

# Progress in the Application of Mobile Health Technology in the Management of Patients with Comorbid Coronary Heart Disease

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**Abstract:** In recent years, with the rapid development of digital technology, mobile health technology has been widely used in the medical field. This article reviews the application forms, application effects, and existing problems of mobile health technology in patients with comorbid coronary heart disease, aiming to provide a reference for the future development of mobile health technology services for patients with comorbid coronary heart disease in China.

**Keywords:** Mobile health technologies; Coronary heart disease; Comorbidity; Review

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## 1. Introduction

Coronary heart disease (CHD), also known as coronary atherosclerotic heart disease, is a significant cardiovascular condition affecting the health of Chinese residents. Its clinical manifestations include palpitations, chest tightness, shortness of breath, and angina pectoris, often characterized by challenging treatment, prolonged therapeutic durations, and recurrent episodes<sup>[1]</sup>. According to the “Report on Cardiovascular Health and Diseases in China 2023” released by the National Center for Cardiovascular Diseases in China, the number of patients with cardiovascular diseases in China is continuously rising<sup>[2]</sup>. It is estimated that the current number of individuals with cardiovascular diseases stands at 330 million, among which 11.39 million are diagnosed with CHD. The mortality rate has also shown a consecutive upward trend over the past five years. Evidently, CHD has emerged as a major public health concern worldwide. CHD comorbidity refers to patients with CHD who also suffer from one or multiple underlying diseases<sup>[3]</sup>. Compared to those with CHD alone, these patients often exhibit poorer physical health, reduced ability to self-manage medical care, and diminished perception of self-management needs<sup>[4]</sup>. With advancements in medical technology and sociodemographic shifts, the number of patients with CHD comorbidity is steadily increasing. In recent years, with the rapid development of digital technology, mobile health technology

has been widely applied in the medical field. Defined by the World Health Organization as a subset of e-health, mobile health utilizes mobile phones, tablets, Personal Digital Assistants (PDAs), patient monitoring devices, wearable devices, applications, interactive voice response systems, internet platforms, and other more complex technologies (such as GPS, Bluetooth, and telecommunications) to deliver health services and information<sup>[5]</sup>. Due to its personalized, convenient, and efficient characteristics, mobile health plays a positive role in the management of patients with CHD comorbidity. This article provides a comprehensive review of the applications of mobile health technology in patients with CHD comorbidity, aiming to offer reference and evidence for the future implementation of mobile health services for this patient population in China.

## **2. Application forms of mobile health technology in patients with CHD comorbidity**

### **2.1. WeChat platform**

WeChat, known for its instant messaging, sharing, and interactive features, has become the most convenient and fastest communication tool nowadays<sup>[6]</sup>. In recent years, an increasing number of hospitals have attempted to use the WeChat platform for post-surgical follow-up of patients with CHD comorbidity. For instance, the catheterization laboratory of Chengde Central Hospital in Hebei Province has utilized WeChat to manage post-discharge health education, blood glucose monitoring, reminder of follow-up visits, and registration of follow-up results for patients with CHD and type 2 diabetes mellitus after PCI surgery. This approach has effectively reduced the occurrence of adverse cardiac events and improved patients' quality of life<sup>[7]</sup>. Miao *et al.* proposed a WeChat-based continuous care program where patients with CHD and comorbid anxiety and depression were guided to join WeChat group chats and follow a dedicated WeChat public account upon discharge<sup>[8]</sup>. Nurses regularly answered patients' care-related questions and encouraged them to share self-care experiences within the group. Additionally, members of the continuous care team pushed relevant care content from the public account to ensure patients maintained a healthy lifestyle. The results indicated that compared to the conventional care and follow-up group, the group receiving continuous care via WeChat, in addition to routine care, had lower SAS and SDS scores, a reduced incidence of cardiovascular adverse events, and higher WHOQOL-BREF (including physical function, social function, mental state, etc.) scores. Given its wide range of functionalities and extensive coverage, WeChat offers a unique platform to address the shortcomings of health education services for patients with CHD in China<sup>[9]</sup>.

### **2.2. Applications (apps)**

Apps, as the mainstream form of mobile health technology, provide significant convenience to both patients and healthcare professionals. Gao *et al.* developed the Digital Human APP, which interfaces with the inspection center, imaging center, and internet clinic of Hefei JD Hospital<sup>[10]</sup>. This APP features six primary functions: constructing a 3D model of a healthy human body, demonstrating 3D surgical procedures for common diseases, exercise check-in, diet recommendations, health education, and internet clinic services. Through this APP, patients can understand surgical procedures, while medical staff can access information on patients' exercise, diet, and medication compliance to provide targeted guidance and supervision. Celia Cruz *et al.* developed the eMOTIVA App, which includes a virtual classroom offering a participatory space<sup>[11]</sup>. This space guides patients using evidence-based information on topics such as scientific diet management and physical exercise to achieve treatment goals recommended by clinical practice guidelines and maintain a healthy lifestyle. These tailored applications for

patients with CHD have demonstrated promising results and played a positive role in controlling blood pressure, blood glucose, blood lipids, and other indicators for patients with CHD comorbidities such as hypertension, hyperglycemia, and hyperlipidemia. In the future, apps with different functionalities can be developed to cater to the diverse needs of patients with CHD comorbidity.

### 2.3. Wearable devices

Wearable devices refer to portable devices that utilize wearable technology to measure and provide feedback on users' daily physical activities <sup>[12]</sup>. In recent years, wearable devices for cardiovascular disease monitoring have mainly encompassed various forms such as wristbands, chest straps, and patches. Their monitoring scope includes multiple indicators like blood pressure, heart rate, respiration, blood oxygen saturation, sleep quality, and electrocardiographic signals <sup>[13]</sup>. Wang *et al.* used the "Xin'an Kang" APP doctor's portal to track the exercise status of patients with coronary heart disease and diabetes, including rehabilitation compliance, whether exercise standards are met, and the presence of abnormal heart rates (rhythm) <sup>[14]</sup>. Patients download the "Xin'an Kang" APP patient portal on their phones and follow the prescribed cardiac rehabilitation exercise plan for home-based rehabilitation, wearing the "Xin'an Kang" remote electrocardiographic telemetry device to monitor their heart rate (rhythm) during the entire exercise process. This study demonstrates that wearable smart devices can effectively control patients' blood glucose and lipid levels, improve their compliance with home-based rehabilitation, and enhance cardiac function. Hughes summarized the application of wearable devices in cardiovascular system diseases <sup>[15]</sup>. Doctors can remotely monitor patients' blood pressure, blood glucose, and other indicators through wearable devices worn by patients. If any indicators are abnormal, doctors can take prompt action. Wearable devices provide convenience for patients in remote healthcare, but researchers also need to pay attention to whether patients wearing smart wearable remote monitoring devices may experience psychological impacts such as avoidance or inferiority complex <sup>[16]</sup>.

### 2.4. Others

Other application forms include phone calls, SMS, VR, etc. Compared to other application forms, telephone follow-up is a very useful and inexpensive method <sup>[17]</sup>. Deng *et al.* conducted a randomized controlled trial <sup>[18]</sup>. The control group received routine nursing, health education, and discharge guidance, while the observation group received additional discharge telephone follow-up health education intervention. The results showed that discharge telephone follow-up health education can lower patients' blood pressure at 3 and 6 months after intervention, improve self-management behavior, medication compliance, and quality of life for patients with coronary heart disease and hypertension, demonstrating high clinical value. SMS is a simple and low-cost form of mobile healthcare. It is popular among elderly patients as it provides regular reminders and prompts for follow-up visits <sup>[19]</sup>. Huo's research shows that health education and disease reminders via SMS for patients with coronary heart disease and diabetes can significantly improve their blood glucose control level, and patient satisfaction is good <sup>[20]</sup>. Existing research indicates that SMS, as a simple, efficient, and low-cost mobile healthcare intervention method not limited by geographical location, has the potential to become an effective auxiliary tool for long-term self-management of chronic diseases such as cardiovascular diseases and diabetes. In recent years, virtual reality (VR) technology has been widely used in the field of medical rehabilitation training due to its unique advantages such as immersion, interactivity, and creativity. It has a positive effect on improving patients' emotions and physical functions <sup>[21]</sup>. Jóźwik conducted a randomized controlled study that showed using VR can improve the mental state of patients

with coronary heart disease combined with anxiety and depression, thereby positively impacting the course of coronary heart disease <sup>[22]</sup>.

### **3. Application effects of mobile health technology in patients with comorbid coronary heart disease**

#### **3.1. Improving patient self-care ability**

Self-care ability refers to a patient's confidence and self-belief in disease treatment. Patients with higher self-ability scores tend to have better prognostic outcomes and stronger disease management skills <sup>[23]</sup>. Studies have shown that improving the self-care ability of coronary heart disease patients can effectively alleviate their comorbid conditions <sup>[24]</sup>. Healthcare professionals can apply mobile health technology to enhance the self-care abilities of coronary heart disease patients, prevent and reduce comorbidities, improve prognosis, and prevent adverse complications. Xu *et al.* explored the application effect of chronic disease management based on a cloud follow-up platform in the care of patients with hypertension and coronary heart disease <sup>[25]</sup>. The observation group, based on the control group, utilized the cloud follow-up platform's chronic disease management, which includes five functions: discharge rehabilitation guidance, information viewing, follow-up interaction, return visit reminders, and medication and outpatient follow-up reminders. The results showed that the management mode based on the cloud follow-up platform is not limited by geography and time, providing patients with real-time and effective information exchange. This ensures that patients can receive systematic health guidance after discharge, contributing to the improvement of their self-care abilities.

#### **3.2. Improving medication adherence**

Medication adherence (MA) refers to the degree to which a patient's medication behavior complies with clinical prescriptions <sup>[26]</sup>. Improving medication adherence among patients with comorbid coronary heart disease can significantly improve their prognosis and reduce mortality. Wang *et al.* created a WeChat public account and group chat through the WeChat platform <sup>[27]</sup>. The public platform provided health education on coronary heart disease and diabetes-related knowledge, while the WeChat group was used for communication between nurses and patients, as well as among patients. The research results indicated that health education based on WeChat can effectively improve patients' medication adherence. There was a statistically significant difference in medication adherence scores between the control group and the intervention group at 16 weeks after discharge for patients with coronary heart disease and diabetes. Utilizing the WeChat platform for health education programs can continuously provide and reinforce health knowledge to patients in a convenient and cost-effective way, thereby effectively improving their medication adherence. This initiative has a positive impact on reducing the incidence of complications and preventing adverse cardiac events.

#### **3.3. Controlling risk factors**

The "China Cardiovascular Health and Disease Report 2023" points out that risk factors for cardiovascular disease include overweight/obesity, hypertension, diabetes, and dyslipidemia <sup>[28]</sup>. For patients with comorbid coronary heart disease, controlling blood pressure, blood glucose, and blood lipids is even more crucial. Kong *et al.* analyzed biochemical indicators of patients in the experimental and control groups before and after intervention <sup>[29]</sup>. They found that the new model of home-based remote doctor-patient interaction based on multi-dimensional wearable



devices improved blood pressure, blood lipids, blood glucose indicators, and control rates in elderly patients with comorbidities. After using the devices, the remote experimental group showed increased attention to their health indicators. They were able to change their eating and exercise habits according to medical professionals' health guidance and improve medication adherence. Tong explored the application effect of using the WeChat platform for continuous nursing care in patients with coronary heart disease and diabetes <sup>[30]</sup>. They found that continuous nursing care based on the WeChat platform has significant advantages in providing health guidance to patients with diabetes and coronary heart disease. The average low values of blood glucose, blood lipids, and blood pressure in the experimental group were lower than those in the control group. Continuous nursing care based on the WeChat platform can significantly reduce the risk of cardiovascular adverse events.

## **4. Existing deficiencies in the application of mobile health technology for patients with comorbid coronary heart disease**

### **4.1. Patient information literacy needs improvement**

A multi-center study on patients with coronary heart disease (CHD) in China found that 75.7% of patients have at least one comorbidity besides CHD, and this proportion is as high as 90% among the elderly population, with over 33.33% of patients having three or more comorbidities <sup>[31]</sup>. However, many elderly people find it difficult to adapt to and master the use of mobile health technology due to physical limitations or educational constraints. Research has shown that after a nursing home in a county introduced smart health monitoring equipment, many elderly people gave up using it because of operational difficulties, resulting in low equipment utilization and failure to achieve the desired effect <sup>[32]</sup>. Therefore, it is necessary to carry out extensive health education and training to improve the acceptability and usage ability of mobile health technology among patients with comorbid coronary heart disease and their families. Similarly, in the future, the needs of the elderly and other groups with lower information literacy should be fully considered, and simpler and convenient forms of mobile health technology should be developed for patients with comorbid coronary heart disease, focusing on user-centered design.

### **4.2. Long-term effectiveness needs further verification**

Although most current studies show that the application of mobile health technology has a positive effect on improving self-care ability and controlling risk factors for patients with comorbid coronary heart disease, the course of the disease is long and requires long-term, even lifelong treatment <sup>[33]</sup>. Currently, follow-up studies on the intervention effects of mobile health technology for patients with comorbid coronary heart disease both domestically and internationally have generally been short-term, which is not sufficient to prove the long-term effectiveness of mobile health technology for these patients. It is hoped that future scholars can conduct more rigorous long-term follow-up studies to provide higher-level evidence to verify its clinical application effects.

### **4.3. Information security and patient privacy protection**

Inadequate mobile medical information systems or mobile health applications support personal health, but due to management and design defects, various mobile health technologies face data security and confidentiality issues as mobile medical services continue to expand <sup>[34]</sup>. Once patients' health information is leaked or illegally used, it can easily lead to violations of their personal dignity and harm to their personal and property safety. Therefore, users are more concerned about health information and have stronger concerns about information disclosure <sup>[35]</sup>.

In the future, the mobile health industry needs to accelerate technological upgrades, adopt encryption algorithms to protect data confidentiality, encrypt sensitive medical data, and ensure that data is not easily accessed by unauthorized users during transmission and storage. Similarly, it is suggested that relevant legal departments strengthen legal supervision and improve relevant laws and regulations on privacy protection of mobile health technology to protect patients' privacy and security.

## 5. Conclusion

With the rapid development of digital technology, mobile health technology has developed rapidly in recent years. As an innovative technology that combines mobile devices and healthcare, mobile health technology provides patients with a more convenient and personalized health management method. Mobile health technology has brought new development opportunities for the nursing management of patients with comorbid coronary heart disease. It has been initially developed and applied in this field, and certain practical results have been achieved. However, there are still some problems, such as the need to improve patients' information literacy, further verify the long-term effectiveness, and strengthen information security and patient privacy protection. In the future, relevant scholars should further explore and conduct high-quality research based on existing studies, taking into account China's national conditions, to promote the application of mobile health technology in patients with comorbid coronary heart disease, thereby establishing a more convenient and effective management model for comorbid coronary heart disease.

## Disclosure statement

The authors declare no conflict of interest.

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