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VIEWPOINT

Exercise, Sports & Cardiovascular Health: Relevant Questions and Answers

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Introduction

Currently, it is quite common for a clinical cardiologist to be questioned about exercise and sports, topics that are rarely discussed during formal medical education. In this regard, there is a clear need to access high-quality data and evidence-based information to give patients and family members the best advice.

Aiming to present the state-of-the art scientific information on the topic, we have invited several experts from different countries, all of them "knowledge-producers" in exercise and sports cardiology, to contribute with their expertise by answering specific and relevant questions in the matter. The answers were limited to about 250 words and they were asked to preferentially refer to their own publications.

This is an innovative type of scientific paper – questions & answers (Q&A) format -, in which all contributors are listed as coauthors in the paper, but for each one of the answers the responder is clearly identified.

Keywords

Exercise; Sports; Exercise Movement Techniques; Muscle Strenght; Hypertension; Preventive Health Care; Exercise Therapy.

Exercise should be a lifelong habit: from childhood to the elderly individual

Barry A. Franklin

Q: There is a well-established consensus that regular exercise is beneficial for mental and physical health. It is also well-recognized that regularity of exercise is an important issue. Notwithstanding, most of the interventional physical activity studies are short-term, most of them rarely exceeding months or one year and, indeed, we do not know very much about the effects of lifelong exercise habits. In addition, it is already known that aerobic and non-aerobic (i.e., muscle strength, flexibility, balance) fitness tends to decrease with aging. So, in a clinical practice setting and based on the most recent evidence, what advice should the cardiologist give about the amount and the intensity of regular weekly exercise for his (her) aging patients? Should they maintain, reduce or increase the exercise dose over the decades for maximal clinical benefit?

A: Both regular physical activity (PA) and higher levels of cardiorespiratory fitness (CRF) are associated with a reduced risk of developing hypertension, type 2 diabetes mellitus, atrial fibrillation, chronic kidney disease, heart failure, and cardiovascular events.[1] Each 1-MET increase in exercise capacity is associated

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with a ~15% reduction in mortality in patients with and without cardiovascular disease. Indeed, a recent landmark study reported that the most physically active cohorts of men and women demonstrated 7- to 8-year gains in life expectancy.[2] Increased levels of habitual PA prior to hospitalization for acute coronary syndromes are also associated with better short-term cardiovascular outcomes. In contrast, individuals with low CRF have higher annual health care costs, higher rates of surgical complications, and are more likely to die prematurely than their matched counterparts.

Although arterial dysfunction has been widely considered a marker of age-associated cardiovascular disease, regular aerobic exercise inhibits large artery stiffening and preserves endothelial function. Increased CRF in middle-age is also associated with a lower risk of developing heart failure, regardless of the body mass index.[3]

Vigorous PA (≥ 6 METs) appears to be superior to moderate-intensity exercise (3.0 to 5.9 METs) in promoting health benefits. However, patients should be counseled to augment their CRF by starting with level walking at a 2.4 to 4.8 km/h pace and gradually progress to more vigorous exercise, provided they remain asymptomatic. Aerobic exercise should be complemented with flexibility and resistance training. Although some studies suggest that high intensity interval training (HIIT) elicits greater increases in CRF than moderate intensity training, concerns regarding the safety of HIIT in "at risk" patients suggest that it should be cautiously prescribed.[4] Vigorous PA appears to be superior to moderate-intensity exercise in promoting health benefits.

Cardiorespiratory fitness (CRF) as a prognostic marker for sudden cardiac death and all-cause mortality

Jari Laukkanen

Q: It is already known that high levels of CRF are related to longer life expectancy. On the other hand, sudden cardiac death, always a very dramatic event, is a rare event that is often difficult to be prevented. What do you currently know about the possible influence of a high CRF on the incidence of sudden cardiac death and if there is such influence, what are the most probable mechanisms involved?

A: Sudden cardiac death (SCD) is a devastating event which has a profound effect on the families affected, and it is an ongoing challenge for physicians, healthcare providers and global economies. Previous evidence supports the concept that modulation of risk factors would provide pivotal ways of preventing SCD in the general population.[5] However, measurements of functional capacity, such as CRF, are correlated with risk for SCD. CRF has been suggested as a strong predictor of SCD in the population and considered a vital marker in patient risk assessment.[6] Our study group has recently found early evidence on the association between good CRF and lowered risk of serious ventricular arrhythmias.[7] We have also found that a good CRF may attenuate the risk of SCD in overweight/obese men, suggesting that a good CRF may reduce the risk of SCD in high risk subjects.[8] In our prospective population study,[5] VO_{2peak} yielded only a modest improvement in SCD risk prediction, and there was a slight improvement in the level of discrimination on the top of cardiovascular risk factors and other confounders. However, further evidence is needed to know to which extent the incremental prognostic information offered by the assessment of CRF aids in risk stratification and prevention of SCD.

Changing from low to high CRF improves clinical prognosis

Jari Laukkanen

Q: An adult with high levels of cardiorespiratory (aerobic) fitness tends to live longer and better. CRF is known to depend on both genetic traits and regular exercise pattern. Unfortunately, most of subjects in the world are either sedentary or have insufficient exercise to keep or to get high CRF levels. So, from a practical viewpoint, is it always time to try to adopt an exercise plan to improve CRF levels or is there an age limit for this? If a previously sedentary patient gets to improve the CRF with exercise training, will this have a positive effect on his/her long-term clinical outcomes?

A: Almost all previously sedentary patients are able to improve their CRF with exercise training and benefit from it considering long-term outcomes. We just need to find the most suitable exercise therapy mode for specific patient groups.

CRF is related to the ability to transport oxygen from the lung to the mitochondria during exercise, regardless of the individual's age. It is known that CRF depends on a chain of processes in multiple organs, including pulmonary ventilation, vascular function, left and right ventricular function, the ability of the vasculature

to transport blood from the heart to meet the oxygen requirements, the ability of muscle cells to use the oxygen and other essential nutrients delivered by the blood. Indeed, the efficiency of this system is only partly related to aging.[6]

When evaluating existing knowledge in exercise medicine, we need to know the difference in findings derived from observational studies as compared with possible effects of exercise interventions on death, myocardial infarction and stroke.[6] An important question is how physicians should deal with individuals who have low CRF level. Should we carry out diagnostic examinations to find out the possibly underlying early disease stages reducing fitness or should we just prescribe exercise training to improve CRF and possibly reduce the risk of death? When comparing the prognosis of physically active versus inactive individuals to prevent serious adverse events, we should understand that many measurable or immeasurable factors are associated with physical activity level even before the intervention or follow-up was started.

CRF is related to reduced health costs

Jonathan Myers

Q: It is widely recognized that a high cardiorespiratory (aerobic) fitness in middle-aged and older men and women is strongly related to many important health outcomes. A substantial amount of years of life and life to years is gained with regular exercise and, as a natural consequence, CRF is improved. Additionally, healthier people tend to use less regular medication and to have lower chances to be hospitalized for chronic diseases. In a time of growing interest in reducing and controlling medical expenses, what is already known about the relationship between CRF and health costs?

A: It is correct that there is a growing body of research on the impact of CRF and health outcomes, and it makes intuitive sense that a fitter individual would have lower healthcare costs. While there has been quite a bit research performed on the impact of physical activity patterns (or more often, corporate wellness programs) on healthcare costs, surprisingly few data are available regarding the association between fitness and healthcare costs. In an era in which there is increasing focus on reducing healthcare costs, it is also surprising that there has been so little attention paid to the potential impact of fitness on costs, given that it so powerfully influences health outcomes.

The effect of fitness on healthcare costs has recently been documented by the Cooper Institute[9] and the Veterans Exercise Testing Study (VETS).[10,11] After controlling for age and the presence of co-morbidities, these studies demonstrate that fitter subjects have markedly lower health care costs compared to those who are less fit. Both groups observed that each 1-MET higher fitness level was associated with approximately 5-7% lower annual costs over lengthy follow-up periods; in the VETS cohort, this represented ≈$1,600 USD lower annual health care costs per higher MET.[11] Much like cardiovascular and all-cause mortality, a small improvement in fitness has a considerable effect on costs. In addition to its effect on health outcomes, improving fitness through regular physical activity should be encouraged for its potential to lower health care costs.

Cardiovascular diseases and indication for exercise training

Claudio Gil Araújo

Q: According to several institutional guidelines, exercise training has been recommended as part of the treatment of patients with coronary artery disease and heart failure. Notwithstanding, it is possible that patients with several other cardiovascular disorders could benefit from exercise training programs. Is it time to extend exercise training prescription as an important therapeutic strategy to cardiovascular disorders other than ischemic heart disease and heart failure?

A: This is 100% true. While there is a large body of evidence showing many relevant benefits of different modalities of exercise training (either alone or in combination with other lifestyle and/or behavioral interventions) for patients with coronary artery disease or heart failure, there are also recent observational studies showing that patients with other cardiovascular diseases – including valve or vascular patients[12] – could also benefit from exercise training. So, for a given patient with a specific cardiovascular disorder, the question would be how to prescribe the most appropriate, individualized exercise program, with a high benefit-risk ratio based on functional assessment results. Competent expertise and knowledge of exercise sciences are basic requirements to prescribe the best, most viable and individually tailored exercise regimen.

Indeed, in the clinical scenario, it is very rare to find a patient to whom all types of exercises would be formally prohibited or contraindicated. Complete avoidance of

exercise would always be an exception and it should be restricted to very special cases and often for a very limited period of time.[13]

Non-aerobic fitness as a valuable prognostic marker for all-cause mortality

Claudio Gil Araújo

Q: For several decades, exercise prescription for cardiac patients was primarily based on aerobic exercises, such as slow and brisk walking, running, cycling, swimming and rowing. Other types of exercise were undervalued and hence, poorly quantified. This approach was based on consistent research studies that identified cardiorespiratory (aerobic) fitness as well as regular aerobic exercise as strongly related to favorable healthy outcomes, including better health-related quality of life and all-cause mortality. More recently, several studies have shown that non-aerobic fitness is also very important for health and even possibly associated to survival. Should non-aerobic fitness be regularly assessed during physical examination or clinical evaluation?

A: Recently, the American Heart Association has suggested that the cardiorespiratory (aerobic) fitness, ideally measured by cardiopulmonary exercise testing, should be considered as a clinical vital sign.[1] On the other hand, there are recent data indicating that, especially in older subjects, adequate or above the sex- and age-median values of non-aerobic fitness – muscle strength/power, flexibility, balance and body composition – are strongly associated with all-cause mortality.[14,15]

Some years ago,[15] using the sitting-rising test (SRT) – a simple, reliable and safe assessment tool for simultaneous evaluation of the four non-aerobic components of physical fitness –, we were able to show that low SRT scores (SRT composite scores from 0 to 3) resulted in a five times higher mortality in middle-aged and older subjects in the following six years as compared with good SRT scores (SRT composite scores from 8 to 10). Indeed, among those scoring 10 – able to sit and rise from the floor without showing unsteady performance and without using hand or knee for support –, the all-cause mortality rate was extremely low.[15] More recently, we have presented preliminary results indicating that maximal muscle power relative to body weight, one of the components of both non-aerobic and musculoskeletal fitness, is also strongly related to all-cause mortality.[14]

It is interesting to point out that, when comparing the top and bottom quartiles of data distribution, the relative risks were extremely high (5 to 10 times higher), depending on the variable and sex of the subjects. It is worthwhile to note that these very high relative risks are considerably higher than those usually seen in studies on classical risk factors for coronary disease, such as hypertension, dyslipidemia and family history.

In summary, yes, it is time to incorporate the assessment of non-aerobic fitness as a valuable clinical tool in nearly all populations. Perhaps, the recently published sex- and age- reference values for SRT could be useful in this context.[16]

Isometric handgrip training as an important strategy to treat hypertension

Philip J. Millar

Q: Some decades ago, adult hypertensive patients were advised not to carry weights, including grocery bags or their own children or grandchildren, negatively affecting their quality of life. Exercises with a significant isometric (static) component were particularly forbidden. However, several experimental and epidemiological studies have shown that resistance exercises were not so risky and, indeed, could be beneficial for hypertensive patients. Recently, a special exercise protocol called isometric handgrip training (IHT) has been proposed to reduce systolic and diastolic resting blood pressure. Is there good evidence to recommend IHT to treat hypertensive patients and if so, is there any group of patients that will respond more favorably to IHT?

A: Initial fears over completing isometric exercise were related to the potential for increased blood pressure responses and increased risk for a cardiovascular event.[17] However, short duration isometric contractions at low-to-moderate intensities (e.g. 1-2 minutes at 30-50% of maximal voluntary contraction) produce blood pressure responses in line with those observed during dynamic aerobic exercise.[18] Also, submaximal isometric exercise may be associated with a lower rate-pressure product (less myocardial oxygen demand) and a higher diastolic blood pressure response (greater coronary perfusion pressure), which together, would lower the risk of exercise-induced myocardial ischemia compared with a similar-intensity dynamic exercise.[18]

Over the last 25 years, a number of research groups around the globe have shown that submaximal IHT (or isometric leg exercise) can reduce resting blood pressure in both normotensive and hypertensive populations. A recent meta-analysis of 16 randomized control trials

found significant reductions in systolic blood pressure (~5 mmHg) and mean arterial pressure (~3 mmHg) – similar reductions to those reported with aerobic exercise training.[19] Reductions in resting blood pressure with IHT seem to be similar between men and women,[19] but whether certain classes of antihypertensive drugs affect IHT efficacy remains unknown. It is also important to note that while IHT may lower resting blood pressure, it is also unclear whether it can modify additional cardiovascular risk factors (e.g. CRF, insulin sensitivity) known to be benefited from aerobic exercise.[18] As a result, the present data supports IHT as an adjuvant exercise-based intervention for hypertensive patients with indications for a similar-intensity dynamic aerobic exercise program.

Exercise and sports competition in hypertensive patients

Josef Niebauer

Q: Until recently, participation in most competitive sport and/or recreational long-distance events (i.e., marathon, triathlons, etc.) was often prohibited for hypertensive patients, even for well-controlled patients. Regarding this very practical and relevant clinical question, where do we stand in 2019? Is it better for hypertensive patients to avoid sports competition, or is it possible to give these patients evidence-based advice and allow them to participate in competitions in a safe way, in terms of risk for cardiovascular events?

A: Current guidelines of the European Society of Cardiology advocate regular physical activity as a class IA recommendation for the prevention and treatment of cardiovascular disease.[20] Nonetheless, competitive athletes with arterial hypertension may be exposed to an increased risk of cardiovascular events. Therefore, timely identification of hypertensive individuals is paramount in the setting of pre-participation screening, in order to implement a healthier lifestyle, appropriate management and follow-up. Therefore, it is not so much a question of whether or not athletes should train for and participate in long-distance sporting events, it is more about identifying and treating arterial hypertension to target levels. Indeed, it is endurance exercise that has been shown to have the most beneficial effects not only in hypertensive subjects, yet another reason to train for and participate in long-distance races, in those whose blood pressure has reached normal values, with or without medication. If drugs are needed, angiotensin-converting enzyme inhibitors and angiotensin II receptor blockers are the preferred choice as they do not affect exercise capacity and are not on the doping list. However, they shall not be given to females during reproductive years, because of potential adverse fetal/neonatal effects. While eligibility for competitive sports may have to be restricted if target organ damage is present, an athlete with well-controlled blood pressure, having no additional risk factors or target organ damage, is eligible for competition in all sports. Details can be found in Niebauer et al.,[21] there, a figure can be found on sport disciplines divided according to acute physiologic responses (i.e. heart rate and blood pressure) and long-term impact on cardiac output and remodeling, which is very helpful when recommendations on the type of sports have to be given.

Cardiac function and markers after marathon running: the correct interpretation

Jurgen Scharhag

Q: Popular participation in long-distance mass events, such as half-marathon, marathon, road cycling, open-water swimming, IronMan etc, has exponentially increased the number of participants in the recent years. Even more interesting, a larger participation of women and a widening in the age of participants – including adolescents and very old subjects – has also been noted. On the other hand, there are several studies suggesting that cardiac markers of undue stress – both biochemical and functional – are triggered by prolonged exercise on the heart of these participants. Do these cardiac markers have clinical relevance or, placing the question from a different perspective, should the cardiologist request any laboratory and imaging tests after the patient completed a mass, recreational sports event?

A: During the last two decades, an increasing number of scientific examinations on the effects of endurance exercise on modern cardiac biomarkers have been performed. It has been demonstrated that strenuous endurance exercise usually induces mild increases in the cardiac biomarkers troponin (Tn) I and T and brain natriuretic peptide (BNP) and its N-terminal end (NT-proBNP) in obviously healthy male and female athletes of all ages. The increases seem to depend on age, training status, and exercise time and intensity, with higher increases in older and less trained athletes as well as in more intensive and longer exercise bouts. Nevertheless, increases in cardiac biomarkers in cardiovascular healthy athletes are lower than in patients with acute

coronary syndromes and cardiac diseases and normalize within two to three days, and therefore are considered as physiologic, corresponding to a release from the cytosol of the cardiomyocyte.[22-26]

However, so far clear cut-off values for Tn and BNP/NTpro-BNP differentiating between physiological and pathological exercise-induced increases in athletes without and with cardiac diseases are still missing. Therefore, exercise-induced increases in cardiac biomarkers can get clinicians into trouble, and it is of utmost importance to take clinical symptoms into consideration and perform additional non-invasive examinations (e.g. ECG, echocardiography) in unclear cases, for not to treat the blood test only.

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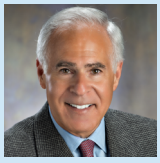

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