008; Woodruff, S. I. et al., 2007).

A meta-analysis of 22 mental health apps by Firth et al.(2017) found that mental health apps can significantly alleviate depressive symptoms. A meta-analysis of the effects of multiple mental health literacy interventions showed that after the intervention, mental health knowledge was significantly improved, stigma attitudes were improved, and the behavior of seeking professional help was improved, and the effect could last for more than 6 months (Zhihong, R., et al., 2020; Ojio Yasutaka et al., 2019; Rong, Y., 2011).The mental health literacy intervention method based on online education can effectively improve mental health literacy and professional psychological help-seeking willingness, and improve mental health status, but it has no significant impact on the well-being of college students (Qin, Q. and L. Jiajin, 2021).

As a therapeutic robot using the direction of integrated theory, Tess can provide real-life interventions through dialogue generated by artificial intelligence, thereby reducing depression and anxiety in college students (Fulmer, R. et al., 2018; Russell Fulmer, 2019). In addition, studies have shown that contingency management (CM) can effectively promote smoking cessation (Dallery Jesse and Raiff Bethany R., 2011; Jesse Dallery et al., 2006), and the combination of withdrawal and job opportunities has a long-term and lasting effect (DeFulio, 2011; Silverman et al., 2007). Similar to traditional psychological intervention, computer intervention can improve the self-efficacy and coping skills of addicts, change their perception of surrounding norms and attitudes towards substance abuse, reduce the attention to relevant clues, and enhance the motivation of withdrawal. The change of these factors further affects the intervention effect (Marsch, Lisa, A, et al., 2006).

In recent years, more and more attention has been paid to mental health problems. Digital psychological intervention has obvious advantages in digital technology with automatic data mining and deep learning functions. Although the application of digital technologies such as artificial intelligence and big data is still in the exploratory stage, there are problems such as a large proportion of visitors falling off and network security. It is believed that the future digital interventions technology of mental health will further give full play to the advantages of discipline integration and improve accurate, comprehensive and safe consultation and treatment.

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