Research on disease management of chronic disease patients based on digital therapeutics: A scoping review

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Abstract

Background: The prevalence of chronic diseases is rising annually due to the aging of the population, and these illnesses constitute a major cause of mortality. Digital therapeutics (DTx) is a promising solution for the prevention and management of chronic diseases. With the rapid advancement of information technology in recent years, software algorithms or applications based on clinical assessment, evidence, and technology can be used to directly provide digital medical interventions to patients to promote disease management. Digital therapeutics has been applied in the field of various diseases. The most significant application area among them is the management, treatment, and intervention of chronic illnesses.

Objectives: To provide a comprehensive understanding of the benefits and drawbacks of using digital therapeutics for the management of patients with chronic diseases.

Methods: The scoping review framework developed by Arksey and O'Malley was applied to the process. Using the research method of scope review, the network retrieval of pertinent papers was conducted in eight databases, including PubMed, Web of Science, ScienceDirect, and CNKI. The database was retrieved between the date of database creation and September 20, 2023. The "PCC" principle was used to determine the inclusion criterion. Analyze and discuss the mentioned literature. Findings were presented in tabular and descriptive formats.

Results: The scoping review included 25 studies. The intervention carriers of digital therapeutics included health management systems, digital health platforms, learning machine models, and so on. Professional technologists, medical personnel, and others were among the implementation personnel. Disease management strategies included application-based home workout plan intervention, virtual reality digital control mode intervention, and so on. Digital therapeutics helped patients with symptom monitoring, medication management, weight control, mental health, and everyday activities.

Conclusion: Digital therapeutics improves the treatment of chronic disease patients and promotes health recovery. In the future, under the supervision of the treatment team, we should formulate scientific, standardized, and relevant digital therapeutic disease management programs according to the application status of patients with chronic diseases and develop more customized digital therapeutic projects.

Keywords

Digital therapeutics, chronic diseases, digital technology, disease management, scope overview

What is known?

According to WHO data (e.g., WHO, 2022), nearly 3/4 of the global deaths are related to chronic diseases, and chronic disease-guided deaths are extremely severe. Limited studies are focusing on disease management in patients with chronic diseases.[1]

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Digital therapeutics has been widely used in the field of chronic disease management in European and American countries, and digital therapeutics has become an effective solution for the prevention and management of chronic diseases with development prospects.[2]

What is new?

Chronic disease management can promote the recovery of patients' health and reduce medical costs. It is safe, feasible, and effective for patients with chronic diseases.[3]

Digital therapeutics has created new ideas for chronic disease management, greatly improved the accessibility and effectiveness of medical service resources, and played an important supporting role in patient disease management.[4]

Introduction

Chronic disorders like diabetes, obesity, cardiovascular disease, chronic obstructive pulmonary disease, and cancer are becoming more common as the population ages.[5] Nearly three-quarters of all fatalities worldwide are attributed to chronic illnesses, per WHO data (e.g., WHO, 2022).[1] Eighty-six percent of all deaths in China are attributable to chronic illnesses.[6] It is evident that the mortality rate from chronic illnesses is very high and has grown to be a significant public health issue that lowers people's health. The focus of chronic illness prevention and treatment in China will shift from disease treatment to health management, according to the medium- and long-term plan for the prevention and treatment of chronic diseases in China (2017–2025).[7] Chronic disease is a disease with long-term and long-lasting effects that often require long-term management by individuals and their health professionals. Under Australia's National Strategic Framework for Chronic Diseases, education and health literacy are considered important tools for chronic disease management.[8] This involves enabling patients to master their role in disease management through self-management.[9] Effective management of chronic diseases can expedite patients' recuperation, lower medical expenses, and maximize the use of available resources in the healthcare system.[10]

The swift advancement of information technology in recent times has led to the creation of a novel digital medical treatment format. This has not only enhanced the effectiveness and accessibility of medical service resources but also inspired new ideas for managing chronic diseases. Digital therapeutics (DTx) is defined by the Digital Therapeutics Alliance (e.g., Digital Therapeutics Alliance, 2021) as evidence-based, clinically proven software for the treatment, management, and prevention of diseases.[11] The concept of DTx was first introduced by a foreign scholar named Dr. Kvedar in 1995. Patients with early-stage diabetes were able to alter their lifestyles thanks to an application created by Omada Health in 2013. This

was the first validation and implementation of DTx. In both European and American nations, the field of managing chronic diseases has made extensive use of DTx. Corresponding clinical trials have been conducted in China in the recent past.[12] However, as a new thing, DTx appears in the field of medical care.[13] Many medical workers lack a clear and comprehensive understanding of it. At present, most of the studies on DTx are randomized controlled trials and based on truth.

DTx represents a promising and effective solution for the prevention and management of chronic diseases. Therefore, this paper aims to review the research scope of disease management of patients with chronic diseases based on DTx at home and abroad, to fully understand the advantages and disadvantages of its management, provide theoretical guidance for the application of DTx intervention programs in the construction of various clinical chronic diseases in the future, and play a reference role in the research of DTx disease management programs in the future.

Method

The scoping review followed the framework of Arksey and O'Malley: identifying research questions, identifying relevant research, selecting research, drawing data charts, and organizing, summarizing, and reporting results. In addition, a series of research methods and steps were carried out under the guidance of the scope review writing guide published by the Joanna Briggs Institute (JBI) in Australia as the methodological framework.[14] The review of existing literature did not require ethical approval.

Identifying the research question

Following a review of the literature and a group discussion, the following were the primary research questions: (1) What is the application status and development trend of DTx in disease management of patients with chronic diseases? (2) What are the specific contents(management equipment, implementers, intervention duration, and outcome indicators) of DTx intervention for patients with chronic diseases? (3) What are the types of research on the application of DTx for patients with chronic diseases in disease management?

Identifying relevant studies

The Chinese biomedical literature database, ScienceDirect, Wanfang, CNKI, PubMed, Web of Science, VIP, and full-text Chinese medical journal databases were all searched by computers. For retrieval, a mix of Boolean logic operator connections, free words, and MeSH topic words was employed. Search terms in English were "digital therapeutics/digital therapeutics '*/digital technology/digital technology*,' 'chronic disease/chronic disease*,' and 'disease

Table 1. Pubmed search strategy.

Procedure	Search strategy
#1	Digital therapeutics [MeSH Terms]
#2	Digital therapeutics* [Title/Abstract]
#3	#1OR#2
#4	Digital technology [MeSH Terms]
#5	Digital technology* [Title/Abstract]
#6	Chronic disease [MeSH Terms]
#7	Chronic disease* [Title/Abstract]
#8	#6OR#7
#9	Disease management [Title/Abstract]
#10	Disease management* [Title/Abstract]
#11	#9OR#10
#12	#3AND#8AND#11OR#4OR#5

management/disease management*.'" Chinese search terms were "digital therapy/digital technology, 'chronic disease,' and 'disease management.'" The database was retrieved between the date of database creation and September 20, 2023. (To retrieve more valuable literature and expand the search time range, the search time was set on the day of the beginning of the search.) Taking PubMed as an example, the specific search strategy is shown in Table 1.

Study selection

The inclusion criteria were established according to the "PCC" principle[15]: (1) patients (P): those suffering from long-term illnesses; (2) concept (C): For patients with chronic illnesses—which the World Health Organization describes as noncommunicable diseases with a protracted course and sluggish development—it entails disease care based on DTx. This study focused on chronic conditions such as diabetes, obesity, heart disease, chronic obstructive pulmonary disease, chronic pain, sleeplessness, nervous system disorders, and mental health issues; (3) context (C): Intervention in disease management is required.

The exclusion criteria were as follows: (1) unable to access the complete text; (2) non-Chinese, English; (3) repeatedly published literature; (4) research plan, guidelines, opinions, and policy papers; (5) review literature; (6) paying attention to how DTx is developing.

Charting the data

To get rid of redundant literature, the retrieved materials were imported into NoteExpress 3.5.0.9054. Two expertly trained researchers separately screened the material by reading the title and abstract under the inclusion and exclusion criteria. They then reviewed the entire text for secondary screening and identified the included literature. Valid information such as author, nation, publication time (year), research location, research kind, intervention item, intervention technique, intervention duration, and effect was extracted from the data independently by two researchers. The information was recorded in a Microsoft Excel file. If the two researchers' viewpoints diverged, they would consult the third researcher.

Collating, summarizing, and reporting the results

To characterize and summarize the results, the data graphs extracted from the included studies were presented in tabular form. We introduced the authors, year, country, study type, sample size, intervention duration, intervention methods, and main findings. We described and analyzed the intervention practice, results, advantages, or challenges of the study in detail to answer our research questions.

Results

A total of 4419 articles were obtained in the initial examination, and 3673 articles were left after removing duplicate articles. After reading the title and abstract, there were 456 articles left, and after reading the full text, there were 21 articles left. The citation tracing method was used to supplement the references of the included literature, and finally, 25 articles[16–40] were included. The specific literature screening process is shown in Figure 1.

Description of included studies

A total of 25 articles were finally included, including 2 qualitative studies,[16,17] 18 randomized controlled trials,[18–35] 1 before-after controlled study,[36] 2 cohort studies,[37,38] and 2 single-arm trials.[39,40] The 25 articles were from 11 countries, including 2 from the UK, 2 from France, 3 from China, 10 from the US, 2 from Japan, 1 from Germany, 1 from South Korea, 1 from Sweden, 1 from Scotland, 1 from Ireland and 1 from the Czech Republic. The detailed characteristics of the included studies are in Table 2.

Characteristics of included studies

According to 25 studies, there were DTx management systems created especially for patients with chronic illnesses. These systems included virtual learning machine models, home video game systems, and more, and their
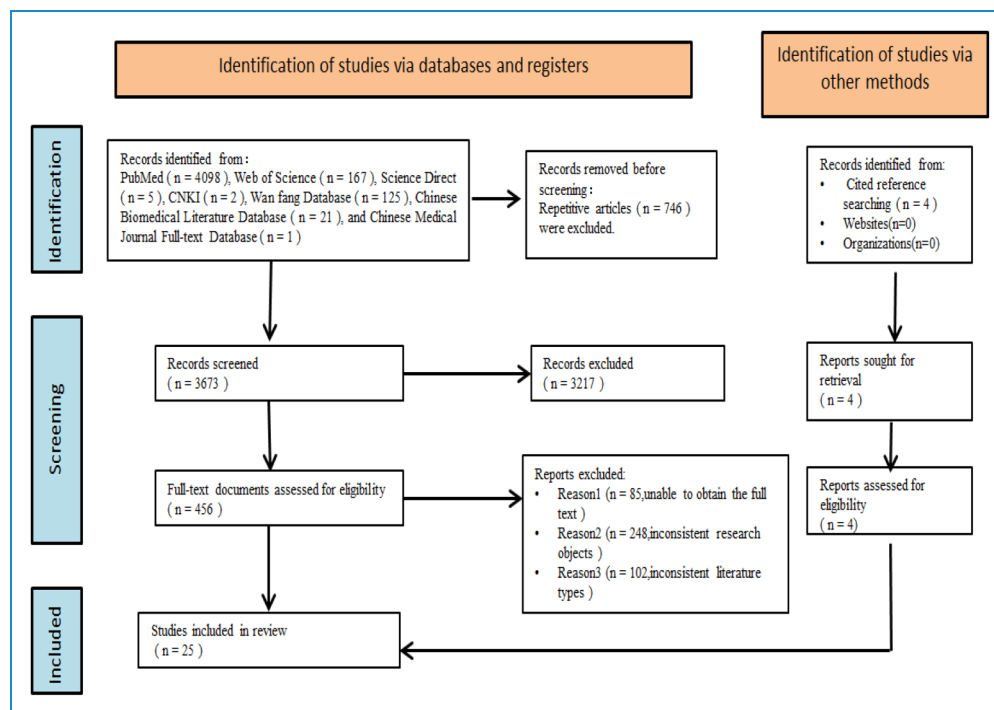
Figure 1. Literature screening flow chart- source: authors' construct.

DTx projects can be tailored to the needs of the patients. Additionally, public DTx platforms and systems are being used more and more in the chronic illness field.

Intervention carrier. The majority of the software algorithms or applications used in the DTx-based chronic illness management intervention were based on technology, clinical judgment, and evidence. Additionally, it served as a link between patients and portable medical services. It served the same or a comparable purpose to traditional medications in terms of illness prevention, management, and treatment, as well as enhancing patient health. Numerous disease management software applications based on customized DTx were emerging as a result of ongoing scientific and technological advancements. Examples included the mobile digital health platform,[17] the digital medical rehabilitation system,[18,19] the VR(virtual reality) digital control headset,[20] the clinical triage service, and the technical service desk using response symptom alarm,[16] the learning machine model,[29] and the self-management mobile application installed on tablet PC.[34] The participation was determined by recording the interaction between the patient and the software application during the trial. Based on real-time feedback, patients were provided with a range of disease management programs, including medications, lifestyle intervention programs, follow-up programs, and teaching materials. It should be highlighted, nonetheless, that the study's DTx-based software application differs from everyday health management apps. The former

belonged to the category of medical services and was capable of giving patients direct medical attention. The latter was an active behavior in health management that was unregulated by healthcare organizations. It was available for independent users to download and use from the application store.

Intervention content. The three functional project product categories that have made up DTx in recent years are prevention, management, and treatment.[41] DTx used in this study was primarily a project product of the management function and was a type of digital intervention used in the management of chronic illnesses. It was characterized by guiding patients to self-manage the factors affecting the development of the disease after the diagnosis of the disease, to control the disease, reduce complications, or reduce adverse reactions. In most studies, DTx was used alone, and disease management was performed through tools with interactive or real-time feedback functions in an Internet digital virtual environment. For example, to achieve the goal of disease management, the wrist-worn smart bracelet was employed to track the application usage rate every 12 weeks for three months. Within the first three months, feedback was given.[19] For instance, automatically integrated structured data from hospital information systems and provided patient medication, lifestyle intervention programs, follow-up programs, and educational materials based on real-time diagnostic feedback.[25] Some studies used DTx containing game components,[33]

Table 2. Included literature characteristics.

Author and year	Research object	Intervention methods	Duration of intervention	Result
Doyle et al., 2021,[16] Ireland	Patients with multiple chronic diseases	120 cases were intervened by ProACT digital health platform technology.	1 year	The patient's self-management ability was effectively improved.
Andersson et al., 2021,[17] Sweden	Hypertensive	22 cases were intervened by a network-based mobile phone application interactive system.	2 months	The patient's blood pressure was effectively controlled and was more closely related to professionals.
Wang et al., 2017,[18] China	Patients with chronic nonspecific low back pain	The intervention group ($n = 30$) was treated with suspension exercise therapy run by digital medical rehabilitation technology; the control group ($n = 30$) received routine treatment.	1 month	The improvement of back pain symptoms in patients was helpful for their functional recovery.
Kim et al., 2023,[19] Korea	Patients with colorectal cancer who have undergone surgery	The postoperative health management intervention group ($n = 216$) was operated by the digital medical rehabilitation system. The control group ($n = 108$) had no special intervention.	1 year	Increased skeletal muscle mass in patients.
Merlot et al., 2023,[20] France	Patients with chronic uterine disease complicated with pain	The intervention group ($n = 60$) was intervened by virtual reality digital control mode. The control group ($n = 60$) had no special intervention.	1 month	The degree of pain was reduced in patients.
Petrella et al., 2023,[21] USA	High-risk patients with Alzheimer's disease	The intervention group ($n = 51$) was intervened with computerized crossword puzzle training; the control group ($n = 56$) had no special intervention.	78 weeks	Beneficial cognitive remodeling was performed on subjects with a higher risk of dementia.
Canonico et al., 2022,[22] USA	Patients with type 2	The intervention group ($n = 325$) was intervened with DTx (BT-001); the control group ($n = 325$) was intervened by a crossword game.	3 weeks	The patient's blood glucose control was strengthened.
Merlot et al., 2022,[23] France	Endometriosis patients with pelvic pain	The intervention group ($n = 23$) was intervened with virtual reality DTx (Endocare); the control group ($n = 22$) had no special intervention.	20 h	The patient's pain perception was weakened.
Weise et al., 2022,[24] Germany	Patients with nonspecific and degenerative back pain	The intervention group ($n = 53$) was intervened with an application-based home exercise program; the control group ($n = 52$) received routine exercise intervention.	3 months	The pain intensity of patients was significantly reduced.
Li et al., 2022,[25] China	CHD patients	The intervention group ($n = 143$) was intervened with a mobile	1 year	The physiological indexes such as blood pressure and cholesterol

Table 2. Continued.

Author and year	Research object	Intervention methods	Duration of intervention	Result
		application-based self-management system (DTx); the control group ($n = 147$) had no special intervention.		were controlled, and drug compliance was improved.
Gumley et al., 2022,[26] Scotland	Prognostic patients with schizophrenia	The intervention group ($n = 42$) was intervened with a smartphone app; the control group ($n = 31$) had no special intervention.	1 year	Motivations and intentions related to patients ' mental health had a positive impact.
Moravcova et al., 2022,[27] Czech rep.	Diabetic obese patients	The intervention group ($n = 50$) was intervened by Vitadio Lifestyle with a digital program. The control group ($n = 50$) was intervened with a structured face-to-face obesity management plan.	1 year	There was a positive effect on reducing body fat, maintaining weight, and reducing insulin resistance in patients.
Kario et al., 2021,[28] Japan	Hypertensive	The intervention group ($n = 199$) was adjusted by the HERB system and standard lifestyle. The control group ($n = 191$) only received standard lifestyle change intervention.	6 months	Effectively controlled and reduced the blood pressure of patients with hypertension.
Jacobson et al., 2021,[29] USA	Patients with depression and anxiety	The intervention group ($n = 303$) was intervened with online supportive expression therapy; the control group ($n = 329$) had no special intervention.	9 months	Patients ' depression and anxiety were reduced.
Roy et al., 2021,[30] USA	Generalized anxiety disorder	The intervention group ($n = 32$) received mindfulness training intervention with application as the carrier; the control group ($n = 33$) had no special intervention.	2 months	Patients ' worry and anxiety were reduced.
Cheng et al., 2021,[31] USA	Insomniac	The intervention group ($n = 102$) was intervened with digital cognitive behavioral therapy (dCBT-I); the control group ($n = 106$) received sleep education intervention.	1 year	The insomnia and depressive symptoms of the patients were reduced, and the overall health status was improved.
Bentley et al., 2020,[32] UK	Chronic obstructive pulmonary disease	The intervention group ($n = 19$) was intervened with SMART-COPD digital health management; the control group ($n = 11$) had no special intervention.	2 months	Self-management of early COPD patients was more beneficial.
Kollins et al., 2020,[33] USA	Attention deficit hyperactivity disorder patients	The intervention group ($n = 9$) was managed with digital therapy (AKL-T01). The control group ($n = 9$) had no special intervention.	1 month	The inattention of patients was reduced.

(continued)

Table 2. Continued.

Author and year	Research object	Intervention methods	Duration of intervention	Result
Velardo et al., 2017,[34] UK	Chronic obstructive pulmonary disease	The intervention group ($n = 110$) was intervened in a digital health way; the control group ($n = 56$) had no special intervention.	6 months	The patient's disease compliance was improved.
Foley et al., 2016,[35] USA	Obese subjects	The intervention group ($n = 176$) was intervened by mobile self-monitoring technology. The control group ($n = 175$) had no special intervention.	1 year	The patient's weight was effectively controlled, and the risk of other chronic diseases was reduced.
Milani et al., 2017,[36] USA	Hypertensive	156 cases were intervened by a family digital medical blood pressure plan.	400 days	Blood pressure control and lifestyle changes in patients were significantly improved.
He et al., 2023,[37] China	Hypertensive adults	The intervention group was divided into 4 groups: normal blood pressure group ($n = 237$), high-normal blood pressure group ($n = 118$), grade 1 hypertension group ($n = 96$), and grade 2 hypertension group ($n = 63$).	26 weeks	Effective control of blood pressure in patients.
Thorndike et al., 2021,[38] USA	Insomniac	350 cases were intervened by digital mobile therapy technology.	9 weeks	Insomnia symptoms were reduced in patients.
Sato et al., 2023,[39] Japan	Patients with nonalcoholic steatohepatitis	48 cases of DTx intervention using newly developed smartphone applications were analyzed.	19 weeks	The symptoms of liver fibrosis deterioration, weight change, and fibrosis regression were reduced.
Hommel et al., 2020,[40] USA	Migraine adolescent patients	40 cases were intervened by a digital treatment self-management tool.	9 weeks	The patient's physical function and quality of life were significantly improved.

such as family video games, to nonspecifically collaborate with multiple specialized cognitive networks involved at a low level in the form of games, which was conducive to cognitive remodeling in patients with chronic diseases.[20] In a small number of studies, DTx was used in conjunction with routine care. For example, DTx was added to the standard lifestyle adjustment plan, which could effectively reduce 24-h outpatient, home, and office blood pressure compared with a separate plan.[28] DTx can be used either on its own or in conjunction with more traditional forms of treatment including medication and medical equipment. These interventions had a positive impact on patients through information factors such as text, pictures, and videos, physical factors such as sound, light, and current, and drug factors.

Implementers. The majority of them were overseen and carried out by the treatment team, which was primarily made up of medical professionals. In certain studies, parents and treatment teams worked together as co-supervisors, with the management intensity being regularly modified based on the children's progress.[33,40]

Intervention duration. The disease management cycle based on DTx ranged from 20 h to 1 year, the frequency ranged from 3 to 7 days per week, and the intensity ranged from 10 to 90 min per day. Five studies were followed up from 9 weeks to 400 days.[36–40]

Intervention results. DTx improved patients' chronic pain (n = 4), cognitive function (n = 1), anxiety and depression

($n = 4$), promoted patients' self-management ($n = 4$), improved patients' medication compliance ($n = 2$), and timely monitored disease symptoms ($n = 13$) in the 25 included studies. The most popular tools for assessing the level of pain in people with chronic pain were the modified Oswestry dysfunction index, the pain digital evaluation scale, and the visual analog scale. Individuals with cognitive impairment were more likely to use instruments like the mental behavior rating scale and cognitive ability screening scale; self-rating depression and anxiety scales were also more frequently used in the assessment of anxiety and depression in patients; some research assessed the changes of chronic diseases like obesity, diabetes, heart disease, and hypertension using various chronic disease criteria.[22,25,27,36–37]

Discussion

The scoping review included 25 articles, summarized the intervention carriers and management strategies of DTx in patients with chronic diseases, and improved patient symptom monitoring, medication management, weight management, mental health, and daily activities.

Patients with chronic illnesses have had some success with the application of DTx-based disease management interventions. The patient's disease management objectives are met by altering their physiological indicators, psychological state, and behavioral patterns. These include alleviating pain,[18,20,23,24] promptly monitoring blood pressure,[17,25,28,36,37] controlling weight,[27,35] fostering positive psychological and cognitive remodeling,[21,26,28–30] enhancing medication compliance,[16,32] and enhancing self-management ability.[25,31,34]

The research on disease management of patients with chronic diseases based on DTx is still in the preliminary stage, and the distribution is not balanced. There is an unequal distribution of research population, time, place, and literature type across the 25 included articles. With 3 articles published in 2020, 7 in 2021, 6 in 2022, 5 in 2023, 1 in 2016, and 3 in 2017, the number has climbed from 2020 to 2023. The United States published the most, with a total of 10 articles, followed by China, with a total of 3. Patients with mental health issues, diabetes, obesity, and cardiovascular disease make up the majority of the study's subjects. Randomized controlled trials, qualitative studies, cohort studies, and single-arm trials are the most common types of research. The literature primarily aims to introduce connected concepts of DTx, the use of technical service desks and digital health platforms, as well as the use of DTx-based management information systems for chronic diseases. Furthermore, the literature assesses the efficacy of DTx-based approaches for managing chronic diseases concerning patient satisfaction and the viability of digital platform systems.

With the "Internet + nursing service" growing at a rapid pace in recent years, DTx has become a popular tool for managing patients with chronic illnesses and preventing sickness. To change negative behavior and encourage health recovery, it is anticipated that in the future, more digital information systems and platforms for the management of patients with chronic diseases will be developed under the collaborative research and mining of academics both domestically and internationally. Additionally, the content and methods of DTx will be updated and optimized regularly.

The intervention carrier of DTx needs to accurately meet the personalized needs of patients with chronic diseases. The foundation of DTx is software, which acts as a conduit to enable information exchange between patients and healthcare providers and greatly expands the accessibility of medical services. In recent years, many disease management software programs for DTx have been developed internationally. However, in some countries, the use of DTx is still not widespread. For example, a study showed that the follow-up management of patients with hypertension through WeChat, due to the small number of participants, the sample size of the study was insufficient. The results showed that the patients had stepped up physical exercise, but there was no significant difference in blood pressure control compared with the control group.[42] Therefore, it is imperative to develop efficient and easy-to-spread DTx management techniques. A small number of patients with chronic diseases have privacy requirements among the 25 studies.[26] To improve patients' compliance with new and improved DTx management strategies, it is necessary to develop and use one-to-one program devices with privacy, pay attention to protecting patients' privacy, and use digital platforms to provide multimedia (such as images and videos) materials. Furthermore, the availability of DTx interventions decreases with complexity, and this issue may have a detrimental effect on participants' motivation to act or participate in the future.[32] Medically vulnerable populations, such as low-income families, still can not afford the cost of digital health technology systems or platforms, and there are challenges in promoting their usage.[35] Consequently, the creation of a customized, user-friendly, and affordable platform or management system is more favorable to the use of digital treatment across a wider range of communities and households. To meet the demands of patients with a range of chronic diseases in terms of disease management, the development team should include a variety of experts, including seasoned specialized nurses, based on the technological support of DTx.

The mechanism of DTx needs to be fully understood to improve the management process of chronic diseases. A problem in the intervention process is that the implementers or supervisors are not clear about the mechanism of the disease management intervention based on DTx, which has a positive effect on symptom monitoring, weight management, cognitive psychology, medication management,

and other aspects of most patients with chronic diseases in the 25 studies that are included. Andersson pointed out that, there was a lack of awareness of the possibilities of digital systems since not all patients and experts had followed instructions on how to utilize them.[17] Studies found that, in the process of disease management intervention, parents and clinicians may not be able to observe the impact of DTx on patients ' disease management..[33] As the primary participants in the patient's disease management process, parents and clinicians have a significant impact on the patient's disease management intervention. They ought to be completely aware of how DTx works and contribute to improving the impact of illness management. To obtain the optimal intervention impact, future research must stress a complete understanding of the working mechanism and influence of DTx. Furthermore, a successful intervention will positively impact the behavioral motivation of patients with long-term conditions. According to some research,[25,28,40] long-term monitoring is necessary for chronic diseases to assess the clinical outcomes and long-term efficacy of mobile application-based therapies. However, most studies do not follow effects over time, and this needs to be taken seriously in later studies.

Due to the long course of chronic diseases, patients have increased various burdens. The burden of patients with chronic diseases mainly includes physical burden, psychological burden, economic burden, and so on. Chronic diseases are usually characterized by a slow progression of the disease, which in the long run damages the health of the body, and may cause a burden on the patient's psychology during the disease, which may increase the prevalence of mental diseases such as depression and anxiety. In addition, patients with chronic diseases usually need long-term medication or regular visits to hospitals for examination, which may impose a burden on the patient's economic situation. DTx can effectively solve the physical burden, psychological burden, and economic burden of patients with chronic diseases. DTx has a positive effect on improving the physical and mental burden of patients through symptom monitoring, weight management, cognitive psychology, and medication management. DTx is based on smartphones and driven by software programs. It continuously tracks the patient's condition and improves the treatment effect and clinical service level. It has the characteristics of personalization, convenient operation, and low cost, and reduces the economic burden of patients.

Limitations

Prior research has indicated that DTx plays an important role in the management of patients with chronic diseases, but it has also revealed several shortcomings. First, the sample population has an issue with singleness.[23] Studies suggested that, in addition to patients of all ages and patients with various chronic diseases, DTx should be extended to patients who have no prior experience with DTx to expand the population.[32] Second, the majority of the current studies have small sample sizes, and additional samples are required to investigate the impact of disease management interventions based on DTx.[23,27,34] Third, the effect of other intervention factors is unclear in some studies,[18] which influences the assessment of the effect of DTx. As per the nursing guidelines, it is imperative to take into account the impact of the control group in addition to the efficacy of DTx.[24] Thus, more pertinent research must be done in the future to create intervention goals and programs that are appropriate, for example, process evaluation can be carried out through mixed research to explain the influence mechanism of intervention factors. Fourth, Selecting a reliable assessment instrument is crucial. A study found that DTx had a positive effect on the mental health of patients with schizophrenia, but there was no significant effect in the scale results.[26] As a result, more suitable evaluation instruments must be created or employed.

Conclusion

Patients with chronic illnesses have been using the DTx-based approach to disease treatment extensively. This study compiles the advantages and disadvantages of DTx for those with chronic conditions. To achieve the best management of disease prevention and control in patients with chronic diseases, more DTx projects appropriate for these patients can be developed in the future based on the research that is currently available. Additionally, personalized management plans can be formulated for different disease management objectives. This scoping review provides theoretical guidance for the design, research, and implementation of future DTx interventions in the management of various clinical chronic diseases.

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References

1. World Health Organization. Invisible numbers: the true extent of noncommunicable diseases and what to do about them. Retrieved Sep 26, 2022. https://www.who.int/publications/i/item/9789240057661.
2. Kario K, Nomura A, Harada N, et al. Efficacy of a digital therapeutics system in the management of essential hypertension: the HERB-DH1 pivotal trial. *Eur Heart J* 2021; 42: 4111–4122.
3. Burke LE, Ma J, Azar KM, et al. Current science on consumer use of mobile health for cardiovascular disease prevention: a scientific statement from the American Heart Association. *Circulation* 2015; 132: 1157–1213.
4. Patel N and Butte J. Characteristics and challenges of the clinical pipeline of digital therapeutics. *Dig Med* 2020; 3: 1–5.
5. World Health Organization. Heads of state commit to noncommunicable disease global compact to save 50 million lives by 2030. Retrieved Sep 26, 2022.
6. World Health Organization. Noncommunicable diseases country Profiles[EB/OL].(2018-09-12)[2022-09-10]. http://www.who.int/nmh/publications/ncd-profiles-2018/en/.
7. National Bureau of Statistics. China's medium and long-term plan for prevention and treatment of chronic diseases (2017-2025 year)[EB/OL]. (2017-02-14)[2022-09-10]. http://www.gov.cn/xinwen/2020-12/23/content_5572785.htm.
8. Australian Institute of Health and Welfare. Australia's health 2018 [internet]. 2018 [cited 2020 Sep 24].
9. Australian Health Ministers Advisory Council. National strategic framework for chronic conditions [Internet]. Australian Government Department of Health; 2017 [cited 2020 Sep 24].
10. Kalliopi M. Quality of life in chronic disease patients. *Health Psychol Res* 2013; 1: e27.
11. Digital Therapeutics Alliance. A new category of medicine[EB/OL]. [2021-06-30]. https://dtxalliance.org/understanding-dtx/.
12. Liu X, Yan QY, Zhou YL, et al. Research advances in application of digital therapy in management of chronic diseases. *J Nurs Sci* 2023; 38: 122–126.
13. Digital Therapeutics Alliance. Transforming global health care by advancing digital therapeutics[EB/OL].[2023-02-21]. https://dtxalliance.org/advancing-dtx/.
14. Lockwood C, Dos Santos KB and Pap R. Practical guidance for knowledge synthesis: scoping review methods. *Asian Nurs Res (Korean Soc Nurs Sci)* 2019 Dec; 13: 287–294.
15. Wang XY, Ye ZH, Tang LW, et al. An integrative review of scoping review applied in nursing literature. *Chin J Nurs* 2019; 54: 1259–1263.
16. Doyle J, Murphy E, Gavin S, et al. A digital platform to support self-management of multiple chronic conditions (ProACT): findings in relation to engagement during a one-year proof-of-concept trial. *J Med Internet Res* 2021 Dec 15; 23: e22672.
17. Andersson U, Bengtsson U, Ranerup A, et al. Patients and professionals as partners in hypertension care: qualitative sub-study of a randomized controlled trial using an interactive web-based system via Mobile phone. *J Med Internet Res* 2021 Jun 3; 23: e26143.
18. Wang TL, Tang YM, Xie J, et al. Application of digital medical rehabilitation technology in suspension exercise therapy (SET) for chronic non-specific lower back pain. *China Digit Med* 2017; 12: 88–90.
19. Kim I, Lim JY, Kim SW, et al. Effectiveness of personalized treatment stage-adjusted digital therapeutics in colorectal cancer: a randomized controlled trial. *BMC Cancer* 2023 Apr 3; 23: 304.
20. Merlot B, Elie V, Périgord A, et al. Pain reduction with an immersive digital therapeutic in women living with endometriosis-related pelvic pain: at-home self-administered randomized controlled trial. *J Med Internet Res* 2023 Jun 28; 25: e47869.
21. Petrella JR, Michael AM, Qian M, et al. Impact of computerized cognitive training on default mode network connectivity in subjects at risk for Alzheimer's disease: a 78-week randomized controlled trial. *J Alzheimers Dis* 2023; 91: 483–494.
22. Canonico ME, Hsia J, Guthrie NL, et al. Cognitive behavioral therapy delivered via digital mobile application for the treatment of type 2 diabetes: rationale, design, and baseline characteristics of a randomized, controlled trial. *Clin Cardiol* 2022 Aug; 45: 850–856.
23. Merlot B, Dispersyn G, Husson Z, et al. Pain reduction with an immersive digital therapeutic tool in women living with endometriosis-related pelvic pain: randomized controlled trial. *J Med Internet Res* 2022 Sep 21; 24: e39531.
24. Weise H, Zenner B, Schmiedchen B, et al. The effect of an app-based home exercise program on self-reported pain intensity in unspecific and degenerative back pain: pragmatic open-label randomized controlled trial. *J Med Internet Res* 2022 Oct 28; 24: e41899.
25. Li Y, Gong Y, Zheng B, et al. Effects on adherence to a Mobile app-based self-management digital therapeutics among patients with coronary heart disease: pilot randomized controlled trial. *JMIR Mhealth Uhealth* 2022 Feb 15; 10: e32251.
26. Gumley AI, Bradstreet S, Ainsworth J, et al. Digital smartphone intervention to recognise and manage early warning signs in schizophrenia to prevent relapse: the EMPOWER feasibility cluster RCT. *Health Technol Assess* 2022 May; 26: 1–174.
27. Moravcová K, Karbanová M, Bretschneider MP, et al. Comparing digital therapeutic intervention with an intensive obesity management program: randomized controlled trial. *Nutrients* 2022 May 10; 14: 2005.

28. Kario K, Nomura A, Harada N, et al. Efficacy of a digital therapeutics system in the management of essential hypertension: the HERB-DH1 pivotal trial. *Eur Heart J* 2021 Oct 21; 42: 4111–4122.

29. Jacobson NC and Nemesure MD. Using artificial intelligence to predict change in depression and anxiety symptoms in a digital intervention: evidence from a transdiagnostic randomized controlled trial. *Psychiatry Res* 2021 Jan; 295: 113618.

30. Roy A, Hoge EA, Abrante P, et al. Clinical efficacy and psychological mechanisms of an app-based digital therapeutic for generalized anxiety disorder: randomized controlled trial. *J Med Internet Res* 2021 Dec 2; 23: e26987.

31. Cheng P, Casement MD, Kalmbach DA, et al. Digital cognitive behavioral therapy for insomnia promotes later health resilience during the coronavirus disease 19 (COVID-19) pandemic. *Sleep* 2021 Apr 9; 44: zsaa258.

32. Bentley CL, Powell L, Potter S, et al. The use of a smartphone app and an activity tracker to promote physical activity in the management of chronic obstructive pulmonary disease: randomized controlled feasibility study. *JMIR Mhealth Uhealth* 2020 Jun 3; 8: e16203.

33. Kollins SH, DeLoss DJ, Cañadas E, et al. A novel digital intervention for actively reducing severity of pediatric ADHD (STARS-ADHD): a randomised controlled trial. *Lancet Digit Health* 2020 Apr; 2: e168–e178.

34. Velardo C, Shah SA, Gibson O, et al. Digital health system for personalised COPD long-term management. *BMC Med Inform Decis Mak* 2017 Feb 20; 17: 19.

35. Foley P, Steinberg D, Levine E, et al. Track: a randomized controlled trial of a digital health obesity treatment intervention for medically vulnerable primary care patients. *Contemp Clin Trials* 2016 May; 48: 12–20.

36. Milani RV, Lavie CJ, Bober RM, et al. Improving hypertension control and patient engagement using digital tools. *Am J Med* 2017 Jan; 130: 14–20.

37. He JY, Zhao LM and Liu K. Assessment of digital therapeutics-based self-management in Chinese hypertensive patients. *Adv Cardiovasc Dis* 2023; 44: 270–276.

38. Thorndike FP, Berry RB, Gerwien R, et al. Protocol for digital real-world evidence trial for adults with insomnia treated via Mobile (DREAM): an open-label trial of a prescription digital therapeutic for treating patients with chronic insomnia. *J Comp Eff Res* 2021 May; 10: 569–581.

39. Sato M, Akamatsu M, Shima T, et al. Impact of a novel digital therapeutics system on nonalcoholic steatohepatitis: the NASH app clinical trial. *Am J Gastroenterol* 2023 Aug 1; 118: 1365–1372.

40. Hommel KA, Carmody J, Hershey AD, et al. Digital therapeutic self-management intervention in adolescents with migraine: feasibility and preliminary efficacy of "migraine manager". *Headache* 2020 Jun; 60: 1103–1110.

41. Luo Y, Liu SS and Zeng Q. Application of digital therapeutics in chronic disease management. *Chin J Clin Healthcare* 2023; 26: 479–483.

42. Norman CD and Skinner HA. eHEALS: the eHealth literacy scale. *J Med Internet Res* 2006 Nov 14; 8: e27.