EUROPEAN JOURNAL OF BIOMEDICAL AND PHARMACEUTICAL SCIENCES

http://www.ejbps.com

ISSN 2349-8870
Volume: 10
Issue: 9
06-19
Year: 2023

THE IMPACT OF MHEALTH INTERVENTIONS ON MENTAL HEALTH OUTCOMES AND QUALITY OF LIFE IN PATIENTS WITH CARDIOVASCULAR DISEASES: A SYSTEMATIC REVIEW

Abimbola Eunice Arisoyin[1], Farah Haider[2], Tope Oloniyo[3], Ransirini T. Wijeratne[4], Salma Badr[5], Efe Oni*[6], Uyonne Theodora Ugwuoke[7], Agho Osamede[8], Uwemedimoh C Okonna[9], Olasumbo Elizabeth Fagbenle[3], Januka Gaire[10], Chidalu Nkeyonyere Ibeneme[11], Ghulam Muhammad Humayun[12], Olusayo Louise-Oluwasanmi[13] and Adekunle Ebenezer Omole[6]

[1]Georgetown Behavioral Health Institute, USA.
[2]Jinnah Medical and Dental College (JMDC), Pakistan.
[3]Windsor University School of Medicine, Saint Kitts and Nevis.
[4]Kasturba Medical College, India.
[5]Alexandria University Faculty of Medicine, Egypt.
[6]American University of Antigua, College of Medicine, Antigua.
[7]East Tennessee State University, USA.
[8]Igbinedion University Medical School, Nigeria.
[9]American University of Barbados, School of Medicine, Barbados.
[10]Universal College of Medical Sciences (UCMS), Nepal.
[11]University of Toledo Ohio, USA.
[12]Allama Iqbal Medical College, Pakistan.
[13]Howard University, USA.

***Corresponding Author: Efe Oni**
American University of Antigua, College of Medicine, Antigua.

Article Received on 21/07/2023 **Article Revised on 11/08/2023** **Article Accepted on 01/09/2023**

ABSTRACT

Background: Mobile health (mHealth) interventions have been increasingly used to improve mental health and quality of life in patients with cardiovascular diseases (CVDs). This systematic review aimed to assess the impact of mHealth interventions on mental health outcomes and quality of life in patients with CVDs. **Methods:** This systematic review followed the PRISMA Statement 2020 guidelines. A comprehensive search of electronic databases (PubMed, Embase, and the Cochrane Library) was conducted to identify relevant articles published until May 5, 2023. The study selection process followed the PICO framework, and data synthesis and reporting were presented in a tabular and textual format. The language of publication was restricted to English, and case reports, case series, and reviews were excluded. A bibliographic management tool, EndNote, was used to manage search results, remove duplicates, and facilitate the screening process. The referencing management tool utilized was Mendeley. **Results:** A total of 943 studies were identified through database searching. After removing 47 duplicates, 896 studies were screened by title and abstract, excluding 847 records that did not meet the inclusion criteria. The remaining 49 full-text articles were assessed for eligibility, and 37 were excluded due to not meeting the inclusion criteria. Ultimately, 12 studies were included in the systematic review. Most included studies reported positive outcomes associated with mHealth interventions, such as improvements in depression, anxiety, and quality of life. However, some studies reported no significant differences between intervention and control groups. **Conclusion:** This systematic review supports the potential of mHealth interventions to improve mental health outcomes and quality of life in patients with CVDs. However, further research is needed to determine the most effective components and designs of mHealth interventions for CVD patients and to address the inconsistencies in the findings.

KEYWORDS: Mobile health interventions; Cardiovascular diseases; Mental health outcomes; Quality of life; Systematic review.

INTRODUCTION

Cardiovascular diseases (CVDs) are the leading cause of morbidity and mortality worldwide, accounting for an estimated 17.9 million deaths annually, which constitutes approximately 31% of all global deaths.[2] CVDs also substantially burden healthcare systems, with healthcare costs expected to rise from $863 billion in 2010 to $1044 billion by 2030 in the United States alone.[2] In recent years, advances in the management and treatment of CVDs have contributed to a decline in mortality rates, leading to an increasing number of individuals living with chronic conditions such as coronary heart disease (CHD), heart failure (HF), and atrial fibrillation (AF).[3]

A critical aspect of managing patients with CVDs is addressing their mental health and well-being. It is well-established that quality of life.[4,5] Furthermore, poor mental health can hinder adherence to recommended lifestyle modifications and medical therapies, leading to poorer clinical outcomes and increased healthcare utilization.[6] Therefore, interventions targeting mental health and quality of life in patients with CVDs are of paramount importance.

Rising cases of CVDs heighten the risk of mental health issues like depression and anxiety, negatively impacting overall health. To improve healthcare access, especially in managing chronic diseases, mHealth interventions, aided by growing digital technologies, are proving promising. In 2021, there were 3.8 billion smartphone users worldwide, and this number is projected to grow to 4.3 billion by 2023.[7,8] mHealth interventions encompass a wide range of applications, including smartphone apps, telemedicine, telemonitoring, and wearable devices, which can provide patients with access to healthcare services and support remotely.[9] These interventions have the potential to empower patients in self-managing their conditions, enhance patient-provider communication, and promote adherence to recommended therapies and lifestyle changes.[10]

Recent systematic reviews and meta-analyses have demonstrated the effectiveness of mHealth interventions in improving various health outcomes in patients with CVDs, such as medication adherence, self-care behaviors, and physiological parameters like blood pressure and lipid levels (11–13). However, there is a paucity of evidence regarding the impact of mHealth interventions on mental health outcomes and quality of life in this population. Given the substantial burden of mental health disorders in patients with CVDs and the potential role of mHealth interventions in addressing this issue, a comprehensive synthesis of the existing literature is warranted. This systematic review aimed to evaluate the effectiveness of mHealth interventions in improving mental health outcomes and quality of life in patients with cardiovascular diseases.

METHODS

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement 2020 guidelines (14). The study selection process followed the PICO framework (Population, Intervention, Comparator, and Outcomes). Data synthesis and reporting were presented in a tabular format as well as in a textual format.

A comprehensive search of electronic databases, including PubMed, Embase, and the Cochrane Library, was performed to identify relevant articles published until May 5, 2023. Articles were eligible for inclusion if they were randomized controlled trials, observational studies, or cohort studies involving patients with cardiovascular diseases, evaluating the impact of mobile health interventions on mental health outcomes and quality of life. The search terms encompassed the following keywords: mobile health applications, mHealth, mobile health, mental health apps, digital health, cardiovascular disease, heart disease, coronary artery disease, congestive heart failure, ischemic heart disease, depression, anxiety, stress, mental health outcomes, psychological outcomes, and/or emotional well-being. The Boolean logic was applied (and/or). The language of publication was restricted to English. Studies were excluded if they were case reports, case series, or reviews. The PICO Framework is as follows:

- Population: Patients with cardiovascular diseases
- Intervention: Mobile health interventions (e.g., smartphone apps, telemedicine, telemonitoring)
- Comparator: Usual care or other traditional interventions
- Outcomes: Mental health outcomes (e.g., depression, anxiety) and quality of life

Data were extracted from the included studies using a standardized data extraction form, which included the following items: author, year, study design, sample size, population, intervention, comparator, outcome measures, results, limitations, and conclusions.

A bibliographic management tool, EndNote, was used to manage the search results, remove duplicates, and facilitate the screening process. The referencing management tool utilized in this study was Mendeley. The software enabled sufficient management of the citations and full-text articles throughout the systematic review process.

RESULTS

A total of 943 studies were identified through database searching. After removing 47 duplicates, 896 studies were screened by title and abstract, excluding 847 records that did not meet the inclusion criteria. The remaining 49 full-text articles were assessed for eligibility. Of these, 37 articles were excluded due to not meeting the inclusion criteria. A total of 12 studies were included in the systematic review (*Figure 1*).

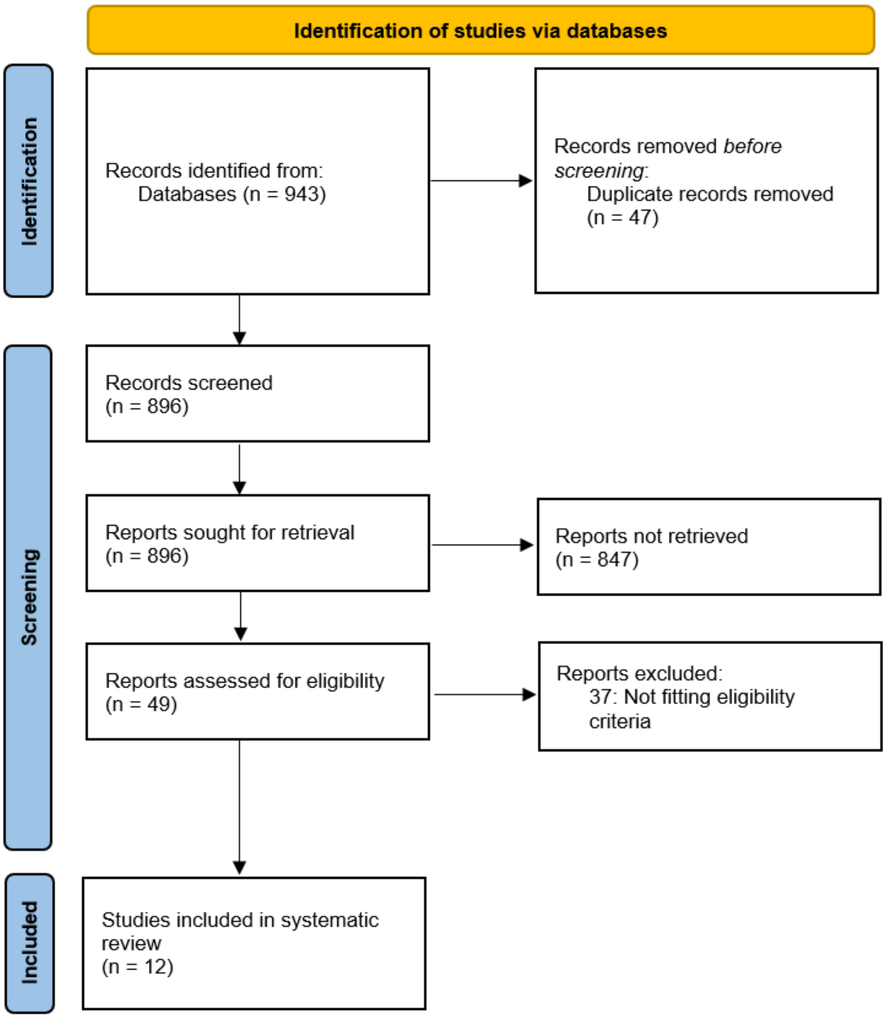

Figure 1: PRISMA Flowchart Depicting the Study Selection Process.

This systematic review included studies examining the use of digital health interventions in cardiac rehabilitation among patients with various heart conditions. In total, 12 studies were reviewed, which comprised diverse patient populations, study designs, and interventions. The interventions ranged from nurse-led eHealth cardiac rehabilitation systems, smartphone apps, telemedical monitoring, web-based programs, and text messaging services. The majority of the studies reported improvements in mental health, such as reduced anxiety and depression, and enhanced quality of life as a result of the interventions. However, some studies found no significant differences in these outcomes, and certain limitations were identified, including small sample sizes, limited generalizability, short follow-up periods, and potential biases. The cumulative sample size across all studies was 2,788 patients. The characteristics of all included studies are listed in *Table 1*.

Table 1: Characteristics of the Included Studies. Abbreviations: 6-MWT: 6-Minute Walk Test; ACS: Acute Coronary Syndromes; AOR: Adjusted.

Author, Year	Study Design	Sample Size	Population	Intervention	Comparator	Outcome Measures	Results	Limitations	Conclusions
Su, 2021	Single-blinded randomized controlled trial	146 patients	Patients hospitalized for coronary heart disease	Nurse-led eHealth cardiac rehabilitation system (NeCR): to identify individualized self-care	Usual care	Lifestyle behaviors, physiological risk parameters, clinical outcomes, health-promoting	-At 6 weeks post-intervention, sustained until week 12, the IG showed	Limited generalizability (small sample size); Single-blinded design may introduce	The NeCR intervention effectively modified behavioral risk factors and improved health-

				needs, set goals, develop an action plan, and orientate the patient to the use of the ICT platform for cardiac rehabilitation; e-platform for disease management and goal attainment of health behavioral changes through the WeChat platform in a small group format		lifestyle profile, self-efficacy, health-related quality of life, anxiety, and depression, measured at baseline, 6 weeks post-intervention, and 12 weeks post-intervention	significant improvement in their health-promoting lifestyle profile (β = 25.17, P<0.001) compared with the CG -Participants in the IG also showed significantly greater improvement in self-efficacy ((β = 0.61, P=0.005) and health-related quality of life (MD=0.56, P<0.001) than the CG at the study endpoint	bias; Short follow-up of 6 and 12 weeks	related quality of life in patients with coronary heart disease
Guo, 2017	Cluster randomized pilot study	113 patients in the mAF App intervention group and 96 patients in the usual care group	Patients with atrial fibrillation	mAF App, which incorporates clinical decision-support tools, educational materials, patient involvement strategies with self-care protocols, and structured follow-up	Usual care	Patients' knowledge, quality of life, drug adherence, anticoagulation satisfaction, anxiety, and depression, evaluated at baseline, 1 month, and 3 months. Usability, feasibility, and acceptability of the mAF App assessed at 1 month	-Quality of life scores significantly increased in the mAF App arm versus usual care, with anxiety and depression reduced (all P < 0.05) -Drug adherence and anticoagulant satisfaction were significantly better with the mAF App versus	Limited generalizability due to small sample size and pilot study design; short follow-up period (3 months); cluster randomized design may introduce potential biases	The mAF App, integrating clinical decision support, education, and patient-involvement strategies, significantly improved knowledge, drug adherence, quality of life, and anticoagulation satisfaction, as well as reduced anxiety and depression

							usual care (all P < 0.05)		
Koehler, 2021	Pre-specified subgroup analysis of the Telemedical Interventional Monitoring in Heart Failure (TIM-HF) trial	710 patients	Patients with CHF and depression	Telemedical intervention using non-invasive devices for daily monitoring of electrocardiogram, blood pressure, and body weight	Usual care	Depression evaluated by the 9-item Patient Health Questionnaire (PHQ-9); quality of tmlife measured by the Short Form-36	-Patients randomized to telemedicine (TM) showed an improvement in their PHQ-9 scores, whereas usual care (UC)c patients remained constant (P = 0.004) -Quality of life parameters were improved in the TM group compared to UC	Pre-specified subgroup analysis may not be powered to detect smaller differences in outcomes; Reliance on self-reported depression measures (PHQ-9) which may be subject to reporting bias	Telemedical care improved depressive symptoms and had a positive influence on quality of life in patients with CHF and moderate depression
Smolis-Bąk, 2015	Prospective, randomized study	52 patients	Patients aged 45-75 years with heart failure, NYHA class III, and implanted CRT-D	Hospital-based exercise training followed by a home-based training program with telemonitoring 5 times a week for 8 weeks (CRT-Ex group)	Hospital rehabilitation without a training program after discharge (CRT-control group)	Spiroergometry (CPX) parameters, 6-MWT distances, echocardiographic evaluation, quality of life, ICD-interventions, mortality, and hospitalization rates	Significant improvement in all domains of quality of life was observed in the CRT-Ex group (P < 0.05), while the CRT-Control patients declared only higher energy levels and less pain	Small sample size, which may limit generalizability of results; Short duration of intervention (8 weeks), which may not reflect the long-term impact; Low intensity of telemonitoring guided home-based exercise training	A structured exercise training program in the hospital and home-based with telemonitoring was a safe option of additional treatment and directly improved physical fitness and quality of life in patients with NYHA III CHF and CRT-D
Vieira, 2018	Randomized controlled trial	33 patients	Subjects with coronary artery disease who had completed	Home-based phase III cardiac rehabilitation (CR) specific exercise program using	CG only subjected to usual care (n = 11)	Executive function (Trail Making Test, Verbal Digit Span test, Stroop test), quality of life	No significant differences were found in the quality of life, and	Small sample size, which may limit generalizability of results;	-The virtual reality format improved selective attention and conflict

			phase II cardiac rehabilitation	virtual reality (Kinect) (IG1, n = 11) or conventional booklet (IG2, n = 11)		(MacNew questionnaire), depression, anxiety, and stress (Depression, Anxiety and Stress Scale 21) assessed at baseline (M0), 3 months (M1), and 6 months (M2)	depression, anxiety, and stress ($P > 0.05$)	Lack of long-term follow-up beyond 6 months to assess sustained effects	resolution ability, revealing the potential of cardiac rehabilitation, specifically with virtual reality exercise, on executive function -However, no significant differences were found in quality of life, depression, anxiety, and stress
Islam, 2019	Substudy and secondary analysis of a parallel-group, single-blind randomized controlled trial	683 patients	Patients with CHD at a tertiary hospital	Tobacco, Exercise and dieT MEssages (TEXT ME) program, which comprised four text messages per week for 6 months providing education, motivation, and support on diet, physical activity, general cardiac education, and smoking (if relevant)	Control group	Depression scores at 6 months measured using the Patient Health Questionnaire-9 (PHQ-9)	-Depression scores at 6 months were lower in the IG compared with the CG, with a mean difference of 1.9 (95% CI: 1.5-2.4, $P < 0.0001$) -The frequency of mild or greater depressive symptoms (PHQ-9 scores ≥5) at 6 months was 6.3% in the IG and 24.6% in the CG (RR: 0.26, 95% CI: 0.16-0.4, $P < 0.001$)	The study did not have a specific mental health component in the intervention; Lack of long-term follow-up beyond 6 months to assess sustained effects	Among people with CHD, a cardiac support program delivered via mobile phone text messaging was associated with fewer symptoms of mild-to-moderate depression at 6 months in the treatment group compared with controls
Dale, 2015	2-arm, parallel, randomized	123 adults	Adults diagnosed with CHD	Personalized 24-week mHealth program	Usual care control (traditional cardiac	Adherence to healthy lifestyle behaviors	-A significant treatment effect in	Limited generalizability due to predominant	A mHealth cardiac rehabilitation

	controlled trial			(Text4Heart) sent by fully automated daily short message service (SMS) text messages and a supporting website, in addition to usual care (traditional cardiac rehabilitation)	rehabilitation)	measured using a self-reported composite health behavior score (≥3) at 3 and 6 months, clinical outcomes, medication adherence score, self-efficacy, illness perceptions, and anxiety and/or depression at 6 months	favor of the intervention was observed for the primary outcome at 3 months (AOR: 2.55, 95% CI: 1.12-5.84, P = 0.03), but not at 6 months (AOR: 1.93, 95% CI: 0.83-4.53, P = 0.13) -The IG reported significantly greater medication adherence score (MD: 0.58, 95% CI: 0.19-0.97, P = 0.004)	ly male and New Zealand European participants; Intervention effect not sustained to the end of the 6-month intervention	intervention plus usual care showed a positive effect on adherence to multiple lifestyle behavior changes at 3 months in adults with CHD compared to usual care alone, but the effect was not sustained to the end of the 6-month intervention
Dorje, 2019	Parallel-group, single-blind, randomized controlled trial	312 patients	Patients aged 18 years or older with CHD who had received percutaneous coronary interventions	A 2-month intensive program followed by a 4-month step-down phase of smartphone-based cardiac rehabilitation and secondary prevention delivered via the social media platform WeChat (SMART-CR/SP)	Usual care group that received standard outpatient cardiology follow-up but without formal cardiac rehabilitation and secondary prevention	Change in functional capacity from baseline, measured by 6-min walk distance, at 2 months and 6 months	-The improvement in 6-min walk distance at 2 months was significantly greater in the SMART-CR/SP group than in the CG (adjusted MD of 20.64 m, P = 0.034) -This improvement was maintained at 6 months (mean between-group difference of 22.29 m, P = 0.027)	The study focused on one social media platform and may not be generalizable to other platforms or settings; Blinding of participants was not possible due to the nature of the intervention	SMART-CR/SP was found to be a cardiac rehabilitation and secondary prevention service model with high efficacy and accessibility and was easy to use.

Duan, 2018	Randomized controlled trial	136 outpatients with CHD (114 assigned to groups after randomization and exclusion)	Cardiac rehabilitation patients with CHD	An 8-week Web-based intervention focusing on PA for the first 4 weeks and FVC for the subsequent 4 weeks	Waiting control group	Physical activity, fruit and vegetable consumption, healthy lifestyle, internal and external resources of PA and FVC behaviors, perceived health outcomes (body mass index, quality of life, and depression)	-The Web-based intervention outperformed the control group for PA, FVC, internal resources of PA and FVC, and an external resource of FVC -The intervention effect was also seen in the improvement of quality of life -Baseline lifestyle and the intervention were significant predictors of a healthy lifestyle at follow-up	The study had a relatively small sample size and used self-reported data, which could be subject to bias. Additionally, the study only assessed participants at the end of the intervention, lacking long-term follow-up data	A Web-based intervention focusing on both physical activity and fruit and vegetable consumption can improve patients' psychological resources, such as motivation, self-efficacy, planning, and social support, as well as their overall lifestyle
Fang, 2019	Two-arm randomized controlled trial	80 post-PCI patients	Low-risk patients after PCI	Home-based cardiac telerehabilitation (HBCTR) program, including outdoor walking/jogging exercise with real-time physiological monitoring and CHD education materials	Usual care group, receiving paper-based CHD educational booklets and biweekly outpatient review	Blood pressure, Six-Minute Walking Test (6MWT), Fagerstrom Test for Nicotine Dependence (FTND), Cardiac Depression Scale (CDS), and SF-36 Health Survey (SF36)	-After the 6-week intervention, both groups showed significant improvements in 6MWT, SF36, FTND, and CDS compared to baseline -The HBCTR group had significantly better improvements in SF36, FTND	The study had a relatively small sample size, and the duration of the intervention was only 6 weeks	The HBCTR program may be successfully applied in Chinese patients who have very little technical skills, and its application may be highly cost-effective

							scores, and 6MWT distance compared to the UC group (P < 0.05)		
Varnfield, 2014	Unblinded randomized controlled trial	120 post-MI patients (60 in each group)	Post-MI patients	Care Assessment Platform Cardiac Rehabilitation (CAP-CR), a smartphone-based home service delivery of CR including health and exercise monitoring, motivational and educational material delivery, and weekly mentoring consultations	Traditional center-based program	Uptake, adherence, and completion rates; clinical outcomes (modifiable lifestyle factors, biomedical risk factors, and health-related quality of life) at baseline, 6 weeks, and 6 months	CAP-CR showed significant improvements in emotional state (K10: median (IQR) 14.6 (13.4-16) to 12.6 (11.5-13.8)), and quality of life (EQ5D-Index: median (IQR) 0.84 (0.8-0.9) to 0.92 (0.9-1)) at 6 weeks	Unblinded study design, short duration of follow-up, and potential for self-report bias	The smartphone-based home care CR program improved post-MI CR uptake, adherence, and completion, and was as effective in improving physiological and psychological health outcomes as traditional CR.
Yudi, 2021	Randomized controlled trial	206 patients with ACS	Patients with acute coronary syndromes (ACS) across six tertiary Australian hospitals	Smartphone-based cardiac rehabilitation program (S-CRP) in addition to usual care (UC)	UC, including referral to traditional cardiac rehabilitation	Change in exercise capacity (6-minute walk test distance) at 8 weeks compared to baseline, uptake and adherence to cardiac rehabilitation, changes in cardiac risk factors, psychological well-being, and quality of life status	There were no significant differences between the S-CRP and UC groups in smoking cessation rates, LDL-cholesterol levels, blood pressure reduction, depression, anxiety, and quality of life measures	Limited generalizability due to specific population and healthcare setting, relatively short follow-up period, and lack of a more diverse sample in terms of age and gender	In patients with ACS, a S-CRP, as an adjunct to UC, improved exercise capacity at 8 weeks in addition to participation and adherence to cardiac rehabilitation; but there were no significant differences in depression, anxiety, and quality of life measures between the two groups

Odds Ratio; CG: Control Group; CHD: Coronary Heart Disease; CHF: Chronic Heart Failure; CPX: Cardiopulmonary Exercise Test; CR: Cardiac Rehabilitation; CRT-D: Cardiac Resynchronization Therapy-Defibrillator; FVC: Fruit and Vegetable Consumption; ICD: Implantable Cardioverter Defibrillator; IG: Intervention Group; mAF App: mobile Atrial Fibrillation App; MD: Mean Difference; NYHA: New York Heart Association; PA: Physical Activity; PCI: Percutaneous Coronary Intervention; PHQ-9: 9-item Patient Health Questionnaire; RR: Relative Risk; S-CRP: Smartphone-based Cardiac Rehabilitation Program; SF-36: Short Form-36 Health Survey; TEXT ME: Tobacco, Exercise and dieT MEssages; TIM-HF: Telemedical Interventional Monitoring in Heart Failure.

Su et al. (2021) conducted a single-blinded randomized controlled trial involving 146 hospitalized coronary heart disease (CHD) patients.[15] The Nurse-led eHealth Cardiac Rehabilitation (NeCR) intervention demonstrated significant improvement in health-promoting lifestyle profile, self-efficacy, and health-related quality of life compared to the usual care group. However, the study had limitations, including a small sample size, potential bias due to the single-blinded design, and short follow-up periods of 6 and 12 weeks.

Guo et al. (2017) performed a cluster randomized pilot study with 113 patients in the mAF App intervention group and 96 in the usual care group.[16] They found that the mAF App significantly improved knowledge, drug adherence, quality of life, and anticoagulation satisfaction, as well as reduced anxiety and depression. The study's limitations included a small sample size, short follow-up period, and potential biases due to the cluster-randomized design.

Koehler et al. (2021) carried out a pre-specified subgroup analysis of the TIM-HF trial, which included 710 patients with CHF and depression.[17] Telemedical care improved depressive symptoms and positively influenced quality of life compared to usual care. Limitations consisted of potential underpowered detection of smaller differences in outcomes and reliance on self-reported depression measures.

Smolis-Bąk et al. (2015) conducted a prospective, randomized study enrolling 52 patients with heart failure, NYHA class III, and implanted CRT-D.[18] They found that a structured exercise training program with telemonitoring significantly improved quality of life compared to the control group. Limitations included a small sample size, short intervention duration, and low intensity of telemonitoring-guided home-based exercise training.

Vieira et al. (2018) performed a randomized controlled trial with 33 coronary artery disease patients and discovered that a home-based phase III cardiac rehabilitation exercise program using virtual reality improved selective attention and conflict resolution ability.[19] However, no significant differences were found in quality of life, depression, anxiety, and stress. Limitations included a small sample size and lack of long-term follow-up beyond 6 months.

Islam et al. (2019) reported a parallel-group, single-blind randomized controlled trial involving 683 CHD patients in the Tobacco, Exercise and dieT MEssages (TEXT ME) program, which was associated with fewer symptoms of mild-to-moderate depression at 6 months in the treatment group compared to controls.[20] Limitations included lack of a specific mental health component in the intervention and lack of long-term follow-up beyond 6 months.

Dale et al. (2015) conducted a 2-arm, parallel, randomized controlled trial with 123 adults diagnosed with CHD.[22] They found that a mHealth cardiac rehabilitation intervention plus usual care positively affected adherence to multiple lifestyle behavior changes at 3 months compared to usual care alone, but the effect was not sustained to the end of the 6-month intervention. Limitations included limited generalizability due to predominantly male and New Zealand participants.

Dorje et al. (2019) performed a parallel-group, single-blind, randomized controlled trial of 312 post-PCI patients using a smartphone-based cardiac rehabilitation and secondary prevention delivered via WeChat (SMART-CR/SP)[22] The intervention significantly improved functional capacity at 2 and 6 months compared to the control group. Limitations included a focus on one social media platform and lack of participant blinding due to the intervention's nature.

In a randomized controlled trial, Duan et al. (2018) investigated the effectiveness of a mobile health intervention for 160 CHD patients.[23] Participants were divided into an intervention group, which received health education, medication reminders, and teleconsultation services, and a control group, which received usual care. After 12 months, the intervention group showed significant improvements in mental health outcomes and better quality of life in physical, psychological, and social domains compared to the control group. The study suggested mobile health interventions could be promising for enhancing mental health and quality of life in CHD patients. However, limitations such as a small sample size and a single-center design called for further research to confirm these findings in larger, multicenter studies and to investigate the long-term effects of mobile health interventions on mental health and quality of life in cardiovascular disease patients.

Fang et al. (2019) conducted a two-arm randomized controlled trial with 80 post-PCI patients, investigating the effects of a home-based cardiac telerehabilitation (HBCTR) program versus usual care on various health outcomes.[24] After the 6-week intervention, both groups showed significant improvements in the Six-Minute Walking Test (6MWT), SF-36 Health Survey (SF36), Fagerstrom Test for Nicotine Dependence (FTND), and Cardiac Depression Scale (CDS). The HBCTR group had significantly better improvements in SF36, FTND scores, and 6MWT distance compared to the usual care group. However, the study had a small sample size and a short intervention duration of 6 weeks.

Varnfield and colleagues (2014) led an unblinded randomized controlled trial with 120 post-MI (myocardial infarction) patients, comparing a smartphone-based home service delivery of cardiac rehabilitation (CAP-CR) to a traditional center-based program (TCR)[25] CAP-CR showed significant improvements in emotional state and quality of life at 6 weeks. However, the study had an unblinded design, short follow-up duration, and potential for self-report bias. The smartphone-based home care CR program improved post-MI CR uptake, adherence, and completion and was as effective in improving physiological and psychological health outcomes as traditional CR.

Yudi et al. (2021) reported a randomized controlled trial involving 206 patients with acute coronary syndromes (ACS), examining a smartphone-based cardiac rehabilitation program (S-CRP) in addition to usual care compared to usual care alone (26). There were no significant differences between the S-CRP and usual care groups in smoking cessation rates, LDL-cholesterol levels, blood pressure reduction, depression, anxiety, and quality of life measures. In patients with ACS, S-CRP improved exercise capacity at 8 weeks in addition to participation and adherence to cardiac rehabilitation. Limitations of the study included limited generalizability, a relatively short follow-up period, and lack of a more diverse sample in terms of age and gender.

DISCUSSION

This systematic review aimed to synthesize the evidence on the impact of mHealth interventions on mental health outcomes and quality of life in patients with CVDs. Our review, following the PRISMA Statement 2020, identified studies that assessed various mHealth interventions, including smartphone apps, telemonitoring, telemedicine, and wearable devices, among others. The findings provide insights into the potential benefits and limitations of mHealth interventions in addressing mental health and quality of life in CVD patients.

Most of the included studies in our systematic review reported positive outcomes associated with mHealth interventions, such as improvements in depression, anxiety, and quality of life. These findings align with previous reviews that demonstrate the effectiveness of mHealth interventions in improving various health outcomes in patients with CVDs, such as medication adherence, self-care behaviors, and physiological parameters like blood pressure and lipid levels.[11,27,28] The growing body of literature on mHealth interventions for CVD patients underscores their potential to enhance patient care and improve health outcomes.[29,30]

However, some studies reported no significant differences between intervention and control groups, which suggests that further research is needed to determine the most effective components and designs of mHealth interventions for CVD patients. The inconsistency in the effectiveness of mHealth interventions across studies may be attributed to the heterogeneity in intervention designs, implementation strategies, and outcome measures. This highlights the need for a more in-depth examination of the various factors that contribute to the success or failure of mHealth interventions in improving mental health and quality of life for CVD patients.[31]

Recent literature has emphasized the importance of understanding the specific components of mHealth interventions that lead to improved outcomes. For instance, some studies have found that interventions incorporating personalized feedback, self-monitoring tools, and tailored education materials are more effective in promoting self-management behaviors and improving clinical outcomes.[10] Additionally, the involvement of healthcare professionals in the design and delivery of mHealth interventions has been shown to enhance patient engagement and satisfaction.[32,33]

Another aspect to consider is the usability and accessibility of mHealth interventions. For these interventions to be effective, they must be user-friendly, culturally sensitive, and tailored to the needs and preferences of the target population. Studies have shown that patients are more likely to adopt and adhere to mHealth interventions when they perceive them as useful, easy to use, and compatible with their lifestyle and healthcare needs.[34,35]

Furthermore, the integration of mHealth interventions into existing healthcare systems and workflows is crucial for their successful implementation and long-term sustainability. Studies have shown that barriers to the adoption of mHealth interventions by healthcare providers, such as lack of time, training, and resources, can impede the effectiveness of these interventions in improving patient outcomes.[36] Therefore, addressing these barriers through the development of appropriate policies, guidelines, and infrastructure is essential for the successful integration of mHealth interventions into routine care for CVD patients.

Our review also identified several limitations in the current literature. Many studies had small sample sizes, which may limit the generalizability of the findings. Additionally, the follow-up periods in some studies were relatively short, which may not adequately capture the long-term effects of mHealth interventions on mental health and quality of life. Furthermore, the heterogeneity of mHealth interventions and outcome measures across studies presents challenges in drawing firm conclusions about their overall effectiveness.

Despite these limitations, the potential of mHealth interventions in improving mental health and quality of life in patients with CVDs is promising. As the prevalence of CVDs continues to rise, innovative and scalable solutions, such as mHealth interventions, are needed to address the growing burden of mental health disorders in this population. By leveraging the increasing accessibility of mobile and digital technologies, mHealth interventions can empower patients to self-manage their conditions, enhance patient-provider communication, and promote adherence to recommended therapies and lifestyle changes.

Future research ought to focus on larger, well-designed randomized controlled trials to further evaluate the effectiveness of mHealth interventions on mental health outcomes and quality of life in CVD patients. Additionally, studies should explore the optimal components, duration, and intensity of mHealth interventions, as well as their cost-effectiveness and implementation in diverse healthcare settings. Understanding the barriers and facilitators to the adoption and use of mHealth interventions by patients and healthcare providers will also be crucial for their successful integration into routine care.

CONCLUSION

The findings of this study suggest that mHealth interventions have the potential to positively impact mental health outcomes, such as depression and anxiety, as well as overall quality of life in CVD patients. These results are consistent with existing literature, which demonstrates the benefits of mHealth interventions in enhancing patient care and improving various health outcomes in patients with CVDs, such as medication adherence, self-care behaviors, and physiological parameters like blood pressure and lipid levels. Despite the promising results, there were some studies in our review that reported no significant differences between the intervention and control groups. This highlights the need for further research to identify the most effective components and designs of mHealth interventions for CVD patients. It is crucial to consider factors such as personalization, user-friendliness, cultural sensitivity, and the involvement of healthcare professionals in the development and implementation of mHealth interventions.

Moreover, addressing barriers to the adoption and integration of mHealth interventions into routine care, such as lack of time, training, and resources for healthcare providers, is essential for the successful and long-term sustainability of these interventions. Our systematic review provides evidence supporting the potential of mHealth interventions in improving mental health and quality of life in CVD patients. By further investigating the factors that contribute to the success or failure of these interventions, we can pave the way for the development of more targeted, evidence-based, and patient-centered interventions that can help enhance the overall well-being of patients with cardiovascular diseases.

REFERENCES

1. Rehman S, Rehman E, Ikram M, Jianglin Z. Cardiovascular disease (CVD): assessment, prediction and policy implications. BMC Public Health, 2021; 21(1): 1–14.
2. Heidenreich PA, Trogdon JG, Khavjou OA, Butler J, Dracup K, Ezekowitz MD, et al. Forecasting the future of cardiovascular disease in the United States: a policy statement from the American Heart Association. Circulation, 2011; 123(8): 933–44.
3. Minja NW, Nakagaayi D, Aliku TO, Zhang W, Ssinabulya I, Nabaale J, et al. Cardiovascular diseases in Africa in the 21st century: Gaps and Priorities going forward. Front Cardiovasc Med, 2022; 3262.
4. De Hert M, Detraux J, Vancampfort D. The intriguing relationship between coronary heart disease and mental disorders. Dialogues Clin Neurosci, 2022.
5. Callow DD, Arnold-Nedimala NA, Jordan LS, Pena GS, Won J, Woodard JL, et al. The mental health benefits of physical activity in older adults survive the COVID-19 pandemic. Am J Geriatr Psychiatry, 2020; 28(10): 1046–57.
6. Sarfraz Z, Sarfraz A, Sarfraz M, Pandav K, Michel G. Ripple collision of three epidemics: vaping, opioid use, and COVID-19. Addict Heal, 2021; 13(4): 277–8.
7. Liu Z, Hu R, Bi X. The effects of social media addiction on reading practice: a survey of undergraduate students in China. J Doc., 2023; 79(3): 670–82.
8. Zilberman A, Ice L. Why computer occupations are behind strong STEM employment growth in the 2019–29 decade. Computer (Long Beach Calif), 2021; 4(5,164.6): 11–5.
9. Ventola CL. Mobile devices and apps for health care professionals: uses and benefits. Pharm Ther, 2014; 39(5): 356.
10. Dineen-Griffin S, Garcia-Cardenas V, Williams K, Benrimoj SI. Helping patients help themselves: a systematic review of self-management support strategies in primary health care practice. PLoS One, 2019; 14(8): e0220116.
11. Arshed M, Mahmud AB, Minhat HS, Ying LP, Umer MF. Effectiveness of mHealth Interventions in Medication Adherence among Patients with Cardiovascular Diseases: A Systematic Review. Diseases, 2023; 11(1): 41.
12. Choi YYC, Fineberg M, Kassavou A. Effectiveness of Remote Interventions to Improve Medication

Adherence in Patients after Stroke: A Systematic Literature Review and Meta-Analysis. Behav Sci (Basel). 2023;13(3):246.
13. Zhong W, Fu C, Xu L, Sun X, Wang S, He C, et al. Effects of home-based cardiac telerehabilitation programs in patients undergoing percutaneous coronary intervention: a systematic review and meta-analysis. BMC Cardiovasc Disord, 2023; 23(1): 101.
14. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ., 2021 Mar; 372: n71.
15. Su JJ, Yu DS-F. Effects of a nurse-led eHealth cardiac rehabilitation programme on health outcomes of patients with coronary heart disease: A randomised controlled trial. Int J Nurs Stud, 2021; 122: 104040.
16. Guo Y, Chen Y, Lane DA, Liu L, Wang Y, Lip GYH. Mobile health technology for atrial fibrillation management integrating decision support, education, and patient involvement: mAF app trial. Am J Med, 2017; 130(12): 1388–96.
17. Koehler J, Stengel A, Hofmann T, Wegscheider K, Koehler K, Sehner S, et al. Telemonitoring in patients with chronic heart failure and moderate depressed symptoms: results of the Telemedical Interventional Monitoring in Heart Failure (TIM-HF) study. Eur J Heart Fail, 2021; 23(1): 186–94.
18. Smolis-Bąk E, Dąbrowski R, Piotrowicz E, Chwyczko T, Dobraszkiewicz-Wasilewska B, Kowalik I, et al. Hospital-based and telemonitoring guided home-based training programs: effects on exercise tolerance and quality of life in patients with heart failure (NYHA class III) and cardiac resynchronization therapy. A randomized, prospective observation. Int J Cardiol, 2015; 199: 442–7.
19. Vieira Á, Melo C, Machado J, Gabriel J. Virtual reality exercise on a home-based phase III cardiac rehabilitation program, effect on executive function, quality of life and depression, anxiety and stress: a randomized controlled trial. Disabil Rehabil Assist Technol, 2018; 13(2): 112–23.
20. Islam SMS, Chow CK, Redfern J, Kok C, Rådholm K, Stepien S, et al. Effect of text messaging on depression in patients with coronary heart disease: a substudy analysis from the TEXT ME randomised controlled trial. BMJ Open, 2019; 9(2): e022637.
21. Pfaeffli Dale L, Whittaker R, Jiang Y, Stewart R, Rolleston A, Maddison R. Text message and internet support for coronary heart disease self-management: results from the Text4Heart randomized controlled trial. J Med Internet Res., 2015; 17(10): e237.
22. Dorje T, Zhao G, Tso K, Wang J, Chen Y, Tsokey L, et al. Smartphone and social media-based cardiac rehabilitation and secondary prevention in China (SMART-CR/SP): a parallel-group, single-blind, randomised controlled trial. Lancet Digit Heal, 2019; 1(7): e363–74.
23. Duan YP, Liang W, Guo L, Wienert J, Si GY, Lippke S. 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 Med Internet Res., 2018; 20(11): e12052.
24. Fang J, Huang B, Xu D, Li J, Au WW. Innovative application of a home-based and remote sensing cardiac rehabilitation protocol in Chinese patients after percutaneous coronary intervention. Telemed e-Health, 2019; 25(4): 288–93.
25. Varnfield M, Karunanithi M, Lee C-K, Honeyman E, Arnold D, Ding H, et al. Smartphone-based home care model improved use of cardiac rehabilitation in postmyocardial infarction patients: results from a randomised controlled trial. Heart, 2014; 100(22): 1770–9.
26. Yudi MB, Clark DJ, Tsang D, Jelinek M, Kalten K, Joshi S, et al. SMARTphone-based, early cardiac REHABilitation in patients with acute coronary syndromes [SMART-REHAB Trial]: a randomized controlled trial protocol. BMC Cardiovasc Disord, 2016; 16: 1–8.
27. Kamaruddin PSNM, Nawi AM, Manaf MRA, Yaman MN, Abd Malek AM. A Meta-Analysis of eHealth Interventions on Ischaemic Heart Disease Health Outcomes. Glob Heart, 2023; 18(1).
28. Schorr EN, Gepner AD, Dolansky MA, Forman DE, Park LG, Petersen KS, et al. Harnessing mobile health technology for secondary cardiovascular disease prevention in older adults: a scientific statement from the American Heart Association. Circ Cardiovasc Qual Outcomes, 2021; 14(5): e000103.
29. Klimis H, Thakkar J, Chow CK. Breaking barriers: mobile health interventions for cardiovascular disease. Can J Cardiol, 2018; 34(7): 905–13.
30. Jindal D, Gupta P, Jha D, Ajay VS, Goenka S, Jacob P, et al. Development of mWellcare: an mHealth intervention for integrated management of hypertension and diabetes in low-resource settings. Glob Health Action, 2018; 11(1): 1517930.
31. Cruz-Cobo C, Bernal-Jiménez MÁ, Vázquez-García R, Santi-Cano MJ. Effectiveness of mHealth Interventions in the Control of Lifestyle and Cardiovascular Risk Factors in Patients After a Coronary Event: Systematic Review and Meta-analysis. JMIR mHealth uHealth, 2022; 10(12): e39593.
32. Addotey-Delove M, Scott RE, Mars M. Healthcare Workers' Perspectives of mHealth Adoption Factors in the Developing World: Scoping Review. Int J Environ Res Public Health, 2023; 20(2): 1244.
33. Graffigna G, Barello S, Bonanomi A, Menichetti J. The motivating function of healthcare professional in eHealth and mHealth interventions for type 2 diabetes patients and the mediating role of patient engagement. J Diabetes Res., 2016; 2016.
34. Zhao Y, Ni Q, Zhou R. What factors influence the

mobile health service adoption? A meta-analysis and the moderating role of age. Int J Inf Manage, 2018; 43: 342–50.

35. Alaiad A, Alsharo M, Alnsour Y. The determinants of m-health adoption in developing countries: an empirical investigation. Appl Clin Inform, 2019; 10(05): 820–40.
36. Kruse C, Betancourt J, Ortiz S, Valdes Luna SM, Bamrah IK, Segovia N. Barriers to the use of mobile health in improving health outcomes in developing countries: systematic review. J Med Internet Res., 2019; 21(10): e13263.