# *Beyond the 6-minute walk test: integrating balance and functional mobility into contemporary cardiac rehabilitation*

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**Abstract:**
Cardiac rehabilitation (CR) has traditionally emphasized aerobic capacity, cardiovascular risk-factor modification, and improvements in exercise tolerance. The 6-Minute Walk Test (6MWT) remains one of the most widely used clinical measures for evaluating functional exercise capacity because it is inexpensive, practical, and responsive to rehabilitation. However, walking distance alone cannot fully describe the complex physical limitations experienced by many individuals with cardiovascular disease. Older adults and patients with heart failure, coronary artery disease, recent cardiac surgery, and multiple comorbidities may also experience impaired balance, reduced lower-limb strength, slow gait, difficulty transferring between positions, postural instability, and an increased risk of falls. These limitations can persist even when walking distance improves. Contemporary cardiac rehabilitation therefore requires a broader assessment strategy that combines aerobic capacity with balance, gait, strength, and functional mobility measures. Tools such as the Short Physical Performance Battery (SPPB), Timed Up and Go (TUG), Berg Balance Scale (BBS), gait speed, five-time sit-to-stand test, and functional reach test can identify deficits that are not adequately represented by the 6MWT. Multidomain rehabilitation programmes incorporating progressive resistance exercise, balance training, gait practice, coordination activities, and task-specific functional exercises may improve physical independence and support safer participation in daily activities. Evidence from the REHAB-HF trial and other studies demonstrates the importance of addressing strength, balance, mobility, and endurance together, particularly in older adults with heart failure and frailty. Recent cardiac rehabilitation guidance also recognizes the importance of assessing frailty and fall risk rather than relying exclusively on aerobic exercise outcomes. This review discusses the limitations of the 6MWT as a stand-alone assessment, the physiological and functional basis of balance impairment in cardiovascular disease, practical assessment tools, evidence for multidomain rehabilitation, exercise prescription, clinical applications, safety considerations, and future directions for integrating balance and functional mobility into contemporary cardiac rehabilitation.

**Keywords:**
Cardiac Rehabilitation, 6-Minute Walk Test, Balance Training, Functional Mobility, Gait Speed, Frailty, Fall Prevention, Short Physical Performance Battery, Cardiovascular Disease.

## 1. Introduction:

Cardiovascular diseases remain a major contributor to morbidity, mortality, disability, and reduced quality of life worldwide. Advances in pharmacological treatment, interventional cardiology, cardiac surgery, and secondary prevention have improved survival in many cardiovascular conditions. Nevertheless, a substantial proportion of patients continue to experience reduced physical capacity, muscle weakness, impaired mobility, exercise intolerance, and difficulty performing routine activities. Cardiac rehabilitation (CR) is an established component of comprehensive cardiovascular care and aims to improve functional capacity, reduce cardiovascular risk, support psychological recovery, and promote long-term participation in physical activity. Contemporary CR programmes include individualized exercise training, cardiovascular risk-factor management, nutritional counselling, psychosocial support, medication education, and outcomes assessment (Brown et al., 2024, Brown et al., 2025). The 6-Minute Walk Test (6MWT) has become a commonly used functional assessment because it provides a practical estimate of submaximal walking capacity and can be

performed in many clinical environments. However, walking distance is only one dimension of physical performance. A patient may demonstrate an acceptable 6-minute walking distance but still have difficulty rising from a chair, maintaining balance while turning, walking on uneven surfaces, negotiating stairs, or carrying out activities that require simultaneous movement and attention. These limitations are particularly relevant among older adults, patients with heart failure, individuals recovering from cardiac surgery, and those with frailty or sarcopenia. The growing recognition of these problems has encouraged a shift from conventional exercise-capacity-centred rehabilitation towards multidimensional functional assessment. This approach considers aerobic endurance, lower-limb strength, static and dynamic balance, gait speed, coordination, postural control, and functional independence as complementary rehabilitation outcomes. The importance of this broader perspective is supported by evidence from multidomain rehabilitation studies in older patients with heart failure, where improvements in physical function were achieved by addressing several functional domains rather than focusing exclusively on walking endurance (Kitzman et al., 2021). Contemporary cardiac rehabilitation should therefore move beyond the assumption that improvement in walking distance automatically represents complete functional recovery.

**2. Limitations of the 6-Minute Walk Test as a Stand-Alone Outcome:**

The 6MWT measures the distance an individual can walk over six minutes, usually along a standardized corridor, while following a prescribed testing procedure. It reflects the integrated response of the cardiovascular, respiratory, muscular, neurological, and metabolic systems during submaximal activity. Its clinical usefulness is supported by its simplicity, low equipment requirements, and ability to monitor changes over time. It is particularly useful when maximal exercise testing is unavailable, impractical, or inappropriate. Nevertheless, the test does not isolate the mechanisms responsible for reduced performance. A low walking distance may result from breathlessness, reduced cardiac output, peripheral muscle weakness, fatigue, joint pain, balance impairment, fear of falling, or a combination of these factors. Similarly, an improvement in walking distance does not establish that the patient has recovered adequate postural control, lower-limb power, or the ability to perform complex daily activities. The test also provides limited information about gait quality, turning ability, movement asymmetry, step variability, and the ability to maintain stability during unexpected environmental challenges. A patient who walks a reasonable distance on a flat corridor may still be unable to negotiate stairs safely or walk while carrying an object. Furthermore, the 6MWT may be influenced by corridor length, encouragement, learning effects, footwear, assistive devices, and the patient's understanding of the instructions. It is therefore more appropriately interpreted as one component of a broader functional assessment rather than a complete measure of physical recovery. The 2024 American Heart Association and American Association of Cardiovascular and Pulmonary Rehabilitation scientific statement emphasizes comprehensive patient assessment and recognizes frailty and fall-risk assessment as important considerations in CR practice (Brown et al., 2024). The clinical implication is that 6MWT findings should be interpreted alongside tests that evaluate strength, balance, gait, and functional mobility.

**3. Why Balance and Functional Mobility Matter in Cardiac Rehabilitation:**

Balance and functional mobility influence the ability of patients to participate safely in exercise and independently perform daily activities. Balance refers to the ability to maintain or regain the body's centre of mass within the limits of stability during static and dynamic conditions. Functional mobility describes the ability to move between positions and environments, including standing up, sitting down, walking, turning, reaching, stepping, and negotiating obstacles. These abilities are interdependent but are not identical. A patient may demonstrate adequate static balance while standing still but experience instability during turning or walking. Similarly, an individual may walk independently on a level surface but require assistance when transferring from a low chair. Cardiovascular disease can affect these functions through reduced exercise tolerance, impaired skeletal muscle perfusion, deconditioning, peripheral neuropathy, autonomic dysfunction, medication-related dizziness, and age-associated changes in sensory and neuromuscular systems. Heart failure may be accompanied by skeletal muscle abnormalities, reduced muscle strength, fatigue, and impaired postural control. After cardiac surgery, pain, sternotomy-related movement restrictions, prolonged bed rest, and postoperative weakness can further reduce mobility. These problems may lead to reduced confidence, activity avoidance, social restriction, and increased dependence on caregivers. Balance assessment is therefore not simply a falls-prevention exercise, it is an important component of understanding the patient's ability to translate physiological improvements into meaningful functional independence. A recent review of balance and mobility impairment in older adults with cardiovascular disease highlights the interaction between musculoskeletal, sensory, cognitive-motor, and cardiovascular limitations and supports a more individualized approach to rehabilitation (Greenlane Cardiovascular Service review, 2026).

## 4. Physiological Basis of Balance and Mobility Impairment in Cardiovascular Disease:

Balance is maintained through the continuous integration of visual, vestibular, and somatosensory information with central nervous system processing and coordinated muscular responses. Visual input helps identify the body's position in relation to the environment, vestibular information contributes to head and spatial orientation, and somatosensory receptors provide information about joint position, muscle length, pressure, and movement. The central nervous system integrates these signals to generate appropriate postural responses. Cardiovascular disease can interfere with this process indirectly through reduced cerebral perfusion, impaired exercise tolerance, autonomic dysfunction, peripheral vascular disease, and associated neurological or metabolic conditions. Reduced lower-limb muscle strength is particularly important because the ankle, hip, and stepping strategies used to maintain balance depend on adequate muscular capacity. Older adults with heart failure may experience reduced muscle mass, impaired muscle quality, and diminished oxidative capacity, contributing to fatigue and difficulty performing repeated functional tasks. Orthostatic hypotension and medication-related symptoms may further compromise postural stability, especially during transitions from lying to sitting or sitting to standing. In addition, cognitive impairment and reduced attention may affect the ability to maintain balance while performing another task. These factors demonstrate why a single endurance test cannot adequately describe the physical performance profile of every cardiac rehabilitation patient.

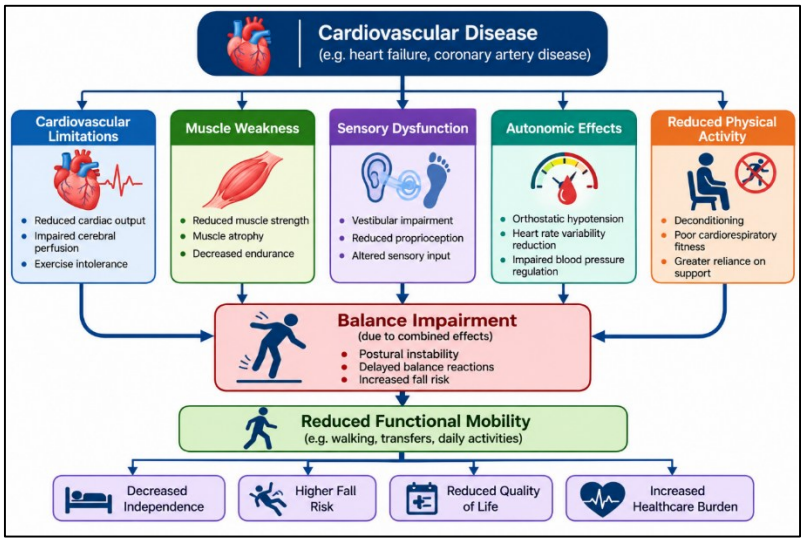



**Figure. 1: Proposed mechanisms contributing to balance impairment and reduced functional mobility in cardiovascular disease, illustrating the interaction between cardiovascular limitations, muscle weakness, sensory dysfunction, autonomic effects, and reduced physical activity**

## 5. The Concept of Multidimensional Functional Assessment:

Multidimensional functional assessment recognizes that physical performance is a combination of several related capacities. Aerobic endurance indicates the ability to sustain activity, muscle strength supports force production, balance maintains postural stability, and functional mobility allows the individual to move safely between positions and environments. Gait speed provides information about walking performance, while repeated chair-rise tasks provide insight into lower-limb strength, power, and movement efficiency. A comprehensive assessment should identify the patient's limitations and determine which factors are most likely to restrict daily activity. For example, a patient with a low 6MWT distance but preserved balance may require progressive endurance training, whereas a patient with a moderate walking distance and poor TUG performance may benefit from additional turning, transfer, and dynamic balance exercises. Patients with reduced gait speed and poor chair-rise performance may require targeted lower-limb strengthening alongside aerobic training. The Short Physical Performance Battery (SPPB) is particularly useful because it combines standing balance, gait speed, and repeated chair stands into a single multidomain assessment. Its inclusion can help clinicians identify deficits that may remain unnoticed when walking distance is the principal outcome. Multidimensional assessment should not replace cardiovascular risk stratification or medically supervised exercise testing, rather, it should complement them by providing a more complete picture of functional capability.

## 6. Clinical Assessment Tools beyond the 6-Minute Walk Test:

A combination of standardized tests can provide a practical and clinically meaningful assessment of balance and functional mobility. Test selection should be based on the patient's clinical condition, age, functional level, safety, available equipment, and the purpose of assessment. The TUG is useful for evaluating transitions, walking, turning, and sitting. The SPPB combines balance, gait speed, and chair-rise performance and is especially relevant to older adults and patients with frailty. The Berg Balance Scale evaluates multiple components of static and dynamic balance, including transfers, reaching, turning, and standing tasks. The five-times sit-to-stand test provides information about lower-limb functional strength and movement efficiency. Gait speed is a simple measure that can be obtained over a short standardized distance, while the Functional Reach Test evaluates the ability to shift the centre of mass forward without taking a step. These tools are complementary rather than interchangeable. A test that identifies impaired turning may not detect reduced endurance, and a test that measures gait speed may not adequately characterize reactive balance. The clinician should therefore select a small but appropriate battery of tests rather than administering every available measure to every patient.

**Table. 1: Clinical assessment tools for evaluating balance and functional mobility in cardiac rehabilitation**

| Assessment tool | Main domain assessed | Clinical information | Practical considerations |
|---|---|---|---|
| 6-Minute Walk Test | Submaximal walking endurance | Walking distance and exercise tolerance | Monitor symptoms, heart rate, and oxygen saturation when indicated |
| Timed Up and Go | Functional mobility | Sit-to-stand, walking, turning, and sitting | Record time and observe movement quality |
| Short Physical Performance Battery | Multidimensional physical performance | Balance, gait speed, and chair-rise ability | Particularly useful in older or frail patients |
| Berg Balance Scale | Static and dynamic balance | Postural control during functional tasks | Requires trained assessment and adequate time |
| Five-Times Sit-to-Stand | Lower-limb functional strength | Repeated transfer ability and movement speed | Use a standardized chair and document arm use |
| Gait speed test | Walking performance | Short-distance walking speed | Record assistive device and testing conditions |
| Functional Reach Test | Limits of stability | Forward reaching ability while standing | Guard patients with instability |
| Four-Stage Balance Test | Static balance | Progression from side-by-side to tandem stance | Stop if the patient cannot safely maintain a position |

**7. The Short Physical Performance Battery in Cardiac Rehabilitation:**

The Short Physical Performance Battery is a standardized assessment designed to evaluate lower-extremity physical performance through three components: standing balance, walking speed, and repeated chair stands. Each component contributes to a combined score, commonly ranging from 0 to 12, with higher scores indicating better performance. The balance component examines the ability to maintain progressively more challenging standing positions. The gait component generally evaluates usual walking speed over a short distance, while the chair-stand component assesses the time required to complete repeated sit-to-stand movements. The SPPB is valuable because it captures several physical capacities that are relevant to independence and mobility. In cardiac rehabilitation, it can help distinguish patients whose main limitation is reduced walking endurance from those who also have impaired balance or lower-limb function. Evidence from the REHAB-HF trial demonstrated the clinical value of multidomain physical rehabilitation in older patients hospitalized with acute decompensated heart failure. The intervention addressed strength, balance, mobility, and endurance, and produced greater improvements in SPPB and other functional outcomes than usual care (Kitzman et al., 2021). This supports the use of multidimensional assessment when planning rehabilitation for patients with substantial functional impairment. The SPPB should nevertheless be interpreted in the context of the patient's diagnosis, symptoms, cognition, and pre-existing mobility limitations. A low score may indicate

the need for targeted rehabilitation, but it does not independently identify the cause of impairment or determine cardiovascular exercise safety.

**8. Timed Up and Go Test: Assessing Integrated Functional Mobility:**

The Timed Up and Go test is a practical measure of functional mobility that incorporates several activities commonly performed in daily life. The patient begins seated in a standard chair, stands on instruction, walks a marked distance, turns, returns to the chair, and sits down. The total time is recorded, but clinical interpretation should also consider movement quality, use of the upper limbs, step symmetry, turning strategy, balance reactions, and signs of breathlessness or dizziness. In cardiac rehabilitation, the TUG may reveal functional difficulties that are not evident during straight-line walking. For example, a patient may walk continuously for several minutes but demonstrate instability while turning or require excessive effort to rise from a chair. The test may also identify patients who need supervision during dynamic exercises. A study examining stability and coordination training in older adults with cardiovascular disease found improvements in TUG and balance-related outcomes when specific balance exercises were added to a conventional CR programme (2019 stability and coordination training study). This suggests that targeted balance interventions can complement traditional cardiovascular exercise.

**9. Berg Balance Scale and Functional Balance Assessment:**

The Berg Balance Scale is a 14-item clinical measure that evaluates the ability to maintain balance during different functional tasks. These tasks include standing unsupported, changing positions, reaching forward, and turning, transferring between chairs, and standing with altered foot positions. Each item is scored according to the patient's ability to complete the task, producing a total score ranging from 0 to 56. The scale is useful for identifying limitations in functional balance, particularly among older patients and individuals recovering from hospitalization or surgery. In cardiac rehabilitation, it can help determine whether patients require additional supervision or balance-specific exercise. However, the BBS may demonstrate ceiling effects in relatively high-functioning individuals and may not fully represent reactive balance during unexpected perturbations. It should therefore be combined with observation of gait, turning, stepping responses, and functional tasks when clinically indicated. A balance score should not be interpreted in isolation as a definitive prediction of falls because falls are influenced by environmental hazards, medication, cognition, vision, previous falls, and exposure to risky activities.

**10. Gait Speed as a Functional and Prognostic Measure:**

Gait speed is a simple and informative indicator of physical performance. It reflects the combined contribution of lower-limb strength, joint mobility, coordination, balance, cardiorespiratory reserve, and motor control. A short-distance gait-speed test can be performed in a corridor using a standardized walking distance, with the time required to complete the measured section converted into metres per second. Usual gait speed is generally more appropriate for routine functional assessment, while fast gait speed may provide additional information about reserve capacity in selected patients. In cardiac rehabilitation, slow gait speed may indicate reduced mobility, frailty, or an increased need for support during daily activities. It can also help clinicians identify patients who may benefit from progressive walking practice, lower-limb strengthening, and balance training. Recent work in older patients with myocardial infarction has highlighted the prognostic relevance of physical performance and gait speed, suggesting that functional assessment can provide information beyond conventional exercise-capacity measures (Physical performance after myocardial infarction study, 2026).

**11. Five-Times Sit-to-Stand Test and Lower-Limb Functional Strength:**

The five-time sit-to-stand test evaluates the ability to rise from and return to a seated position repeatedly. It requires coordinated activity of the quadriceps, gluteal muscles, trunk stabilizers, and postural control systems. The test is particularly relevant to daily activities because standing up from a chair is performed repeatedly throughout the day. Reduced performance may indicate lower-limb weakness, impaired movement efficiency, pain, balance impairment, or reduced exercise tolerance. In cardiac rehabilitation, it can help identify patients who require strengthening before progressing to more demanding functional activities. The test should be standardized by documenting chair height, arm position, footwear, and whether the patient uses the arms for support. Clinicians should also observe movement quality and monitor symptoms rather than focusing exclusively on completion time. Patients with significant dizziness, severe dyspnea, chest discomfort, or unstable cardiovascular symptoms should not be asked to perform repeated chair stands until medically assessed.

**12. Functional Reach and Dynamic Balance Testing:**

The Functional Reach Test evaluates the ability to reach forward while maintaining a stable standing position. It provides a simple estimate of the limits of stability during a controlled movement. The patient stands beside a measuring surface, raises an arm to shoulder height, and reaches forward as far as possible without stepping or losing balance. The difference between the initial and final reach positions is recorded. The test can be useful for identifying restricted forward weight shifting, reduced confidence, or impaired postural control. However, it does not assess all dimensions of balance and may be influenced by shoulder mobility, trunk flexibility, and the patient's understanding of the task. In cardiac rehabilitation, it can be combined with tandem stance, turning, stepping, and gait observation to develop a more complete picture of postural stability.

**13. Integrating Balance and Mobility Assessment Into Routine Cardiac Rehabilitation:**

A practical assessment strategy should be feasible, repeatable, and relevant to clinical decision-making. It is not necessary to administer a large number of tests at every visit. Instead, clinicians can use a staged approach that begins with medical review and safety screening, followed by a brief functional assessment. The 6MWT may remain the principal endurance measure, while the TUG or SPPB provides additional information about mobility and lower-limb function. Patients with a history of falls, impaired transfers, slow gait, or observed instability may undergo more detailed balance assessment using the BBS or other appropriate tools. Assessment should occur at baseline and be repeated at clinically meaningful intervals, such as programme completion or after a defined rehabilitation phase. Reassessment should use the same protocol, equipment, walking distance, chair height, instructions, and assistive devices whenever possible. The results should be interpreted together rather than as isolated numbers. For example, an increase in 6MWT distance accompanied by no improvement in TUG or chair-rise performance may indicate that endurance has improved while functional mobility remains restricted. Conversely, improved chair-rise performance with unchanged walking distance may suggest gains in lower-limb strength without a corresponding improvement in aerobic endurance. This distinction is important when deciding how to modify the exercise programme.

**Table. 2: Suggested multidimensional assessment schedule in a contemporary cardiac rehabilitation programme**

| Rehabilitation stage | Recommended assessment | Purpose |
|---|---|---|
| Initial assessment | Medical history, symptom review, 6MWT or appropriate exercise test, TUG, gait speed | Establish baseline capacity and identify mobility limitations |
| Frailty or fall-risk screening | SPPB, BBS, fall history, chair-rise test | Identify balance, strength, and mobility deficits |
| Early rehabilitation | Repeat selected functional tasks and observe exercise response | Assess tolerance and determine initial supervision requirements |
| Mid-programme review | 6MWT, TUG or SPPB, gait speed, symptom assessment | Evaluate progress and modify exercise prescription |
| Programme completion | Repeat baseline measures | Quantify changes in endurance and functional mobility |
| Long-term follow-up | Functional status, falls, activity level, patient-reported outcomes | Monitor maintenance of independence and participation |

**14. Evidence Supporting Multidomain Rehabilitation:**

The strongest rationale for integrating balance and functional mobility into cardiac rehabilitation comes from studies demonstrating that physical impairment in cardiovascular disease is not limited to reduced aerobic capacity. Older adults with heart failure may have substantial deficits in balance, lower-limb strength, transfers, and walking ability. The REHAB-HF trial evaluated a multidomain rehabilitation intervention in older patients hospitalized with acute decompensated heart failure. The programme incorporated strength, balance, mobility, and endurance training, with individualized progression based on functional status. Participants receiving the intervention demonstrated greater improvement in physical function than those receiving usual care, including meaningful improvements in SPPB and walking distance (Kitzman et al., 2021). The trial is particularly important because it demonstrated that rehabilitation can address several interacting functional deficits rather than treating exercise intolerance as the only relevant problem. However, the results should not be interpreted as evidence that every patient with heart failure requires the same balance-training protocol. The intervention

was individualized, and the study population had substantial functional impairment. The findings support careful assessment and tailored exercise prescription rather than universal application of a fixed programme.

**15. New England Journal of Medicine:**

A randomized exploratory study of stability and coordination training in older adults with cardiovascular disease examined the addition of balance-focused exercises to conventional cardiac rehabilitation. The intervention included approximately 20 minutes of stability and coordination training within the rehabilitation session. Improvements were observed in TUG and balance-related performance compared with conventional rehabilitation alone, although the sample was small and the findings require confirmation in larger studies (2019 stability and coordination training study). A further randomized trial involving older adults with cardiovascular disease evaluated balance exercise assist robot training compared with conventional resistance exercise. Both groups demonstrated improvements in functional outcomes, and the robot-assisted approach was reported to be safe in the study setting (2024 balance exercise assist robot trial). These studies suggest that balance-focused training can be incorporated into cardiac rehabilitation using relatively simple exercises or technology-supported methods. Evidence from postoperative cardiac rehabilitation is also relevant. Patients recovering from coronary artery bypass graft surgery may experience reduced mobility due to pain, weakness, respiratory limitations, and reduced activity during hospitalization. Early mobilization is an established component of postoperative recovery, but patients may also require specific attention to balance and transfer ability. A recent randomized trial investigated the addition of early balance training to Phase I cardiac rehabilitation after coronary artery bypass graft surgery, using measures such as the Berg Balance Scale and five-repetition sit-to-stand test (2025/2026 early balance training trial). This area of research is promising, although clinical protocols must account for postoperative precautions, haemodynamic stability, wound healing, and the patient's ability to tolerate upright activity.

**16. Designing a Multidomain Cardiac Rehabilitation Programme:**

A multidomain programme should combine aerobic exercise, resistance training, balance activities, gait practice, and functional task training. The relative emphasis on each component should be determined by the patient's clinical condition and baseline assessment. Aerobic exercise remains essential for improving cardiorespiratory fitness and supporting cardiovascular risk reduction. Resistance exercise improves muscle strength and supports the performance of transfers, stair climbing, and other activities requiring force production. Balance training addresses postural control and stability, while functional mobility practice translates improvements in strength and coordination into everyday tasks. These components should be integrated rather than delivered as unrelated activities. For example, repeated sit-to-stand exercises can improve lower-limb strength while also practising a meaningful daily movement. Step-ups can combine lower-limb strengthening, dynamic balance, and cardiovascular conditioning when prescribed at an appropriate intensity. Walking with controlled direction changes can address gait, turning, and postural control. A structured programme should begin with simple, supported tasks and progress towards more challenging activities as the patient's functional capacity improves.

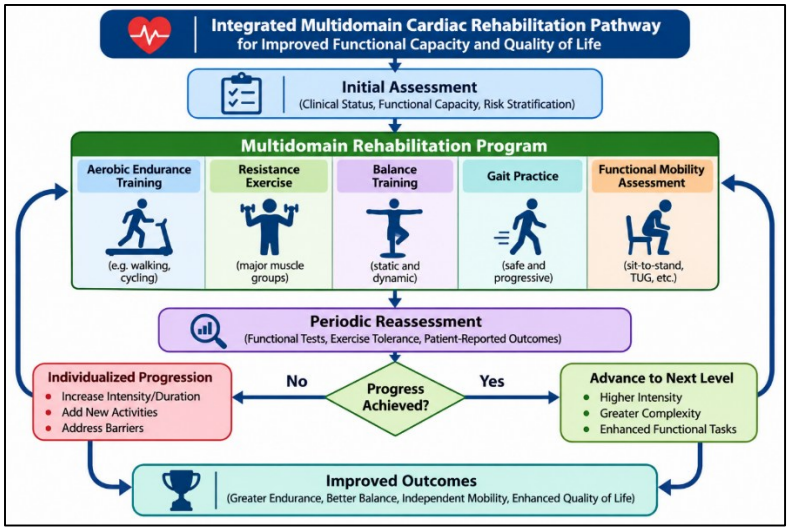



**Figure. 2: Integrated multidomain cardiac rehabilitation pathway combining aerobic endurance, resistance exercise, balance training, gait practice, and functional mobility assessment, with reassessment guiding individualized progression**

**17. Exercise Prescription for Balance and Functional Mobility:**

Exercise prescription should follow the principles of individualization, gradual progression, specificity, and safety. The initial programme should reflect the patient's cardiovascular risk, clinical stability, functional capacity, previous falls, musculoskeletal limitations, and level of independence. Balance exercises may begin with supported standing, weight shifting, controlled reaching, and stepping in different directions. Progression can include narrower bases of support, tandem stance, controlled turning, obstacle negotiation, and dynamic stepping. Resistance exercises should target major muscle groups, particularly the quadriceps, hamstrings, gluteal muscles, calf muscles, and trunk stabilizers. Functional mobility training should include repeated sit-to-stand movements, walking at different speeds, turning, step-ups, and stair practice when appropriate. The intensity of aerobic and resistance exercise should follow established cardiac rehabilitation principles, with monitoring of symptoms, perceived exertion, heart rate, blood pressure, and oxygen saturation when clinically indicated. Balance exercises are not necessarily prescribed using conventional aerobic intensity zones, instead, progression is determined by task difficulty, postural challenge, movement quality, and the amount of support required. The clinician should increase only one or two task demands at a time, avoiding abrupt changes that may compromise safety.

**18. Practical Balance Training Components:**

**18.1. Static balance training:**

Static balance training involves maintaining a stable posture while the base of support remains relatively fixed. Activities may include standing with feet apart, feet together, semi-tandem stance, tandem stance, and single-leg standing when appropriate. Exercises should initially be performed near a stable support surface, with the therapist positioned to provide assistance if required. Progression may involve reducing upper-limb support, increasing the duration of the position, or introducing controlled head movements. Eyes-closed activities should be reserved for carefully selected patients under appropriate supervision because removing visual input increases the balance challenge.

**18.2. Dynamic balance training:**

Dynamic balance training involves maintaining stability while the body or centre of mass moves. Activities may include forward and lateral weight shifting, reaching in different directions, stepping, turning, controlled changes in walking direction, and obstacle negotiation. These exercises are particularly relevant to daily activities because patients frequently need to change direction, avoid obstacles, and adjust their posture while moving. Dynamic balance tasks should be progressed according to movement quality rather than speed alone.

**18.3. Gait and walking adaptability:**

Walking adaptability refers to the ability to modify gait in response to changes in the environment. Rehabilitation may include walking around cones, stepping over low obstacles, changing walking direction, stopping and starting, and negotiating different surfaces. These activities should be introduced only when the patient can walk safely under simpler conditions. Patients with severe balance impairment may initially require parallel bars, a walking aid, or close therapist supervision.

**18.4. Functional transfer training:**

Transfer training includes sit-to-stand, stand-to-sit, bed mobility, and movement between chairs or other surfaces. These tasks are essential for independence and may be particularly challenging in patients with lower-limb weakness or postoperative deconditioning. Exercise progression can include repeated chair rises, changes in chair height, controlled lowering, and reaching activities performed during supported standing. Patients recovering from cardiac surgery should follow their surgical team's instructions regarding upper-limb loading and movement precautions.

**18.5. Dual-task training:**

Dual-task training involves performing a motor activity while simultaneously completing a cognitive or secondary motor task. Examples include walking while responding to simple questions, carrying a light object, or identifying visual targets. The aim is to improve the ability to maintain safe movement when attention is divided. Research in cardiovascular disease has demonstrated that dual-task conditions can influence gait parameters, supporting the need to consider cognitive-motor demands when evaluating mobility (2025 dual-task gait study). However, dual-task training should be introduced cautiously and only after adequate single-task stability has been established.

### 18.6. Exercise Progression and Individualization:

Progression should be based on clinical stability, symptom response, functional performance, and movement quality. A patient who can maintain a supported standing position safely may progress to less support or controlled weight shifting. A patient who performs chair rises with difficulty may begin with a higher chair and progress towards a lower seat as strength improves. Walking tasks can progress from straight-line walking to controlled turning, obstacle negotiation, and changes in speed. Progression should not be based solely on the number of repetitions or duration because movement quality and cardiovascular tolerance are equally important. Patients with heart failure may require more gradual increases because of fatigue, fluctuating symptoms, and reduced exercise reserve. Individuals with a history of falls may need additional supervision and a slower progression of dynamic tasks. Patients with significant neuropathy, visual impairment, vestibular disorders, or cognitive impairment may require modified exercise conditions and specialist input.

**Table. 3: Suggested balance and functional mobility exercise prescription in cardiac rehabilitation**

| Exercise component | Example activities | Initial approach | Progression |
|---|---|---|---|
| Static balance | Feet together, semi-tandem, tandem stance | Supported standing, short holds | Reduce support or increase hold duration |
| Dynamic balance | Weight shifting, reaching, controlled turning | Small controlled movements | Increase reach distance and movement complexity |
| Lower-limb strength | Sit-to-stand, heel raises, knee extension | Low resistance and controlled repetitions | Increase resistance or repetitions gradually |
| Gait training | Straight-line walking, direction changes | Comfortable pace on level surface | Add turns, obstacles, or speed variation |
| Functional mobility | Chair transfers, step-ups, stair practice | Supported task-specific practice | Increase task height or reduce assistance |
| Dual-task activity | Walking with simple cognitive tasks | Only after stable single-task walking | Gradually increase cognitive or motor demand |
| Coordination | Alternating steps, target stepping | Slow, predictable movements | Increase accuracy demands and task variation |

## 19. Clinical Applications across Cardiovascular Conditions:

### 19.1. Heart failure:

Heart failure is frequently associated with exercise intolerance, skeletal muscle abnormalities, fatigue, reduced walking capacity, and frailty. Some patients experience substantial difficulty with transfers and balance even when their cardiovascular condition is medically stable. Multidomain rehabilitation may be particularly valuable in older adults with heart failure because it addresses several physical limitations simultaneously. The REHAB-HF trial provides important evidence for this approach, demonstrating improvements in physical function following an intervention targeting strength, balance, mobility, and endurance (Kitzman et al., 2021). Rehabilitation should be individualized according to heart failure phenotype, symptom burden, volume status, blood pressure, medication response, and exercise tolerance.

### 19.2. Coronary artery disease and myocardial infarction:

Patients recovering from myocardial infarction or living with chronic coronary disease may experience deconditioning, reduced muscle strength, fear of exertion, and reduced physical confidence. Conventional CR remains essential, but assessment of mobility and balance may identify additional barriers to independent activity. Patients who have been inactive for prolonged periods may require gradual strengthening and gait practice before undertaking more challenging functional tasks. The inclusion of balance assessment may be especially useful in older adults and those with previous falls or multiple comorbidities.

### 19.3. Coronary artery bypass graft surgery:

After coronary artery bypass graft surgery, early mobilization is important for restoring functional independence and reducing the consequences of prolonged bed rest. However, postoperative weakness, pain, respiratory impairment, and altered movement patterns may affect transfers and walking stability. Phase I rehabilitation should emphasize medically appropriate mobilization, breathing exercises, circulation, and

gradual functional activity. Balance tasks may be added when the patient is haemodynamically stable and able to tolerate upright activity. Exercise selection must respect surgical precautions and the advice of the cardiac surgical team.

**19.4. Valve surgery and other cardiac procedures:**
Patients recovering from valve repair or replacement may experience reduced exercise capacity and mobility due to preoperative deconditioning, postoperative weakness, and associated comorbidities. Functional assessment can help identify limitations that remain after the initial recovery period. Balance training may be useful in older adults, particularly those with reduced lower-limb strength or a history of falls. Patients with arrhythmias, anticoagulation-related concerns, or orthostatic symptoms require individualized supervision.

**19.5. Older adults with frailty:**
Frailty is characterized by reduced physiological reserve and increased vulnerability to adverse outcomes following relatively minor stressors. In cardiac rehabilitation, frailty may present as slow gait, reduced strength, impaired balance, fatigue, and difficulty performing everyday tasks. Older adults with frailty may not tolerate conventional endurance-focused programmes at the same starting intensity as younger or higher-functioning patients. A multidomain programme should initially prioritize safe transfers, standing tolerance, lower-limb strength, and basic mobility before progressively increasing endurance demands. A 2026 systematic review of frailty-targeted cardiovascular rehabilitation reported favourable signals for selected physical performance outcomes, including SPPB and walking distance, but also emphasized the low certainty and limitations of the available evidence (Frailty-targeted cardiovascular rehabilitation review, 2026).

**20. Falls Risk Assessment and Prevention:**
Falls are multifactorial events influenced by intrinsic and extrinsic factors. Intrinsic factors include muscle weakness, impaired balance, slow gait, visual impairment, neuropathy, cognitive impairment, orthostatic hypotension, and medication effects. Extrinsic factors include poor lighting, uneven surfaces, unsuitable footwear, loose rugs, and environmental obstacles. In cardiac rehabilitation, falls-risk assessment should begin with a history of previous falls, near-falls, dizziness, syncope, and fear of falling. Clinicians should also review medications that may contribute to hypotension or dizziness, while recognizing that medication changes must be made by the appropriate prescribing clinician. Functional tests such as the TUG, SPPB, gait speed, and BBS can help identify physical limitations that warrant intervention. However, no single test should be used as a definitive falls prediction tool. A patient with a satisfactory test score may still experience falls because of environmental or medical factors. Prevention should combine targeted exercise, patient education, appropriate walking aids, footwear advice, and referral for vision or neurological assessment when indicated. The purpose of falls prevention in CR is not to eliminate all movement challenges but to improve the patient's capacity to manage everyday movement safely.

**21. The Role of Physiotherapists in Multidomain Cardiac Rehabilitation:**
Physiotherapists play a central role in evaluating and addressing physical limitations in cardiac rehabilitation. Their responsibilities extend beyond prescribing aerobic exercise and include assessment of posture, muscle strength, balance, gait, transfers, coordination, and movement quality. They can identify whether reduced walking performance is primarily associated with cardiovascular limitation, lower-limb weakness, pain, impaired balance, or a combination of factors. Physiotherapists can also select appropriate functional tests, design progressive exercise programmes, monitor movement responses, and provide education on safe activity. Collaboration with cardiologists, nurses, occupational therapists, clinical exercise physiologists, dietitians, and other healthcare professionals is essential when patients have complex clinical needs. In particular, the physiotherapist should communicate observed instability, falls history, orthostatic symptoms, or unexpected deterioration to the medical team. A multidisciplinary approach ensures that functional rehabilitation remains consistent with the patient's cardiovascular treatment plan and broader recovery goals.

**22. Safety Considerations during Balance and Mobility Training:**
Safety is particularly important when balance activities are introduced into cardiac rehabilitation because patients may have cardiovascular instability, dizziness, reduced exercise tolerance, or an increased risk of falling. Before exercise, the clinician should review the patient's clinical status, symptoms, blood pressure, heart rate, and any relevant exercise restrictions. Patients with acute decompensated heart failure, unstable angina, uncontrolled arrhythmias, severe uncontrolled hypertension, acute clinical deterioration, or unexplained syncope should not undertake routine exercise training until medically assessed and stabilized.

During balance exercises, a stable support surface should be available, and patients with significant instability should receive close supervision. Exercises should be stopped if the patient develops chest pain, severe or disproportionate breathlessness, and dizziness, presyncope, palpitations associated with symptoms, unusual fatigue, or other concerning signs. Patients with a history of falls may require a gait belt, parallel bars, an appropriate walking aid, or direct assistance. Postoperative patients should follow the precautions provided by the surgical team. The aim is to create a safe environment in which functional challenges can be progressively introduced without exposing the patient to unnecessary risk.

**23. Patient-Reported Outcomes and Functional Independence:**

Objective performance tests should be complemented by patient-reported outcomes because improvements in test scores do not always translate into meaningful changes in daily life. Patients may report that they can walk farther but remain unable to climb stairs, carry groceries, stand for prolonged periods, or participate in social activities. Measures of health-related quality of life, physical function, activity limitation, confidence, and fear of falling can help identify these discrepancies. Clinicians should ask patients which activities remain difficult and use this information to select meaningful rehabilitation goals. Functional goals should be specific and relevant to the individual's living environment. For example, one patient may prioritize walking independently to a local shop, while another may wish to climb stairs without assistance. A goal-oriented approach improves the relevance of rehabilitation and encourages patients to recognize improvements beyond numerical test scores.

**24. Technology-Supported Assessment and Rehabilitation:**

Digital technologies may expand the ability to assess and train balance and mobility in cardiac rehabilitation. Wearable sensors, accelerometers, gyroscopes, smartphone applications, pressure-sensitive platforms, and instrumented walkways can provide information about gait speed, step count, cadence, movement variability, and postural sway. These technologies may help identify subtle changes that are not captured by conventional clinical tests. Video-based movement analysis can support the observation of sit-to-stand performance, turning, and gait patterns. Virtual reality and exergaming may provide interactive environments for practising stepping, reaching, weight shifting, and coordination. Robot-assisted balance training has also been investigated in older adults with cardiovascular disease, with early findings suggesting feasibility in selected settings (2024 balance exercise assist robot trial). However, technology should complement rather than replace clinical assessment. Devices may be expensive, require staff training, and produce measurements that are difficult to interpret without standardized protocols. Further research is needed to determine whether technology-supported balance training improves long-term independence, reduces falls, or produces better clinical outcomes than conventional physiotherapy.

**25. Home-Based and Community Cardiac Rehabilitation:**

Many patients face barriers to centre-based rehabilitation, including transportation difficulties, work commitments, geographical distance, financial limitations, and caregiving responsibilities. Home-based and community-based programmes may improve access, but they require careful planning when patients have balance impairment or a history of falls. Home programmes should include an assessment of the patient's environment, availability of support, access to stable furniture or exercise equipment, and ability to follow instructions safely. Simple exercises such as supported sit-to-stand, heel raises, controlled weight shifting, and walking practice may be appropriate for selected patients. Patients with significant balance impairment should not be asked to perform unsupported or high-challenge exercises without appropriate supervision. Remote monitoring may support adherence and allow clinicians to review activity levels, symptoms, and selected functional outcomes. The 2024 AHA/AACVPR statement recognizes the expansion of virtual and remote CR delivery while emphasizing that alternative delivery models must retain the essential therapeutic components of rehabilitation (Brown et al., 2024).

**26. Barriers to Implementation:**

Despite the clinical rationale for integrating balance and mobility assessment, implementation may be limited by time, staffing, equipment availability, and variation in professional training. Some rehabilitation programmes are designed primarily around treadmill, cycle, and resistance exercise, leaving limited time for specific functional assessment. Clinicians may also be uncertain about which balance tools to select or how to interpret their results in relation to cardiovascular risk. In smaller facilities, access to instrumented equipment or specialized balance platforms may be limited. These barriers can be addressed by using brief, low-cost tools such as gait speed, TUG, and chair-rise testing, supported by a standardized assessment protocol. Staff

education should emphasize test selection, safe guarding, documentation, and interpretation. Programme managers should also consider how functional outcomes can be included in routine quality improvement activities. A practical approach does not require expensive equipment, it requires consistent assessment, individualized exercise planning, and appropriate follow-up.

**27. Research Gaps and Future Directions:**

Further research is required to determine the optimal balance-training dose, exercise frequency, progression strategy, and duration for different cardiovascular populations. Although studies support multidomain rehabilitation, the evidence base remains heterogeneous in terms of patient characteristics, intervention content, assessment methods, and outcome reporting. Larger randomized trials should compare conventional CR with programmes that include structured balance and functional mobility components. Outcomes should extend beyond the 6MWT to include SPPB, gait speed, TUG, BBS, falls, functional independence, quality of life, and healthcare utilization. Researchers should also examine whether improvements in balance and mobility are maintained after programme completion and whether they translate into fewer falls or greater participation in daily activities. Studies should include women, older adults, patients with heart failure with preserved ejection fraction, individuals with frailty, and populations with multiple comorbidities. Future research should also investigate the role of wearable sensors and digital assessment in identifying patients who may benefit from targeted rehabilitation. Importantly, improvements in functional test scores should not automatically be interpreted as evidence of reduced mortality or hospitalization unless these outcomes are directly evaluated.

**28. Practical Recommendations for Contemporary Cardiac Rehabilitation:**

Contemporary CR programmes should retain the 6MWT or another appropriate exercise-capacity measure while adding a brief assessment of functional mobility and balance. The choice of tests should be individualized, with TUG, gait speed, SPPB, chair-rise testing, or BBS selected according to the patient's age, clinical condition, and functional limitations. Patients with a history of falls, frailty, slow gait, difficulty rising from a chair, or observed instability should receive a more detailed functional assessment. Exercise programmes should integrate aerobic conditioning with progressive resistance exercise, balance training, gait practice, and task-specific mobility activities. Progression should be based on symptoms, cardiovascular stability, movement quality, and functional performance. Reassessment should occur at baseline and at appropriate intervals to determine whether improvements in endurance are accompanied by improvements in balance and independence. Patient-reported goals should guide the selection of functional tasks, and safety procedures should be maintained throughout the programme. These recommendations are consistent with the broader movement towards comprehensive patient assessment and individualized rehabilitation in contemporary cardiovascular care.

**29. Conclusion:**

The 6-Minute Walk Test remains a valuable and practical measure of functional exercise capacity in cardiac rehabilitation, but it cannot fully characterize the complex physical limitations experienced by many patients with cardiovascular disease. Improvements in walking distance do not necessarily indicate recovery of balance, lower-limb strength, turning ability, transfer performance, or independence in daily activities. Contemporary cardiac rehabilitation should therefore adopt a multidimensional assessment approach that combines aerobic capacity with gait speed, balance, functional mobility, and lower-limb performance. Tools such as the SPPB, TUG, BBS, five-time sit-to-stand test, and Functional Reach Test can provide clinically meaningful information that complements the 6MWT. Multidomain rehabilitation programmes incorporating aerobic exercise, resistance training, balance activities, gait practice, and functional task training may be particularly valuable for older adults, patients with heart failure, and individuals with frailty or postoperative deconditioning. The strongest evidence supports individualized programmes that address several interacting physical limitations rather than relying on endurance training alone. Physiotherapists and multidisciplinary cardiac rehabilitation teams should use functional assessment findings to guide exercise selection, progression, safety, and patient-centred goals. Moving beyond the 6MWT does not mean abandoning an established assessment tool, it means recognizing that successful cardiac rehabilitation should improve not only how far a patient can walk, but also how safely, confidently, and independently that person can move through everyday life.

**30. References:**

(1) Aggarwal, P., Yannamani, A., Jain, J., Klipa, I., Oehler, A., & Kassis-George, H. (2026). Cardiac rehabilitation in heart failure: Evidence, coverage, and implementation. Journal of Clinical Medicine, 15(17), 6576.
(2) Barry, E., Galvin, R., Keogh, C., Horgan, F., & Fahey, T. (2017). Is the Timed Up and Go test a useful predictor of risk of falls in community-dwelling older adults? A systematic review and meta-analysis. BMC Geriatrics, 17, 14.
(3) Brown, T. M., Pack, Q. R., Aberegg, E., Brewer, L. C., Ford, Y. R., Forman, D. E., et al. (2024). Core components of cardiac rehabilitation programs: 2024 update. Circulation, 150(18), e328–e347.
(4) T. M., Pack, Q. R., Aberegg, E., Brewer, L. C., Ford, Y. R., Forman, D. E., et al. (2025). Core components of cardiac rehabilitation programs: 2024 update: A scientific statement from the American Heart Association and the American Association of Cardiovascular and Pulmonary Rehabilitation. Journal of Cardiopulmonary Rehabilitation and Prevention, 45(2), E6–E25.
(5) Clegg, A., Young, J., Iliffe, S., Rikkert, M. O., & Rockwood, K. (2016). Frailty in older people. The Lancet, 381, 752–762.
(6) De Vries, N. M., Staal, J. B., van Ravensberg, C. D., Hobbelen, J. S. M., Olde Rikkert, M. G. M., & Nijhuis-van der Sanden, M. W. G. (2018). Outcome instruments to measure frailty: A systematic review. Ageing Research Reviews, 42, 1–14.
(7) Fleg, J. L., Cooper, L. S., & Borlaug, B. A. (2019). Exercise training as therapy for heart failure: Current evidence and future directions. Journal of the American College of Cardiology, 73, 1950–1962.
(8) Forman, D. E., Arena, R., Boxer, R., Dolansky, M. A., Eng, J. J., Fleg, J. L., et al. (2017). Prioritizing functional capacity as a principal end point for therapies oriented to older adults with cardiovascular disease. Circulation, 135, e894–e918.
(9) Greenlane Cardiovascular Service. (2026). Balance and mobility impairment in older adults with cardiovascular disease before and after rehabilitation: A narrative review. [Journal details should be checked against the final indexed record before submission].
(10) Hurst, C., Weston, K. L., McLaren, S. J., & Weston, M. (2019). The effects of same-session combined exercise training on cardiorespiratory and muscular fitness in older adults: A systematic review and meta-analysis. Aging Clinical and Experimental Research, 31, 1701–1717.
(11) Kitzman, D. W., Whellan, D. J., Duncan, P., Pastva, A. M., Mentz, R. J., Reeves, G. R., et al. (2021). Physical rehabilitation for older patients hospitalized for heart failure. The New England Journal of Medicine, 385, 203–216.
(12) Kitzman, D. W., Whellan, D. J., Duncan, P., Pastva, A. M., Mentz, R. J., Reeves, G. R., et al. (2020). Design and rationale of a multicenter, randomized trial of rehabilitation therapy in older patients with acute heart failure. Circulation: Heart Failure, 13, e006687.
(13) Kitzman, D. W., Whellan, D. J., Duncan, P., Pastva, A. M., Mentz, R. J., Reeves, G. R., et al. (2019). Physical function and exercise training in older adults with heart failure. Journal of the American College of Cardiology, 73, 2454–2465.
(14) McDonagh, T. A., Metra, M., Adamo, M., Gardner, R. S., Baumbach, A., Böhm, M., et al. (2021). 2021 ESC guidelines for the diagnosis and treatment of acute and chronic heart failure. European Heart Journal, 42(36), 3599–3726.
(15) McPhee, J. S., French, D. P., Jackson, D., Nazroo, J., Pendleton, N., & Degens, H. (2016). Physical activity in older age: Perspectives for healthy ageing and frailty. Biogerontology, 17, 567–580.
(16) Montero-Odasso, M., van der Velde, N., Martin, F. C., Petrovic, M., Tan, M. P., Ryg, J., et al. (2022). World guidelines for falls prevention and management for older adults: A global initiative. Age and Ageing, 51(9), afac205.
(17) Pahor, M., Guralnik, J. M., Ambrosius, W. T., Blair, S., Bonds, D. E., Church, T. S., et al. (2018). Effect of structured physical activity on prevention of major mobility disability in older adults: The LIFE study. The Journals of Gerontology: Series A, 73, 1151–1157.
(18) Pelliccia, A., Sharma, S., Gati, S., Bäck, M., Börjesson, M., Caselli, S., et al. (2021). 2020 ESC guidelines on sports cardiology and exercise in patients with cardiovascular disease. European Heart Journal, 42(1), 17–96.
(19) Piepoli, M. F., Hoes, A. W., Agewall, S., Albus, C., Brotons, C., Catapano, A. L., et al. (2016). 2016 European guidelines on cardiovascular disease prevention in clinical practice. European Heart Journal, 37(29), 2315–2381.
(20) Reeves, G. R., Whellan, D. J., O'Connor, C. M., Duncan, P., Eggebeen, J. D., Morgan, T. M., et al. (2017). A novel rehabilitation intervention for older patients with acute decompensated heart failure: The REHAB-HF pilot study. JACC: Heart Failure, 5, 359–366.

(21) Reeves, G. R., Whellan, D. J., O'Connor, C. M., Duncan, P., Eggebeen, J. D., Morgan, T. M., et al. (2019). Rehabilitation therapy in older acute heart failure patients: Design and rationale of the REHAB-HF trial. American Heart Journal, 211, 77–85.

(22) Fairhall, N. J., Wallbank, G. K., Tiedemann, A., Michaleff, Z. A., Howard, K., et al. (2019). Exercise for preventing falls in older people living in the community. Cochrane Database of Systematic Reviews, 1, CD012424.

(23) Sherrington, C., Fairhall, N. J., Wallbank, G. K., Tiedemann, A., Michaleff, Z. A., Howard, K., et al. (2020). Exercise for preventing falls in older people living in the community: An abridged Cochrane systematic review. British Journal of Sports Medicine, 54, 885–891.

(24) Studenski, S., Perera, S., Patel, K., Rosano, C., Faulkner, K., Inzitari, M., et al. (2016). Gait speed and survival in older adults. JAMA, 305, 50–58.

(25) Thomas, R. J., Beatty, A. L., Beckie, T. M., Brewer, L. C., Brown, T. M., Forman, D. E., et al. (2019). Home-based cardiac rehabilitation: A scientific statement from the American Association of Cardiovascular and Pulmonary Rehabilitation, the American Heart Association, and the American College of Cardiology. Circulation, 140, e69–e89.

(26) Trombini-Souza, F., de Moura, V. T. G., da Silva, L. W. N., Leal, I. S., Nascimento, C. A., Silva, P. S. T., et al. (2023). Effects of two different dual-task training protocols on gait, balance, and cognitive function in community-dwelling older adults: A 24-week randomized controlled trial. PeerJ, 11, e15030.

(27) Virani, S. S., Newby, L. K., Arnold, S. V., Bittner, V., Brewer, L. P. C., Demeter, S. H., et al. (2023). 2023 AHA/ACC guideline for the management of patients with chronic coronary disease. Journal of the American College of Cardiology, 82(9), 833–955.

(28) Visseren, F. L. J., Mach, F., Smulders, Y. M., Carballo, D., Koskinas, K. C., Bäck, M., et al. (2021). 2021 ESC guidelines on cardiovascular disease prevention in clinical practice. European Heart Journal, 42(34), 3227–3337.

(29) World Health Organization. (2020). WHO guidelines on physical activity and sedentary behaviour. World Health Organization.

(30) World Health Organization. (2021). Step safely: Strategies for preventing and managing falls across the life-course. World Health Organization.

(31) Zasadzka, E., Trzmiel, T., Pieczyńska, A., & Hojan, K. (2020). Modern technologies in the rehabilitation of older adults: A systematic review. International Journal of Environmental Research and Public Health, 17, 4915.