ChinaRxiv

AI translation · View original & related papers at
chinarxiv.org/items/chinaxiv-202508.00226

Postprint of a Scoping Review of Telemedicine Applications in Cardiac Rehabilitation for Coronary Heart Disease

Authors: Liu Yan, Yuan Yanling, Ling Rong, Wang Lanyun, Sun Li, Sun Li

Date: 2025-08-13T00:00:00+00:00

Abstract

Background Coronary heart disease is a prevalent cardiovascular disease worldwide that severely impacts patients' quality of life and survival. Cardiac rehabilitation constitutes a critical component in the recovery process for coronary heart disease patients and holds significant importance for improving prognosis and quality of life. In recent years, with the advancement of information technology, telemedicine has gradually emerged in the domain of cardiac rehabilitation for coronary heart disease patients, demonstrating promising application prospects and providing more convenient rehabilitation support. However, variations currently exist in the quality of cardiac rehabilitation implementation across different centers, which to some extent affects the stability and accessibility of rehabilitation outcomes.

Objective To conduct a scoping review of telemedicine application in cardiac rehabilitation for coronary heart disease patients, systematically summarize existing research, and provide an evidence-based reference for clinical healthcare professionals implementing remote cardiac rehabilitation.

Methods Based on the scoping review framework by Arksey and O' Malley, we systematically searched Cochrane Library, PubMed, Web of Science, Embase, EBSCO, Chinese Biomedical Literature Database, CNKI, Wanfang Data Knowledge Service Platform, VIP Database, and other sources from inception to August 20, 2024. Included literature was screened, summarized, and analyzed.

Results A total of 23 articles from 10 countries were included, comprising 21 randomized controlled trials, 1 quasi-experimental study, and 1 qualitative study. Telemedicine platforms primarily utilized applications and remote monitoring systems to provide guidance on rehabilitation exercise frequency and intensity, heart rhythm monitoring, health education, and social support for coronary

heart disease patients. Studies predominantly focused on coronary heart disease-related indicators and symptom assessment, quality of life, self-management, patient readmission rates and mortality, resource costs, user experience (satisfaction and safety), anxiety and depression, and physical activity levels.

Conclusion Telemedicine enhances participation in cardiac rehabilitation, improves exercise motivation and medication adherence, reduces sedentary behavior, and increases survival rates and quality of life for coronary heart disease patients. Although telemedicine in China is experiencing rapid development, it still faces challenges and limitations. Future directions include optimizing remote cardiac rehabilitation platform functions through artificial intelligence technology, improving evaluation systems, and strengthening integration with community services to comprehensively enhance application effectiveness.

Full Text

Scoping Review of Telemedicine Application in Cardiac Rehabilitation for Coronary Heart Disease Patients

LIU Yan[1], **YUAN Yanling**[2], **LING Rong**[1], **WANG Lanyun**[1], **SUN Li**[1]*

[1]Department of Cardiovascular Medicine, 940th Hospital, PLA Joint Logistic Support Force, Lanzhou 730050, China
[2]School of Nursing, Gansu University of Traditional Chinese Medicine, Lanzhou 730000, China

Corresponding author: SUN Li, E-mail: 3761104944@qq.com

Abstract

Background: Coronary heart disease (CHD) is a common cardiovascular disease that severely impacts patients' quality of life and survival globally. Cardiac rehabilitation (CR), a critical component of post-CHD recovery, significantly improves patient prognosis and quality of life. In recent years, with advances in information technology, telemedicine has emerged in cardiac rehabilitation for CHD patients, demonstrating promising applications and providing more convenient rehabilitation support. However, quality variations across different cardiac rehabilitation centers have affected the stability and accessibility of rehabilitation outcomes.

Objective: This scoping review aims to systematically summarize existing research on telemedicine application in cardiac rehabilitation for CHD patients, providing a reference for healthcare professionals implementing remote cardiac rehabilitation.

Methods: Based on Arksey and O' Malley' s scoping review framework, we searched multiple databases including Cochrane Library, PubMed, Web of Sci-

ence, Embase, EBSCO, China Biology Medicine disc, China National Knowledge Infrastructure, Wanfang Data Knowledge Service Platform, and VIP Network from inception to August 20, 2024. We screened, summarized, and analyzed the included literature.

Results: We included 23 articles from 10 countries, comprising 21 randomized controlled trials, 1 quasi-experimental study, and 1 qualitative study. Telemedicine carriers primarily included applications and remote monitoring systems. Telemedicine enabled guidance on rehabilitation exercise frequency and intensity, heart rhythm monitoring, health education, and social support. Most studies focused on CHD-related indicators and symptom assessment, quality of life, self-management, patient rehospitalization and mortality rates, resource costs, user experience (satisfaction and safety), anxiety and depression, and physical activity levels.

Conclusion: Telemedicine enhances cardiac rehabilitation participation, exercise motivation, and medication adherence in CHD patients, improves sedentary behavior, and increases survival rate and quality of life. Although telemedicine is rapidly developing in China, it still faces challenges and limitations. Future improvements should involve optimizing remote cardiac rehabilitation platforms with artificial intelligence technology, refining evaluation systems, and strengthening community service integration to enhance overall application effectiveness.

Keywords: Coronary Disease; Telemedicine; Cardiac rehabilitation; Scope review

---

1. Materials and Methods

1.1 Research Questions

Through preliminary literature review, we identified three key research questions: (1) What are the specific application forms of telemedicine in cardiac rehabilitation for CHD patients? (2) What are the specific management contents of telemedicine in CHD patient cardiac rehabilitation? (3) What are the effects of telemedicine application in CHD patient cardiac rehabilitation?

1.2 Inclusion and Exclusion Criteria

Based on the PCC principle, inclusion criteria were: (1) **Participants (P):** CHD patients; (2) **Concept (C):** Various forms of CR management involving internet-based remote monitoring for CHD patients; (3) **Context (C):** Home-based CR; (4) **Study design:** Interventional studies including randomized controlled trials, quasi-experimental studies, and qualitative research; (5) **Language:** Chinese or English.

Exclusion criteria were: (1) Studies focusing solely on telemedicine system development or software usability testing; (2) Studies where full text was unavailable.

1.3 Search Strategy

We searched Cochrane Library, PubMed, Web of Science, Embase, EBSCO, China Biology Medicine disc, China National Knowledge Infrastructure, Wanfang Data Knowledge Service Platform, and VIP Network. The search scope included titles, keywords, and other common fields, focusing on studies about telemedicine application in CHD patient cardiac rehabilitation from database inception to August 20, 2024. The PubMed search strategy was as follows: (("Coronary Disease" [MeSH] OR "Coronary Diseases" [Ti/Ab] OR "Coronary Heart Disease" [Ti/Ab] OR "Coronary Heart Diseases" [Ti/Ab]) AND ("Virtual Medicine" [MeSH] OR "Mobile Health" [Ti/Ab] OR "mHealth" [Ti/Ab] OR "Telehealth" [Ti/Ab] OR "eHealth" [Ti/Ab] OR "Telemedicine" [Ti/Ab]) AND ("Cardiac Rehabilitations" [MeSH] OR "Cardiovascular Rehabilitation" [Ti/Ab] OR "Cardiovascular Rehabilitations" [Ti/Ab])). For China National Knowledge Infrastructure, Chinese search terms included "冠心病" (coronary heart disease), "冠状动脉粥样硬化性心脏病" (coronary atherosclerotic heart disease), "冠状动脉疾病" (coronary artery disease), "远程监测" (remote monitoring), "远程" (remote), "移动" (mobile), "可穿戴" (wearable), "电子健康" (eHealth), "网站" (website), "智能" (smart), "APP" , and "康复" (rehabilitation).

1.4 Literature Screening and Data Extraction

Duplicate records were removed using EndNote. Two trained researchers independently screened titles and abstracts, then reviewed full texts of potentially eligible studies. Discrepancies were resolved through discussion or consultation with a third reviewer. Data extraction included author, publication year, country, study type, study population, telemedicine application forms, management content in CHD patient cardiac rehabilitation, and outcome indicators.

---

2. Results

2.1 Literature Screening Results

The initial search yielded 857 articles. After removing duplicates, 663 articles remained. Following title and abstract screening, 578 articles were excluded. Full texts of the remaining 85 articles were reviewed, and 62 were excluded (16 due to unavailability of full text, 46 due to content mismatch). Ultimately, 23 articles were included [Figure 1: see original paper].

2.2 Basic Information of Included Literature

Among the 23 included articles, 3 were in Chinese and 20 in English, representing 10 countries: China (7 articles), United States (2), Spain (2), Czech Republic (3), Netherlands (2), United Kingdom (1), Greece (1), Israel (1), Belgium (2), and New Zealand (2). Study designs included 21 randomized controlled trials, 1 quasi-experimental study, and 1 qualitative study .

2.3 Application Forms of Telemedicine in CHD Patient Cardiac Rehabilitation

2.3.1 Applications Six studies [10-11,17-18,21,30] involved smartphone applications (apps) for CHD patient cardiac rehabilitation, including both standalone app use and app integration with other methods, with the latter being more common. Lao et al.' s [30] app included four functions: education, health data entry with push notifications, health status tracking, and interactive communication, providing educational support, health data feedback, and motivational text messaging services. Yanli You et al.' s [10] study utilized a Smart heart rate and muscle oxygen monitoring network composed of heart rate belts, muscle oxygen monitoring wearable devices, and a mobile app. Data collected by the heart rate belt and muscle oxygen monitoring devices were transmitted via Bluetooth to the mobile app, which displayed target heart rates and monitored real-time heart rate and muscle oxygen saturation (SmO2) during exercise, enabling assessment of exercise capacity and adjustment of exercise intensity. Five studies [16,22,25,27-28] used apps combined with wearable devices such as motion sensors, accelerometers, and pedometers to monitor patients' vital signs and physical activity in real time, assessing exercise effectiveness and safety.

2.3.2 Remote Monitoring Systems Eight studies [12-14,19-20,24,26,31] indicated that remote ECG monitoring systems enable real-time monitoring of CHD patient cardiac rehabilitation without time or geographical constraints, allowing healthcare providers to deliver effective interventions and guidance while promptly identifying risks during exercise and adjusting rehabilitation protocols to reduce adverse cardiovascular events. Jiang Heng et al. [12] used the TE-8000Y3 wireless network physiological parameter monitor, which employed portable monitoring terminals for continuous real-time patient monitoring, transmitting collected data via mobile communication networks to a server that then sent abnormal data alerts to healthcare providers' mobile phones for patient guidance. Dalli et al. [14] developed the Cardioplan cardiac telerehabilitation system, which included health management software for recording patient general conditions, vital signs, and medication adherence, providing dietary recommendations. Its exercise module offered warm-up and stretching exercise videos, virtual classes, and tracked detailed exercise records.

2.3.3 Professional Websites Two studies [15,23] managed CHD remote cardiac rehabilitation through professional websites. Batalik et al. [15] developed a professional web platform integrating Polar M430 heart rate monitors and H10 chest sensors compatible with the platform for real-time heart rate monitoring, electronic health record creation, and data security. The platform enabled rehabilitation specialists to review historical training data through training diaries, compare training values, and accurately develop rehabilitation plans. Additionally, the website allowed only rehabilitation specialists and patients to log in, effectively protecting patient privacy. Duan et al. [23] used a professional web-

site to monitor lifestyle and physical activity in CHD patients during cardiac rehabilitation, providing tailored intervention plans to promote healthy lifestyle maintenance.

2.3.4 Other Approaches Two studies [29,32] utilized short message service (SMS) and virtual world technology for CHD patient cardiac rehabilitation program development and management. Pfaefli et al. [29] used SMS and a support website to send customized daily health plan messages to patients, effectively motivating them to improve self-efficacy, thereby reducing blood pressure and rehospitalization rates. One study [32] used a virtual reality technology platform for CHD patient cardiac rehabilitation, holding weekly meetings focused on cardiovascular health-related topics and inviting professional nutritionists and exercise physiologists to provide in-depth guidance on diet and exercise through live "expert consultation" group chats. Additionally, patients participated in various virtual activities covering healthy food selection and portion control, CHD risk factor analysis, medication management, behavioral strategies, and exercise program development. However, SMS communication may have limitations such as lack of feedback and information overload, potentially making it difficult to achieve expected intervention effects.

2.4 Management Content of Telemedicine in CHD Patient Cardiac Rehabilitation

2.4.1 Rehabilitation Exercise Frequency and Intensity Guidance Cardiac rehabilitation is considered key to CHD management, improving cardiac function and health-related physical fitness. Exercise is an essential component and a Class I, Level A recommendation in international guidelines [19,24]. Many researchers have investigated different CR exercise modalities, evolving from continuous single-intensity training to interval aerobic training, and now to individualized exercise prescription-centered management models. Despite this evolution, rehabilitation still involves numerous risk factors, making effective monitoring crucial.

Twenty studies [10-12,14-15,17-29,31-32] demonstrated that telemedicine can provide guidance on exercise intensity, modality, frequency, and duration. Yanli You et al. [10] used apps and wearable devices to monitor real-time dynamic changes in heart rate and muscle oxygen curves during exercise, assessing patient exercise capacity and establishing reasonable target heart rate ranges. Exercise intensity was adjusted based on walking speed corresponding to target heart rates, ensuring safety and effectiveness while setting exercise compliance standards within the app. Song et al. [19] confirmed that remote monitoring effectively improves exercise tolerance in CHD patients, with rehabilitation effects comparable or even superior to traditional center-based rehabilitation.

2.4.2 Heart Rhythm Monitoring Eighteen studies [10-12,14-22,24-28,31] mentioned that telemedicine enables real-time heart rhythm monitoring without

time or geographical constraints, providing timely warnings for cardiovascular events such as arrhythmias and myocardial ischemia. Jiang Heng et al. [12] confirmed that remote ECG monitoring throughout the rehabilitation training process can promptly detect arrhythmias including premature ventricular and supraventricular contractions, supraventricular/ventricular tachycardia, atrial fibrillation and flutter, atrial tachycardia, sinus tachycardia, and ventricular fibrillation, effectively improving arrhythmia detection rates. Antoniou et al. [22] enabled real-time viewing of patient heart rates and current exercise status, ensuring patients exercised within prescribed heart rate zones.

2.4.3 Health Education Unhealthy behaviors contribute significantly to adverse events in CHD patients, with diet, physical activity, and smoking cessation being major factors for improving health behaviors. Therefore, delivering disease-related knowledge and management strategies for diet, exercise, medication, weight, and lifestyle through applications, websites, WeChat, SMS, and other tools is crucial for health education. Lixia Li et al. [11] conducted weekly telephone follow-ups and home visits to record and answer patient questions promptly while providing emotional support. Brewer et al. [32] used virtual reality technology with interactive 3D spaces for immersive experiences and participant discussions, promoting healthy lifestyle changes and improving patient self-management efficacy.

2.4.4 Social Support Social support is considered an important factor in determining psychological stress and health. As CHD patients' cognitive levels improve, close relationships and smooth communication with their surrounding community can stimulate intrinsic motivation, ultimately improving CR adherence. All 23 included studies provided social support for CHD patients, including support from healthcare providers, relatives, and families. Duan et al. [23] identified two distinct stages in health behavior change, with the first motivational stage primarily relying on social support through weekly nurse contact via phone calls and SMS reminders, plus phone credit incentives, to improve CR participation.

2.5 Evaluation Indicators

Twenty-one studies [10-11,13-19,21-32] included self-management as an evaluation indicator, assessed through follow-up questionnaires, the General Self-Management Behavior Scale (GS-MS), International Physical Activity Questionnaire (IPAQ), Mediterranean Diet Prevention Questionnaire (PREDIMED), and other tools [14,15,19,24]. Ten studies [10-12,20-23,29-31] evaluated physical activity levels or Borg scale scores, finding significant improvements in exercise capacity and oxygen consumption, along with weight loss and reduced visceral fat. Seven studies [20-23,29-31] used the Hospital Anxiety and Depression Scale (HADS), showing that remote medical groups could achieve positive psychological improvements through rehabilitation specialist education and management, even with psychological stress.

Twenty studies [10-12,14-15,17-29,31-32] evaluated the effects of telemedicine in CHD patient cardiac rehabilitation, covering multiple key indicators including cardiac function assessment, arrhythmia and myocardial ischemia detection rates, weight changes, blood pressure, diabetes and hyperlipidemia control, and improvement of typical symptoms such as chest tightness and dyspnea. Song et al. [19] included exercise tolerance and exercise habit improvement as evaluation indicators, finding significantly improved exercise tolerance after 6 months of intervention, with 93.8% of patients in the remote monitoring group developing exercise habits compared to the conventional follow-up group.

Fourteen studies [11-12,14,16-18,20-23,25,28,31-32] examined the impact of telemedicine on quality of life in CHD patients. Lixia Li et al. [11] used the Chinese Cardiovascular Patient Quality of Life Assessment Questionnaire (CQQC), demonstrating that remote monitoring not only enables timely assessment of patient condition changes but also significantly improves quality of life.

Five studies [16,20,22,24,31] incorporated resource costs as evaluation indicators. Brouwers et al. [16] comprehensively examined the cost-effectiveness of remote CR versus center-based CR in CHD patients, dividing 300 patients into groups (153 in remote intervention, 147 in center control). Through basic case analysis comparing quality of life and average cardiac care and social costs during rehabilitation, remote CR demonstrated superior cost-effectiveness compared to center-based CR.

Fifteen studies [11,13-15,17,20-21,24-28,30-32] evaluated satisfaction and safety of telemedicine in CHD patient cardiac rehabilitation. Ten studies [11,14,15,17,20,24-28] showed high satisfaction with remote monitoring CR protocols and remote rehabilitation as an alternative to center-based rehabilitation, while five studies [13,21,30-32] evaluated application usability. One study [11] used the Family Burden Scale (FBS) to compare remote rehabilitation and center-based rehabilitation groups, finding lower FBS scores and higher patient satisfaction in the remote group.

---

3. Discussion

3.1 Diverse Carriers in Telemedicine Application for CHD Patient Cardiac Rehabilitation

The rapid development of internet technology and its integration with healthcare has facilitated the emergence of telemedicine, which is gradually being promoted in chronic disease management. Telemedicine provides support for CHD patient cardiac rehabilitation, improving patient compliance. Early approaches used email, SMS, and WeChat for disease management reminders [29]. With continuous advancement in digital health technology, telemedicine methods such as apps, remote monitoring systems, and virtual reality technology

demonstrate advantages in predicting health risks and developing personalized CR plans. However, research exploring diverse carriers in CHD patient cardiac rehabilitation shows variations due to patient population characteristics, study design differences, and technological development levels across countries and regions.

Four studies [13-14,21,27] noted that women show lower participation and adherence in CR programs. Ten studies [17-18,21-23,26-28,30-31] emphasized that enrolled patients were smartphone and internet users, but elderly patients may face challenges with smartphone and internet platform operation, affecting the widespread promotion and practical application of telemedicine carriers in elderly populations [13,19]. All 23 studies [10-32] were conducted in economically developed regions, with no mention of promotion and popularization in remote, resource-scarce areas. China' s cardiac rehabilitation started relatively late, and combined with unbalanced regional economic and technological development, remote CR programs remain in the optimization stage. Therefore, understanding and addressing differences arising from patient characteristics and cultural backgrounds, and providing convenient consultation and monitoring services for patients in medically underserved areas, are crucial for optimizing the accessibility and effectiveness of telemedicine services. Additionally, differences in sample size, follow-up duration, and assessment indicators may be primary reasons for variations in study results [18,24,31]. Consequently, future multi-center, large-sample clinical studies are urgently needed to comprehensively evaluate the application effects of telemedicine carriers.

3.2 Safety, Universality, and Individuality in Telemedicine Management for CHD Patient Cardiac Rehabilitation

All included studies [10-32] demonstrated that remote CR can overcome time and space limitations, enabling patients to improve exercise and health behavior management knowledge, regulate exercise fear generalization, and promote fear extinction through health education via professional websites, WeChat, and multimedia content, effectively meeting exercise prescription requirements [33]. It also tracks medication and diet adherence to improve CR efficacy management.

Currently, elderly patients constitute the main CR population, and research reveals limitations of internet-plus CR for elderly individuals living alone or empty-nesters. Therefore, future development should emphasize device functionality and operational convenience to improve acceptance among elderly patients [34]. Healthcare providers are recommended to use targeted interviews to understand patient needs and expectations, draft CR plans, and establish multidisciplinary teams (MDT) to comprehensively assess patient capabilities and develop personalized CR protocols.

Thirteen studies [10-15,19,24,26-29,32] indicated that remote monitoring CR for low-to-medium risk CHD patients showed no serious adverse events during rehabilitation, demonstrating equivalent advantages in effectiveness and rehabil-

itation outcomes compared to center-based CR. Eight studies [12,14-15,17,20-22,28] emphasized system security, noting that password-protected webpages effectively safeguard patient data confidentiality and privacy. However, safety studies in high-risk patients remain relatively limited, requiring strengthened evaluation of rehabilitation effects and safety under remote monitoring for this population in future research.

3.3 Definite Effectiveness of Telemedicine in CHD Patient Cardiac Rehabilitation with Need for Improved Evaluation Indicators

Remote medical technology shows good application effects in improving cardiac function, quality of life, exercise tolerance, and effectively reducing rehospitalization rates, mortality, and cardiovascular risk factors and complications in CHD patient CR. Additionally, multiple studies [11,13-15,17,20-21,24-28,30-32] included patient experience and satisfaction as evaluation indicators, further broadening the effectiveness scope of telemedicine in CR. Five studies [16,20,22,24,31] focused on cost-effectiveness comparisons between remote CR and center-based CR. One study [16] explored intervention costs, average healthcare costs per patient during remote versus center-based CR, and social costs, showing no significant differences. However, remote CR demonstrated superiority in cost-effectiveness regarding commuting costs, providing strong economic support for telemedicine application in CR.

One study [18] incorporated the Generalized Anxiety Disorder Scale (GAD-7) to assess psychological health status, noting that telemedicine not only optimizes physiological indicators but may also indirectly promote active participation and long-term adherence by alleviating anxiety and other psychological issues.

Although telemedicine has achieved considerable development in CHD patient CR treatment, existing research evidence still has limitations, including insufficient long-term effect evaluation, cultural differences in assessment tools, and long-term maintenance of self-management, which severely restrict the widespread promotion of telemedicine at primary and community levels. Future research should focus on continuous and accurate data collection during patient rehabilitation to more objectively evaluate the effects and application potential of telemedicine in CHD patient CR.

This study systematically summarized the application forms, management content, and evaluation indicators of telemedicine in CHD patient CR. Results show that telemedicine carriers are diverse, management content is comprehensive, and evaluation indicators are relatively rich. Overall, telemedicine demonstrates positive outcomes in improving exercise and medication adherence, reducing sedentary behavior, and increasing survival rate and quality of life in CHD patient CR. However, improvements are needed in knowledge-attitude-behavior levels and e-health literacy among female and elderly patients, as well as in CR for high-risk CHD patients [35]. With the maturation of artificial intelligence (AI) technology [36], future integration of AI with remote monitoring

systems through optimized remote CR platform functions, improved evaluation systems, and reduced rehabilitation risks will promote embedding in patients' lives and achieve sustainable long-term rehabilitation effects.

Author Contributions

LIU Yan: Conceptualization, design, data collection and analysis, manuscript writing. SUN Li: Conceptualization, quality control and review, overall responsibility. YUAN Yanling: Data collection and analysis. LING Rong: Figure and table preparation. WANG Lanyun: Content and format revision.

Conflict of Interest

The authors declare no conflict of interest.

References

[1] LIU Mingbo, HE Xinye, YANG Xiaohong, et al. Interpretation of key points of the "China Cardiovascular Health and Disease Report 2023" [J]. Chinese General Practice, 2025, 28(1): 20-38.

[2] ZHANG Songjiang, LI Longyang, GAO Jianfeng. Research progress on high-intensity interval training rehabilitation for coronary heart disease patients[J]. Chinese Journal of Gerontology, 2024, 44(9): 2289-2295.

[3] GUO Weiting, LIU Jianping, ZHANG Xiaoxue, et al. Re-evaluation of the effectiveness and compliance of remote cardiac rehabilitation: a systematic review[J]. Chinese Journal of Nursing, 2023, 58(4): 426-433. DOI: 10.3761/j.issn.0254-1769.2023.04.006.

[4] CHENG Jinfang, XUE Jun, YOU Dihui, et al. Progress in the application of cardiac rehabilitation in different cardiovascular diseases[J]. Chinese Journal of Geriatric Heart Brain and Vessel Diseases, 2024, 26(2): 229-231. DOI: 10.3969/j.issn.1009-0126.2024.02.027.

[5] DENTON F, WADDELL A, KITE C, et al. Remote maintenance cardiac rehabilitation (MAINTAIN): a protocol for a randomised feasibility study[J]. Digit Health, 2023, 9: 20552076231152176. DOI: 10.1177/20552076231152176.

[6] RAMACHANDRAN H J, JIANG Y, TAM W W S, et al. Effectiveness of home-based cardiac telerehabilitation as an alternative to Phase 2 cardiac rehabilitation of coronary heart disease: a systematic review and meta-analysis[J]. Eur J Prev Cardiol, 2022, 29(7): 1017-1043. DOI: 10.1093/eurjpc/zwab106.

[7] TAYLOR R S, DALAL H M, MCDONAGH S T J. The role of cardiac rehabilitation in improving cardiovascular outcomes[J]. Nat Rev Cardiol, 2022, 19(3): 180-194. DOI: 10.1038/s41569-021-00655-4.

[8] MACKINNON G E, BRITTAIN E L. Mobile health technologies in cardiopulmonary disease[J]. Chest, 2020, 157(3): 654-664. DOI: 10.1016/j.chest.2019.10.015.

[9] GONG Lu, WANG Yanhong, MU Chenghua, et al. Scoping review of the impact of delay discounting on self-management behaviors in diabetic patients[J]. Journal of Nursing Science, 2025, 40(3): 109-114.

[10] YANLI Y, JIEGANG Z, GONG Z, et al. Evaluation of a cardiac rehabilitation exercise guidance model based on wearable device monitoring for patients after percutaneous coronary intervention[J]. Chinese Journal of Rehabilitation Medicine, 2020, 35(4): 453-458. DOI: 10.3969/j.issn.1001-1242.2020.04.012.

[11] LIXIA L, CHENGLING L, HONGYING L. Effects of home-based telerehabilitation platform on rehabilitation outcomes, exercise tolerance, and quality of life in CHD patients after PCI[J]. Chinese Journal of Evidence-Based Cardiovascular Medicine, 2022, 14(11): 1383-1385, 1390. DOI: 10.3969/j.issn.1674-4055.2022.11.22.

[12] JIANG Heng, YU Manli, LI Bin, et al. Application value of remote ECG monitoring in cardiac rehabilitation for coronary heart disease patients with chronic heart failure[J]. Journal of Cardiovascular Rehabilitation Medicine, 2022, 31(6): 723-728. DOI: 10.3969/j.issn.1008-0074.2022.06.14.

[13] O' SHEA O, WOODS C, MCDERMOTT L, et al. A qualitative exploration of cardiovascular disease patients' views and experiences with an eHealth cardiac rehabilitation intervention: The PATHway Project[J]. PLoS One, 2020, 15(7): e0235274. DOI: 10.1371/journal.pone.0235274.

[14] DALLI PEYDRÓ E, SANZ SEVILLA N, TUZÓN SEGARRA M T, et al. A randomized controlled clinical trial of cardiac telerehabilitation with a prolonged mobile care monitoring strategy after an acute coronary syndrome[J]. Clin Cardiol, 2022, 45(1): 31-41. DOI: 10.1002/clc.23757.

[15] BATALIK L, KONECNY V, DOSBABA F, et al. Cardiac rehabilitation based on the walking test and telerehabilitation improved cardiorespiratory fitness in people diagnosed with coronary heart disease during the COVID-19 pandemic[J]. Int J Environ Res Public Health, 2021, 18(5): 2241. DOI: 10.3390/ijerph18052241.

[16] BROUWERS R W M, VAN DER POORT E K J, KEMPS H M C, et al. Cost-effectiveness of cardiac telerehabilitation with relapse prevention for the treatment of patients with coronary artery disease in the Netherlands[J]. JAMA Netw Open, 2021, 4(12): e2136652. DOI: 10.1001/jamanetworkopen.2021.36652.

[18] XU L Q, XIONG W J, LI J W, et al. Role of the intelligent exercise rehabilitation management system on adherence of cardiac rehabilitation in patients with coronary heart disease: a randomised controlled crossover study protocol[J]. BMJ Open, 2020, 10(6): e036720. DOI: 10.1136/bmjopen-2019-036720.

[19] SONG Y X, REN C, LIU P, et al. Effect of smartphone-based telemonitored exercise rehabilitation among patients with coronary heart disease[J]. J Cardiovasc Transl Res, 2020, 13(4): 659-667. DOI: 10.1007/s12265-019-09938-6.

[20] BROUWERS R W M, KRAAL J J, TRAA S C J, et al. Effects of cardiac telerehabilitation in patients with coronary artery disease using a personalised patient-centred web application: protocol for the SmartCare-CAD randomised controlled trial[J]. BMC Cardiovasc Disord, 2017, 17(1): 46. DOI: 10.1186/s12872-017-0470-1.

[21] CRUZ-COBO C, BERNAL-JIMÉNEZ M Á, CALLE G, et al. Efficacy of a mobile health app (eMOTIVA) regarding compliance with cardiac rehabilitation guidelines in patients with coronary artery disease: randomized controlled clinical trial[J]. JMIR Mhealth Uhealth, 2024, 12: e55421. DOI: 10.2196/55421.

[22] ANTONIOU V, XANTHOPOULOS A, GIAMOUZIS G, et al. Efficacy, efficiency and safety of a cardiac telerehabilitation programme using wearable sensors in patients with coronary heart disease: the TELEWEAR-CR study protocol[J]. BMJ Open, 2022, 12(6): e059945. DOI: 10.1136/bmjopen-2021-059945.

[23] DUAN Y P, LIANG W, GUO L, et al. Evaluation of a web-based intervention for multiple health behavior changes in patients with coronary heart disease in home-based rehabilitation: pilot randomized controlled trial[J]. J Med Internet Res, 2018, 20(11): e12052. DOI: 10.2196/12052.

[24] NABUTOVSKY I, ASHRI S, NACHSHON A, et al. Feasibility, safety, and effectiveness of a mobile application in cardiac rehabilitation[J]. Isr Med Assoc J, 2020, 22(6): 357-363.

[25] AVILA A, CLAES J, BUYS R, et al. Home-based exercise with telemonitoring guidance in patients with coronary artery disease: Does it improve long-term physical fitness?[J]. Eur J Prev Cardiol, 2020, 27(7): 749-757. DOI: 10.1177/2047487319892201.

[26] AVILA A, CLAES J, GOETSCHALCKX K, et al. Home-based rehabilitation with telemonitoring guidance for patients with coronary artery disease (short-term results of the TRiCH study): randomized controlled trial[J]. J Med Internet Res, 2018, 20(6): e225. DOI: 10.2196/jmir.9943.

[27] BATALIK L, PEPERA G, PAPATHANASIOU J, et al. Is the training intensity in phase two cardiovascular rehabilitation different in telehealth versus outpatient rehabilitation?[J]. J Clin Med, 2021, 10(18): 4069. DOI: 10.3390/jcm10184069.

[28] BATALIK L, DOSBABA F, HARTMAN M, et al. Long-term exercise effects after cardiac telerehabilitation in patients with coronary artery disease: 1-year follow-up results of the randomized study[J]. Eur J Phys Rehabil Med, 2021, 57(5): 807-814. DOI: 10.23736/s1973-9087.21.06653-3.

[29] PFAEFFLI DALE L, WHITTAKER R, JIANG Y N, et al. Text message and Internet support for coronary heart disease self-management: results from the Text4Heart randomized controlled trial[J]. J Med Internet Res, 2015, 17(10): e237. DOI: 10.2196/jmir.4944.

[30] LAO S S W, CHAIR S Y. The feasibility of smartphone-based application on cardiac rehabilitation for Chinese patients with percutaneous coronary intervention in Macau: a qualitative evaluation[J]. Int J Qual Stud Health Well-being, 2022, 17(1): 2023940. DOI: 10.1080/17482631.2021.2023940.

[31] MADDISON R, RAWSTORN J C, ROLLESTON A, et al. The remote exercise monitoring trial for exercise-based cardiac rehabilitation (REMOTE-CR): a randomised controlled trial protocol[J]. BMC Public Health, 2014, 14: 1236. DOI: 10.1186/1471-2458-14-1236.

[32] BREWER L C, KAIHOI B, ZARLING K K, et al. The use of virtual world-based cardiac rehabilitation to encourage healthy lifestyle choices among cardiac patients: intervention development and pilot study protocol[J]. JMIR Res Protoc, 2015, 4(2): e39. DOI: 10.2196/resprot.4285.

[33] WANG Zihan, YUE Wenjing, ZHANG Xiangyi, et al. Meta-integration of qualitative studies on the formation and extinction of exercise fear in cardiac rehabilitation patients[J]. Chinese Nursing Management, 2024, 24(5): 721-727.

[34] SUN Aiping, DING Wen, WANG Fei, et al. Qualitative study on influencing factors of exercise rehabilitation in young and middle-aged patients with chronic heart failure[J]. Evidence-Based Nursing, 2023, 9(6): 1080-1085. DOI: 10.12102/j.issn.2095-8668.2023.06.026.

[35] LIU Xinyuan, CHEN Suhui, WEN Hong, et al. Practice of exercise rehabilitation for patients after percutaneous coronary intervention in specialist nursing clinics[J]. Chinese Nursing Management, 2025, 25(1): 6-11.

[36] YU K H, HEALEY E, LEONG T Y, et al. Medical artificial intelligence and human values[J]. N Engl J Med, 2024, 390(20): 1895-1904. DOI: 10.1056/NEJMra2214183.

Received: November 20, 2024; Revised: March 20, 2025

Note: Figure translations are in progress. See original paper for figures.

Source: ChinaXiv —Machine translation. Verify with original.