Editorial

Cardiorespiratory fitness and muscular strength in late adolescence protects against long-term heart failure risk

Michael D. Morledge, Carl J. Lavie

Department of Cardiovascular Diseases, John Ochsner Heart and Vascular Institute, Ochsner Clinical School-University of Queensland School of Medicine, New Orleans, Louisiana, USA

Correspondence to: Carl J. Lavie, MD, FACC, FACP, FCCP. Medical Director, Cardiac Rehabilitation, Director, Exercise Laboratories, John Ochsner Heart and Vascular Institute, Ochsner Clinical School, The University of Queensland School of Medicine, 1514 Jefferson Highway, New Orleans, LA 70121-2483, USA. Email: clavie@ochsner.org.

Comment on: Lindgren M, Aberg M, Schaufelberger M, *et al*. Cardiorespiratory fitness and muscle strength in late adolescence and long-term risk of early heart failure in Swedish men. Eur J Prev Cardiol 2017;24:876-84.

Received: 25 April 2017; Accepted: 12 May 2017; Published: 16 May 2017.

doi: 10.21037/jphe.2017.05.03

View this article at: http://dx.doi.org/10.21037/jphe.2017.05.03

Physical fitness is one of the strongest predictors of cardiovascular (CV) disease (CVD) and all-cause morbidity and mortality (1). Cardiorespiratory fitness (CRF), and more recently muscular strength (MusS), have been increasingly recognized in the pathogenesis and prevention of chronic diseases (1).

Although some genetic effects may be present, the amount and intensity of physical activity (PA) and exercise training (ET) are the major determinants of CRF, which is one of the strongest risk factors for CVD (2-5). Preserved levels of CRF are associated with favorable prognosis in patients with chronic diseases, including hyperlipidemia, hypertension (HTN), and type-2 diabetes mellitus, to such degree that patients with these disorders but with higher levels of CRF have a considerably better prognosis than patients without these disorders but with lower levels of CRF (3-5). Patients with most CVD and higher levels of CRF have lower mortality than patients without CVD but with lower levels of CRF (6,7). Several studies have also indicated that CRF markedly alters the relationship between obesity and prognosis in both coronary heart disease (CHD) and heart failure (HF) with only those patients with the lowest CRF demonstrating an obesity paradox (6,8) (*Tables 1*,*2*).

The major determinant of MusS is muscle-strengthening exercises, however, MusS is also influenced by other factors, including age, gender, genotype, nutritional factors, and subclinical disease (1). As we have reviewed (1), observational studies have suggested in middle-age adults an independent protective effect of MusS on all-cause and cancer mortality, as well as all-cause mortality in men with HTN and in patients with HF. MusS has also been inversely associated with age-related weight and adiposity gains, risk of HTN, and prevalence and incidence of metabolic syndrome. In children and adolescents, higher levels of MusS have been inversely associated with insulin resistance, clustered cardiometabolic risk factors and inflammatory proteins. Higher levels of MusS also seem to some extent counteract the adverse CV profile of overweight and obese individuals.

In different population studies, MusS and CRF have been shown to be only moderately correlated (r: ~0.3–0.4), indicating that MusS may prevent CVD at least partially through biological pathways different than those associated with CRF (1).

In a recent issue of *European Journal of Preventive Cardiology*, Lindgren *et al.* (9) analyzed data from a cohort of >1.2 million Swedish adolescents of average age 18 years, followed for an average 28 years. In this study they found an inverse association between CRF levels in adolescence and future risk of HF (adjusted hazards ratio: 1.60; 95% confidence interval: 1.44–1.77). They also found that having low MusS was associated with risk of HF comparable with that of having low CRF (adjusted hazards ratio: 1.45; 95% confidence interval: 1.32–1.58). This study was notable in that although there have been previous studies investigating the impact of CRF and MusS on HF in middle-aged or older people, there are few studies of adolescents.

Table 1 Potential benefits of cardiorespiratory fitness on prognosis

Physiological benefits
Reduced
Blood pressure
Blood and plasma viscosity
Systemic inflammation
Visceral adiposity
Myocardial oxygen demands
Increased
Myocardial function
Mitochondrial density
Capillary density
Maintenance lean mass
Improved
Heart rate variability
Endothelial function
Insulin sensitivity
Mood and psychological stress
Sleep
Reduced risk of developing
Hypertension
Diabetes mellitus
Metabolic syndrome
Osteoporosis
Osteoarthritis
Depression
Dementia and Alzheimer disease
Breast, colon, and other cancers

Table 2 Potential benefits of exercise training on heart failure

Increased
Exercise capacity
Skeletal muscle function
Muscle strength and endurance
Reduced
Heart rate response to submaximal exercise
Inflammatory cytokines
Hospitalizations and hospital stay
All-cause mortality
Improved
Endothelial function
Autonomic nervous system function
Health status and quality of life

CVD is now recognized as partly a pediatric problem because the formation of atherosclerotic plaques is known to start in early childhood (1). Timing of interventions is critical and should focus on primordial prevention, preventing risk factor development in the first place, followed by primary prevention, modification of risk factors once they are established. Extensive evidence supports current United States (US) youth PA guidelines, which include both aerobic and muscle-strengthening activities to maintain cardiometabolic health at early ages and later in life.

Physical inactivity is one of the greatest threats to health in the US and in most of the Westernized World (3-5,10-12). In the US approximately 80% of adults and greater than 80% of adolescents do not meet PA guidelines for both aerobic and muscle-strengthening activities (12,13). PA guidelines have been developed for all stages of life (14). Although CVD usually becomes symptomatic in middle-aged or older people, it is clear that multiple risk factors may develop in early adolescence and continue through the lifespan that impact future CVD risk, including HF. We have made a call to action that all clinicians should be promoting PA throughout the health care system and throughout all stages of life as a cost-effective preventive strategy potentially effective world-wide (15-18), starting in adolescence—the future CV and general health of our society strongly depends on the success of these efforts.

In addition to decreasing morbidity and mortality, daily PA, regular ET and higher levels of CRF improve the quality of life of people of all ages, regardless of the presence of a chronic disease or disability. In children, regular PA has been documented to reduce symptoms of anxiety and depression, improve cognitive skills and ability to concentrate and pay attention, and also improve self-confidence and self-esteem (19,20). In adults, we have demonstrated regular PA to reduce measures of psychosocial stress (PS) including anxiety, hostility and depression (21). Considerable evidence indicates that PS is involved in the pathogenesis and progression of

CVD and adversely impacts most chronic diseases. The INTERHEART study (22) demonstrated that among nine major modifiable CHD risk factors, PS was third in importance and accounted for close to one-third of the total attributable risk for acute infarction. Substantial evidence suggests that PS also adversely impacts prognosis after major CHD events (3). Our recent study indicated that PS and PS—related mortality rates are markedly reduced after formal cardiac rehabilitation ET programs (21).

US PA guidelines for adults recommend at least 150 min/week of moderate-intensity, 75 min/week of vigorous-intensity aerobic PA or an equivalent combination of both (14). Running is a popular and practical form of PA that is attractive for many reasons (23). Compared with other types of vigorous-intensity sports and exercises, there are less barriers to running as it is easily accessible and convenient as it does not require a gym membership or specialized equipment or training. Additionally, even slow jogging is considered vigorous-intensity PA and thus reduces the time commitment of exercise to reach the recommended levels of PA, which is often cited as the primary barrier preventing people from exercising. Mounting evidence suggests that running durations well below those suggested by these national and international guidelines may provide substantial, and possibly maximal, mortality benefit. In our recent analysis of 55,000 individuals (13,000 runners) from the Aerobics Center Longitudinal Study database, runners had a 30% reduction in all-cause mortality and 45% reduction in CVD mortality compared to non-runners, with an average increase in life expectancy of 3 years (24,25). Persistent runners had the greatest reduction in mortality and those who started running but stopped or those who were not running at baseline but subsequently started running had about half of the reduction in mortality. Maximal reduction in CVD- and all-cause mortality occurred at low doses of running at less than 6 miles per week and less than 52 minutes of running per week. Because time is one of the greatest barriers to exercise, this finding may motivate more people to run for health benefits as a practical, achievable and sustainable goal.

US PA guidelines for children and adolescents recommend 60 min/day or more of moderate- or vigorous-intensity aerobic PA as well as muscle-strengthening and bone-strengthening PA at least 3 days per week with PA being appropriate for age, enjoyable and offering variety (14). PA behavioral patterns are developed early in life and persist with moderate to high stability from youth to adulthood (19). Schools have a great influence on promoting and improving PA due to the large amount of time youth spend at school. Greater efforts should be made to capitalize on key opportunities such as recess, intramurals, interscholastic sports, classroom PA breaks and walk and bicycle to school initiatives.

PA is extremely cost-effective, and lack of PA is extremely costly. The United States alone spends $117 billion on health care costs associated with inadequate PA each year, not including lost productivity from death and disability associated with illness (15). Great efforts are needed to increase PA at the population level at all ages, from childhood through older adulthood, around the world, with evidence-based strategies specific to country, culture and context.

Acknowledgments

Funding: None.

Footnote

Provenance and Peer Review: This article was commissioned by the editorial office, *Journal of Public Health and Emergency*. The article did not undergo external peer review.

Conflicts of Interest: Both authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/jphe.2017.05.03). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

References

1. Artero EG, Lee DC, Lavie CJ, et al. Effects of muscular

strength on cardiovascular risk factors and prognosis. J Cardiopulm Rehabil Prev 2012;32:351-8.
2. Franklin BA, Lavie CJ, Squires RW, et al. Exercise-based cardiac rehabilitation and improvements in cardiorespiratory fitness: implications regarding patient benefit. Mayo Clin Proc 2013;88:431-7.
3. Lavie CJ, Arena R, Swift DL, et al. Exercise and the cardiovascular system: clinical science and cardiovascular outcomes. Circ Res 2015;117:207-19.
4. Myers J, McAuley P, Lavie CJ, et al. Physical activity and cardiorespiratory fitness as major markers of cardiovascular risk: their independent and interwoven importance to health status. Prog Cardiovasc Dis 2015;57:306-14.
5. Swift DL, Lavie CJ, Johannsen NM, et al. Physical activity, cardiorespiratory fitness, and exercise training in primary and secondary coronary prevention. Circ J 2013;77:281-92.
6. Lavie CJ, De Schutter A, Parto P, et al. Obesity and Prevalence of Cardiovascular Diseases and Prognosis-The Obesity Paradox Updated. Prog Cardiovasc Dis 2016;58:537-47.
7. Lavie CJ, Cahalin LP, Chase P, et al. Impact of cardiorespiratory fitness on the obesity paradox in patients with heart failure. Mayo Clin Proc 2013;88:251-8.
8. Carbone S, Lavie CJ, Arena R. Obesity and Heart Failure: Focus on the Obesity Paradox. Mayo Clin Proc 2017;92:266-79.
9. Lindgren M, Aberg M, Schaufelberger M, et al. Cardiorespiratory fitness and muscle strength in late adolescence and long-term risk of early heart failure in Swedish men. Eur J Prev Cardiol 2017;24:876-84.
10. Blair SN. Physical inactivity: the biggest public health problem of the 21st century. Br J Sports Med 2009;43:1-2.
11. Lavie CJ, Lee DC, Sui X, et al. Effects of Running on Chronic Diseases and Cardiovascular and All-Cause Mortality. Mayo Clin Proc 2015;90:1541-52.
12. Ward BW, Clarke TC, Nugent CN, et al. Early release of selected estimates based on data from the 2015 National Health Interview Survey. In: National Center for Health Statistics. May 2016. Available online: https://www.cdc.gov/nchs/fastats/exercise.htm
13. Song M, Carroll DD, Fulton JE. Meeting the 2008 physical activity guidelines for Americans among U.S. youth. Am J Prev Med 2013;44:216-22.
14. 2008 Physical Activity Guidelines for Americans. US Department of Health and Human Services, 2008. Available online: https://health.gov/paguidelines/
15. Carlson SA, Fulton JE, Pratt M, et al. Inadequate physical activity and health care expenditures in the United States. Prog Cardiovasc Dis 2015;57:315-23.
16. Lavie CJ, Arena R, Blair SN. A call to increase physical activity across the globe in the 21st century. Future Cardiol 2016;12:605-7.
17. Pratt M, Perez LG, Goenka S, et al. Can population levels of physical activity be increased? Global evidence and experience. Prog Cardiovasc Dis 2015;57:356-67.
18. Sallis R, Franklin B, Joy L, et al. Strategies for promoting physical activity in clinical practice. Prog Cardiovasc Dis 2015;57:375-86.
19. Hills AP, Dengel DR, Lubans DR. Supporting public health priorities: recommendations for physical education and physical activity promotion in schools. Prog Cardiovasc Dis 2015;57:368-74.
20. Rasberry CN, Lee SM, Robin L, et al. The association between school-based physical activity, including physical education, and academic performance: a systematic review of the literature. Prev Med 2011;52 Suppl 1:S10-20.
21. Lavie CJ, Menezes AR, De Schutter A, et al. Impact of Cardiac Rehabilitation and Exercise Training on Psychological Risk Factors and Subsequent Prognosis in Patients With Cardiovascular Disease. Can J Cardiol 2016;32:S365-S373.
22. Yusuf S, Hawken S, Ounpuu S, et al. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study. Lancet 2004;364:937-52.
23. Lee DC, Brellenthin AG, Thompson PD, et al. Running as a Key Lifestyle Medicine for Longevity. Prog Cardiovasc Dis 2017. [Epub ahead of print].
24. Lee DC, Lavie CJ, Sui X, et al. Running and Mortality: Is More Actually Worse? Mayo Clin Proc 2016;91:534-6.
25. Lee DC, Pate RR, Lavie CJ, et al. Leisure-time running reduces all-cause and cardiovascular mortality risk. J Am Coll Cardiol 2014;64:472-81.

doi: 10.21037/jphe.2017.05.03
Cite this article as: Morledge MD, Lavie CJ. Cardiorespiratory fitness and muscular strength in late adolescence protects against long-term heart failure risk. J Public Health Emerg 2017;1:50.

