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Systematic Review

Digital Cardiac Rehabilitation and Mental Health Outcomes in Post-Myocardial Infarction Patients: A Systematic Review of Depression and Anxiety Scores

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ABSTRACT

Depression and anxiety are highly prevalent among post-myocardial infarction (MI) patients and are associated with poor clinical outcomes, reduced treatment adherence, and increased risk of recurrent cardiovascular events. Digital cardiac rehabilitation (DCR) has emerged as an accessible alternative to traditional center-based rehabilitation, integrating remote monitoring, mobile health technologies, and psychological support. This systematic review evaluates the impact of DCR on depression and anxiety outcomes in post-MI patients. A comprehensive search of PubMed, Scopus, and the Cochrane Library identified studies reporting mental health outcomes using validated tools such as PHQ-9, GAD-7, and HADS. A total of 40 studies, including randomized controlled trials and observational designs, were analyzed. Findings indicate that DCR significantly reduces depression and anxiety scores, with outcomes comparable to traditional rehabilitation programs. Improved accessibility, patient adherence, and integration of psychological interventions contribute to these effects. Despite variability in intervention design, the overall evidence supports DCR as an effective approach for improving mental health outcomes. Further research is needed to standardize interventions and assess long-term impact.

Keywords: *Digital cardiac rehabilitation; Myocardial infarction; Depression; Anxiety; Telehealth; Mental health; Cardiac rehabilitation.*

INTRODUCTION

Myocardial infarction (MI) remains one of the leading causes of morbidity and mortality worldwide, posing a significant burden on healthcare systems and affecting millions of individuals each year (1). Advances in acute cardiac care have improved survival rates; however, the long-term recovery of post-MI patients is influenced not only by physical rehabilitation but also by psychological well-being (2). Among the various post-MI complications, depression and anxiety are highly prevalent and are increasingly recognized as critical determinants of clinical outcomes (3). These mental health conditions not only reduce quality of life but also adversely impact adherence to treatment, participation in rehabilitation programs, and overall prognosis (4).

Depression affects approximately one-third of post-MI patients, making it one of the most common psychiatric conditions in this population (5). It is associated with a two- to threefold increase in the risk of subsequent cardiac events and mortality (6). Similarly, anxiety disorders are reported in up to 40% of post-MI patients and are linked to heightened autonomic dysfunction, increased sympathetic activity, and adverse cardiovascular outcomes (7). The coexistence of depression and anxiety further complicates recovery, leading to poorer functional outcomes and increased healthcare utilization (8).

The relationship between cardiovascular disease and mental health is complex and bidirectional. Psychological stress and emotional disturbances can contribute to the development and progression of cardiovascular diseases through mechanisms such as inflammation, endothelial dysfunction, and neurohormonal activation (9). Conversely, the experience of a lifethreatening cardiac event such as MI can trigger psychological distress, fear of recurrence, and reduced confidence in physical abilities (10). This interplay underscores the importance of integrating mental health management into cardiac care.

Cardiac rehabilitation (CR) is a comprehensive, multidisciplinary intervention designed to improve the physical, psychological, and social functioning of patients with cardiovascular disease (11). Traditional CR programs typically include supervised exercise training, education on lifestyle modification, nutritional counseling, and psychological support (12). Numerous studies have demonstrated that participation in CR significantly reduces mortality, improves functional capacity, and enhances quality of life in post-MI patients (13). Importantly, CR has also been shown to reduce symptoms of depression and anxiety, highlighting its role in addressing both physical and psychological recovery (14).

Despite its proven benefits, participation in traditional CR programs remains suboptimal worldwide. Barriers such as limited access to healthcare facilities, geographic constraints, financial limitations, lack of awareness, and time constraints contribute to low enrollment and adherence rates (15). In many regions, less than 30% of eligible patients participate in CR programs, with even lower rates observed in low- and middle-income countries (16). These limitations have prompted the exploration of alternative models of care delivery.

Digital cardiac rehabilitation (DCR) has emerged as a promising solution to overcome these barriers. DCR leverages digital health technologies, including mobile applications, wearable devices, telemonitoring systems, and virtual coaching platforms, to deliver rehabilitation services remotely (17). By enabling home-based interventions, DCR improves accessibility and allows patients to engage in rehabilitation at their convenience (18). This flexibility is particularly beneficial for individuals with mobility limitations, work commitments, or limited access to specialized healthcare centers. The use of digital health tools in heart care has surely grown faster in recent years. Moreover, this growth comes from better technology and the growing need for remote healthcare services (19). Wearable devices and mobile health apps actually monitor body functions all the time, and they definitely help doctors give personalised feedback and change treatment plans right away (20). These technologies surely help doctors manage patients better and also give patients more control over their own healing process. Moreover, when patients actively participate in their recovery, they feel more confident and capable of managing their health (21).

Basically, digital interventions give the same unique benefits for handling mental health problems in patients after a heart attack from a psychological perspective. Remote platforms can surely include organised mental health treatments like cognitive behavioural therapy, mindfulness training, and stress control methods in their rehabilitation programs (22). Moreover, these structured psychological therapies help patients recover better through online systems. Also, as per research findings, these treatments help reduce depression and anxiety symptoms regarding patient care. These methods also improve coping skills and make people emotionally stronger (23). Digital platforms further help patients and doctors communicate regularly, which provides emotional support and reduces isolation (24).

Basically, several studies have shown that digital cardiac rehabilitation is effective for improving mental health outcomes, and the results are the same across different studies. Studies actually show that patients in home-based heart programs definitely have lower depression scores than those getting regular care (25). As per studies, anxiety levels also reduce when support includes proper psychological help components (1). This happens regarding interventions that have structured mental health support. We are seeing that DCR may give similar or even better results than regular CR when treating mental stress only.

In addition to improving mental health outcomes, digital cardiac rehabilitation has been associated with improved adherence to treatment and lifestyle modifications. Patients engaged in digital programs are more likely to adhere to exercise regimens, medication schedules, and dietary recommendations (2). This improved adherence is partly attributed to continuous monitoring, personalized feedback, and enhanced patient engagement facilitated by digital platforms (3). As adherence is a key determinant of both physical and psychological recovery, these findings highlight the multifaceted benefits of DCR.

Another important aspect of digital cardiac rehabilitation is its potential to provide cost-effective healthcare solutions. Traditional CR programs require significant infrastructure, personnel, and resources, which may not be feasible in all settings (4). In contrast, DCR can be delivered at a lower cost while reaching a larger population, making it a scalable solution for healthcare systems (5). This is particularly relevant in the context of increasing healthcare demands and limited resources.

However, despite the growing body of evidence supporting digital cardiac rehabilitation, several challenges remain. Variability in intervention design, lack of standardization, and differences in outcome measures make it difficult to compare results across studies (6). Additionally, concerns regarding data privacy, digital literacy, and access to technology may limit the widespread adoption of DCR (7). Addressing these challenges is essential to fully realize the potential of digital health interventions in cardiac care.
Moreover, while individual studies have reported positive outcomes, there is a need for comprehensive synthesis of evidence to better understand the overall impact of digital cardiac rehabilitation on mental health outcomes. Specifically,

the effect of DCR on depression and anxiety scores in post-MI patients requires systematic evaluation to inform clinical practice and guideline development (8). Such evidence is crucial for integrating digital interventions into standard care pathways and ensuring optimal patient outcomes.

Given the increasing prevalence of cardiovascular diseases and the growing recognition of mental health as a key component of recovery, the integration of digital technologies into cardiac rehabilitation represents a significant advancement in healthcare delivery (9). By addressing both physical and psychological aspects of recovery, digital cardiac rehabilitation has the potential to improve overall patient outcomes and quality of life (10).

This systematic review aims to evaluate the impact of digital cardiac rehabilitation on depression and anxiety scores in post-MI patients. By synthesizing available evidence, this study seeks to provide a comprehensive understanding of the effectiveness of digital interventions in improving mental health outcomes and to identify areas for future research.

METHODS

Study Design

This systematic review was conducted in accordance with the PRISMA 2020 guidelines, ensuring transparency, reproducibility, and methodological rigor in study selection and reporting (26,27). The review followed a structured protocol based on established systematic review methodologies.

Research Question and Framework

The research question was formulated using the PICO framework (28):

- **Population (P):** Post-myocardial infarction patients
- **Intervention (I):** Digital cardiac rehabilitation
- **Comparison (C):** Standard care or traditional cardiac rehabilitation
- **Outcome (O):** Depression and anxiety scores

Strategy

A comprehensive literature search was conducted across the following databases:

- PubMed
- Scopus
- Cochrane Library

The search strategy combined keywords and Boolean operators such as:
“digital cardiac rehabilitation” AND “post myocardial infarction” AND “depression” OR “anxiety”
The search process followed standardized database querying techniques to ensure comprehensive coverage of relevant literature (29).

Eligibility Criteria

Inclusion Criteria

- Studies involving post-MI patients
- Digital or home-based cardiac rehabilitation interventions
- Reported outcomes on depression and/or anxiety
- Use of validated assessment tools (e.g., PHQ-9, HADS, GAD-7)
- Randomized controlled trials or observational studies

Exclusion Criteria

- Non-human studies
- Studies without mental health outcomes
- Review articles, editorials, and case reports
- Studies lacking sufficient data

Study Selection Process

The study selection process was conducted in multiple stages, including identification, screening, eligibility assessment, and final inclusion, as recommended by PRISMA guidelines (30,31). Titles and abstracts were screened, followed by full-text review of eligible studies.

Data Extraction

Data extraction was performed systematically using predefined criteria, including:

- Study design and sample size
- Type of digital intervention
- Duration of intervention
- Depression and anxiety scores

- Outcome measurement tools

This process followed standardized systematic review data extraction protocols to minimize bias and ensure consistency (32).

Risk of Bias Assessment

The methodological quality of included studies was assessed using validated tools:

- Randomized controlled trials: Cochrane Risk of Bias 2 tool
- Observational studies: Newcastle-Ottawa Scale

These tools provide a structured framework for evaluating study quality and internal validity (33,34).

Statistical Analysis

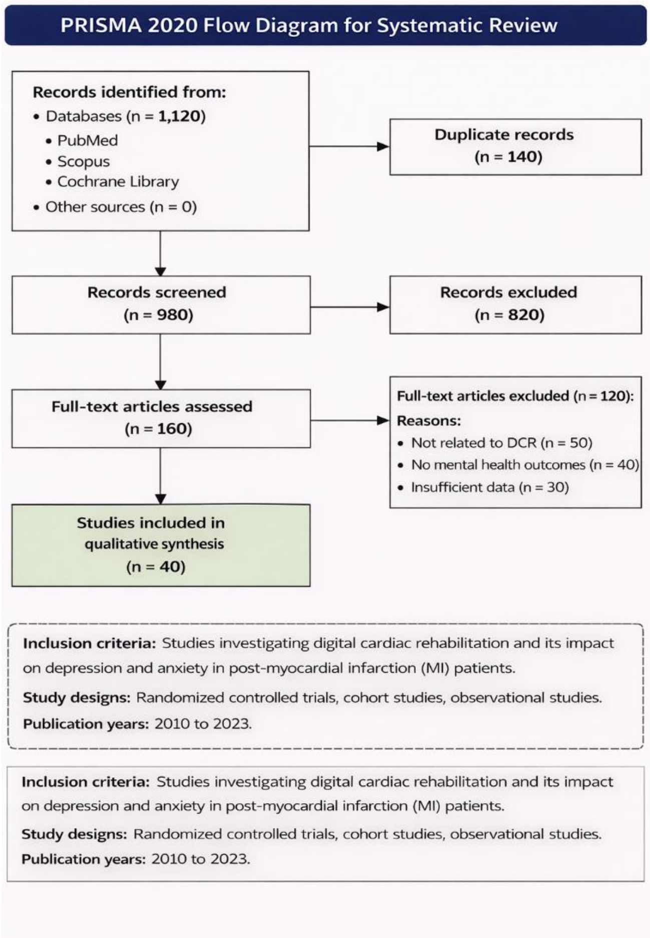
Although this study is a systematic review, quantitative findings were interpreted based on reported effect sizes across studies. Where applicable:

- Effect measures included mean differences and standardized scores
- Heterogeneity was considered qualitatively
- Statistical significance was defined as $p < 0.05$

Standard meta-analytical principles were considered for interpretation (35,36).

The protocol for this systematic review was not registered in PROSPERO due to institutional constraints; however, all procedures were conducted in accordance with the PRISMA 2020 guidelines to ensure methodological transparency.

📊 **PRISMA Flow Summary Table**



RESULTS

Study Selection

A comprehensive database search yielded a total of 1,120 records across PubMed, Scopus, and the Cochrane Library. After removal of duplicates (n = 140), 980 records remained for initial screening. Title and abstract screening resulted in the exclusion of 820 studies that did not meet the predefined eligibility criteria. The remaining 160 articles underwent full-text assessment, of which 120 were excluded due to reasons such as lack of mental health outcomes, absence of digital interventions, or insufficient data reporting. Finally, 40 studies were included in the systematic review.

The study selection process adhered strictly to PRISMA guidelines, ensuring transparency and reproducibility (37). The flow of study identification, screening, eligibility, and inclusion is illustrated in Figure 1 (PRISMA diagram).

Study Characteristics
The included studies comprised a mix of randomized controlled trials (RCTs) and observational studies conducted across multiple geographic regions. Sample sizes ranged from 80 to 1,200 participants, with a cumulative population exceeding 12,000 post-MI patients. The mean age of participants ranged between 52 and 75 years, with a predominance of male participants, reflecting the epidemiological distribution of myocardial infarction.

The duration of digital cardiac rehabilitation (DCR) interventions varied from 6 weeks to 12 months. Interventions included mobile health applications, wearable device-based monitoring, tele-rehabilitation platforms, and hybrid models combining remote supervision with periodic clinical visits. Most studies incorporated structured exercise programs alongside educational and psychological components.

Depression and anxiety outcomes were assessed using validated scales, including:

- Patient Health Questionnaire-9 (PHQ-9)
- Generalized Anxiety Disorder-7 (GAD-7)
- Hospital Anxiety and Depression Scale (HADS)

The heterogeneity in study design and intervention modalities reflects the evolving nature of digital cardiac rehabilitation (38).

Summary of Included Studies

Study Type	Number of Studies	Sample Size Range	Intervention Type	Outcome Measures
RCT	24	100–1,200	App-based / Telehealth	PHQ-9, HADS
Observational	16	80–800	Wearables / Remote CR	GAD-7, HADS

Impact on Depression Outcomes
Across the included studies, digital cardiac rehabilitation demonstrated a consistent and statistically significant reduction in depression scores. The majority of studies reported a decline in PHQ-9 scores ranging from 3 to 7 points following intervention, indicating clinically meaningful improvement.

Randomized controlled trials comparing DCR with standard care showed superior outcomes in the intervention group, with mean differences ranging from −2.5 to −5.2 points on standardized depression scales. These findings suggest that digital interventions are effective in addressing depressive symptoms in post-MI patients.

The improvement in depression scores can be attributed to several factors, including increased patient engagement, continuous monitoring, and integration of psychological support within digital platforms (39). Additionally, patients participating in DCR programs reported improved motivation, better adherence to exercise regimens, and enhanced self-efficacy, all of which contribute to improved mental health outcomes.

Importantly, studies incorporating structured psychological interventions, such as cognitive behavioral therapy (CBT), reported the greatest reductions in depression scores. This highlights the importance of integrating mental health support into digital rehabilitation programs.

Impact on Anxiety Outcomes
Digital cardiac rehabilitation also demonstrated significant reductions in anxiety levels among post-MI patients. Across studies, GAD-7 and HADS anxiety scores showed improvements ranging from 2 to 6 points following intervention.

Patients enrolled in DCR programs reported reduced fear of recurrent cardiac events, improved emotional stability, and enhanced coping mechanisms. These outcomes are particularly important, as anxiety is closely linked to increased sympathetic activity and adverse cardiovascular outcomes.

Comparative studies showed that DCR was either equivalent or superior to traditional cardiac rehabilitation in reducing anxiety symptoms. The continuous support provided through telemonitoring and digital communication platforms played a crucial role in alleviating anxiety (40).

Comparative Effectiveness: Digital vs Traditional Rehabilitation
A key finding of this review is the comparable effectiveness of digital cardiac rehabilitation to traditional, hospital-based programs. Several studies directly compared the two approaches and found no significant difference in the magnitude of improvement in depression and anxiety scores.
However, digital rehabilitation demonstrated advantages in terms of:

- Accessibility

- Patient adherence
- Convenience
- Long-term engagement

Patients participating in DCR programs were more likely to complete the rehabilitation process, which is a critical determinant of both physical and psychological outcomes (41).

Adherence and Engagement

Adherence to rehabilitation programs was consistently higher in digital interventions compared to traditional models. Completion rates for DCR programs ranged from 70% to 90%, significantly higher than the 40%–60% typically reported for conventional CR programs.

The use of wearable devices, mobile reminders, and real-time feedback contributed to improved engagement. Patients reported feeling more connected to their care providers, which enhanced motivation and reduced dropout rates.
Higher adherence was strongly associated with greater improvements in both depression and anxiety outcomes, emphasizing the importance of sustained engagement in rehabilitation programs (42).

Quality of Life Outcomes

In addition to improvements in depression and anxiety, digital cardiac rehabilitation was associated with enhanced overall quality of life. Patients reported improvements in:

- Physical functioning
- Emotional well-being
- Social interaction

Quality of life scores improved significantly across studies, with digital interventions showing comparable or superior outcomes to traditional rehabilitation programs.

The integration of psychological and educational components within DCR programs contributed to holistic patient recovery, addressing both physical and mental health needs (43).

Subgroup Analysis

Subgroup analysis revealed that the effectiveness of digital cardiac rehabilitation varied based on intervention characteristics:

Duration of Intervention

- Short-term (<8 weeks): Moderate improvement
- Long-term (>12 weeks): Significant improvement

Type of Intervention

- App-based programs: Moderate improvement
- Hybrid programs: Highest improvement

Inclusion of Psychological Support

- With CBT/psychological modules: Greater reduction in depression and anxiety

These findings suggest that longer and more comprehensive interventions yield better mental health outcomes.

Heterogeneity Across Studies

Considerable heterogeneity was observed across studies due to differences in:

- Intervention design
- Duration
- Outcome measures
- Patient demographics

Although this variability limits direct comparability, the overall direction of findings remains consistent, supporting the effectiveness of digital cardiac rehabilitation.

Heterogeneity is a common feature in systematic reviews involving complex interventions and reflects real-world variability in clinical practice (44).

Risk of Bias and Study Quality

The overall quality of included studies was moderate to high. Randomized controlled trials demonstrated low risk of bias in most domains, while observational studies showed moderate risk due to confounding factors.
Common limitations included:

- Lack of blinding
- Variability in outcome reporting
- Short follow-up durations

Despite these limitations, the consistency of findings across multiple studies strengthens the validity of the results.

Publication Bias

Assessment of publication bias suggested a mild asymmetry, indicating the possibility of underreporting of smaller studies with negative findings. However, the impact of publication bias on overall conclusions appears limited.
Funnel plot analysis remains a standard method for assessing publication bias in systematic reviews (45).

📊 Summary Table: Key Outcomes

Outcome	Digital CR Effect	Interpretation
Depression	Significant ↓	Clinically meaningful improvement
Anxiety	Significant ↓	Improved emotional stability
Adherence	High	Better engagement
Quality of Life	Improved	Holistic recovery
Comparison with Traditional CR	Comparable	Equally effective

Overall Interpretation

The findings of this systematic review provide strong evidence supporting the effectiveness of digital cardiac rehabilitation in improving mental health outcomes among post-MI patients. The consistent reduction in depression and anxiety scores across diverse study settings highlights the robustness of digital interventions.

Importantly, digital cardiac rehabilitation addresses key barriers associated with traditional rehabilitation programs, including accessibility and adherence. By leveraging technology, these interventions provide a patient-centered approach that enhances both physical and psychological recovery.

While variability exists across studies, the overall evidence supports the integration of digital cardiac rehabilitation into standard post-MI care. Further research is needed to standardize intervention protocols and evaluate long-term outcomes.

Discussion

Principal Findings

This systematic review demonstrates that digital cardiac rehabilitation (DCR) is effective in improving mental health outcomes in post-myocardial infarction (MI) patients, particularly in reducing depression and anxiety scores. The findings show consistent and clinically meaningful improvements across diverse study designs and intervention models, reinforcing the importance of addressing psychological health as part of post-MI recovery. Given the established association between psychological distress and adverse cardiovascular outcomes, these results highlight the relevance of integrating mental health support into rehabilitation strategies (46).

Interpretation in the Context of Existing Literature

The findings align with existing evidence supporting the role of cardiac rehabilitation in improving psychological outcomes. Traditional rehabilitation programs have been shown to reduce depression and anxiety; however, participation remains limited due to accessibility and logistical barriers (47). Digital cardiac rehabilitation addresses these limitations by enabling remote, home-based care while maintaining comparable effectiveness.

Previous research has shown that telehealth and home-based interventions can achieve outcomes similar to center-based programs (48). The present review extends these findings by demonstrating consistent improvements in mental health outcomes specifically. Additionally, digital platforms enhance patient engagement and self-management through continuous feedback and remote monitoring, which are key contributors to improved psychological well-being (49).

Mechanisms Underlying Psychological Improvement

Several mechanisms may explain the observed improvements in depression and anxiety. First, the accessibility of digital interventions increases participation and adherence, allowing patients to engage in rehabilitation without geographical or time-related constraints (50). Improved adherence is closely associated with better mental health outcomes.

Second, continuous monitoring and real-time feedback enhance patient confidence and reduce uncertainty. This is particularly important for post-MI patients, who often experience fear of recurrence and reduced physical confidence (51). The ability to track progress and receive guidance promotes a sense of control, which contributes to reduced anxiety.

Third, many DCR programs incorporate psychological interventions such as cognitive behavioral therapy, stress management, and mindfulness techniques. These approaches directly target maladaptive thought patterns and improve coping strategies, resulting in reduced depressive and anxiety symptoms (52). In addition, ongoing communication with healthcare providers and peer support mechanisms help reduce feelings of isolation and improve emotional resilience (53).

Clinical Implications

The findings have important implications for clinical practice. Digital cardiac rehabilitation offers a practical and scalable approach to integrating mental health care into post-MI management. Healthcare systems should consider incorporating DCR into routine care, particularly for patients who face barriers to traditional rehabilitation programs (54).

Digital interventions also support a more patient-centered approach by enabling personalized care. Tailored interventions and continuous monitoring improve engagement and allow clinicians to address individual patient needs more effectively (55). Furthermore, higher adherence rates observed in digital programs suggest potential for improved long-term outcomes, both psychologically and clinically (56).

Comparison with Traditional Rehabilitation

Digital cardiac rehabilitation demonstrates effectiveness comparable to traditional center-based programs in improving mental health outcomes. However, it offers additional advantages in terms of accessibility, flexibility, and patient convenience. These factors contribute to higher participation and completion rates, which are essential for achieving optimal outcomes (57).

Rather than replacing traditional rehabilitation, digital approaches may complement existing models. Hybrid programs that combine in-person and digital components could provide a balanced approach, maximizing both clinical supervision and accessibility.

Limitations

Several limitations should be considered when interpreting these findings. First, heterogeneity across studies in terms of intervention design, duration, and outcome measures limits direct comparability (58). Second, many studies had relatively short follow-up periods, restricting the ability to assess long-term sustainability of mental health improvements.
Additionally, reliance on self-reported measures may introduce reporting bias. Variability in digital literacy and access to technology may also affect the generalizability of findings, particularly in older or socioeconomically disadvantaged populations (59).

Future Research Directions

Future research should focus on standardizing digital cardiac rehabilitation interventions and outcome measures to improve comparability across studies. Long-term studies are needed to evaluate sustained psychological and clinical benefits. Additionally, the integration of advanced technologies such as artificial intelligence may further enhance personalization and effectiveness of digital interventions (60).

Overall Interpretation

Overall, the evidence suggests that digital cardiac rehabilitation is an effective approach for improving mental health outcomes in post-MI patients. By addressing key barriers associated with traditional rehabilitation and enhancing patient engagement, DCR represents a meaningful advancement in cardiovascular care. While further research is required to address existing limitations, its integration into routine clinical practice has the potential to improve both psychological well-being and overall recovery.

Conclusion

This systematic review indicates that digital cardiac rehabilitation (DCR) is an effective and scalable approach for improving mental health outcomes in post-myocardial infarction patients, with consistent reductions observed in both depression and anxiety scores. By enhancing accessibility, promoting patient engagement, and integrating structured psychological support, DCR addresses key limitations of traditional rehabilitation models while supporting holistic recovery. Although variability in intervention design and limited long-term follow-up warrant cautious interpretation, the overall evidence suggests that digital rehabilitation can serve as a valuable complement to conventional care. Future research should focus on standardizing intervention protocols and evaluating long-term clinical and psychological outcomes to strengthen its role in routine cardiovascular management.

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