Volume of Aerobic Exercise to Optimize Outcomes in Cardiac Rehabilitation: An Official Statement From the American Association of Cardiovascular and Pulmonary Rehabilitation

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Exercise training is a core component of cardiac rehabilitation (CR) programming. Exercise and, more broadly, physical activity are critical elements to secondary prevention of cardiovascular disease. The central components of the exercise prescription are well-defined and include frequency (how many bouts of exercise per week), intensity (how hard to exercise), time (duration of exercise session), type (modality of exercise), and progression (rate of increase in the dose of exercise). Specific targets for the volume (total amount) of exercise, however, are less well-defined. This Position Statement provides a general overview of the specific goals for the volume of aerobic exercise to optimize long-term outcomes for participants in CR. Additionally, examples are provided to illustrate how to integrate the various aspects of the exercise

Key Words: AACVPR Position Statement • cardiac rehabilitation • optimizing exercise Volume

KEY PERSPECTIVES

What is novel?

- Evidence suggests that the exercise volume per session typically achieved in cardiac rehabilitation (CR) is quite modest.
- There is clear evidence that, in general, a greater exercise volume is associated with more favorable cardiovascular outcomes.
- This Position Statement provides an overview of the specific goals for the volume of aerobic exercise to optimize long-term outcomes for participants in CR.
- We describe how to integrate the various components of the exercise prescription (ie, frequency, intensity, duration, and type) to achieve the optimal volume of aerobic exercise.

What are the clinical implications?

- To achieve the higher volumes of aerobic exercise that have been described in this Position Statement will require alterations to the traditional exercise prescription and, in some cases, programmatic changes in the way CR services are delivered.

Participation in phase 2 cardiac rehabilitation (CR) is associated with a multitude of benefits including improvements in mortality and morbidity, cardiorespiratory fitness (CRF), quality of life, and metabolic disorders.[1] Accordingly, CR is a class 1 recommendation for individuals with myocardial infarction and coronary revascularization[2] Exercise training is a foundational aspect of CR programming as both exercise training and physical activity (PA) counseling are core components of CR and are critical factors for the secondary prevention of cardiovascular disease (CVD).[3,4] While the terms "exercise" and "PA" are often used interchangeably, there are important distinctions. PA is the global term denoting all forms of activity related to occupation, transportation, household, and leisure time, whereas exercise is an activity done with the intention to sustain or improve health and CRF.[5]

To illustrate the integral role of exercise in the prevention and treatment of CVD, the concept of *Exercise as Medicine* has been advanced.[6] As with any medicine, it is important that the proper dose is prescribed. The dose or the exercise volume (ExVol) involves the integration of the central components of the exercise prescription (ExRx) including the *F*requency (how many sessions), *I*ntensity (how vigorous), *T*ime (duration), and *T*ype (modality) (a.k.a. F.I.T.T.).[5] While the components of the ExRx are adjusted during CR, a specific target for the total ExVol is typically not delineated, which may lead to incorrect or not optimal dosing. Ultimately, the ExRx goal is to titrate the ExVol to maximize CVD risk reduction and improve CRF.[4]

The purpose of this Position Statement is to define targets for ExVol to optimize long-term outcomes for participants in CR. Additionally, examples are provided to illustrate how to incorporate the components of the ExRx to achieve the desired ExVol. The focus of this Position Statement is aerobic exercise training (AET), the type of training most closely tied to CVD risk reduction. Examples are provided to illustrate how to incorporate the various components of the ExRx to achieve the desired ExVol.

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All authors have read and approved the manuscript.

The authors declare no financial support and conflict of interest.

Supplemental digital content is available for this article. Direct URL citation appears in the printed text and is provided in the HTML and PDF versions of this article on the journal's website (www.jcrpjournal.com).

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DOI: 10.1097/HCR.0000000000000941

GENERAL RECOMMENDATIONS FOR VOLUME OF EXERCISE

The ExVol can be described in a variety of units. The most common unit of measure of energy expenditure is the kilocalorie (kcal).[5] However, in clinical settings, energy expenditure is frequently estimated using an expression of metabolic equivalents of task (MET). The energy requirement associated with sitting in a restful state is 1 MET.[5] Energy expenditure increases above the resting level when performing PA and can be expressed as a multiple of METs (eg, activity that requires 5.5 times the resting amount of energy, such as walking at a pace of 4 mph, would be 5.5 METs). A compendium is available to provide estimated MET levels for many activities.[7] Also, the American Association of Cardiovascular and Pulmonary Rehabilitation Position Statement on Progression of Exercise Training in CR provides an Excel spreadsheet calculator that can be used to determine MET levels.[8]

The World Health Organization[9] and the US Department of Health and Human Services PA guidelines for Americans[10] provide evidence-based recommendations regarding the requisite PA for substantial health benefits. Both guidelines describe the amount or dose of PA in terms of frequency, time, and intensity. These guidelines recommend achieving a minimum of 150 min/wk of moderate or 75 min/wk of vigorous-intensity (or some combination thereof) PA. This volume of PA (ie, 150 min/wk of moderate PA) is equivalent to an energy expenditure volume of 1000 kcal/wk (Figure 1). While these PA guidelines suggest this amount as a threshold level to derive benefit, there is evidence that additional benefits are obtained with up to 300 min/wk of moderate-intensity or 150 min/wk of vigorous-intensity PA.

Notably, the guidelines put forth recommendations on a weekly basis and that PA should be "spread throughout the week." A precise number of exercise sessions per week is not specified. These guidelines provide a method to estimate the volume of PA by calculating the MET-min/wk, which is derived by multiplying frequency (d/wk), intensity (METs), and time (min/d). For example, a 5 MET activity done for 30 minutes 7 d/wk would equate to 1050 MET-min/wk (the aforementioned American Association of Cardiovascular and Pulmonary Rehabilitation Position Statement on assessing PA also provides an Excel spreadsheet calculator to determine MET-min/wk).[8,11] According to the PA guidelines for Americans, the amount of PA necessary to improve CRF and, thus, obtain health benefits is ≥500 to 1000 MET-min/wk.[10]

TYPICAL EXERCISE VOLUMES IN PHASE 2 CARDIAC REHABILITATION

Historically, the ExRx typically used in CR is essentially the same for all participants, irrespective of diagnosis or demographic characteristics.[12] Generally, the ExRx focuses on moderate-intensity continuous AET (MCT), employing multiple modalities, performed 2 to 3 times/wk for a duration of 30 to 45 min/session. Notably, a delineation of the ExVol is typically not specified. For the purposes of this Position Statement, we will be referencing this training regimen of MCT as the traditional or standard CR ExRx.

Studies of energy expenditure in CR are scarce but the ExVol per session typically obtained utilizing MCT in CR is low.[13] The traditional CR ExRx is associated with a relatively low level of energy expenditure of 270 ± 112 kcal/session. Both women and older (≥65 years) participants were found to have significantly lower energy expenditures (195 ± 110 and 266 ± 100 kcal/session, respectively) compared to men and younger (<65 years) participants (292 ± 103 and 305 ± 108 kcal/session, respectively). Therefore, on average, CR-related exercise results in an energy expenditure of <1000 kcals/wk.

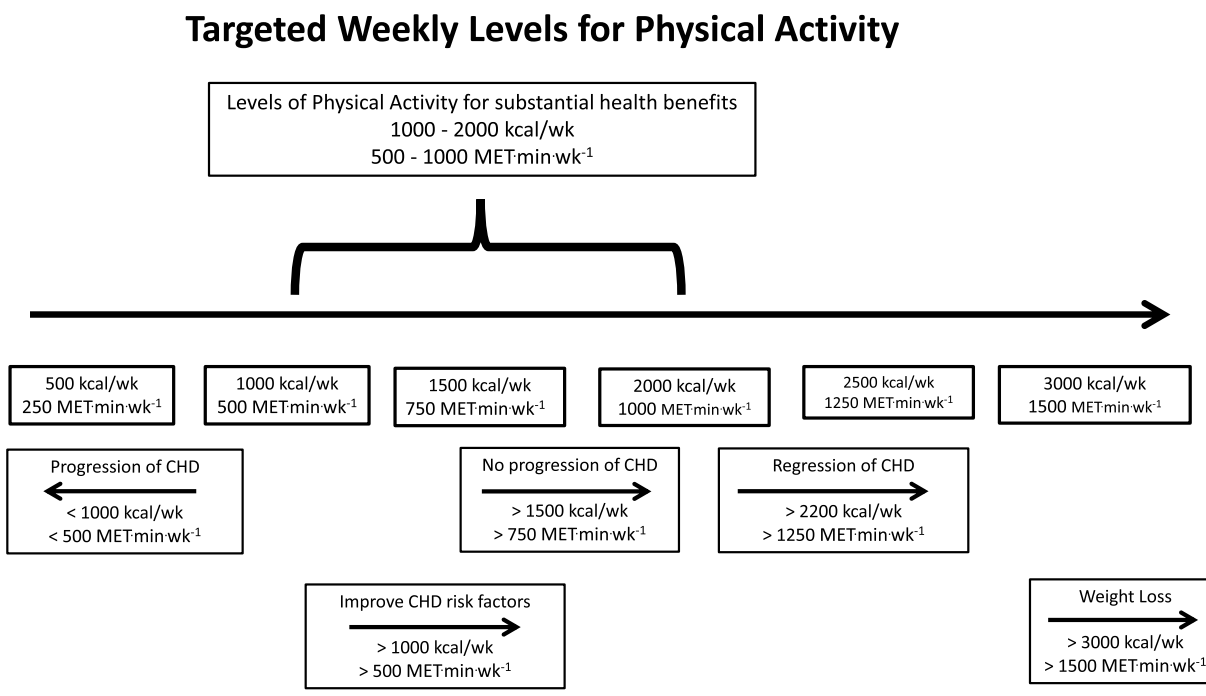

Figure 1. Physical activity volume. CAD, coronary artery disease; MET, metabolic equivalent of task.

Parenthetically, while the focus of this Position Statement is on phase 2 CR, it is important to note that participants in "maintenance CR" (a.k.a. phase 3) also have volumes of energy expenditure that is <1000 kcal/wk. Schairer et al found that patients only expended 230 ± 88 kcals/session.[14]

VOLUME OF EXERCISE FOR SECONDARY PREVENTION

The most specific information related to the ExVol for secondary prevention is derived from the seminal study by Hambrecht et al.[15] This study, utilizing coronary angiography, demonstrated that with the combination of a low-fat diet and AET, it is not only possible to halt disease progression but to achieve regression of atherosclerotic lesions. Results demonstrated that a threshold of approximately 1500 kcal/wk of PA was associated with halting the progression of CVD (Figure 1). Achieving CVD regression required a mean of 2200 kcal/wk of PA. Importantly, significantly greater improvements in CRF were also associated with higher volumes of PA.

An important caveat when considering the results of Hambrecht et al is that the study occurred in the 1990s before the widespread use of a variety of therapeutics that are currently standard of care for secondary prevention of CVD such as lipid-lowering, antithrombotic, antiplatelet, and hypoglycemic agents. Therefore, the dose-response to exercise may not be the same in the setting of more aggressive and efficacious secondary prevention strategies.

There are few, if any, studies that have directly analyzed the ExVol of patients in CR and outcomes. There was one report that utilized a metric called the Personalized Activity Intelligence to assess the dose of PA.[16] The Personalized Activity Intelligence is derived by an algorithm that awards activity points relative to PA time and intensity. A greater number of Personalized Activity Intelligence points are earned at higher intensities of PA. In a study of subjects with CVD followed for an average of 12.5 years, achieving a Personalized Activity Intelligence score of >100/wk resulted in a 36% reduction in CVD mortality.

There is substantial evidence that the greatest benefit from CR occurs with exercise that improves levels of CRF.[17] In individuals with CVD followed for an average of 6.4 years, those experiencing the greatest improvement in peak VO_2 > 2.5 mLO_2/kg/min had improved survival compared to those with less or no improvement.[18] In a subsequent study of CVD patients followed on average for 6.7 years, the best predictor of survival was the end of CR peakVO_2, with a threshold effect at ≥17.6 mLO_2/kg/min.[19] Importantly, maintaining a CRF level of 2.5 mLO_2/kg/min above baseline after completion of CR was associated with lower mortality rates.[19,20] As mentioned previously, the results from Hambrecht et al demonstrated that higher volume was associated with halting the progression of atherosclerotic lesions and greater improvements in CRF.[15] Therefore, either higher volumes of exercise and/or higher intensity exercise training (HIIT), which will be discussed in greater detail below, are needed to ensure improvements in CRF and prognosis.

SURROGATE MEASURE OF VOLUME OF EXERCISE

Given the difficulty of accurately quantifying PA energy expenditure outside of the research setting, targets for daily step counts have been established for secondary prevention. The American Association of Cardiovascular and Pulmonary Rehabilitation Statement on Assessing PA describes how accelerometers, which provide an indicator of exercise intensity, can be used to determine MET-min/wk.[8]

The American College of Sports Medicine suggests that pedometers, measuring steps/d, can be used to estimate PA volume.[5] While a target of 10 000 steps/d is often referenced, evidence suggests that a daily amount of 7000 to 8000 steps, with >3000 steps/d performed with a rate of >100 steps/min (a brisk walk) is a threshold for adults to accrue health benefits. A meta-analysis revealed that taking more steps/d was associated with lower CVD in older adults (ie, ≥60 years of age).[21] Taking 6000 to 9000 steps/d was associated with a 40% to 50% lower risk of CVD, compared with taking 2000 steps/d. A separate meta-analysis reported that as few as 2800 steps/d yield significant mortality and CVD benefits, with progressive risk reductions up to 8800 and 7200 steps/d, respectively.[22] Additional mortality benefits were found at a moderate to high (median 88 steps/min) vs a low (median 29 steps/min) step cadence. These findings underline that both volume (steps/d) and intensity (steps/min) are independently associated with health and that their risk reductions are additive. It is important to note that these observations regarding steps/d are derived from a general adult population, not specifically from participants in CR.

EXERCISE VOLUME VS EXERCISE INTENSITY

A positive relationship between AET volume and acquired health benefits in CR emphasizes the need to consistently progress the ExVol as tolerated.[11] Investigators have had a long-standing interest in determining whether AET volume, despite or because of, exercise intensity level, contributes to greater improvements in CRF, cardiovascular function, glycemic control, quality of life, and other health outcomes. Studies have provided evidence for the potential of AET to be used as a form of precision medicine to target improvements in various CVD risk factors by adjusting exercise intensity, duration, and frequency.[23-25] A study by Ross et al provides valuable evidence depicting the ability to improve CRF based on increasing volume and/or intensity of exercise in a cohort of individuals with metabolic syndrome.[25] Participants were randomized to low amount (180 and 300 kcal/session, for women and men, respectively) low intensity (50% of CRF), high amount (360 and 600 kcal/session for women and men, respectively) low intensity, or high amount high intensity (75% of CRF) exercise on 5 d/wk. A higher ExVol (low amount, low intensity vs high amount, low intensity) and higher exercise intensity (high amount, low intensity vs high amount, high intensity) contributed to a greater number of individuals who improved their CRF. Of note, all participants in the high volume, high intensity (1800 and 3000 kcals/wk for women and men, respectively) group improved their CRF, whereas nearly 40% of individuals in the low amount, low intensity (800 and 1500 kcals/wk, for women and men, respectively) experienced no improvement in CRF.

BENEFITS OF HIGHER INTENSITY EXERCISE TRAINING VS MODERATE-INTENSITY CONTINUOUS AET

Investigations across various populations with chronic health conditions have compared HIIT to MCT.[26,27] The types of HIIT protocols employed can be separated into either "high volume" or "low volume." High-volume protocols accumulate ≥15 minutes of time spent during the high-intensity intervals, with all other protocols defined as low volume.[28,29] The HIIT model most studied with

individuals with CVD is the "high volume" version, 4 × 4 method, which consists of 4 high-intensity intervals at 85% to 95% peak heart rate for 4 minutes interspersed by 3-minute active recovery periods at 70% of peak heart rate.[29,30] Importantly, most studies examining HIIT vs other exercise training protocols control for the ExVol. Therefore, while the total exercise time is of significantly shorter duration for HIIT vs MCT, the ExVol is similar. As an example, a study by Rognmo et al that employed high-volume HIIT vs MCT resulted in an average caloric expenditure of approximately 250 kcal/session for both groups.[31]

In general, HIIT is associated with superior CRF improvements compared to MCT within CVD populations.[27,31-36] Meta-analyses have found HIIT to improve CRF in those with CVD[27] by 1.25 ml/kg/min and 1.35 ml/kg/min in individuals with heart failure (HF) with a reduced ejection fraction.[33] The relative safety of performing HIIT in CR has spurred investigators to examine its application in other individuals.[35-39] HIIT is more effective in increasing CRF compared to MCT in women in CR,[34] individuals at intermediate to high risk of an acute pulmonary embolism,[38] patients with a left ventricular assist device,[40] and heart transplant recipients.[39] Though some studies have shown similar improvements in CRF between HIIT and MCT, HIIT has indisputably contributed to greater improvements in cardiac function and remodeling.[35] It is also important to note that most studies that have established the superiority of HIIT in modifying CRF and cardiac function have been done so in controlled settings under specific guidance and direct supervision. Findings from the Study of Myocardial Recovery After Exercise Training in Heart Failure investigation showed no difference in CRF improvements between HIIT and MCT groups.[41] This may have been due to 51% of HIIT participants exercising below the prescribed intensity and 80% of MCT participants exercising above moderate-intensity thresholds.

Despite studies supporting the greater CRF gains with HIIT than MCT, MCT has been shown to promote similar reductions in weight, blood pressure, and lipid levels and improvements in body composition and blood glucose control as HIIT.[35] Moreover, the enormous body of literature that is associated with positive outcomes in CR derives from studies utilizing typical (ie, MCT) CR exercise training.[12] These are valuable observations as a portion of patients participating in CR may not be good candidates for HIIT or may prefer MCT instead.

An important practical consideration regarding the relative benefits of HIIT vs other exercise protocols is that the results are derived from the research setting. Research participants may not necessarily reflect a general clinical population. Moreover, study participants are thoroughly screened, and, in most cases, a symptom-limited exercise tolerance test is performed, which is an important factor in enhancing patient safety.[4] Additionally, the exercise test results provide critical data for the development of an individualized ExRx.[4,5] While, ideally, all able participants would undergo an exercise test prior to commencing with CR, it is important to acknowledge that most CR programs do not routinely perform these tests. However, there is evidence that the use of "ratings of perceived exertion" can be used to effectively guide patients through a HIIT training session.[29,30]

COMORBID MEDICAL CONSIDERATIONS

Participants in CR are often older with significant comorbid medical conditions that impact their capacity to achieve an adequate ExVol.[42] It is not unusual for comorbid conditions in a patient to be more of a barrier to exercise than their heart condition. In general, however, the goals for ExVol are the same, irrespective of age or chronic health conditions.[10] A pre-CR program evaluation is critical in identifying special considerations for prescribing exercise and PA.[4] When indicated, CR professionals need to consider modifications of PA recommendations based on pre-existing conditions. Individuals with chronic conditions or disabilities, who are able, should follow the guidelines and do both AET and muscle-strengthening activities. The PA Guidelines for Americans for adults with chronic conditions or disabilities are no different than for other individuals (i.e. accumulate >150 min/wk) [10] When adults with disabilities are not able to meet the PA guidelines, they should engage in regular PA according to their abilities and avoid inactivity. As previously mentioned, meta-analysis of daily step counts revealed that as few as about 2800 steps/d yield significant mortality and CVD benefits.[22]

For many reasons, the CR setting is an ideal place for individuals with chronic medical conditions to develop an exercise routine that achieves a desired ExVol. Professionals working in CR are very familiar with providing guidance and counsel regarding PA to individuals with chronic medical conditions. Also, CR programs generally have a wide variety of equipment. This enables individuals to avoid exercise that may exacerbate a pre-existing medical condition. Furthermore, individuals may tolerate a few minutes on multiple modalities rather than a prolonged period on a single type of exercise.

While prescribing exercise in the controlled environment of CR with multiple exercise modalities is challenging, finding opportunities for individuals to perform PA away from CR can be difficult. It is important to have a discussion and assess the opportunities and resources that an individual has at their disposal. Often, with thought and creativity, it is possible to identify opportunities for individuals to be physically active in a safe and appropriate manner away from CR (Table 1). At a minimum, individuals should avoid prolonged time in sedentary pursuits.[10] Individuals with chronic medical conditions may be able to tolerate multiple, short bouts of light to moderate exercise. Increasing the frequency of short bouts of PA may be better tolerated than extending an individual session. After a desired total time is achieved through multiple bouts, then time can be extended and the frequency reduced. Because the prescribed intensity is relatively light, exercise done nearly every day may be well tolerated, but close attention to avoid overuse injuries or exacerbation of pre-existing medical conditions is important.

EXERCISE VOLUME AND CVD RISK FACTORS AND DIAGNOSES

Exercise, as a treatment strategy, favorably impacts multiple CVD risk factors including hypertension, dyslipidemia, physical inactivity, obesity, and type 2 diabetes mellitus.[1] While the focus of this Position Statement is on AET, it is important that it is viewed in the broader context of secondary prevention. Optimizing ExVol does not obviate the role of other aspects of secondary prevention including medications, patient education, and psychosocial support. Given the synergistic effects of the different aspects of secondary prevention, it is impossible to directly assess the independent effect of any given intervention, including exercise. Therefore, the goal is to optimize all aspects of secondary prevention.

Table 1

Guidelines for Developing an Exercise Prescription to Optimize the Volume of Exercise

Frequency
• Initially, an every-other-day schedule will allow for an improvement in CRF while providing adequate recovery time
• Eventually, exercise therapy should be viewed as a medicine that is "dosed" nearly every day. Exercise performed nearly every day maximizes the ExVol and solidifies the exercise routine as a habit that will be sustained long-term
Intensity
• Initially, exercise intensity should be "light to moderate" (ie, rating of perceived exertion of "Light" to "Moderate"), which, for most individuals, equates to approximately 60-70% of peak CRF
• As tolerated, increase exercise intensity. For a given amount of time, an increase in exercise intensity will result in a greater ExVol (ie, caloric expenditure)
• There is a need to balance efficiency (ie, caloric expenditure per unit time) with a greater risk of injury or excessive fatigue
• When an individual is unable or unwilling to perform higher intensity exercise, a greater ExVol can be achieved by increasing duration
Type
• At a given intensity, a greater ExVol (ie, caloric expenditure) occurs when the activity performed is not weight-supported and uses the large muscle groups such as treadmill walking vs an arm ergometer in the seated position
• It may be advisable to consider utilizing multiple modalities when first starting an exercise training program, gradually incorporating more weight-bearing modes to enhance the ExVol
• As exercise tolerance improves, higher caloric activities should be substituted for exercise that produces lower caloric expenditures
• Encourage individuals to increase PA separate from exercise by engaging in "lifestyle activities" (eg, taking stairs instead of elevators, utilizing walking or biking as alternative modes of transportation, participating in recreational activities, and avoiding energy-saving devices)
Time
• Initial exercise duration will depend on baseline CRF and current PA level
• To achieve greater ExVol, individuals with low CRF need to exercise for a longer duration
• If an individual chooses to exercise less frequently, then longer duration exercise bouts are necessary to achieve the requisite ExVol

Abbreviations: CRF, cardiorespiratory fitness; ExVol, exercise volume; PA, physical activity.

OVERWEIGHT AND METABOLIC DISEASE

Greater volumes of PA are associated with improvements in metabolic-related risk factors.[43-46] Moreover, a greater volume of PA has been used as an effective intervention to aid individuals in losing weight in CR. Specifically, there have been 2 studies in CR that have used exercise, as a sole intervention, to promote weight loss.[47,48] The ExRx for both these studies included gradually increasing walking distance up to >60 min/session, 5 to 7 d/wk. In both studies, individuals were instructed to maintain their current dietary habits. Individuals in both studies achieved a mean weight loss of 4.5 kg. This exercise and weight loss were associated with favorable effects on the lipid profile, lower insulin levels, and CRF increased by 21%.

To optimize weight loss, CR programs should develop a comprehensive behavioral weight loss approach that includes both exercise and dietary intervention.[49] Ades et al examined the use of high-caloric expenditure exercise *combined* with a hypocaloric diet in the CR setting.[50] Individuals were randomized to either high-caloric exercise training or standard CR exercise. Both groups received dietary counseling. Patients who performed the high-caloric exercise program eventually expended 3000 to 3500 kcal/wk (Figure 1). Over 4 months, individuals in the high-caloric exercise group lost double the weight (8.2 vs 3.7 kg) and double the fat mass (5.9 vs 2.8 kg) as participants who performed standard CR exercise.

LOW CARDIORESPIRATORY FITNESS

Change in CRF is inversely and proportionally associated with mortality risk in individuals with CVD.[51] Targeting improvements in CRF is indicated in that CR participants have significantly lower measures of CRF than an otherwise healthy population.[52] The standard CR ExRx (eg, MCT and volume of <1000 kcals/wk) is associated with a mean increase of 15% to 20% in directly measured CRF.[53] Problematically, however, studies have reported that over 20% of CR participants experience absolutely no improvement in CRF.[18,54]

As described earlier, compared to standard AET (ie, MCT) in CR, a training regimen of HIIT results in significantly greater improvements in CRF. However, the total ExVol for a HIIT session is relatively modest (approximately 250 kcals/session) and is of insufficient volume (unless the exercise is done 6 times/wk) to achieve the level that is associated with halting CVD progression.[31] Moreover, doing HIIT nearly every day would increase the risk of incurring an injury and experiencing fatigue. Developing an ExRx that includes both HIIT with MCT may be appropriate for most CR participants (Table 1). Most CR participants should be encouraged to exercise or, at least, be physically active on their "non-CR days." Therefore, a form of HIIT could be done under the guidance and supervision during "in-person" CR sessions. Concurrently, on the "non-CR" days, individuals should exercise at a light to moderate intensity. While future studies are needed, a combination of HIIT and MCT may be of adequate volume and intensity to improve CRF and optimize CVD risk factors.

HEART FAILURE

For individuals with HF, participation in standard CR is associated with improvements in symptomology, CRF, and quality of life, as well as reduced disability and hospitalization rates.[55] A subgroup analysis of individuals with HF demonstrated a 15% lower mortality rate in those who attended CR compared to a matched cohort who did not attend CR.[56] Accordingly, practice guidelines for HF recognized AET as a class I level recommendation.[57]

The MET level achieved at the end of CR is strongly and inversely associated with all-cause mortality and HF hospitalization. Each 1 MET higher workload at the end of CR was associated with a 42% and 38% lower adjusted risk for all-cause mortality and HF hospitalization, respectively.[58] There are few studies, however, examining the effects of varying ExVol on outcomes. Secondary analysis from HF-Action demonstrated that an ExVol of between 1260 and 1940 MET-min/wk was associated with decreased cardiovascular mortality and HF-related rehospitalization.[59] On the other hand, HF patients participating in HIIT demonstrated a 46% improvement in CRF compared to a 14% increase with MCT.[32] Further study is needed to ascertain the optimal ExVol for individuals with HF.

HEART VALVE DISEASE

CR is associated with decreased 1-year cumulative hospitalization and mortality risk after surgically repaired or replaced heart valve surgery.[60] Heart valve surgery patients achieve similar improvement in CRF from participating in CR exercise training as individuals who had coronary artery bypass surgery.[61] For individuals who are post-transcatheter aortic valve replacement, participation in CR is associated with significant improvements in exercise capacity, functional independence, and frailty.[62] There are observational data that suggest moderate to high levels of PA after heart valve surgery are associated with higher survival rates. Utilizing self-report of PA, the "moderate" category was equivalent to 30 minutes of moderate-intensity PA on most days or 600 MET-min/wk, while the "high" category was equivalent to ≥1 hour of moderate-intensity PA/d or 1500 MET-min/wk.[63]

PRACTICAL CONSIDERATIONS FOR DEVELOPING AN EXRX TO OPTIMIZE EXVOL

Most CR programming is delivered in a hospital or physician-based setting. To expand access to secondary programming, alternative CR delivery models such as hybrid, remote, and virtual have been proposed.[64] While there are key differences in how CR services are provided in the remote or virtual setting vs the hospital setting, the exercise parameters used in alternative programs are the same as those used in center-based programs.[64] Therefore, the goals for optimizing ExVol should be the same, irrespective of the CR delivery model, and many of the practical considerations apply whether an individual is exercising at home or in a hospital. A randomized controlled trial demonstrated that a hybrid model of CR versus standard hospital-based programming resulted in equivalent improvements in exercise capacity and health status.[65]

Table 2

Factors to Consider When Developing Goals for Total Volume of Exercise

Patient Level Factors
• Individual goals and preferences
• Level of self-efficacy regarding exercise
• Commitment or willingness to exercise
• History or experience with PA
• Conflicts for time (eg, family, work)
• Social support
• Diagnosis and cardiovascular disease risk factors
• Availability and accessibility of safe places to exercise or engage in PA away from CR
• Exercise limiting comorbid conditions
• Medical or safety concerns that may preclude exercise done at or away from monitored CR
Programmatic Factors
• Availability of symptom-limited exercise tolerance testing to assess cardiorespiratory fitness
• Limited equipment and space
• Departmental policies, procedures, and philosophy
• Staff knowledge and experience

Abbreviations: CR, cardiac rehabilitation; PA, physical activity.

Table 3

Specific Recommendations for Volume of Exercise in Cardiac Rehabilitation

1. Any level of PA is beneficial, and sedentary pursuits should be minimized. The benefits start to accrue with even low levels of PA done regularly
2. Establishing the proper ExVol involves the integration of frequency, intensity, time, and type of exercise
3. For each patient, specific targets for the ExVol should be identified and individualized
4. Minimum targets to achieve substantial health benefits are ≥150 min/wk of moderate or 75 min/wk of vigorous-intensity PA
5. ~1500 kcal/wk of AET is associated with halting the progression of CVD
6. ~2200 kcal/wk of AET is associated with regression of CVD
7. ~3000 kcal/wk of AET is associated with weight loss
8. 7000-8000 steps/d is associated with CVD risk reduction
9. Optimal benefits are achieved through a combination of higher volume and higher intensity PA

Abbreviations: AET, aerobic exercise time; CVD, cardiovascular disease; ExVol, exercise volume; PA, physical activity.

There are a number of factors that practitioners need to consider when developing targets for the ExVol. Generally, these concerns fall into 2 categories, (1) patient level factors and (2) programmatic concerns (Table 2). From the patient's perspective, achieving the optimal volume of PA is affected by medical issues, motivation, social support, and living environment. It is critical that the CR professional work with the patient in a shared decision-making process to develop strategies to overcome obstacles and barriers.

Programs need to consider alternatives to how services are delivered. Because additional time is needed to achieve higher volumes of exercise, it may require an adjustment to program philosophy and operating procedures. For example, instead of targeting 30 to 40 minutes of AET as a standard for all participants, greater duration should be considered when appropriate. Consequently, increasing the time that certain individuals spend exercising may result in bottlenecks. Furthermore, achieving desired levels of PA will require that most individuals perform some portion of their PA away from CR. Thoroughly tracking progress and providing guidance regarding home PA requires staff time that, heretofore, has been directed elsewhere.

Clinically the typo relevant recommendations are provided in Table 1 to assist CR professionals in developing an ExRx to optimize the ExVol. The recommendations are applicable to essentially all individuals in CR that do not have contraindications to exercise training. A case study has been provided in Supplementary Digital Content, available at: http://links.lww.com/JCRP/A591.

SUMMARY

Exercise and, more broadly, PA are critical elements in the secondary prevention of CVD. It is recognized that participation in CR is associated with enormous health and psychological benefits. While more research is needed to determine the optimal levels of ExVol for the wide variety of individuals and diagnoses in CR, a greater ExVol is associated with more favorable CVD outcomes. Unfortunately, the ExVol typically prescribed in CR is quite modest. Accordingly, most individuals in CR would

potentially benefit from a greater ExVol than is typically prescribed. Specific recommendations for ExVol in CR have been summarized in Table 3. Importantly, higher levels of ExVol are safe, appropriate, and achievable for most participants in CR. Therefore, as a general practice, ExVol should be quantified, and participants in CR should be counseled and encouraged to achieve the volume of PA to optimize secondary prevention. Achieving the higher ExVol that has been described in this Position Statement will require alterations to the traditional CR ExRx, and in some cases, programmatic changes in the way CR services are delivered. It is incumbent on CR professionals to develop strategies to aid participants to successfully achieve volumes of PA that will optimize long-term CVD risk reduction.

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