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Review

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Strategies to Optimize Recovery in Frail Patients With Cardiovascular Disease Through Exercise-Based Cardiac Rehabilitation

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ABSTRACT

Cardiovascular disease (CVD) remains a critical global health challenge, with frailty in older adults further exacerbating the risk of adverse outcomes. Exercise-based cardiac rehabilitation (EBCR) offers a promising approach to improving cardiovascular function, reducing mortality, and enhancing quality of life in individuals with CVD. However, frail patients often encounter unique barriers, including reduced muscle strength, impaired mobility, and logistical challenges, which hinder their participation in traditional EBCR programs. Resistance training has been shown to improve muscle strength, balance, and functional independence while reducing fall risk, making it a key intervention for frail individuals. Aerobic exercise, when introduced gradually, further enhances cardiovascular endurance and overall resilience. Telehealth exercise strategies can provide an effective means of overcoming logistical barriers by fostering adherence and enabling real-time adjustments to exercise regimens, despite challenges such as digital literacy. This narrative review highlights innovative strategies integrating personalized exercise regimens and telehealth solutions to address the unique needs of frail patients. By prioritizing adaptable, accessible, and evidence-based strategies, an evolved EBCR approach holds the potential to significantly improve long-term health outcomes and quality of life for this vulnerable population.

Keywords: Cardiovascular diseases; Cardiac rehabilitation; Frailty

INTRODUCTION

Despite significant advancements in cardiovascular interventions and diagnostic technologies, cardiovascular disease (CVD) remains the leading health challenge, responsible for nearly 18 million deaths annually and accounting for 32% of all global fatalities.[1] The burden of CVD is immense, encompassing coronary artery disease, heart failure, stroke, and valvular heart disease, each of which often demands urgent interventions.[2] However, while acute treatments effectively reduce immediate risks, the chronic nature of CVD requires sustained, proactive strategies to ensure long-term recovery and quality of life. Exercise-based cardiac rehabilitation (EBCR) has emerged as a cornerstone in this continuum of care, proven to improve cardiovascular function, elevate physical fitness, and prevent disease recurrence.[3-5]

A robust body of systematic reviews and meta-analyses consistently underscores the transformative impact of EBCR on long-term cardiovascular outcomes, with documented reductions in all-cause mortality, CVD mortality, and hospitalization rates.[3-5] Incorporating EBCR into standard care is, therefore, essential not only for improving patient prognosis but also for fostering a return to functional independence and quality of life. However, the effectiveness of EBCR is limited by coexisting conditions such as frailty.[6,7] Characterized by depleted physiological reserves, reduced muscle strength, and heightened vulnerability to adverse events, frailty—often accompanied by sarcopenia—significantly elevates risks of falls, fractures, and CVD-related mortality, adding complexity to EBCR.[8] For frail patients with CVD, barriers, including impaired mobility, transportation hurdles, and the physical demands of regular rehabilitation sessions, limit their ability to participate in traditional EBCR programs.[9] Addressing these barriers through adaptive approaches is imperative to extend the benefits of EBCR to this high-risk population.[10]

To address the unique challenges faced by frail patients, telehealth technologies offer a promising solution by reducing logistical and physical barriers to rehabilitation.[6,11] Telehealth enables patients to engage in EBCR from the comfort of their homes, with real-time monitoring of physiological parameters such as heart rate, blood pressure, electrocardiogram, and physical activity levels.[12,13] Facilitated by wearable devices and video conferencing, telehealth-based exercise programs can provide a structured, safe, and effective alternative that minimizes the strain of frequent in-person visits.[14] Despite these benefits, digital literacy remains a significant obstacle, particularly among older and frail populations, potentially limiting their full participation.[15] Overcoming these digital literacy challenges is vital to the successful integration of EBCR through telehealth, ensuring that this approach reaches its full potential as an accessible, impactful option for comprehensive EBCR.[16]

This review highlights tailored exercise strategies within EBCR for frail CVD patients, with a focus on the critical role of telehealth interventions in addressing their specific needs. It also examines digital literacy challenges and current efforts to improve access to telehealth-based exercise. Additionally, the review explores future research directions, such as combining cognitive training with physical exercise and advancing personalized exercise protocols through precision exercise medicine. These innovative approaches have the potential to significantly improve long-term cardiovascular outcomes, enhance quality of life, and promote health equity for these vulnerable populations.

A COMPREHENSIVE FRAMEWORK FOR FRAIL PATIENTS WITH CVD TO OPTIMIZE EBCR

Given the multifaceted needs in delivering EBCR for frail patients with CVD, a comprehensive framework is illustrated in this review (**Fig. 1**). This framework addresses key barriers—including frailty, limited access to center-based programs, digital literacy, and the need to incorporate innovative exercise modalities such as high-intensity interval training (HIIT) and cognitive training to enhance the accessibility, inclusivity, and effectiveness of EBCR for high-risk populations. This flowchart serves as a guiding structure for the subsequent discussion, offering a systematic approach to implementing a comprehensive EBCR model.

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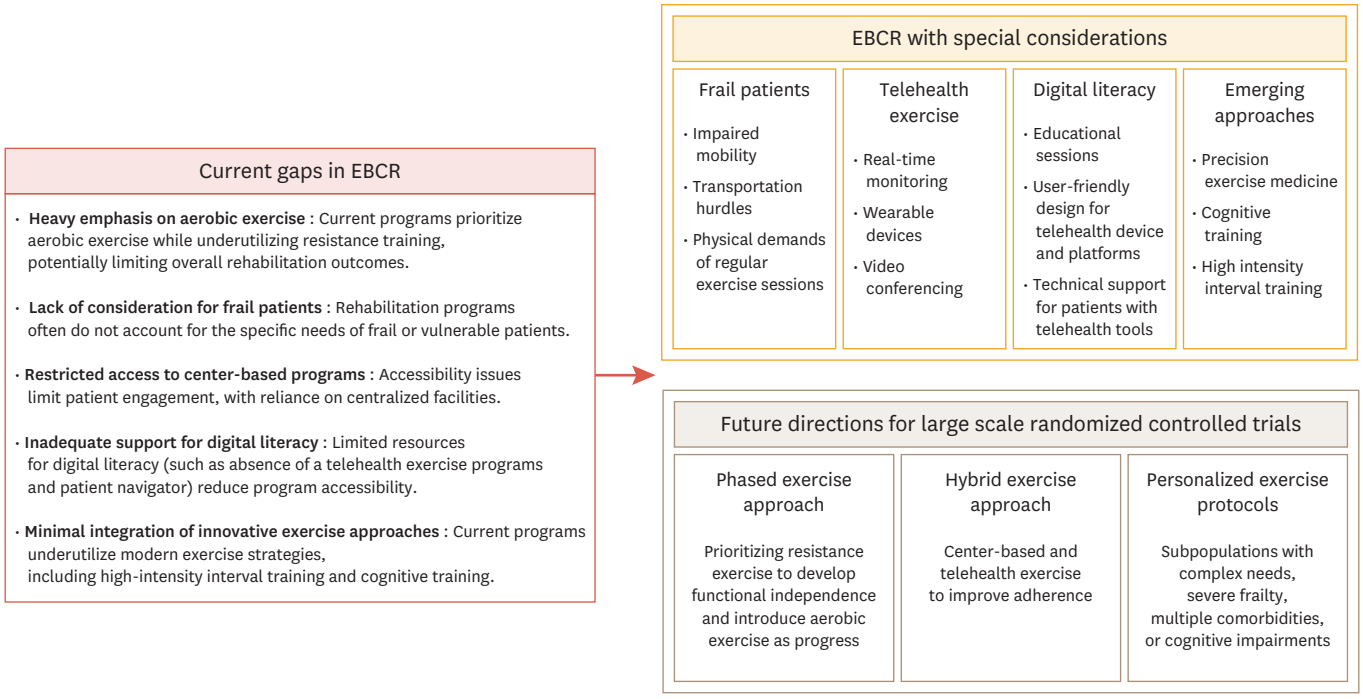

Fig. 1. Comprehensive flowchart for EBCR: integrating frailty management, telehealth exercise, digital literacy, and innovative exercise approaches.
EBCR, exercise-based cardiac rehabilitation.

FRAILTY IN CVD: CHALLENGES IN CLINICAL APPLICATION TO EXERCISE FOR FRAIL PATIENTS WITH CVD

Frailty is prevalent clinical syndrome in older patients with CVD, characterized by decreased physiological reserves (i.e., reduced physiologic capacity) and increased vulnerability to stressors such as illness or surgery.[8,9] Frailty is more prevalent among older adults with established CVD, compared to the general population, affecting up to 30% of individuals with coronary artery disease, 80% of those with heart failure, and 74% of those with aortic stenosis.[8] Frailty is often defined by Fried Frailty Phenotype which includes 3 or more of clinical characteristics such as sarcopenia (loss of muscle mass and strength), fatigue, reduced energy expenditure, and diminished functional capacity (reduced gait speed),[17,18] all of which can directly impact a patient's ability to participate in EBCR.

The clinical significance of frailty was emphasized in a recent study from the National Health and Aging Trends Study which examined the broader cardiovascular risks associated with frailty. In this large prospective cohort study assessing 4,656 participants, 16% were classified as frail, and 47% as pre-frail, with a higher prevalence of chronic conditions such as hypertension, diabetes, lung disease, and dementia compared to non-frail individuals.[19] Frailty was strongly associated with a higher incidence of major adverse cardiovascular events, including death, acute myocardial infarction, stroke, and peripheral vascular disease over 6 years. Notably, frail individuals had a 2.7-fold higher risk of all-cause mortality and significantly elevated cardiovascular event risk, underscoring the importance of early frailty identification, even in patients without preexisting CVD, to mitigate its detrimental effects on cardiovascular health later. This finding is supported by another large study of over 3 million US Veterans, showing that frailty was a strong, independent predictor of

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cardiovascular mortality. Specifically, veterans classified as pre-frail had a 1.8 times higher risk of cardiovascular death (hazard ratio [HR], 1.8, 95% confidence interval [CI], 1.7–1.9), while those with mild frailty had a 3.2-fold increased risk (HR, 3.2, 95% CI, 3.1–3.3).[20] For individuals with moderate frailty, the HR increased to 5.2 (95% CI, 5.1–5.4), and in cases of severe frailty, the risk was 8.6 times higher (HR, 8.6, 95% CI, 8.3–8.9). These associations remained significant even after adjusting for variables such as age, race, smoking status, hyperlipidemia, and statin use, highlighting the crucial role of frailty as a cardiovascular risk factor independent of other conditions.

Given the profound impact of frailty on cardiovascular risk, its presence in patients undergoing EBCR presents additional, unique challenges. However, conventional EBCR may not address the distinct needs of frail patients. Consequently, frail patients struggle to meet the prescribed exercise volume and intensity, resulting in lower adherence rates and less pronounced improvements in cardiovascular and physical health. Studies have shown that frail patients experience greater difficulty completing the prescribed volume and intensity of exercise, leading to lower adherence rates and suboptimal improvements in cardiovascular outcomes.[21,22] As a result, frail individuals may not fully benefit from EBCR, underscoring the need for tailored exercise interventions that incorporate both resistance and aerobic training to enhance physical function, reduce fall risk, and improve cardiovascular mortality in this vulnerable group.[23] In the following sections, strategies for adapting EBCR to better serve frail individuals will be discussed, aiming to mitigate the compounded risks and ultimately improve long-term cardiovascular outcomes.

SPECIFIC EXERCISE RECOMMENDATIONS FOR MANAGING FRAILTY IN PATIENTS WITH CVD

Given these unique challenges, a conventional EBCR approach may be inadequate for frail individuals. Frail patients often require modified exercise protocols that not only improve cardiovascular fitness but also address specific functional deficits associated with frailty.[22,24] Aerobic exercise has long been the foundation of EBCR, primarily aimed at enhancing cardiovascular fitness. In fact, 73% of EBCR trials focused on aerobic exercise, with only 27% incorporating resistance training in a recent meta-analysis.[4] However, for frail patients who frequently experience sarcopenia, muscle weakness, and reduced physical resilience, aerobic exercise alone may be insufficient.[25] While aerobic exercise improves cardiovascular endurance, it does not address critical aspects such as sarcopenia, balance, and functional independence—key factors for frailty management.[7] Emerging evidence highlights the importance of resistance training as a crucial intervention to meet the unique needs of frail individuals with sarcopenia.[26,27]

Importantly, exercise interventions for frail patients with CVD, particularly those incorporating resistance training, have shown significant benefits across diverse settings, including in-hospital,[28,29] outpatient,[30] home-based,[31] and telehealth platforms[32] (**Table 1**). Tailored in-hospital resistance and functional exercises have proven effective in enhancing balance, mobility, muscle strength, and independence, ultimately leading to shorter hospital stays.[33,34] Structured resistance and balance training programs have also yielded improvements in functional capacity, with marked increases in the 6-Minute Walk Distance, Timed Up-and-Go scores, and relative workload capacity.[35-38]

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Table 1. Exercise interventions for frailty reduction in patients with CVD

Author (Year)	Study sample	Intervention	Outcome measures	Main findings
Opasich et al. (2010)[33]	RCT; 224 older adults post-cardiac surgery	Tailored in-hospital physiotherapy with mobility and functional exercises	Nursing needs, mobility, balance, and muscle strength	Significant improvement in mobility, balance, muscle strength, increased independence, shorter length of hospital stay
Busch et al. (2012)[34]	RCT; 173 patients post-CABG	Daily resistance and balance training within cardiac rehabilitation	CPET, 6MWT, TUG, isometric strength	Significant improvement in 6MWD, TUG, and relative workload soon after CABG
Waite et al. (2017)[31]	Prospective pilot; 22 pre-CABG patients	Home-based preoperative program with balance and strength exercises	6MWT, SPPB, frailty score	Significant improvement in clinical frailty score, 6MWT, SPPB, hospital length of stay
Eichler et al. (2017)[35]	RCT; 136 patients post-TAVI	Multicomponent cardiac rehabilitation including aerobic, resistance, and flexibility training	6MWT, frailty index, maximum workload, Short form-12	Significant improvement in 6MWD, maximum workload, and quality of life
Reeves et al. (2017)[36]	RCT, n=27 (older adults with acute decompensated heart failure)	Tailored, progressive multidomain physical rehabilitation intervention including strength, balance, mobility, and endurance exercises	SPPB score; Secondary: 6-mon all-cause rehospitalization rate	Significant improvement in SPPB score at 3 mon. Reduction in 6-mon rehospitalization rate. SPPB improvement strongly correlated with reduced rehospitalizations
Lutz et al. (2020)[37]	Retrospective; 243 frail older adults	Phase II cardiac rehabilitation with aerobic and strength exercises	Gait speed, TUG, hand grip strength, 6MWT	Frail patients showed greater improvement in TUG than the other groups
Ushijima et al. (2021)[30]	Observational; 89 elderly CVD patients (65+ yr)	3-mon outpatient cardiac rehab with aerobic, resistance, and flexibility training	Frailty status, CPET	Significant improvement in gait speed, grip strength, and lower extremity strength
Tamulevičiūtė-Prascienė et al. (2021)[29]	RCT; 252 patients post-valve surgery	Resistance and balance training integrated into cardiac rehab	6MWT, SPPB, leg strength (one repetition maximum)	Significant improvement in 6MWD, SPPB, frailty and sustained over 3 mon follow-up
Kitzman et al. (2021) [38]	RCT, n=349 (older adults hospitalized for acute decompensated heart failure)	36-session transitional, tailored, progressive rehabilitation intervention targeting 4 domains: strength, balance, mobility, and endurance	SPPB, 6-mon all-cause rehospitalization rate	Significant improvement in SPPB score at 3 mon in intervention group. No significant difference in 6-mon rehospitalization rate between groups
Pandey et al. (2023)[28]	RCT, n=337 (older adults with acute decompensated heart failure, stratified by frailty status)	3-mon early, transitional, tailored, multidomain physical rehabilitation intervention	SPPB, 6-mon all-cause hospitalization or mortality	Frail patients showed a 2.6-fold greater improvement in SPPB score compared to prefrail
Su et al. (2024)[32]	Pilot RCT, n=43 (older adults with CHD)	12-wk CTR with individualized assessments, e-coaching, and home-based CTR	Daily steps, HPLP scores, CTR usage statistics	Significant improvements in daily steps and health-promoting lifestyle profile scores. 40% used the website for data uploads, 90% used a pedometer for telemonitoring. Barriers: physical discomfort, technology use difficulties

CVD, cardiovascular disease; RCT, randomized controlled trial; CABG, coronary artery bypass grafting; CPET, cardiopulmonary exercise testing; 6MWT, Six-Minute Walk Test; TUG, Timed Up and Go; SPPB, Short Physical Performance Battery; TAVI, transcatheter aortic valve implantation; CHD, coronary heart disease; CTR, cardiac telerehabilitation; HPLP, health-promoting lifestyle profile.

Determining the optimal type of exercise—whether resistance, aerobic exercise, or a combination of both—that can best support frail patients with CVD in enhancing their physical resilience and cardiovascular health is a crucial consideration (**Fig. 2**). A recent large exercise trial provides compelling insights into the benefits of resistance training.[39] This randomized controlled trial investigated the comparative effects of aerobic, resistance, and combined exercise on CVD risk profiles in overweight or obese adults. The study involved 406 participants (aged 35–70) who were randomized into 4 groups: resistance training, aerobic exercise, combined aerobic plus resistance, or no exercise for one year. Although aerobic exercise offers well-established cardiovascular benefits, it did not significantly improve muscle strength or hypertrophy in this study. Resistance training, on the other hand, specifically promoted muscle hypertrophy and muscular strength. The trial further emphasized that resistance training offers unique advantages in building muscular strength and lean body mass, benefits that aerobic exercise alone cannot provide which translate into better mobility and physical performance, key for maintaining independence in older adults and frail populations. The combined exercise group offered additional benefits by improving composite CVD risk scores and muscular strength—an outcome not seen in the aerobic

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Exercise modalities			
Types	Advantages	Practical applications	Limitations
Resistance exercise	· Improved muscle mass and strength · Enhanced joint stability and mobility · Increased bone density	· Recommended 2–3 sessions/week with progressive intensity · Suitable for early phases of exercise interventions in frail patients	· Requires equipment and supervision · May not address cardiovascular health sufficiently if used alone
Aerobic exercise	· Enhanced oxygen delivery/utilization · Reduced risk of cardiovascular events · Improved lipid profile	· Ideal for patients with adequate baseline stability and mobility · Can be introduced gradually	· Limited impact on muscle mass, strength and balance · May not be suitable for patients with severe frailty
Combined exercise	· Synergistic benefits	· Phased approach addressing both muscular and cardiovascular needs	· May be too demanding for frail patients initially · Requires adequate baseline physical resilience

Exercise implementation strategies			
Types	Advantages	Practical applications	Limitations
Center-based approach	· Direct supervision and patient interaction, immediate feedback and adjustment, access to specialized equipment	· Highly structured approach for moderate-to-severe frailty, suitable for patients requiring close supervision	· Accessibility challenges due to transportation barriers, time constraints, and logistical issues
Telehealth-based approach	· Convenience and accessibility, flexible scheduling, scalability for larger patient populations, no constraints of physical space	· Overcomes logistical barriers, enables personalized adjustments through wearable devices and telehealth platforms	· Dependent on patient digital literacy · May lack social interaction and hands-on guidance compared to in-person programs
Hybrid exercise approach	· Combines the benefits of in-person supervision with the flexibility of remote monitoring · Improved adherence	· Allows for personalized supervision during initial sessions, transitioning to remote guidance, suitable for patients with moderate frailty	· Requires coordination between in-person and remote sessions · Increased training requirements for healthcare providers

Fig. 2. Comparison of exercise interventions and delivery models for frail cardiovascular patients: benefits, evidence, practical applications, and limitations.

group alone. Notably, adherence to the exercise program was higher in the resistance and combined groups compared to the aerobic group, suggesting that these interventions are not only effective but also feasible for long-term commitment. Resistance training, therefore, should emerge as a cornerstone intervention for restoring and preserving functional independence in vulnerable populations, significantly reducing the likelihood of injury.

A PHASED EXERCISE APPROACH: THE ROLE OF RESISTANCE TRAINING IN EBCR FOR FRAIL PATIENTS

As outlined in the preceding sections, it is obvious that integrating both aerobic and resistance exercises is crucial for the success of EBCR in frail patients with CVD. Yet, frail patients face significant challenges that often impede their ability to engage in both aerobic and resistance exercise modalities within a single session. One potential solution is to alternate aerobic and resistance training on different days, thereby reducing the physical and mental strain on patients.[40,41] This strategy enables them to focus on one exercise type at a time, while also allowing for adequate recovery between sessions—particularly beneficial for those with diminished muscle strength and endurance. Despite these potential advantages,

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separating exercise modalities across alternate days may not be feasible in real-world clinical settings as participation rates in EBCR programs remain disappointingly low. In most countries including the United States, Europe and Korea, less than 50% of eligible patients participate in these programs.[42,43] These low adherence rates are driven by various factors, including logistical barriers such as transportation, time constraints, and inadequate patient education and support systems.[44]

While participating both aerobic and resistance exercise modalities may theoretically improve multiple clinical outcomes, the practical reality of low adherence necessitates alternative approaches. Given the limitations frail patients face and low adherence, a phased exercise approach to rehabilitation can be implemented. A phased approach could be effective for frail patients in EBCR, where resistance training is prioritized initially to build muscular strength and functional capacity, followed by a gradual introduction of aerobic exercise in later phases.[45] This hypothetical strategy may address specific needs of frail patients, who suffer from sarcopenia and reduced muscle strength, making it difficult to tolerate the demands of aerobic exercise early in rehabilitation. Supporting this, a meta-analysis of 25 studies involving 2,267 participants demonstrated that resistance training alone significantly improves handgrip strength (effect size [ES]=0.51, p=0.001), lower-limb strength (ES=0.93, p<0.001), agility (ES=0.78, p=0.003), gait speed (ES=0.75, p<0.001), postural stability (ES=0.68, p=0.007), functional performance (ES=0.76, p<0.001), fat mass (ES=0.41, p=0.001), and muscle mass (ES=0.29, p=0.002).[45] Resistance training during early stages of rehabilitation is particularly effective for improving gait speed and functional strength. Based on these findings, resistance training should be considered a highly effective preventive strategy for delaying and mitigating the negative effects of frailty across both early and late stages of rehabilitation.[46]

Specifically, focusing on resistance training for several weeks or months in the initial phase would help improve muscle mass, neuromuscular function, and overall physical resilience. As the patient's strength and balance improve, this could lead to better mobility and reduced risk of falls, which are critical for maintaining independence in frail individuals. Once a solid foundation of muscular health is established, aerobic exercise can be introduced progressively in the subsequent phase. This phased approach may allow patients to safely and gradually increase cardiovascular endurance without overloading their weakened musculoskeletal system.[47] Furthermore, early success with resistance training can boost confidence and improve adherence, setting the stage for the introduction of more demanding aerobic exercises later. This phased exercise strategies could potentially offer a more sustainable and less overwhelming intervention, ensuring that frail patients can eventually benefit from the full spectrum of EBCR while reducing the risk of dropout and non-adherence. This hypothetical phased approach, if validated in a large randomized controlled trial, could offer a sustainable recovery, ensuring that frail patients benefit from the full spectrum of EBCR.

A PARADIGM SHIFT IN EBCR: TAILORED APPROACHES FOR FRAIL POPULATIONS

As exercise science continues to advance, the landscape of EBCR is shifting towards more innovative, personalized and evidence-based approaches. While conventional aerobic and resistance exercise remains foundational, novel modalities such as HIIT is gaining

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attention for its time-efficient—improving both cardiovascular fitness and muscle strength in shorter, possibly more manageable efforts.[48] When combined with resistance training, HIIT may provide a comprehensive exercise strategy that targets both cardiovascular and muscular needs of frail patients, allowing for more efficient recovery in a shorter timeframe. A recent study investigated the effects of 2 different resistance training modalities—cluster training (CT: short inter-repetition rest periods) and traditional training (TT)—on the force-velocity relationship, physical function, and frailty in pre-frail and frail older adults.[49] Forty-three participants (average age 81.4±5.1 years) were assigned to one of 3 groups: cluster (CT; 10-second intra-set rest), traditional (TT; no intra-set rest), or a control group. Results indicated that both CT and TT groups achieved significant improvements in physical function (i.e. Short Physical Performance Battery) and reductions in frailty. These findings suggest that both training methods can be effective for improving physical function and mitigating frailty in older adults, with TT potentially offering additional benefits for enhancing both force and velocity capabilities. However, these interventions are still in the early stages of clinical testing in frail CVD populations. Future research should focus on validating the safety, feasibility, and long-term outcomes of HIIT in combination with resistance training for frail CVD patients. Key questions include whether HIIT can be adapted for varying levels of frailty, how it compares to traditional rehabilitation in terms of adherence and outcomes, and whether it can mitigate the risks of sarcopenia and falls that are particularly prevalent in this population.

Another area for future investigation is the integration of cognitive training with physical exercise, particularly for frail patients with CVD. Cognitive decline frequently coexists with physical frailty, and emerging research suggests that combining cognitive tasks with exercise may offer synergistic benefits.[50,51] This dual approach may not only enhance cognitive function but also promotes physical function, potentially addressing 2 critical aspects of frailty. Future studies are warranted to explore the mechanisms behind this interaction, determine the most effective cognitive and physical training combinations, and assess long-term outcomes in delaying or mitigating the onset of cognitive dysfunction, further emphasizing the need for rigorous clinical trials to evaluate its full impact.

Precision exercise medicine has garnered increasing scientific attention for its potential to revolutionize exercise science by offering more personalized and targeted interventions.[52] This emerging field focuses on tailoring exercise programs to an individual's genetic, molecular, and physiological characteristics, ensuring that the prescribed regimen is both effective and safe.[53] By customizing exercise protocols to each patient's unique profile, particularly across varying levels of frailty, precision exercise medicine can minimize risks while maximizing therapeutic benefits. However, no studies to date have specifically targeted frail patients with CVD using exercise training grounded in precision medicine approaches. Future research should aim to investigate this new EBCR protocols, investigating how precision exercise prescriptions can improve clinical outcomes and address the specific needs of frail patients.

PATIENT MONITORING AND ADDRESSING CHALLENGES IN FRAIL POPULATIONS

Given the unique needs of frail CVD patients, leveraging telehealth in EBCR presents an opportunity to bridge access gaps and offer more adaptable care. Telehealth-delivered EBCR provides a promising alternative for patients who may struggle with the logistical and

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physical demands of center-based programs. Several systematic reviews and meta-analyses aimed to evaluate the effectiveness of telehealth-delivered cardiac rehabilitation compared to center-based rehabilitation in patients with CVD, analyzing outcomes such as exercise capacity, weight, blood pressure, lipid profile, mortality, and quality of life.[44,54,55] The findings indicated no significant differences between telehealth and center-based EBCR in terms of these clinical outcomes, suggesting that telehealth is a viable alternative for delivering EBCR, especially for low to moderate risk CVD patients who face barriers to accessing traditional center-based programs.

Telehealth can play a crucial role in this context by offering remote monitoring and virtual consultations, allowing patients to participate in exercise programs from home while receiving continuous feedback and guidance. This is possible due to wearable devices, such as smartwatches, fitness trackers, and heart rate monitors, especially useful for monitoring cardiovascular responses to exercise, such as heart rate, blood pressure, and electrocardiogram monitoring.[56] These devices help ensure that patients can participate in regular exercise at a safe intensity level, allowing healthcare providers to adjust exercise prescriptions as needed,[14] to avoid overexertion and mitigate the risk of adverse cardiovascular events. This approach not only improves adherence but also reduces the logistical challenges of attending in-person exercise sessions regularly, which are often difficult for frail individuals.[57,58]

Notably, video conferencing tools may play a crucial role in telehealth-based cardiac rehabilitation by enabling real-time interactions that support exercise demonstrations, posture correction, consultations, and progress assessments.[59] This interactive communication allows healthcare providers to closely monitor patient adherence to prescribed exercise regimens and to intervene promptly if health concerns arise.[60] In cases of medical emergencies, having family members or caregivers present can provide immediate support, further reducing risks, though such events are rare during supervised sessions.[61,62] This approach is particularly valuable for patients who face barriers to in-person exercise due to geographic, logistical, or health-related constraints by ensuring consistent, high-quality care without the need for frequent travel to rehabilitation centers. Building on the advantages of remote exercise interventions for older adults, a recent study compared 2 technology-driven exercise methods: video conference (VC) and video-based home exercise (VBHE).[59] In this study, 30 older adults aged 65 to 75 participated in a 6-week calisthenic exercise program. The VC group engaged in exercises via real-time video conferencing with a physical therapist, while the VBHE group performed identical exercises by following pre-recorded videos. Both groups showed significant improvements in physical performance measures, including chair sit-stand, 6-minute walk, and grip strength tests; however, no changes were observed in skeletal muscle mass and body fat percentage. Notably, the VC method was found to be more effective than VBHE for enhancing physical performance, likely due to the interactive nature of live guidance. This suggests that real-time interaction may enhance engagement and adherence, underscoring the potential of telehealth interventions to provide structured support and improve physical outcomes for older adults. Through telehealth, patients can receive essential guidance and oversight, enabling them to engage actively in their recovery within the comfort and safety of their homes.

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CHALLENGES OF DIGITAL LITERACY IN TELEHEALTH EXERCISE FOR PATIENTS WITH CVD

Despite the clear benefits, telehealth exercise faces distinct challenges, particularly in managing frail patients with CVD.[63] A primary obstacle is obtaining reliable health data from patients. Although wearable devices facilitate continuous monitoring, capturing the full scope of a patient's health status is especially challenging in frail individuals with complex health needs.[64] Particularly, ensuring that older patients feel comfortable and confident using these technologies poses another significant challenge.[65] These patients often present a combination of physical, cognitive, and technological barriers, limiting their engagement with digital health tools.[16] Frailty involves reduced muscle strength and mobility, making it difficult to operate wearable devices or mobile applications that require fine motor skills.[65] Additionally, cognitive decline, common in older adults, impairs their ability to understand and navigate complex digital interfaces and telehealth platforms.[66] Older adults lack familiarity with smartphones, apps, and wearable health monitors, leading to improper use or misunderstanding of key health metrics such as heart rate, blood pressure, or physical activity levels. This digital gap can result in inaccurate data reporting or misinterpretation of health information, compromising the effectiveness of telehealth monitoring.[67] Patients with lower digital literacy may struggle to adhere to prescribed exercise programs or report essential health changes in real time, limiting the potential benefits of telehealth exercise interventions.

ADDRESSING DIGITAL LITERACY IN TELEHEALTH FOR FRAIL PATIENTS

To ensure that telehealth interventions reach their full potential for frail CVD patients, additional digital support and education are necessary. Addressing this issue requires ensuring that devices are user-friendly and that sufficient training and support are provided.[68] This might include simplified interfaces, step-by-step guidance, and regular technical assistance. In a hospital or rehabilitation center, patient navigators can play a critical role in educating patients about telehealth services and their use.[69-71] At home, implementing telehealth interventions for frail patients often requires the involvement of caregivers or family members to assist with operating digital tools and interpreting health data.[72] Their support ensures that patients can fully engage with remote monitoring systems and follow exercise programs effectively, enhancing the overall success of telehealth-based rehabilitation.[73] As frailty increases the risk of falls, fractures, and other adverse events, close monitoring of how patients respond to exercise is essential.[23] Periodic in-person check-ins could complement remote monitoring to ensure that digital literacy challenges do not undermine the overall care plan.[74,75] Ultimately, hybrid models that combine in-person visits with telehealth check-ins may provide a balanced approach for patients who need more hands-on guidance but also benefit from the flexibility of remote care (**Fig. 2**).[76,77] By integrating technology with enhanced digital support, telehealth exercise can eliminate geographical and physical barriers, ensuring broader access to effective EBCR.

CONCLUSION

Despite the advances in EBCR, substantial gaps remain in the literature. One of the most critical needs is for large-scale, longitudinal studies that demonstrate the long-term impact

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of telehealth-based exercise programs on robust clinical outcomes including mortality, hospital admission rates and recurrence of cardiovascular events in frail patients with CVD. While recent findings are promising, we need robust data to definitively demonstrate the sustained benefits of EBCR over time. Furthermore, there is a clear need for research that delves deeper into personalized exercise protocols for subpopulations with complex needs, such as those with advanced frailty, multiple comorbidities, or cognitive impairments. The traditional one-size-fits-all model of EBCR is inadequate for these patients. Future research should focus on designing safe, personalized interventions that optimize efficacy while ensuring patient safety. Although wearable technology and telehealth are opening a new era of accessibility, there remains a critical gap in understanding how to best integrate these tools into clinical practice. More research is needed to identify the most effective methods for incorporating wearable technology and telehealth into existing healthcare systems while ensuring that these innovations are accessible to all, regardless of socioeconomic status. If not carefully managed, the digital device could exacerbate health disparities rather than bridge them. Finally, the combination of exercise, nutrition, and mental health is an underexplored yet critical area for future research. The development of comprehensive, interdisciplinary interventions that combine physical rehabilitation with nutritional counseling and mental health support could unlock new pathways for improving outcomes, particularly in frail, older adults with CVD. This comprehensive approach can transform EBCR by addressing the multifaceted needs of this vulnerable population.

REFERENCES

1. Luo Y, Liu J, Zeng J, Pan H. Global burden of cardiovascular diseases attributed to low physical activity: an analysis of 204 countries and territories between 1990 and 2019. Am J Prev Cardiol 2024;17:100633. PUBMED | CROSSREF
2. Ullah A, Kumar M, Sayyar M, Sapna F, John C, Memon S, et al. Revolutionizing cardiac care: a comprehensive narrative review of cardiac rehabilitation and the evolution of cardiovascular medicine. Cureus 2023;15:e46469. PUBMED | CROSSREF
3. Patti A, Merlo L, Ambrosetti M, Sarto P. Exercise-based cardiac rehabilitation programs in heart failure patients. Heart Fail Clin 2021;17:263-271. PUBMED | CROSSREF
4. Dibben GO, Faulkner J, Oldridge N, Rees K, Thompson DR, Zwisler AD, et al. Exercise-based cardiac rehabilitation for coronary heart disease: a meta-analysis. Eur Heart J 2023;44:452-469. PUBMED | CROSSREF
5. Long L, Anderson L, Dewhirst AM, He J, Bridges C, Gandhi M, et al. Exercise-based cardiac rehabilitation for adults with stable angina. Cochrane Database Syst Rev 2018;2:CD012786. PUBMED | CROSSREF
6. Han HW, Park SW, Kim DY, Lee BS, Kim D, Jeon N, et al. E-Health interventions for older adults with frailty: a systematic review. Ann Rehabil Med 2023;47:348-357. PUBMED | CROSSREF
7. Calle A, Onder G, Morandi A, Bellelli G, Ortolani E, Pérez LM, et al. Frailty related factors as predictors of functional recovery in geriatric rehabilitation: the sarcopenia and function in aging rehabilitation (SAFARI) multi-centric study. J Nutr Health Aging 2018;22:1099-1106. PUBMED | CROSSREF
8. James K, Jamil Y, Kumar M, Kwak MJ, Nanna MG, Qazi S, et al. Frailty and cardiovascular health. J Am Heart Assoc 2024;13:e031736. PUBMED | CROSSREF
9. Doody P, Lord JM, Greig CA, Whittaker AC. Frailty: pathophysiology, theoretical and operational definition(s), impact, prevalence, management and prevention, in an increasingly economically developed and ageing world. Gerontology 2023;69:927-945. PUBMED | CROSSREF
10. Alfaraidhy MA, Regan C, Forman DE. Cardiac rehabilitation for older adults: current evidence and future potential. Expert Rev Cardiovasc Ther 2022;20:13-34. PUBMED | CROSSREF
11. Sarkar S, MacLeod J, Hassan A, Brunt KR, Palmer K, Légaré JF. Enhanced telehealth home-monitoring intervention for vulnerable and frail patients after cardiac surgery (THE-FACS Pilot Intervention Study). BMC Geriatr 2022;22:836. PUBMED | CROSSREF
12. Haleem A, Javaid M, Singh RP, Suman R. Telemedicine for healthcare: Capabilities, features, barriers, and applications. Sens Int 2021;2:100117. PUBMED | CROSSREF

13. Gajda R, Gajda J, Czuba M, Knechtle B, Drygas W. Sports heart monitors as reliable diagnostic tools for training control and detecting arrhythmias in professional and leisure-time endurance athletes: an expert consensus statement. Sports Med 2024;54:1-21. PUBMED | CROSSREF
14. Golbus JR, Lopez-Jimenez F, Barac A, Cornwell WK 3rd, Dunn P, Forman DE, et al. Digital technologies in cardiac rehabilitation: a science advisory from the American Heart Association. Circulation 2023;148:95-107. PUBMED | CROSSREF
15. Campanozzi LL, Gibelli F, Bailo P, Nittari G, Sirignano A, Ricci G. The role of digital literacy in achieving health equity in the third millennium society: a literature review. Front Public Health 2023;11:1109323. PUBMED | CROSSREF
16. Oh SS, Kim KA, Kim M, Oh J, Chu SH, Choi J. Measurement of digital literacy among older adults: systematic review. J Med Internet Res 2021;23:e26145. PUBMED | CROSSREF
17. Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, et al. Frailty in older adults: evidence for a phenotype. J Gerontol A Biol Sci Med Sci 2001;56:M146-M156. PUBMED | CROSSREF
18. Arora M, Sun CL, Ness KK, Teh JB, Wu J, Francisco L, et al. Physiologic frailty in nonelderly hematopoietic cell transplantation patients: results from the bone marrow transplant survivor study. JAMA Oncol 2016;2:1277-1286. PUBMED | CROSSREF
19. Damluji AA, Chung SE, Xue QL, Hasan RK, Moscucci M, Forman DE, et al. Frailty and cardiovascular outcomes in the National Health and Aging Trends Study. Eur Heart J 2021;42:3856-3865. PUBMED | CROSSREF
20. Shrauner W, Lord EM, Nguyen XT, Song RJ, Galloway A, Gagnon DR, et al. Frailty and cardiovascular mortality in more than 3 million US Veterans. Eur Heart J 2022;43:818-826. PUBMED | CROSSREF
21. Pobrotyn P, Pasieczna A, Diakowska D, Uchmanowicz B, Mazur G, Banasik M, et al. Evaluation of frailty syndrome and adherence to recommendations in elderly patients with hypertension. J Clin Med 2021;10:3771. PUBMED | CROSSREF
22. Groen WG, Wattel EM, de Groot AJ, Meiland FJM, Hertogh CMPM, Gerrits KHL. Exercise testing and training in frail older adults with an orthopedic impairment participating in a geriatric rehabilitation program: an international Delphi study. Eur Geriatr Med 2023;14:985-997. PUBMED | CROSSREF
23. Güner Oytun M, Topuz S, Baş AO, Çöteli S, Kahyaoğlu Z, Boğa İ, et al. Relationships of fall risk with frailty, sarcopenia, and balance disturbances in mild-to-moderate Alzheimer's disease. J Clin Neurol 2023;19:251-259. PUBMED | CROSSREF
24. Shimizu A, Maeda K, Fujishima I, Kayashita J, Mori N, Okada K, et al. Hospital Frailty Risk Score predicts adverse events in older patients with hip fractures after surgery: analysis of a nationwide inpatient database in Japan. Arch Gerontol Geriatr 2022;98:104552. PUBMED | CROSSREF
25. Hurst C, Sayer AA. Improving muscle strength and physical function in older people living with sarcopenia and physical frailty: not all exercise is created equal. J R Coll Physicians Edinb 2022;52:166-171. PUBMED | CROSSREF
26. Hurst C, Robinson SM, Witham MD, Dodds RM, Granic A, Buckland C, et al. Resistance exercise as a treatment for sarcopenia: prescription and delivery. Age Ageing 2022;51:afac003. PUBMED | CROSSREF
27. Aguirre LE, Villareal DT. Physical exercise as therapy for frailty. Nestle Nutr Inst Workshop Ser 2015;83:83-92. PUBMED | CROSSREF
28. Pandey A, Kitzman DW, Nelson MB, Pastva AM, Duncan P, Whellan DJ, et al. Frailty and effects of a multidomain physical rehabilitation intervention among older patients hospitalized for acute heart failure: a secondary analysis of a randomized clinical trial. JAMA Cardiol 2023;8:167-176. PUBMED | CROSSREF
29. Tamulevičiūtė-Prascienė E, Beigienė A, Thompson MJ, Balnė K, Kubilius R, Bjarnason-Wehrens B. The impact of additional resistance and balance training in exercise-based cardiac rehabilitation in older patients after valve surgery or intervention: randomized control trial. BMC Geriatr 2021;21:23. PUBMED | CROSSREF
30. Ushijima A, Morita N, Hama T, Yamamoto A, Yoshimachi F, Ikari Y, et al. Effects of cardiac rehabilitation on physical function and exercise capacity in elderly cardiovascular patients with frailty. J Cardiol 2021;77:424-431. PUBMED | CROSSREF
31. Waite I, Deshpande R, Baghai M, Massey T, Wendler O, Greenwood S. Home-based preoperative rehabilitation (prehab) to improve physical function and reduce hospital length of stay for frail patients undergoing coronary artery bypass graft and valve surgery. J Cardiothorac Surg 2017;12:91. PUBMED | CROSSREF
32. Su JJ, Wong AKC, He XF, Zhang LP, Cheng J, Lu LJ, et al. Feasibility and effectiveness of cardiac telerehabilitation for older adults with coronary heart disease: a pilot randomized controlled trial. Contemp Clin Trials Commun 2024;42:101365. PUBMED | CROSSREF

33. Opasich C, Patrignani A, Mazza A, Gualco A, Cobelli F, Pinna GD. An elderly-centered, personalized, physiotherapy program early after cardiac surgery. Eur J Cardiovasc Prev Rehabil 2010;17:582-587. PUBMED | CROSSREF

34. Busch JC, Lillou D, Wittig G, Bartsch P, Willemsen D, Oldridge N, et al. Resistance and balance training improves functional capacity in very old participants attending cardiac rehabilitation after coronary bypass surgery. J Am Geriatr Soc 2012;60:2270-2276. PUBMED | CROSSREF

35. Eichler S, Salzwedel A, Reibis R, Nothroff J, Harnath A, Schikora M, et al. Multicomponent cardiac rehabilitation in patients after transcatheter aortic valve implantation: predictors of functional and psychocognitive recovery. Eur J Prev Cardiol 2017;24:257-264. PUBMED | CROSSREF

36. Reeves GR, Whellan DJ, O'Connor CM, Duncan P, Eggebeen JD, Morgan TM, et al. A novel rehabilitation intervention for older patients with acute decompensated heart failure: the REHAB-HF pilot study. JACC Heart Fail 2017;5:359-366. PUBMED | CROSSREF

37. Lutz AH, Delligatti A, Allsup K, Afilalo J, Forman DE. Cardiac rehabilitation is associated with improved physical function in frail older adults with cardiovascular disease. J Cardiopulm Rehabil Prev 2020;40:310-318. PUBMED | CROSSREF

38. Kitzman DW, Whellan DJ, Duncan P, Pastva AM, Mentz RJ, Reeves GR, et al. Physical rehabilitation for older patients hospitalized for heart failure. N Engl J Med 2021;385:203-216. PUBMED | CROSSREF

39. Lee DC, Brellenthin AG, Lanningham-Foster LM, Kohut ML, Li Y. Aerobic, resistance, or combined exercise training and cardiovascular risk profile in overweight or obese adults: the CardioRACE trial. Eur Heart J 2024;45:1127-1142. PUBMED | CROSSREF

40. Jones TW, Howatson G, Russell M, French DN. Performance and neuromuscular adaptations following differing ratios of concurrent strength and endurance training. J Strength Cond Res 2013;27:3342-3351. PUBMED | CROSSREF

41. Fisher G, McCarthy JP, Zuckerman PA, Bryan DR, Bickel CS, Hunter GR. Frequency of combined resistance and aerobic training in older women. J Strength Cond Res 2013;27:1868-1876. PUBMED | CROSSREF

42. Olsen SJ, Schirmer H, Bønaa KH, Hanssen TA. Cardiac rehabilitation after percutaneous coronary intervention: Results from a nationwide survey. Eur J Cardiovasc Nurs 2018;17:273-279. PUBMED | CROSSREF

43. Song IS, Park YS, Jang SY, Nam JM, Lee CJ, Park EC. Impact of cardiac rehabilitation on cardiovascular event in Korea. Sci Rep 2023;13:19146. PUBMED | CROSSREF

44. Neubeck L, Freedman SB, Clark AM, Briffa T, Bauman A, Redfern J. Participating in cardiac rehabilitation: a systematic review and meta-synthesis of qualitative data. Eur J Prev Cardiol 2012;19:494-503. PUBMED | CROSSREF

45. Talar K, Hernández-Belmonte A, Vetrovsky T, Steffl M, Kałamacka E, Courel-Ibáñez J. Benefits of resistance training in early and late stages of frailty and sarcopenia: a systematic review and meta-analysis of randomized controlled studies. J Clin Med 2021;10:1630. PUBMED | CROSSREF

46. Rønnestad BR, Hansen EA, Raastad T. High volume of endurance training impairs adaptations to 12 weeks of strength training in well-trained endurance athletes. Eur J Appl Physiol 2012;112:1457-1466. PUBMED | CROSSREF

47. Lauersen JB, Andersen TE, Andersen LB. Strength training as superior, dose-dependent and safe prevention of acute and overuse sports injuries: a systematic review, qualitative analysis and meta-analysis. Br J Sports Med 2018;52:1557-1563. PUBMED | CROSSREF

48. Morcillo-Losa JA, Díaz-Martínez MDP, Ceylan HI, Moreno-Vecino B, Bragazzi NL, Párraga Montilla J. Effects of high-intensity interval training on muscle strength for the prevention and treatment of sarcopenia in older adults: a systematic review of the literature. J Clin Med 2024;13:1299. PUBMED | CROSSREF

49. Baltasar-Fernandez I, Alcazar J, Martín-Braojos S, Ara I, Alegre LM, García-García FJ, et al. Power-oriented resistance training combined with high-intensity interval training in pre-frail and frail older people: comparison between traditional and cluster training set configurations on the force-velocity relationship, physical function and frailty. Eur J Appl Physiol 2024;124:623-632. PUBMED | CROSSREF

50. Chuang IC, Chiau HY, Liao WW, Wu YR, Chang CH, Wu CY. Effects of computer-based cognitive training combined with physical training for older adults with cognitive impairment: a four-arm randomized controlled trial. Digit Health 2023;9:20552076231203633. PUBMED | CROSSREF

51. Gavelin HM, Dong C, Minkov R, Bahar-Fuchs A, Ellis KA, Lautenschlager NT, et al. Combined physical and cognitive training for older adults with and without cognitive impairment: a systematic review and network meta-analysis of randomized controlled trials. Ageing Res Rev 2021;66:101232. PUBMED | CROSSREF

52. Wang RS, Maron BA, Loscalzo J. Multiomics network medicine approaches to precision medicine and therapeutics in cardiovascular diseases. Arterioscler Thromb Vasc Biol 2023;43:493-503. PUBMED | CROSSREF

53. Ross R, Goodpaster BH, Koch LG, Sarzynski MA, Kohrt WM, Johannsen NM, et al. Precision exercise medicine: understanding exercise response variability. Br J Sports Med 2019;53:1141-1153. PUBMED | CROSSREF

54. McDonagh ST, Dalal H, Moore S, Clark CE, Dean SG, Jolly K, et al. Home-based versus centre-based cardiac rehabilitation. Cochrane Database Syst Rev 2023;10:CD007130. PUBMED | CROSSREF

55. Huang K, Liu W, He D, Huang B, Xiao D, Peng Y, et al. Telehealth interventions versus center-based cardiac rehabilitation of coronary artery disease: a systematic review and meta-analysis. Eur J Prev Cardiol 2015;22:959-971. PUBMED | CROSSREF

56. Chen C, Ding S, Wang J. Digital health for aging populations. Nat Med 2023;29:1623-1630. PUBMED | CROSSREF

57. Galloway M, Marsden DL, Callister R, Nilsson M, Erickson KI, English C. The feasibility of a telehealth exercise program aimed at increasing cardiorespiratory fitness for people after stroke. Int J Telerehabil 2019;11:9-28. PUBMED | CROSSREF

58. Alolayan RA, Aldisi DA, Hussain DS, Alafif N, Abulmeaty MMA. The efficacy of telehealth versus in-person management delivery in adult patients with obesity. Healthcare (Basel) 2024;12:2190. PUBMED | CROSSREF

59. Elmas Ö, Cemali M, Livanelioğlu A. Comparison of the effects of video conference and video-based home exercise on physical performance and body composition in older adult individuals. Medicine (Baltimore) 2024;103:e40329. PUBMED | CROSSREF

60. Lee K, Shamunee J, Lindenfeld L, Ross E, Hageman L, Sedrak MS, et al. Feasibility of implementing a supervised telehealth exercise intervention in frail survivors of hematopoietic cell transplantation: a pilot randomized trial. BMC Cancer 2023;23:390. PUBMED | CROSSREF

61. Goldfarb MJ, Bechtel C, Capers Q 4th, de Velasco A, Dodson JA, Jackson JL, et al. Engaging families in adult cardiovascular care: a scientific statement from the American Heart Association. J Am Heart Assoc 2022;11:e025859. PUBMED | CROSSREF

62. Goldfarb M, Bibas L, Burns K. Patient and family engagement in care in the cardiac intensive care unit. Can J Cardiol 2020;36:1032-1040. PUBMED | CROSSREF

63. Haimi M, Goren U, Grossman Z. Barriers and challenges to telemedicine usage among the elderly population in Israel in light of the COVID-19 era: a qualitative study. Digit Health 2024;10:20552076241240235. PUBMED | CROSSREF

64. Kyaw MY, Aung MN, Koyanagi Y, Moolphate S, Aung TNN, Ma HKC, et al. Sociodigital determinants of eHealth literacy and related impact on health outcomes and eHealth use in Korean older adults: community-based cross-sectional survey. JMIR Aging 2024;7:e56061. PUBMED | CROSSREF

65. Li S, Cui G, Zhang X, Zhang S, Yin Y. Associations between digital skill, ehealth literacy, and frailty among older adults: evidence from China. J Am Med Dir Assoc 2024;25:105275. PUBMED | CROSSREF

66. Wu YH, Lewis M, Rigaud AS. Cognitive function and digital device use in older adults attending a memory clinic. Gerontol Geriatr Med 2019;5:2333721419844886. PUBMED | CROSSREF

67. Guo Y, Hong Z, Cao C, Cao W, Chen R, Yan J, et al. Urban-rural differences in the association of ehealth literacy with medication adherence among older people with frailty and prefrailty: cross-sectional study. JMIR Public Health Surveill 2024;10:e54467. PUBMED | CROSSREF

68. Wong AKC, Bayuo J, Su JJ, Chow KKS, Wong SM, Wong BP, et al. Exploring the experiences of community-dwelling older adults on using wearable monitoring devices with regular support from community health workers, nurses, and social workers: qualitative descriptive study. J Med Internet Res 2024;26:e49403. PUBMED | CROSSREF

69. Chen K, Katranji K, Bailey K, Rains M, Mirzoyan H, Zhang C, et al. Effect of a telehealth navigator program on video visit scheduling and completion in primary care. J Prim Care Community Health 2024;15:21501319231225997. PUBMED | CROSSREF

70. Mechanic OJ, Lee EM, Sheehan HM, Dechen T, O'Donoghue AL, Anderson TS, et al. Evaluation of telehealth visit attendance after implementation of a patient navigator program. JAMA Netw Open 2022;5:e2245615. PUBMED | CROSSREF

71. Jaso-Yim B, Eyllon M, Sah P, Pennine M, Welch G, Schuler K, et al. Evaluation of the impact of a digital care navigator on increasing patient registration with digital mental health interventions in routine care. Internet Interv 2024;38:100777. PUBMED | CROSSREF

72. Shen N, Jankowicz D, Strudwick G. Patient and family engagement approaches for digital health initiatives: protocol for a case study. JMIR Res Protoc 2021;10:e24274. PUBMED | CROSSREF

73. Tse MMY, Chan AWY, Wu TCM, Tsang WWN, Tse PPS. Assessing the fidelity of the "photo-with-movement program" (PMP) for community-dwelling older adults with pain: a randomized controlled trial. Geriatr Nurs. Forthcoming 2024. PUBMED | CROSSREF

74. Aweidah H, Safadi K, Jotkowitz A, Chowers I, Levy J. Hybrid telehealth medical retina clinic due to provider exposure and quarantine during COVID-19 pandemic. Clin Ophthalmol 2020;14:3421-3426. PUBMED | CROSSREF

75. Catenacci V, Couturier J. Experiences of a virtual day program for adolescents with eating disorders: a qualitative analysis of benefits and barriers. J Eat Disord 2023;11:133. PUBMED | CROSSREF

76. Johnson T, Isakazde N, Mathews L, Gao Y, MacFarlane Z, Spaulding EM, et al. Building a hybrid virtual cardiac rehabilitation program to promote health equity: Lessons learned. Cardiovasc Digit Health J 2022;3:158-160. PUBMED | CROSSREF

77. Owen RR, Woodward EN, Drummond KL, Deen TL, Oliver KA, Petersen NJ, et al. Using implementation facilitation to implement primary care mental health integration via clinical video telehealth in rural clinics: protocol for a hybrid type 2 cluster randomized stepped-wedge design. Implement Sci 2019;14:33. PUBMED | CROSSREF