



Optimal Dose and Modality of Exercise in Patients with Coronary Artery Disease: A Review

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Abstract

Cardiac rehabilitation has established efficacy in reducing mortality in coronary artery disease (CAD) patients. While the optimization of exercise modality and quantity for each patient is still an area of development, the purpose of this clinical review is to look at some of the latest research of such exercise modalities and quantities. We searched for randomized controlled trials and meta-analysis that would compare methods of physical rehabilitation in coronary artery disease patients. The research was critically appraised. We found that interval training is a new method of cardiac rehabilitation exercise that has thus far proven to be safe and efficient in low-risk coronary artery disease patients. Resistance training alone may be an alternative to the traditional combination of aerobic training and resistance training. Resistance training can begin to take a more prominent role in cardiac rehabilitation exercises. Interval training can be used in cardiac rehabilitation of low-risk CAD patients. More research is still needed to refine the optimal dosages and compare modalities of exercise and their mortality benefits.

Keywords: Coronary artery disease; Exercise; Modality

Introduction

Coronary artery disease is still the number one cause of death worldwide at 13.2% of all deaths [1]. As our first responder programs improve and medical technologies advance, the world will continue to see a substantial growth in patients surviving acute coronary events and living with coronary artery disease. With the established effectiveness of cardiac rehabilitation programs, there has been a call for the optimization of the exercise and dose prescribed in cardiac rehabilitation [2-4]. The latest cardiac rehabilitation guidelines have reflected some of this research on optimization of exercise protocols by incorporating resistance training exercises into what once was only an aerobic exercise protocol. The American Heart Association (AHA) guidelines were last update in 2007 for cardiac rehabilitation secondary prevention programs [2]. These guidelines require rigorous methodology for formulating the recommendations, establishing applicability when it comes to implementation, mortality benefits and many other factors [3]. As such, they are often not updated on a year to year basis, however, the current literature must be considered. While establishing the 2007 guide there were sufficient trials to establish the efficacy of cardiac rehabilitation in reducing cardiovascular mortality and to slightly modify them to include resistance training. There was, however, an overall paucity of randomized controlled trials comparing the different modalities of exercise and the frequency and duration to which they should be applied. With increased randomized controlled trials and meta-analysis of such trials, the topic constitutes a second visit. The purpose of this clinical review is to revisit the established exercise guidelines of the AHA and look at what recent literature shows for further refining the optimal dose and modality of exercise in patients with coronary artery disease.

Methodology

The literature was obtained by the databases Cochrane Database of System Reviews, MEDLINE search via pubmed, and CINHALL plus. Search items entered were optimal exercise AND CHD, exercise AND cardiovascular disease, exercise AND coronary artery disease, cardiovascular rehabilitation, exercise modality AND coronary artery disease. The GRADE guidelines regarding hierarchy of evidence were

used in order to critically appraise the articles that were to be used for recommendations [5]. Of the 59 articles only 30 were considered to be used in this clinical review. Other articles were found to be either low or very low quality research and were not considered in the review. Suggestions for treatment will only be made with high GRADE evidence. Only 15 articles were used to make suggestions for treatment. Moderate GRADE may be mentioned in order to stimulate further research on the topic.

Results

Cardiac rehabilitation is a critical component of treating patients with CAD and has a clinically significant impact on cardiovascular mortality [6]. Current research suggests interval training in CAD patients is a safe and more efficient mechanism of improving surrogate markers in low-risk coronary artery disease patients [7-14, 15,16]. Due to insufficient evidence of the morbidity and mortality effects of high-intensity interval training (HIIT) compared to moderate-intensity continuous training (MICT), its use should only be in low-risk CAD patients with medical personal present [17,18]. Resistance training alone has shown promising results to give better peak VO2 markers than standard exercise therapy for CAD patients and may be an alternative for patients who do not wish to do aerobic exercises in the future. With current evidence, resistance training could begin to take a more prominent role by increasing the days per week in cardiac rehabilitation. The guidelines currently being used for repetition number, weight, warm-up and cooldown can be used for the added

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resistance training days until future studies refine these quantities [19]. Emerging research on the effects of patients' characteristics and responses to physical exercise may eventually help us tailor exercise programs and expected results for individual patients [20]. Lastly, the current guidelines are effective at reducing cardiovascular related mortality and home-based rehabilitation is just as effective as center-based lending a safe and possibly more convenient option for patients [2,21,16]. The recommended exercise protocols and summarized key points are noted in [Table 1], Criteria for low-risk Coronary Artery Disease Patients are listed in [Table 2], and Key New Findings Regarding Exercise in Coronary Artery Disease is noted in [Table 3].

Discussion

Cardiac rehabilitation is a multifaceted approach to the care of patients with CAD. It not only includes the component of physical exercise, but also includes counseling in psychosocial, nutritional,

medication, lifestyle, blood pressure, diabetes, smoking and weight management. It is recognized as an integral part of treatment by the AHA, American College of Cardiology and the American Association of Cardiovascular and Pulmonary Rehabilitation [2].

The AHA guidelines for exercise treatment currently recommend an aerobic exercise of frequency 3-5 days/wk, intensity of 50-80% of exercise capacity, a duration of 20-60 mins and modality of any of the following: walking, treadmill, cycling, rowing, stair climbing, arm/leg ergometry. These exercises can be done in continuous or interval training. A resistance component is also recommended with all cardiac rehabilitation programs. The frequency in the AHA is 2-3 days/wk and modality can include any of the following: calisthenics, elastic bands, cuff/hand weights, dumbbells, free weights, wall pulleys or weight machines. All exercises are advised to include a warm-up, cooldown and flexibility exercises of unspecified duration [2].

		Mode of Exercise	Frequency	Duration	Intensity
1	Low-Risk CAD pts* Supervised by medical professionals	Aerobic: Treadmill, cycling, stair climb or arm/leg ergometry Resistance: Calisthenics, elastic bands, dumbbells, weights, wall pulleys, or weight machine	2-3 days/wk 3-5 days/wk	20-40 mins 2-4 sets, 10-15 reps, 8-10 different muscle groups including upper and lower body	Intervals 4 mins high 85-95% PHR 3 mins moderate 70% PHR. 10 min warm-up at 60% PHR and 5 min cooldown 50% PHR Upper body: 30-40% 1 RM Lower body: 50-60% 1 RM
2	Post CABG pts (>6wks and <12 months)**	Aerobic: Treadmill, cycling, stair climb or arm/leg ergometry After 3 months begins Resistance: Calisthenics, elastic bands, dumbbells, weights, wall pulleys, or weight machine	2-3 days/wk 3-5 days/wk	20-40 mins 2-4 sets, 10-15 reps, 8-10 different muscle groups including upper and lower body	Moderate-intensity continuous 50-80% PHR. 15 min warm-up and 10 min cooldown Upper body: 30-40% 1 RM Lower body: 50-60% 1 RM
3	Post MI pts (<4 wks)	Aerobic: Treadmill, cycling, stair climb or arm/leg ergometry Resistance: Calisthenics, elastic bands, dumbbells, weights, wall pulleys, or weight machine	2-3 days/wk 3-5 days/wk	20-40 mins 2-4 sets, 10-15 reps, 8-10 different muscle groups including upper and lower body	Moderat- intensity continuous 50-80% PHR. 15 min warm-up and 10 min cooldown Upper body: 30-40% 1 RM Lower body: 50-60% 1 RM
4	Post PCI pts (<12 months)	Aerobic: Treadmill, cycling, stair climb or arm/leg ergometry Resistance: Calisthenics, elastic bands, dumbbells, weights, wall pulleys, or weight machine	2-3 days/wk 3-5 days/wk	20-40 mins 2-4 sets, 10-15 reps, 8-10 different muscle groups including upper and lower body	Moderate intensity continuous 50-80% PHR. 15 min warm-up and 10 min cooldown Upper body: 30-40% 1 RM Lower body: 50-60% 1 RM
5	Unstable Angina	No exercise Pt will need PCI or CABG prior to Cardiac Rehabilitation			

6	Exercise induced Angina	Aerobic: Treadmill, cycling, stair climb or arm/leg ergometry	2-3 days/wk	20-40 mins Stop if symptoms of angina, sit and take nitro	Moderate- intensity continuous 50-80% PHR. 15 min warm-up and 10 min cooldown Upper body: 30-40% 1 RM Lower body: 50-60% 1 RM
		Resistance: Calisthenics, elastic bands, dumbbells, weights, wall pulleys, or weight machine	3-5 days/wk	2-4 sets, 10-15 reps, 8-10 different muscle groups including upper and lower body Stop if symptoms of angina, sit and take nitro	

see table 2 for characteristics of low risk Formal exercise with cardiac rehabilitation is not to begin until 6 weeks after CABG if no sternal complications or when CT surgeon deems appropriate. Prior to this rehabilitation can begin with light walking, light hand weights <3 lbs, Resistance training starts at 3 months

Table 1: Recommended exercise programs for coronary artery disease patients.

unstable angina pectoris
uncompensated heart failure
recent myocardial infarction (<4 weeks ago)
recent coronary artery bypass graft (<12 months)
recent percutaneous coronary intervention (<12 months)
heart disease that limits exercise (valvular, congenital, ischemic and hypertrophic cardiomyopathy)
complex ventricular arrhythmias or heart block
severe chronic obstructive pulmonary, cerebrovascular disease or peripheral vascular disease,
uncontrolled diabetes mellitus
blood pressure >180/110
severe neuropathy.

Table 2: The criteria for low risk coronary artery disease patients.

The Association of Chartered Physiotherapist in Cardiac Rehabilitation guideline is used by the National Institute for Clinical Health and Excellence. This guideline recommends cardiovascular fitness exercise 2-3 days/wk at an intensity of 40-70% heart rate reserve for 20-60min continuous or interval plus 15 min warm-up and 10 min cooldown. The cardiovascular fitness is defined in this case as large muscle groups worked rhythmically. Muscle strength and endurance training is recommended at 2-3 days/wk to include both upper and lower body. Upper is recommended at 30-40% of 1 repetition maximum (RM) and lower body is recommended at 50-60% 1RM. It is recommended that these strength exercises are performed at 2-4 sets of 10-15 reps in 8-10 different muscle groups [22].

In both of the guidelines mentioned above, the quantification of resistance training is based largely on studies of healthy populations, with few recent head-to-head RCTs of CAD patients and different dosages [2, 22]. In regards to comparing the different modalities of aerobic exercise, a few large cohorts have shown greater risk reductions of future CAD from running/jogging over other modalities such as swimming, rowing or other modalities. The prescriptions used give more emphasis to running aerobic exercise as compared to others reflecting these cohorts; however, as was the case with resistance training there is a paucity of RCTs that compare the benefits of specific modalities in patients with established CAD [2, 22,23]. Interval length and intensity is a paucity of more un quantified measures used in the guidelines for cardiac rehabilitation. These points of questionable quantity and efficacy have opened opportunities for further trials to possibly improve the efficacy of the cardiac rehabilitation as we had seen recently with the addition of resistance training [2,6,24,20].

One interesting example of this was a meta-analysis in 2015 that

compared resistance training exercises without aerobic exercises compared to usual cardiac rehabilitation [19]. The usual cardiac rehabilitation in this case included either only aerobic training or aerobic training with resistance training. 22 trials totaling 1095 patients were analyzed and the results showed a statistically significant increase in exercise capacity in both middle aged (<65 years) and elderly (>65 years) measured by peak oxygen uptake (peak VO2) when compared to the controls (.92ml/kg/min, 95% CI: .012 to 1.72). This mechanism also had added benefit of increasing mobility in the elderly by a statistically significant margin compared to the control [19]. Peak oxygen uptake has traditionally been a strong predictor of cardiovascular mortality in patients with CAD [20]. This meta-analysis suggests that changes may need to be made to favor more time spent in resistance training than in aerobic exercises. Further studies need to be attained to look at the morbidity and mortality in patients undergoing resistance training only programs.

A Cochrane Review in 2014 looking at exercise-based cardiac rehabilitation in 14,486 patients showed a statistically significant reduced risk of cardiovascular mortality compared with no exercise groups (RR 0.74 95% CI: 0.64 to 0.86) [6]. There was also a reduced risk in hospital readmission and health-related quality of life measures showed significant improvement in the cardiac rehabilitation program patients. Interestingly, in this study the benefits were determined to be independent of the dose of exercise [6]. A long-term RCT evaluating the outcomes after cardiac rehabilitation for different doses of 40 versus 60 minute exercise training corroborated the dosage evidence found in the Cochrane Review [25].

Interval training has become a popular trend of aerobic exercise in the sports world due to its efficacy in burning calories in short periods

1	Interval training produces greater increases in peak VO2 with less time than traditional moderate intensity continuous training [16-19].
2	Interval trials using shorter times (60 seconds x 60 seconds) have shown less increase in peak VO2 compared to trials using longer intervals (4 mins x 3 mins) [17].
3	Resistance training alone in recent RCTs has been shown to increase peak VO2 more than traditional moderate intensity continuous training or moderate intensity continuous with resistance training with the added benefit of increased mobility in elderly (> 65) [11].
4	40 vs 60 mins of aerobic exercise has shown no difference in morbidity or mortality [8,12].
5	Home-based cardiac rehabilitation is just as effective at reducing morbidity and mortality as center-based programs [28,30].

Table 3: Key new findings regarding exercise in coronary artery disease.

of time. This trending exercise technique has made its way into cardiac rehabilitation programs as can be seen in the AHA guideline as well as others [2,22]. It is still a new technique in CAD patients and thus research on this exercise modality has in recent years been increasing. Most of the interval exercises in small RCTs use an 80-90% heart rate reserve as the high-intensity interval training “HIIT” with a 60-80% heart rate reserve for the moderate-intensity continuous training (MICT) [7-10]. The duration of intervals differs amongst the studies. In one meta-analysis comparing high-intensity interval training with moderate-intensity continuous training in 273 patients with CAD, a significant increase in VO2 peak was seen in HIIT compared to MICT (MD 3.03 ml/kg/min 95% CI 2.00-4.07) [11]. Using this meta-analysis and looking at the different levels of effects from differing interval regimens, the authors suggested the most effective interval regimen according to available data. They recommended a frequency of 3x/wk, duration of 40 min total to include intervals of 4 min high-intensity at 85-95% peak heart rate (PHR) alternated with 3 min rest phase of 70% PHR. This is to include a 10 min 60% PHR warm-up and a 5 min 50% PHR cooldown [11]. In another meta-analysis of high-intensity interval versus moderate-intensity continuous training in patients with CAD that included 472 patients, VO2 peak was significantly higher in the high-intensity interval versus the moderate-intensity continuous training. The moderate intensity continuous training group, however, had a statistically significant decrease in resting heart rate and body weight as compared to the high-intensity interval training group. No measures of morbidity, mortality or health-related quality of life were taken for this meta-analysis, however several meta-analysis and RCTs have shown similar results in VO2 improvements [10-13].

In a large multicenter randomized study morbidity, mortality and quality of life factors were considered in addition to VO2 peak while comparing aerobic interval training versus continuous training programs in CAD patients [14]. This study had 200 CAD patients performing cardiac rehabilitation at 3 days/wk for a 12 week study. The intervals were preceded by 10 min warm-up and consisted of 4 mins high-intensity (90-95% peak HR) followed by 3 min of 50-70% peak HR. The continuous training was preceded by a 5 min warm-up and 5 min cooldown and continuous exercise for 37 min for a total time of 47 min. The intervals were less total time at 38 mins. Both groups tested improved peak VO2, peripheral endothelial function and quality of life factors equally, however there was no difference between the two groups tested. No adverse events including all-cause mortality, ventricular arrhythmias or hospitalizations occurred during the training sessions [14]. This study contradicts the findings of the prior mentioned meta-analysis of interval training [12,14]. The interval averages of the meta-analysis may have been longer in comparison to this prior study leading to the divergence in results. Also the total duration of exercise was different amongst the two groups. This further supports the need for research quantifying the interval ratios and durations.

Although the studies discussed here have suggested little or no adverse events reported in HIIT, a recent study that showed a cardiac arrest rate of 1/129456 hours of traditional MICT versus a cardiac arrest

rate of 1/23182 hours of HIIT raised the issue of continued study before full implementation into all CAD patient exercises [17]. This difference was not statistically significant because the study was not significantly powered and there were only a total of 3 cardiac arrests in the combined groups [17]. Because of the raised concerns of the intensity of exercise causing arrhythmias or myocardial damage and the extensive exclusion criteria used in such HIIT exercises studies, one of the meta-analysis suggested contraindications to HIIT. These are summarized in Table 2 [11].

Water-based training is a modality of interest to researchers due to the enjoyment that many patients obtain during this form of cardiac rehabilitation exercise. A small RCT compared aerobic and resistance training on land with traditional methods of treadmill, cycling and dumbbell weights [26]. The water-based exercises include a water treadmill for walking, jogging, running and resistance exercises of chest press, squats, calf lifts with water equipment. The end points measured of body composition, strength, and hemodynamic parameters were all improved in both groups with no significant difference between the groups [26]. This was a small study and would require more RCTs to evaluate the safety and efficacy of water-based exercise as compared to traditional cardiac rehabilitation. There have been some concerns raised in a study showing increased incidence in cardiac ventricular ectopic beats and supraventricular ectopic beats related to cold water exercises in patients with CAD [27]. None of the arrhythmias were accompanied by symptoms or the need for treatment. Larger RCTs need to be performed to distinguish any morbidity or mortality from this finding.

Pursuing the effects of alternative exercises and their impact specifically on coronary heart disease patients could yield improvements in cardiovascular mortality. One meta-analysis on the impact of different exercise modalities and divergent restructuring of the heart muscle in healthy athletes suggests that certain exercise modalities will restructure the heart differently [28]. Thus some exercises may be better suited for the CAD patient. A recent observational study looked at the effects endurance exercises of rowing and running and the divergent cardiac remodeling accompanied by each [29]. No randomized trials to my knowledge have looked at the impact specific sports have on a CAD patient’s heart. This is an area where future research could prove very helpful.

Another study of 106 patients with CAD found a high negative correlation between age and monitored clinical parameters such as blood pressure, peak VO2 [20]. Producing more data in this area could improve the provider’s ability to prescribe the optimal exercise dose for a given patient. As was seen in a study looking at jogging dose and long term mortality in healthy patients, exercise beyond certain parameters may increase mortality from other causes [30]. Looking at a prospective cohort of 2,377 CAD patients demonstrated the benefits of running or walking in regards to CVD mortality were abated at very high levels of running or walking (3.2 fold increase in CVD mortality for >7.1 metabolic equivalent task hours/day P=.006) [31]. This is why finding

the optimal dose of the exercise modalities we prescribe would be in the best interest of our patients.

Regardless of modality and dose of exercise training, the most important objective is to enroll the patient in cardiac rehabilitation if they have CAD. The Cochrane Review showed that there was no difference in mortality or exercise capacity at 12 months follow up in center-based programs versus home-based programs [21]. The alternative exercise plans of aerobic-interval training and high-intensity intervals at home in two randomized control trials did not show any differences from controlled center-based program in clinical parameters [15,16]. The high-intensity program was proven to be safe, with no arrhythmias or signs of ischemic events during training at home with medical professionals [15]. This offers a viable option for patients who may rather be in the comfort of their own home.

Conclusions

Exercise is important to reducing future morbidity and mortality in patients with coronary artery disease. Specifically, aerobic exercise, including use of high-intensity interval training, is offering a safe and efficient option in low-risk patients. Also, resistance training is important to strengthen muscle groups, stabilize joints, and improve mobility. More research is needed to determine which specific doses and modalities of exercise can bring the most benefits to this patient group.

References

1. Organization, W.H. (2012-2016) The Top 10 Causes of Death.
2. Balady GJ (2007) Core components of cardiac rehabilitation/secondary prevention programs: update: a scientific statement from the American Heart Association Exercise, Cardiac Rehabilitation, and Prevention Committee, the Council on Clinical Cardiology; the Councils on Cardiovascular Nursing, Epidemiology and Prevention, and Nutrition, Physical Activity, and Metabolism; and the American Association of Cardiovascular and Pulmonary Rehabilitation. *Circulation* 115: 2675-2682.
3. Seron P (2015) Evaluation of the quality of clinical guidelines for cardiac rehabilitation: a critical review. *J Cardiopulm Rehabil Prev* 35: 1-12.
4. Thompson PD (2005) Exercise prescription and proscription for patients with coronary artery disease. *Circulation* 112: 2354-2363.
5. Guyatt G (2011) GRADE guidelines: 1. Introduction- GRADE evidence profiles and summary of findings tables. *J Clin Epidemiol* 64: 383-394.
6. Anderson L (2016) Exercise-Based Cardiac Rehabilitation for Coronary Heart Disease: Cochrane Systematic Review and Meta-Analysis. *J Am Coll Cardiol* 67: 1-12.
7. Warburton DE (2005) Effectiveness of high-intensity interval training for the rehabilitation of patients with coronary artery disease. *Am J Cardiol* 95: 1080-1084.
8. Keteyian SJ (2014) Greater improvement in cardiorespiratory fitness using higher-intensity interval training in the standard cardiac rehabilitation setting. *J Cardiopulm Rehabil Prev* 34: 98-105.
9. Currie KD (2013) Low-volume, high-intensity interval training in patients with CAD. *Med Sci Sports Exerc* 45: 1436-1442.
10. Elliott AD (2015) Interval training versus continuous exercise in patients with coronary artery disease: a meta-analysis. *Heart Lung Circ* 24: 149-157.
11. Weston KS, Wisloff U, Coombes JS (2014) High-intensity interval training in patients with lifestyle-induced cardiometabolic disease: a systematic review and meta-analysis. *Br J Sports Med* 48: 1227-1234.
12. Liou K (2016) High Intensity Interval versus Moderate Intensity Continuous Training in Patients with Coronary Artery Disease: A Meta-analysis of Physiological and Clinical Parameters. *Heart Lung Circ* 25: 166-174.
13. Wisloff U (2007) Superior cardiovascular effect of aerobic interval training versus moderate continuous training in heart failure patients: a randomized study. *Circulation* 115: 3086-3094.
14. Conraads VM (2015) Aerobic interval training and continuous training equally improve aerobic exercise capacity in patients with coronary artery disease: the SAINTEX-CAD study. *Int J Cardiol* 179: 203-210.
15. Aamot IL (2014) Home-based versus hospital-based high-intensity interval training in cardiac rehabilitation: a randomized study. *Eur J Prev Cardiol* 21: 1070-1078.
16. Moholdt T (2012) Home-based aerobic interval training improves peak oxygen uptake equal to residential cardiac rehabilitation: a randomized, controlled trial. *PLoS One*.
17. Rognum Ø (2012) Cardiovascular risk of high- versus moderate-intensity aerobic exercise in coronary heart disease patients. *Circulation* 126: 1436-1440.
18. Levinger I (2015) What Doesn't Kill You Makes You Fitter: A Systematic Review of High-Intensity Interval Exercise for Patients with Cardiovascular and Metabolic Diseases. *Clin Med Insights Cardiol*, 9: 53-63.
19. Yamamoto S (2015) Effects of resistance training on muscle strength, exercise capacity, and mobility in middle-aged and elderly patients with coronary artery disease: A meta-analysis. *J Cardiol*.
20. Vysoky R (2015) Preventive training programme for patients after acute coronary event- correlation between selected parameters and age groups. *Cent Eur J Public Health* 23: 208-213.
21. Dalal HM (2010) Home based versus centre based cardiac rehabilitation: Cochrane systematic review and meta-analysis. *BMJ* 340: b5631.
22. Excellence, N.I.f.H.a.C (2015) Secondary Prevention in Primary and Secondary Care for Patients Following a Myocardial Infarction in NICE Clinical Guideline 48.
23. Tanasescu M (2002) Exercise type and intensity in relation to coronary heart disease in men. *JAMA* 288: 1994-2000.
24. Marzolini S (2008) Aerobic and resistance training in coronary disease: single versus multiple sets. *Med Sci Sports Exerc* 40: 1557-1564.
25. Hansen D (2010) Long-term effect of rehabilitation in coronary artery disease patients: randomized clinical trial of the impact of exercise volume. *Clin Rehabil* 24: 319-327.
26. Volaklis KA, Spassis AT, Tokmakidis SP (2007) Land versus water exercise in patients with coronary artery disease: effects on body composition, blood lipids, and physical fitness. *Am Heart J* 154: 560.e1-560.e6
27. Korzeniowska KI, Bilinska M, Wasilewska BD, Baranowski R, Piotrowicz E, et al. (2015) The Influence of Water-based Training on Arrhythmia in Patients with Stable Coronary Artery Disease and Preserved Left Ventricular Function. *Cardiol J Cardiology Journal*
28. Pluim BM (2000) The athlete's heart. A meta-analysis of cardiac structure and function. *Circulation* 101: 336-344.
29. Wasfy MM (2015) Endurance Exercise-Induced Cardiac Remodeling: Not All Sports Are Created Equal. *J Am Soc Echocardiogr* 28: 1434-1440.
30. Schnohr P (2015) Dose of jogging and long-term mortality: the Copenhagen City Heart Study. *J Am Coll Cardiol* 65: 411-419.
31. Williams PT, Thompson PD (2014) Increased cardiovascular disease mortality associated with excessive exercise in heart attack survivors. *Mayo Clin Proc* 89: 1187-1194.