Cardiorespiratory fitness, muscle strength and risk of cardiovascular outcomes

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Provenance: This is a Guest Editorial commissioned by the Editor-in-Chief: Baoli Zhu (Jiangsu Provincial Center for Disease Control and Prevention, Nanjing, China).


Received: 24 April 2017; Accepted: 26 April 2017; Published: 16 June 2017.

doi: 10.21037/jphe.2017.05.10

View this article at: http://dx.doi.org/10.21037/jphe.2017.05.10

Physical fitness is associated with lower cardiovascular disease (CVD) mortality, with multiple studies demonstrating a consistent, inverse association between cardiorespiratory fitness (CRF) and mortality even after adjustment for the traditional risk factor burden (1,2). This association has persisted across the lifespan, as a single measurement of CRF in midlife is strongly associated with the lifetime risk for cardiovascular mortality decades later. Cardiorespiratory fitness is associated with a reduced risk of several adverse health outcomes (3-9). Although CRF is recognized as an important marker of both functional ability and cardiovascular health, it is currently one of the most important risk factors that is not routinely and regularly assessed in either the general or specialized clinical setting. The relationship between CRF and other nonfatal cardiovascular outcomes is not well understood, which reflects the limited data on nonfatal cardiovascular events including atrial fibrillation, heart failure (HF) and stroke with objectively measured physical fitness and muscle strength. Much of the focus on the mechanisms of benefit of physical exercise and CRF have focused on prevention of atherosclerosis and its complications, although the specific effects of physical exercise on cardiac and vascular function suggest that low CRF might be an important risk factor for HF and other nonfatal cardiovascular events (10).

Increasing attention is being given to the importance of physical activity and fitness, including both CRF and muscular strength, for decreasing the incidence of chronic diseases, promoting overall cardiovascular and general health, improving quality of life, and delaying CVD and mortality (1,11). The importance of CRF has been neglected in the equation of coronary heart disease and CVD risk, despite the fact that it appears to be one of the most important correlates of overall health status and a predictor of an individual’s future risk of CVD (1). Among both asymptomatic subjects and those with previous CVD, the least fit individuals had about 4 times higher risk of all-cause mortality compared with those with the highest level of CRF (12). Importantly, an individual’s CRF level was even a stronger predictor of mortality than traditional risk factors such as smoking, hypertension, high cholesterol, and type 2 diabetes mellitus (2,12,13). It has been suggested that the greatest health benefits are observed between the least fit and the next least fit group; whereas lesser improvements in health outcomes occur between individuals who are in the moderate- to high-fit groups. From the public health point of view, the health benefits of CRF are most evident in the low end of the fitness spectrum.

Cardiorespiratory fitness has been shown to be a more powerful predictor of risk than other exercise test variables, including ST-segment depression, symptoms, and hemodynamic responses (1,12,13), a fact not
Cardiorespiratory fitness (CRF), ideally assessed directly by VO₂ max from respiratory gases, has been found to be one of the strongest predictor for fatal and non-fatal CVD.
events (4,7,23-25), although the clinical value of muscle strength seems to be underrated. It is not well known to which extent the incremental information offered by functional capacity in risk stratification beyond that of conventional risk factors, would prompt interventions and ultimately reduce CVD-related events. Previous results may indicate that CRF and muscle strength partly influence the risk of HF through different causal pathways, where metabolic aberrations and their effects on atherosclerotic disease and myocardial function seem to be important (21,22).

Frailty is usually quantified by the degree of impairment in functional reserve across multiple organ systems and is often associated with fatigue, reduced muscle strength, and high susceptibility to chronic disease. Further research is needed to examine the associations between changes in capability with age and HF and mortality, as a decline in physical capability may be a better predictor of mortality than is the absolute level at a single point in time. In addition, associations between these measures of functional capacity (CRF and muscle strength) and cause specific mortality and other health outcomes, including potential effects on mental well-being (26), may help to clarify the pathways underlying the associations with HF and all-cause mortality. Elucidating the underlying biological pathways that link poorer functional capacity such muscle strength to HF and mortality will help in the development of effective interventions.

An unanswered question is still if new epidemiological data on the importance of functional capacity including assessment of CRF and muscle strength can be used to implement a stronger recommendation in favor of routine functional capacity recordings for risk assessment in normal clinical practice. It would be important to know if physical exercise, muscle strength training and other lifestyle interventions would decrease frailty, which is known to be related to HF and CVD outcomes. There is still need to study the role of preventive measures and exercise-based life-style interventions. Although muscular fitness is considered to be an indicator of general health, further studies are needed to show whether improvement in muscle strength is associated with lower HF and CVD risk independently of CRF level (VO$_2$max).

**Acknowledgements**

None.

**Footnote**

Conflicts of Interest: The authors have no conflict of interest to declare.

**References**


doi: 10.21037/jphe.2017.05.10