Chapter

Moving beyond Cardio: The Value of Resistance Exercise Training for Cardiovascular Disease

Brandon S. Shaw, Gavin R.H. Sandercock, Anneke Van Biljon and Ina Shaw

Abstract

Cardiovascular disease (CVD) continues to be the leading cause of death and continuous efforts are needed to reduce CVD risk and established CVD. Most exercise training guidelines do not recommend RT as an integral component of an overall CVD prevention and/or rehabilitation programme. This is notwithstanding the increasing evidence of RT's orthopaedic and hemodynamic safety, its cardioprotective effects and positive effects on mortality, and even its unique role on improving the comorbidities associated with CVD. As with cardiorespiratory fitness, muscular fitness is increasingly being demonstrated to be related to the integrated function of numerous physiological systems and as a reflection of whole-body health and function. As such, '"counting reps'" should be as important as '"counting steps'" in any CVD prevention and management programme. While many current international recommendations and guidelines are based on the fact that not all health benefits can be achieved through a single type of exercise, emphasis is still placed on aerobic training over RT. This chapter will not only discuss the importance of RT in overall CVD prevention and/or rehabilitation, but will directly inform recommendations and provide guidelines on practical exercise as a safe and foundational component of CVD programmes.

Keywords: cardiac rehabilitation, exercise, non-communicable disease, physical fitness, strength training, weight training

1. Introduction

Cardiovascular disease (CVD) continues to be the number one cause of death worldwide [1] and accounts for approximately 50% percent of all deaths in high-income countries (HICs) and approximately 28% of deaths in low- and middle-income countries (LMICs), with figures increasing exponentially [2]. Problematically, the emergence of COVID-19, officially known as Severe Acute Respiratory Syndrome-Coronavirus-2 (SARS-CoV-2), presents an unparalleled challenge for people with CVD. This is because individuals with pre-existing CVD are more likely to develop COVID-19 are more likely to present with more severe symptoms and have worse clinical outcomes [3, 4]. Recent findings are also demonstrating that COVID-19 is responsible for both the development of new and exacerbation of pre-existing CVD due to a variety of factors, such as resultant myocardial injury and the development of new-onset cardiac dysfunction from the infection [3] and long-term consequences arising from infection, such as possible continued abnormalities of lipid metabolism [5].

2. Exercise training and the primary, secondary and tertiary prevention of cardiovascular disease

Although more than 200 risk factors have now been identified that can give rise to CVD, the major risk factors of smoking, hypertension, dyslipidemia and physical inactivity have been recognised for over 50 years [6, 7]. Problematically, the 200 or so risk factors often perform complex interactions and may act synergistically acting to amplify the damage caused by any one risk factor alone [8]. Despite the existence of proven strategies for the prevention and management of CVD risk, millions of individuals worldwide continue to develop and display behaviours and characteristics that increase the risk for developing CVD.

In this regard, physical inactivity, while listed as the fourth leading cause of death worldwide [6], is modifiable with an overwhelming body of evidence demonstrating the benefits of physical activity for cardiovascular health. Physical activity can both modify individual risk factors, but it also reduces overall risk of CVD [9]. As such, evidence supports the inclusion of exercise training in a) the primary prevention (preventing the onset of CVD) [10], b) secondary prevention (reducing the impact of CVD prior to any critical or permanent damage to health) [11] and c) tertiary prevention of CVD (slowing, arresting, or reversing CVD to prevent further deterioration, and reduce the risk of subsequent events) [12]. In addition, physical exercise can be employed in low, middle or high income countries [13].

3. Rationale for resistance training exercise training and the primary, secondary and tertiary prevention of cardiovascular disease as cardiovascular therapy

3.1 Moving beyond cardio and cardiorespiratory fitness: the value of resistance training in cardiovascular disease prevention and management

Many health organisations, such as the American Heart Association (AHA), provide exercise guidelines and recommendations for CVD, which tend to focus on aerobic exercise prescription [14]. While the health benefits of aerobic exercise are well established there is sufficient evidence from experimental studies, reviews and meta-analyses to justify the inclusion of RT, either alone, or at least in equal combination to aerobic training, not only in apparently healthy populations [15] but also for the attenuating of several risk factors of CVD [16] and in comprehensive cardiovascular therapy programmes [17]. Recently, in fact, a low volume, single-set RT exercise programme has proven sufficient to reduce CVD risk in untrained older women [18].

Further, evidence is mounting that RT plays a significant role in morbidity. This is because muscular fitness (a general term that describes the general health, endurance, power and strength of muscles) is increasingly being correlated to many types of mortality, including cardiovascular mortality [19]. As with cardiorespiratory fitness, muscular fitness may also be directly related to the integrated function of numerous physiological systems, including the cardiorespiratory and musculoskeletal systems, and could be utilised to provide a reflection of whole-body health and function. Research on the relationship between morbidity and muscular strength, and specifically handgrip strength [20, 21], quadriceps testing [21, 22] and bench press testing [22] suggest that muscular strength should be viewed as an independent CVD risk factor [23]. This is because these proxies of overall strength have been proven to have significant inverse relationships with all-cause mortality, even after controlling for other risk factors, including level of cardiorespiratory fitness [19, 24]. With regards to muscular endurance, research has shown an inverse association between the number of sit-ups in one minute and mortality [25]. Research has also demonstrated that death rates of 30 per 10,000 in individuals with low muscular fitness, compared with just 12 per 10,000 in individuals with high muscular fitness [26]. As with cardiorespiratory fitness, there may be many health benefits directly and indirectly associated with muscular fitness, for example, high levels of muscular fitness may indirectly improve cardiovascular health profiles, through its beneficial effects on hypertension [27], dyslipemia [8], body composition [28, 29], diet [30], aerobic performance [31] and functional capacity [19]. Given the prognostic power of muscular fitness (and specifically muscular endurance and muscular strength) as a predictor of all-cause mortality, muscular fitness assessments should be highly considered to improve the efficacy of individualised CVD patient risk assessment and resultant clinical decisions.

3.2 The rise of home-based exercise training

Many governments adopted hardened nationwide quarantine or implemented forms of lockdowns in attempts to reduce the spread of COVID-19. Lockdowns present a major problem in terms of physical activity. Lockdowns promote inactivity through direct personal restrictions, shutting down gymnasiums and fitness centers, and through suspension or cessation of many outdoor activities [32, 33]. These COVID-19 restriction attempts rapidly accelerated the uptake of home-based exercise training [34], a trend which has been building, albeit slowly, for decades [35]. As gymnasiums and fitness centers closed due to COVID-19 restrictions, individuals and health professionals were forced to exercise differently using limited equipment in limited space. While COVID-19 restrictions are being lifted worldwide, and even as gymnasiums and fitness centers begin to open, home-based exercise training may become a new mainstay, whether due to their ease of use, or even due to economic downturns. Already, the American College of Sports Medicine (ACSM) ranks home exercise gymnasiums, strength training with free weights and body weight training at 2, 4 and 8, respectively in their Worldwide Survey of Fitness Trends for 2022 [34]. Notwithstanding the COVID-19 crisis, many individuals chose to and will continue to choose home-based exercise training as it is more convenient and flexible. Importantly, home-based exercise training can be as effective as facility-based exercise training, in clinically stable low- to moderate-risk patients with CVD [36].

4. Cardiovascular disease and resistance training across the lifespan

While the focus of much CVD studies is on adults, it is important to recognise that CVD risk factors may develop and even begin to detrimentally affect health during in childhood and adolescence [37]. The arteriosclerotic process can begin and rapidly accelerate at an early age [38]. As with adults, CVD risk factors, and especially composite CVD scores, are strongly associated with physical fitness in children [39, 40]. This has led to several recent changes having occurred in international recommendations for children's participation in physical activity for health [39]. Research, evidence and subsequent guidelines predominantly promote the benefits of aerobic activity for children and adolescents. Again, RT has proven to be a safe exercise modality able to promote improved cardiovascular health in children. Despite some research indicating that the beneficial effects from RT interventions are sometime modest [39], RT can supply additional, unique benefits to the health and functional capacity of children in particular. These benefits can be realised over and above those from aerobic exercise [40]. In this regard, low muscle strength has been independently associated with a poorer metabolic profile during adolescence [41]. In addition, increasing evidence is arising indicating that concurrent training programmes utilising both aerobic and RT components display additive or crossover effects of both modes of training when compared to a single mode of exercise alone, even in children [40]. It is for this reason that the promotion of physical activity, including RT, should be a critical element in public health policy to prevent the onset of CVD later in life [39, 42]. This is because childhood provides an excellent window of opportunity to educate children about healthy lifestyle habits and cardiovascular health, rather than to attempt to re-programme well-established unhealthy behaviours in adults.

Despite some developed countries, such as the United Sates of America, seeing an overall reduction in CVD mortality, CVD mortality is on the rise in younger women [43]. This is because in addition to an increasing prevalence of CVD risk factors, women display several clinical conditions or sex-specific CVD risk factors, such as pre-eclampsia, gestational diabetes, polycystic ovary syndrome, early menopause and autoimmune diseases that have been shown to increase the development of CVD [43, 44]. Although great strides have been made regarding CVD mortality in women, not all women are benefitting equally from CVD-related mortality reduction. In this regard, women could gain significant cardioprotective benefits from engaging in RT. This is because RT has been proven safe for use in women and has a unique ability to maintain or increase muscle mass [45, 46] and may offset their lower muscle mass and higher fat mass when compared to men [47]. Individuals with high muscle mass, especially when combined with low fat mass display the lowest mortality risk compared with other body composition subtypes [48, 49]. Women's lower muscle mass when combined with their average 40% less upper-body strength and 33% less lower-body muscle strength and their effect on mortality [50], calls for the specific inclusion of RT as part of any guideline-directed, evidence-based, and sex-specific management and treatment recommendations aimed at improving CVD outcomes in women.

Age also plays a critical role in the deterioration of cardiovascular function, and it is for this reason that risk and prevalence of CVD both increase with age [51, 52]. Increases in CVD in older adults can be linked to functional changes in the ageing heart (i.e. diastolic and systolic dysfunction) and/or electrical dysfunction (i.e. arrhythmias) and other CVD risk factors, such as inflammation, oxidative stress, apoptosis and degeneration [52, 53]. This degeneration is as a result of a significant loss of muscle mass or sarcopenia that is one of the hallmarks of ageing. Without intervention, sarcopenia may eventually lead to physical disability and loss of independence [54]. Thankfully, older adults can gain the health benefits of physical activity, regardless of age, provided that the threshold for irreversible frailty has not been reached [54, 55]. While the optimal health benefits of exercise are best realised from a combination of aerobic and resistance exercise training, most older adults do not meet minimum guidelines for exercise or when they do, they do not engage in RT [56]. This is problematic in that RT remains the most consistent and effective method of promoting global muscular adaptations [56] and for promoting increases in muscle mass [46]. It is for this reason that RT, especially in the form of strengthening- and hypertrophic-exercise is even more critical for older adults and should be emphasised in future guidelines, as it may be the most effective standalone exercise strategy for improving health of older adults [57, 58]. Failing this, RT should be highlighted as an essential component in multimodal exercise training programmes in older adults, and especially frail adults [59, 60]. Problematically, even when RT training is recommended as equally important to aerobic exercise as in the UK PA Guidelines, guidelines regarding RT appear to be interpreted as secondary to the primary message of achieving 150 minutes of aerobic training, and there is some evidence that the strength guideline is both less well known and less often achieved. Given the importance of maintaining or increasing muscle strength, particularly for adults at the upper end of the 19–64 age range, this guideline should be given equal emphasis.

5. Practical resistance training Programme design for CVD prevention and management

RT, sometimes referred to as weight training or erroneously as strength training, involves the performance of physical exercise against resistance or weight. While RT is commonly associated with lifting of dumbbells and barbells in a gymnasium setting, it can also incorporate a variety of training techniques, such as callisthenics, Pilates, yoga, free weights, weight machines, resistance bands, isometrics, high-intensity interval training (HITT) and plyometrics [17]. It is this plethora of RT exercise types and programme design iterations (i.e. frequency, intensity, muscle groups, single−/multi-joint exercise, sets, repetition, rest intervals, etc.) that provides much consternation for many health organisations and health professionals, leading to guidelines

Frequency	Intensity	Repetitions	Sets	Type
RT Programme Design for Apparently Healthy Individuals/Low to Moderate CVD Risk				
2 or more sessions per week	Moderate to high 50–70% 1-RM	8–12 reps	3–4 sets per exercise; with short rest intervals (30–60 s)	8–10 different RT exercises using multi-joint or compound movements involving >1 muscle group
RT Programme Design for Individuals with High CVD Risk and existing CVD				
3 days per week	Low intensity >30% 1-RM	10–12 reps	1–3 sets per exercise; medium to long rest intervals (60–90 s)	8–10 different exercises including multi-joint or compound movements involving >1 muscle group

Table 1.
Guidelines for resistance training programme design based on CVD risk/presence of CVD (adapted from Shaw, Brown & Shaw, 2021 [17]).

or position statements for each CVD [17]. While it is these same design considerations that can be fine-tuned, by advanced exercise scientists in cardiovascular therapy, to exact a similar plethora of physiological changes and adaptions that are well suited to CVD prevention and management, practical and easy-to-follow RT regimes do exist for prevention and management of CVD (**Table 1**) [17].

6. Conclusions

The available evidence continues to support the recommendation that all adults should undertake activities which increase or maintain muscle strength at least twice a week. A credible amount of research exists demonstrating that RT, even when performed in isolation, does contribute to prevention [59], management and rehabilitation of CVD. Further, the historical idea that the benefits of RT and aerobic exercise training are independent of one another, with minimal crossover, is no longer supported by the evidence. This is because, at present, sufficient evidence exists to challenge existing exercise guidelines and recommendations that call for aerobic exercise training to be considered as the gold standard in CVD prevention and management, with RT, at best, being assigned a minor role in a comprehensive exercise therapy programme. In this regard, the available data clearly indicates that when RT is combined aerobic training, the impact in terms of reduction in CVD risk from this combination is greater than the sum of its parts. This is likely caused by the synergistic benefits realised through positive transference by modality - or crossover effect.

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Conflict of interest

The authors declare no conflict of interest.

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