Review

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Adherence to Exercise and Functional Rehabilitation Programs in Patients with Cardiovascular Diseases: Barriers and Strategies

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Abstract

Adherence to exercise and rehabilitation programs is crucial for effectively managing and preventing cardiovascular disease (CVD). While cardiac rehabilitation (CR) offers clear benefits, patient engagement can be suboptimal, with noticeable gender gaps affecting program success and outcomes. This review examines adherence patterns to exercise and rehab in individuals with CVD, focusing on gender differences, barriers to participation, and potential improvement strategies. we integrate diverse findings into a practical, gender-aware model for CR delivery that can be adopted and evaluated across settings.Optimal adherence to CR programs leads to a 27% decrease in all-cause mortality, a 31% reduction in cardiac-related deaths, lower rates of rehospitalization, and improvements in functional capacity and quality of life. On the other hand, non-adherence is associated with decreased functional abilities, higher risk of re-injury, and poorer long-term outcomes. Women, in particular, may benefit significantly from participation in CR but are often undertreated or underrepresented. Consistent adherence to exercise and CR poses a significant challenge in cardiovascular care, with evident gender disparities necessitating tailored solutions. Women face various barriers, biological, psychological and social, that require gender-specific approaches to rehab program design and delivery. Promising strategies include technology-enabled interventions, home-based programs, multidisciplinary team care, and a family-centered model that considers individual patient needs. Moving forward, efforts should focus on program delivery and ongoing support systems to maximize adherence and fully realize the benefits of CR for all patients.

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1. Define Adherence and Its Importance

Adherence to exercise and rehabilitation programs reflects how well patients follow prescribed exercise plans, attend scheduled sessions, and sustain recommended activity levels throughout the program. This level of engagement is crucial for achieving the expected health benefits after cardiac events like heart attacks or heart failure. In academic literature, adherence in cardiovascular rehabilitation (CR) is typically defined as participating in at least 80% of the recommended training sessions, a standard often used to evaluate outcomes [1]. The 80% threshold is a widely adopted benchmark for deeming exercise interventions adherent across various studies. Adherence can also be described as the alignment between a patient's actions and the agreed-upon exercise regimen, which can be influenced by psychological and sociocultural factors. It includes not only frequency but also adherence to prescribed intensity and the overarching goals of the CR program [1].

Adhering to exercise and CR regimens is essential for improving patient outcomes and supporting ongoing, active lifestyles after cardiac events. Understanding the various factors that influence engagement, such as personalized treatment plans and strong psychological support, is critical to maximizing the effectiveness of CR programs [1].

Unfortunately, evidence shows that adherence to CR programs is often limited, with up to half of patients dropping out within the first few months. Major factors for non-adherence include age, the presence of additional health conditions, socioeconomic challenges, and limited awareness of the benefits of CR [2,3].

Increased exercise participation is associated with improved clinical outcomes across multiple domains. In CR, higher adherence enhances exercise capacity, reduces angina symptoms, and leads to overall better clinical results and quality of life [4]. Conversely, nonadherence is linked to reduced functional ability, weaker strength, limited range of motion, and a higher risk of re-injury [3].

2. Importance of Adherence in CVD Patients

Adhering to exercise and CR regimens leads to significant health benefits, such as decreased rates of death and hospitalizations. Engaging in CR has been linked to a 27% decrease in all-cause mortality and a 31% reduction in cardiac mortality, as well as a reduced risk of rehospitalization [3,5,6], improved quality of life (Regular exercise during CR improves patients' functional capacity, mood, and overall wellbeing, leading to a better quality of life [6], and enhanced cardiac function (Adherence to structured exercise programs leads to improved cardiac functioning and exercise tolerance). CR programs have been proven to reduce mortality rates and the risk of rehospitalization, while regular exercise boosts functional capacity, mood, and overall well-being [7].

Among older patients (median age, 80 years) with myocardial infarction and impaired physical performance, multidomain rehabilitation (risk-factor management, nutritional counseling, and exercise) reduced the 1-year composite of cardiovascular death or unplanned hospitalization for cardiovascular causes compared with usual care (HR, 0.57; 95% CI, 0.36-0.89,8].

Sustained engagement with therapeutic programs is essential for the success of secondary prevention in cardiovascular disease. Overcoming participation barriers through comprehensive, personalized care approaches can boost patient involvement and lead to better health outcomes. Continuous support throughout the CR journey is vital to maintain adherence and ultimately improve the quality of life and prognosis for these individuals [7].

Mortality and morbidity reductions are key advantages of adhering to exercise rehabilitation. CR programs, especially those that include structured exercise, consistently lower overall mortality and reduce the recurrence of cardiovascular events. Research shows that regular exercise can cut cardiovascular mortality by up to 31% [9].

Engaging in exercise improves functional capacity and quality of life. CR offers two main benefits: increased physical fitness and overall well-being. Evidence suggests a positive relationship between program adherence and physical capacity, which helps individuals return to daily activities and achieve greater independence [9].

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Psychological benefits are another major advantage. Regular physical activity yields measurable improvements in mental health, notably reducing anxiety and depression. This reduction in psychological distress strengthens commitment to exercise, creating a reinforcing cycle that supports long-term adoption of healthy lifestyle habits [10].

Decreased hospital readmissions are another important outcome of adherence. CR programs play a critical role in recovery after a cardiac event, with data showing that adherent patients experience fewer subsequent hospital admissions compared to non-adherent individuals. This underscores the importance of sustained engagement in CR for improved long-term health outcomes [9].

3. Prevalence of Adherence to Exercise/Rehabilitation Programs According to Sex in CVD Patients

Men generally exhibit higher adherence to CR [11] programs than women. A meta-analysis reported that CR adherence rates range from approximately 36.7% to 84.6%, with an average of around 66.5%. After a myocardial infarction, women's participation rates are approximately 36% lower than men's, and women demonstrate significantly lower completion rates in CR programs [12].

Women are often under-referred to CR. One study found that women were about 12% less likely to be referred for CR than men [11]. Across multiple studies, referral and enrollment in CR tend to be significantly lower for women compared with men [13].

Women comprise a minority of CR participants, about 27.3% in meta-analytic analyses. Female patients show lower referral, participation, and completion rates relative to their male counterparts [14]. For example, an 18-year study from Iran reported men making up 73.69% of CR participants [15].

Adherence is influenced by psychosocial factors such as caregiving duties, mental health concerns (depression, anxiety), and broader societal norms. Underrepresentation of women in research also plays a role. The Yentl syndrome describes a pattern where women receive equitable care only when their symptoms resemble those traditionally associated with men [16].

Lower adherence among women is associated with worse health outcomes, including a higher risk of recurrent cardiovascular events compare to men. This highlights the importance of targeted interventions to improved adherence to CR among women [16]. A systematic review revealed that women's participation and completion rates in CR are significantly lower than those of men which can impact overall morbidity and mortality [17].

In conditions like heart failure, women demonstrate significantly lower adherence to exercise programs and encounter more barriers than men. Research suggests that various factors, such as educational disparities and limited access to services, contribute to these discrepancies [13].

Data specific to regions further highlights differences. In Germany, adherence to follow-up initiatives after phase III CR averaged 54%, with gender gaps (55% in men vs. 50% in women,16). On the other hand, a study from Portugal showed higher engagement, with patients completing an average of 14 CR sessions, which is equivalent to 92% of the planned sessions [12].

The studies showed that in training frequency, men attended significantly more sessions per week than women ($p<0.05$,16). Moreover, men were more likely than women to complete the training program. The study revealed that women represented only 17.8% of CR program participants despite accounting for 31% of acute coronary syndrome events [18]. Also, female individuals are underrepresented in CR programs with lower referral rates, participation, and completion compared to males [19].

In stroke rehabilitation, completion rates were nearly equal between sexes (women 74.5% vs men 75.4%; $p = 0.7$) and there was no significant difference in attendance to pre-scheduled sessions ($p = 0.6$). The only notable sex difference occurred in patients younger than 41 years, with 59% of women completing vs 85% of men ($p = 0.02$,10).

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Among 59,807 eligible post-PCI patients, 38,246 (63.9%) participated in CR, 28,263 (73.9%) initiated the program, and 22,173 (78.5%) completed it [20]. This yields a completion rate of 78.5% among those who started.

Home-based CR shows promising adherence, with a 6-week program achieving an 81.3% completion rate (13 of 16 participants) and an 83.1% adherence to the exercise protocol [21]. Network meta-analyses suggest home-based CR, especially when combined with mobile health interventions, achieves the highest adherence (83.8%). Hospital-based CR with mobile health follows closely at 79.9% [25].

In a phase III community-based CR program, attendance decreased significantly from 73.38% ± 18.09%at three months to 68.14% ± 17.15% at the six-month interval ($p<0.001$,21). Among participants who completed 12 months, attendance further declined to 66.8% ± 18.34% at the one-year follow-up [22].

At one year, adherence varied across behaviors:

-98% maintained acceptable adherence to the Mediterranean diet

-83% showed good adherence to physical exercise

-79% of smokers achieved smoking cessation

On average, 68% of patients achieved good adherence across all three lifestyle components [23].

The largest dropout occurs between program eligibility and initiation. Approximately 36% of eligible patients never engage with CR, and another 26% who do engage fail to initiate. Once the program starts, completion rates are relatively strong at 78.5% [20].

Several factors are associated with higher dropout, including Eastern European nationality, a sedentary lifestyle, and participation in home-based programs (which correlated with lower adherence), [23]. Younger age and being employed in a "blue-collar" occupation showed a tendency toward poorer adherence, though these associations were not statistically significant [23].

4. Biological Factors

4.1. Hormonal Influences

Sex differences and hormonal influences play a role in the complex patterns of adherence to CR programs [24,27]. These patterns are influenced by biological factors such as sex hormones, psychological variations in motivation and barriers, and social factors like gender roles and expectations. Understanding these various influences is crucial for developing more inclusive and effective CR programs.

Estrogen has multiple protective effects on skeletal muscle through three main pathways:

1. Acting as an antioxidant to limit oxidative damage.
2. Serving as a membrane stabilizer by intercalating into membrane phospholipids.
3. Binding to estrogen receptors to regulate downstream genes and molecular targets.

In addition, estrogen stimulates muscle repair and regenerative processes, including the activation and proliferation of satellite cells [24,25,27,28].

Testosterone replacement at physiological doses has shown promise as a potential therapy to counteract anabolic deficiency in heart failure patients, with studies indicating improvements in functional capacity and muscle performance. The hormone's effects extend beyond muscle function to influence pathophysiological mechanisms that sustain heart failure progression [26,29].

A systematic review of 88 studies examining physiological responses to CR found that men and women respond similarly to most physiological variables, but men show greater benefits in maximal oxygen consumption, functional capacity, six-minute walk distance, and grip strength [24]. However, women may benefit as much as men, if not more, in terms of mortality reduction [24].

Analyses of CR patients revealed significant sex differences in training responses. Women had lower baseline aerobic capacity across all diagnoses and showed less improvement in directly measured peak oxygen uptake (13% vs 17% improvement) ,[27].Recognizing sex differences in CR responses should inform program design to optimize adherence and outcomes for both sexes.

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Women-focused CR programs may address specific barriers and preferences, although current evidence shows mixed results compared with traditional mixed-sex programs [28].

4.2. Physiological Differences

The physiological differences between men and women, especially in muscle mass, bone density and aerobic capacity, have important consequences for how well patients with cardiovascular diseases (CVD) adhere to exercise and CR programs [25,29,30,32].

Sex-based differences in body composition influence the results of calorie restriction. Men typically have greater muscle mass and strength than women, largely due to hormonal factors such as testosterone [31,33]. These differences may contribute to better performance in strength-related tasks and could be a key driver of why men often show larger gains in exercise capacity [27,30].

Evidence suggests that women can achieve similar relative improvements in strength as men when engaged in strength training, but they generally experience less muscle hypertrophy [32,34]. This discrepancy can affect performance in resistance training and may influence adherence, as observable gains tend to be more evident in men, which could impact motivation for women.

Sex differences in body composition significantly influence CR outcomes. Men typically have greater baseline muscle mass and bone density, which may contribute to their superior performance in strength-related measures [31,33]. These differences in lean muscle mass appear to be major determinants of sex-based variations in exercise capacity improvements [27,30].

Women face a higher risk of osteoporosis, especially after menopause, due to reduced estrogen levels that negatively impact bone health [33,40]. This underscores the importance of including weight-bearing exercises in women's rehabilitation programs to maintain bone density. Postmenopausal women may experience exercise-related muscle damage. Clinicians should monitor symptoms, consider gradual progression, incorporate resistance training, and implement recovery strategies to reduce risks [24,27].

On average, women have a lower maximal oxygen uptake (VO2 max) compared to men, partly due to smaller heart size and lower hemoglobin levels that affect oxygen transport [34,37]. However, both genders can experience similar relative improvements in VO2 max through aerobic training [31,33]. These differences in aerobic capacity suggest that CR programs should be customized for each gender to enhance effectiveness and safety.

Despite women's participation, completion rates often fall behind those of men [19]. In a retrospective study involving 1,395 patients, men completed a similar number of training weeks but attended more sessions per week and achieved greater improvements in exercise capacity (peak VO2 and peak power) compared to women [35].

The literature frequently fails to distinguish between sex (biological factors) and gender (sociocultural factors), which can complicate the interpretation of results. A clearer delineation of these dimensions is crucial for understanding and addressing adherence and outcomes [19].

5. Physiological Factors

5.1. Sociodemographic Factors:

Sociodemographic factors have a significant impact on patients' adherence to CR programs. Married individuals demonstrate a statistically higher completion rate for phase 2 rehabilitation ($p=0.031$). Patients with a high school education or less are more likely to adhere to phase 2 sessions ($p=0.014$) and are more inclined to participate in CR centers. Retired or unemployed patients are more likely to complete phase 2 rehabilitation compared to those who are employed ($p=0.06$). Further research is necessary to understand the influence of gender on adherence. These findings highlight the importance of considering sociodemographic characteristics when creating strategies to improve engagement and outcomes in CR [36].

Social support patterns between genders. Women often face challenges balancing caregiving responsibilities that can impact their participation in CR programs [37,44]. Higher perceived social

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support is linked to improved self-care adherence, with women potentially benefiting more from social support interventions [16].

Gender-related factors play a role in healthcare interactions and treatment adherence. Higher education and clear communication between physicians and patient are linked to better adherence, potentially influenced by sociocultural contexts [16].

The long-term benefits of CR, such as reduced mortality and lower recurrence of cardiovascular events, tend to be more favorable for men. Women often experience less positive outcomes following events like acute coronary syndrome, with higher mortality rates reported despite lower event rates before treatment [11].

Despite lower participation rates, women may still experience equal or greater mortality benefits from CR [34], although they typically achieve lower metabolic equivalent (MET) scores compared to men after completing rehabilitation [27]. Figure 1 shows the important factors in cardiac rehabilitation.

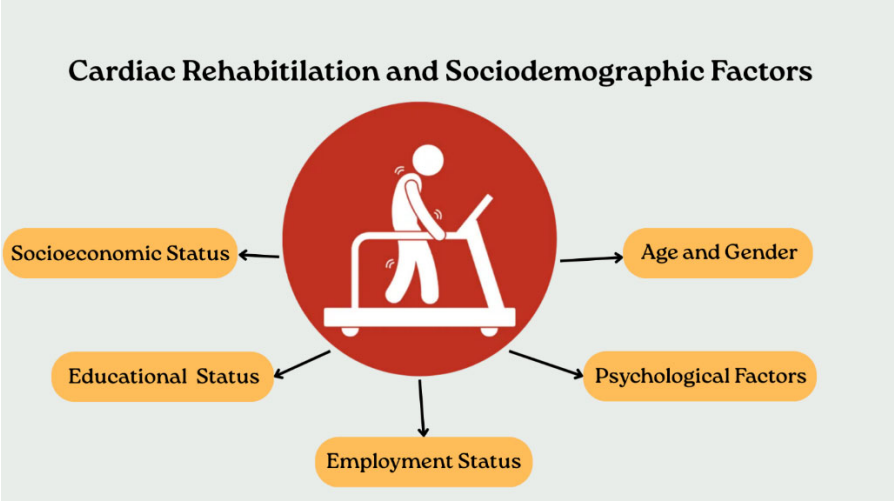

Figure 1. The Importance of Sociodemographic Factors in Cardiac Rehabilitation.

5.2. Role of Social and Family Support

The role of social and family support in adherence to exercise and CR programs for patients with cardiovascular disease (CVD) has gained prominence in recent studies. While this support often promotes healthier lifestyles and better health outcomes, findings in the available literature show both positive and, in one sample, negative associations. These divergent results likely reflect differences in measurement methods, cultural contexts and potential confounders. A mixed-methods behavioral model demonstrated that perceived social support directly improves exercise adherence, with this effect further augmented through higher exercise self-efficacy and reduced fear of exercise [38].

Across multiple studies, clear positive associations have been found between levels of social support and adherence to self-care behaviors among people with CVD. Social support can be categorized into emotional, instrumental and informational types, all of which significantly influence patients' motivation to engage in health-promoting behaviors, including exercise and CR [38]. Emotional support, such as encouragement and expressions of care, appears to be particularly impactful in reducing feeling of isolation and depression that often accompany CVD [39].

Women often face unique obstacles when it comes to participating in CR, highlighting the potential benefits of having a family-focused support system in place. Participation rates in traditional CR programs are typically lower for women compared to men, underscoring the importance of creating programs that cater to their specific needs and incorporate family support [33].

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Research emphasizes the significant role that family plays in CVD rehabilitation. Families can act as a valuable source of support and encouragement, but they can also contribute to emotional stress. Positive family relationships, characterized by encouragement and active participation in health-related activities, have been shown to improve adherence to CR programs, while negative dynamics can impede recovery [40].

Family members understanding and actively encouraging healthy behaviors can reshape patients' motivation over time. Shared family experiences in physical activity often correlate with better adherence to CR after a myocardial infarction (MI),[33].

Interviews with patients and their families indicate that adjusting to a new post-MI life frequently requires family backing, which can be crucial in shaping patients' commitment to physical activity [33]. Families that recognize the importance of exercise provide instrumental support, reinforcing patients' confidence and willingness to follow exercise regimens [7].

6. Barriers to Adherence and Non-Adherence as a Major Challenge

Cardiovascular rehabilitation [9] programs are essential for the secondary prevention and management of cardiovascular disease (CVD). However, non-adherence to these programs, particularly to exercise-based components, undermines their effectiveness [9,41]. Many people discontinue activity early, and gender differences in participation rates persist. Non-adherence emerges as a central component of this challenge, amplifying negative clinical consequences such as mortality, morbidity, hospital exacerbations, and a deterioration in quality of life. Addressing the combined biological, psychological and social influences is crucial to improve CR outcomes for both sexes [19,42,43].

6.1. Knowledge and Awareness Barriers

A significant barrier is the lack of knowledge regarding its benefits and processes. Many patients are not adequately informed about their condition and do not understand how participating in CR exercises can improve their cardiovascular health and overall well-being. This limited understanding of the importance of CR has been linked to lower participation rates [33] and reluctance to engage with CR programs.

6.2. Fear and Anxiety

Patients with CVD often experience fear related to physical activity, especially concerns about potential cardiovascular risks and exacerbating their condition. Fears of re-injury or additional heart complications greatly affect their willingness to participate in exercise sessions. Physical limitations caused by chronic illness can heighten fear of injury or worsening of the disease, leading to kinesiophobia that impedes engagement in more intense CR activities [37,44].

6.3. Physical Limitations and Health Status

Many patients mention physical limitations, such as activity intolerance due to their health conditions. Chronic fatigue, mobility issues, and other comorbid conditions can make participating in physical activities challenging. Patients may feel unable to keep up with the demands of the CR program due to low energy levels or physical limitations18.Cultural norms, gender roles, and group-specific beliefs shape how individuals with cardiovascular disease perceive exercise. These attitudes impact their willingness to participate in CR and sustain physical activity. Various cross-cultural and population-specific studies have identified common themes, including role expectations for women, body-image norms, safety and access to facilities and limited awareness of CR [45].

6.4. Logistical Challenges

Barriers related to logistics include transportation issues, scheduling conflicts, and the distance to CR facilities. Many patients struggle with travel arrangements, especially those living in rural areas

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where such amenities may be distant and hard to access. Additionally, limited availability of sessions during convenient times (such as after working hours) dissuades participation. Accessibility to CR facilities is often limited by geographical distance, inadequate transportation, and other socio-environmental factors. These barriers can make it difficult for patients to attend sessions regularly [41].

6.5. Cost and Insurance Issues

Financial constraints are common, especially for low- and fixed-income patients who may be hesitant to pay out-of-pocket expenses for CR sessions that are not fully covered by insurance. The burden of co-pays and deductibles makes CR less accessible for many individuals, leading to reduced participation rates. Additionally, costs associated with transportation, equipment, or even the CR sessions themselves can discourage participation. Some evidence suggests that patients with Medicaid insurance have a particularly low CR participation rate [46].

6.6. Self-Efficacy and Psychological Factors

Self-efficacy, which is the belief in one's ability to perform behaviors necessary to achieve specific goals, plays a vital role. Patients with low self-efficacy regarding their exercise abilities may be less likely to engage in or continue with CR programs. This is often exacerbated by psychological distress or previous negative exercise experiences. On the other hand, work-related demands and time constraints are commonly cited as obstacles to exercise and CR. Some studies indicate that these barriers are more pronounced for men in certain environments, but they also impact women who are working. The strength of these gendered trends varies depending on the location, employment rates, and societal roles. In a study conducted in Iran, men reported work responsibilities and time constraints as greater barriers to CR compared to women, which aligns with the higher rate of male employment in that population [47].

6.7. Support Systems

Family and social support have been identified as both facilitators and barriers. Supportive family members can boost adherence by encouraging participation, while a lack of support or negative comments can hinder patient motivation and confidence. Peer support within CR programs is helpful, but not all patients have access to a network that promotes their participation [48].

Qualitative studies and surveys, consistently highlight caregiving and family responsibilities as significant obstacles to exercise and CR participation particularly for women. International research consistently demonstrates that family obligations decrease attendance, enrollment, and interfere with the time and energy required for recommended exercise [49].

In settings where women are expected to prioritize household roles and family harmony, illness can threaten their identity, leading women to deprioritize self-care activities such as exercise [48]. Caregiving creates role conflict that undermines exercise and participation in CR [49]. Among women enrolled in CR, family responsibilities were explicitly identified as one of the top barriers to session adherence, alongside distance and transportation, in a large multi-country assessment [50]. Mixed-methods data indicate that women with caregiving roles are statistically less likely to engage in physical activity programs, with family responsibilities reported by large proportions of participants [45].In some cultural groups (e.g., South Asian Punjabis), women more frequently reported a lack of time due to combined work and family duties, highlighting the dual demands faced by employed women [51].

7. Strategies to Improve Adherence

7.1. Personalized Interventions

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Tailoring the CR program to meet individual patient needs has been shown to significantly improve adherence. Conversely, understanding the barriers and motivational factors can assist in customizing CR programs to better suit individuals. This can include personalized communication strategies, such as sending motivational text messages to reinforce participation. Platforms like Well-Beat utilize psychological models to assist patients in coping with stress and staying engaged with the CR process. Personalizing exercise prescriptions to each patient's abilities and health status can improve engagement and adherence [51].

Motivation to stick to adhere and CR can be categorized into two main groups: beliefs and group cohesion, with a focus on support networks as well. Patients' beliefs regarding the effectiveness and significance of CR are crucial for their participation. A strong belief in the health benefits of CR can enhance dedication to the program, as demonstrated in qualitative studies where participants emphasized the perceived importance of CR for their recovery [51].

7.2. Multidisciplinary Approach

Effective CR relies on a team of health professionals, including cardiologists, dietitians, physical therapists and psychologists, to address the diverse needs of patients and provide comprehensive support. This team collaborates to address various factors affecting patient outcomes, such as medication adherence, dietary changes, and risk factor management [52].

7.3. Education and Counseling

Providing education about the benefits of CR, along with dietary counseling and exercise training, is crucial for patient compliance. Encouraging patients to incorporate physical activity into their daily lives outside of formal CR sessions significantly improves long-term adherence [4]. Structured educational programs can lead to improved knowledge, which is associated with better adherence to lifestyle modifications. Evidence suggests that participation in educational sessions can enhance motivation and understanding of health behaviors. Group based exercise fosters a supportive environment and encourages social interaction among participants. The camaraderie and shared experiences within a group can boost motivation and reduce feelings of isolation, making participants more likely to continue [51]. Many participants report that exercising in a group setting increases motivation and lowers the likelihood of dropping out due to mutual encouragement.

7.4. Addressing Barriers to Participation

Identifying and minimizing barriers to participation, such as transportation issues, scheduling conflicts, and financial constraints, is essential. Solutions may include flexible scheduling, telehealth options, and providing transport support for patients45.Innovative approaches, such as smartphone apps for activity monitoring and reminder prompts, show promise in enhancing engagement and adherence [53].Remote monitoring via wearables tracks activity levels and vital signs, helping clinicians assess engagement and intervene when needed [54].

7.5. Behavioral and Psychological Support

CR is a structured program recommended for individuals recovering from cardiovascular disease (CVD). It combines exercise training, education on lifestyle changes, and psychosocial support to boost physical fitness, reduce cardiovascular risks and improve overall quality of life [55].There is a strong emphasis on both aerobic and resistance training, with benefits observed from combining the two [56].Enhancing psychological support through counseling and behavioral interventions can help patients overcome anxiety and fear associated with physical activity. Programs that include mindfulness training and stress management can improve self-efficacy related to exercise. Addressing psychological factors such as anxiety and depression is crucial. Incorporating behavioral health counseling can help patients manage their emotional well-being and strengthen their adherence to CR programs [56].

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7.6. Social Support

The role of support systems is crucial. Social support from family, friends, and healthcare providers has a significant impact on adherence to CR programs. Research indicates that patients who receive encouragement from their family members or have positive interactions with rehabilitation staff are more likely to adhere to their CR plans [51]. Verbal encouragement and reassurance from rehabilitation staff can empower patients, increasing their confidence to engage in exercise routines [3].

7.7. Monitoring and Feedback

Regular follow-ups and progress tracking can help maintain patient motivation and adherence. The rise of smartphone-based interventions could be transformative for CR. These programs often include remote monitoring, digital education and communication tools that improve adherence by making CR more accessible. They also enable tailored guidance aligned with individual patient needs and preferences, which can boost intrinsic motivation [57].Utilizing technology such as smartphones and wearable devices (e.g., pedometers) for self-monitoring of physical activity can facilitate this process.

7.8. Enhanced Referral Processes

Improving the referral rates to CR programs by healthcare providers ensures that eligible patients receive timely information and resources to participate in CR. Educating providers about the importance of CR can enhance patient referrals and attendance5.Mobile applications and devices, such as smartphones and fitness trackers, have been shown to increase engagement in CR by enabling real-time monitoring and personalized feedback. Studies suggest that patients using mobile health (mHealth) tools during CR attend more sessions, demonstrate better adherence and achieve improved outcomes, such as greater exercise capacity and better weight management [58].

The summary of barriers and strategies is shown in Figure 2.

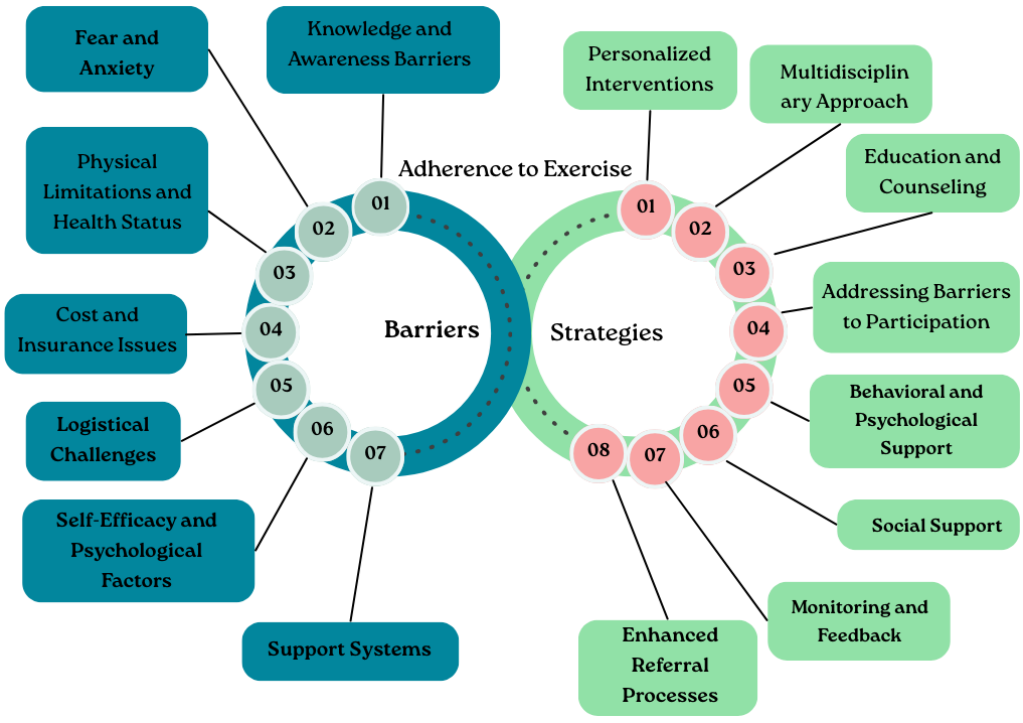

Figure 2. Summarizes the main barriers to adherence and the strategies proposed to overcome them.

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8. Conclusions

Sticking to exercise and CR plans is a crucial factor in effectively managing cardiovascular disease and preventing relapse. Evidence shows that participation in CR can significantly lower mortality rates, by as much as 31%, and improve quality of life. However, persistent low participation, especially among women, continues to hinder the full potential of these programs.

Adherence is a complex issue that goes beyond simply attending sessions; it also involves consistently engaging in exercise routines and lifestyle changes. The commonly accepted benchmark is 80% participation, but many patients struggle to meet this goal, with dropout rates reaching up to 50% in the initial months of a program. This early disengagement highlights the importance of addressing barriers right from the start of CR.

Gender disparities in adherence present significant challenges in modern CR. Women consistently have lower referral, participation and completion rates compared to men, despite potentially benefiting equally or even more from these programs in terms of survival. A combination of biological factors (such as hormonal and physiological differences), psychological obstacles (including higher levels of anxiety and depression) and social barriers (such as caregiving responsibilities) create a unique set of challenges that require targeted interventions.

Barriers to adherence are diverse and interconnected. Physical limitations, lack of knowledge, financial constraints and accessibility issues all hinder participation. Caregiving duties, which disproportionately affect women, often lash with rehabilitation commitments. Cultural norms and expectations related to gender roles further complicate participation highlighting the need for culturally sensitive and tailored rehabilitation approaches for diverse populations.

Nevertheless, evidence also highlights several promising avenues for enhancement. Structuring programs to support autonomy, tailoring exercise prescriptions to individuals, and delivering care through a collaborative, multidisciplinary team can boost patient engagement. Incorporating technological solutions, such as smartphone apps, telemedicine, and remote monitoring, opens new possibilities for improving access and sustaining long-term adherence. These innovations are especially useful for overcoming geographic limitations and offering flexible options that suit a wide range of patient needs and preferences.

Equally important is the role of social and family support. While family dynamics can both help and hinder adherence, the overall data indicate that strong support networks positively influence CR outcomes. This finding emphasizes the value of family-centered strategies that involve the broader support system in the CR process while proactively addressing potential conflicts or competing demands.

Looking ahead, CR must adopt a more personalized and inclusive framework that acknowledges the varied needs and circumstances of all patients. This includes creating gender-responsive interventions that address barriers specific to women, offering flexible delivery models that adapt to different life situations and leveraging technology to enhance the removal of obstacles. It also involves ensuring patients receive comprehensive education about the benefits of CR and ongoing encouragement throughout their recovery.

Ultimately, the goal of maximizing adherence to exercise and CR extends beyond simply tracking participation. It represents a dedication to improving health outcomes, lowering healthcare costs and enhancing the quality of life of individuals with cardiovascular disease. Achieving this goal necessitates continuous collaboration among healthcare systems, providers, patients and their support networks to overcome obstacles and create environments where CR can realize its full potential and revolutionize the management and secondary prevention of cardiovascular disease.

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