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Arrival and Survival of the Fittest

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Over the past four decades, substantial evidence from exercise scientists around the globe have demonstrated the potential effects of regular physical activity (PA) and higher levels of cardiorespiratory fitness (CRF) against cardiovascular disease (CVD) and CVD- and all-cause mortality.[1-3] Although a component of CRF may be genetic or inherited, the major part of CRF is derived from persistent and effective PA and exercise training.[3] Although PA is extremely important,[1-3] substantial data has suggested CRF predicts prognosis even more so than does PA.[3-5] In fact, each one metabolic equivalent (MET) increase in CRF is associated with 13% and 15% reductions in all-cause mortality and CVD/coronary events, respectively, in a major meta-analysis.[6] Additionally, in a study of over 14,000 subjects followed for over 11 years in the Aerobic Center Longitudinal Study (ACLS), Lee et al[7] demonstrated that every one MET increase in CRF over time assessed in CRF examinations separated by an average of over six years was associated with all-cause and CVD-mortality reductions of 15% and 19%, respectively. These substantial data on the potential benefits of CRF (Table) have led some of us to suggest CRF should become a vital sign for clinical practices.[8]

In the current issue of American Heart Journal, Davidson and her well-known co-authors[9] analyzed 8,171 male veterans followed for close to 9 years and determined the association/impact of PA and CRF on subsequent mortality (n = 1349 deaths). In analyses when either PA or CRF were adjusted for clinical factors, both were associated reductions in mortality. Meeting national guidelines for PA (≥ 150 minutes per week of moderate PA assessed by questionnaire) was associated with a 17% lower risk of mortality ($p = 0.001$), and every one MET increase in CRF was associated with a 15% reduction in mortality ($p < 0.001$), when both were adjusted for other clinical factors. However, in analyses including CRF, PA was no longer associated with lower mortality in either fit (defined as ≥ 7 METs) or unfit (< 7 METs), whereas when adjusted for PA, CRF and being fit was still associated with lower mortality, supporting data that CRF is superior to PA for predicting prognosis and supporting the potential measurement of CRF in clinical practices.

We applaud Davidson and colleagues[9] for adding to the literature on this topic, and their study clearly demonstrates that "Survival of the Fittest" is not only an unforgettable phrase, it is an unequivocal truth. And given that exercise frequency and/or intensity of PA/exercise training has been shown to have a positive impact on CRF,[3] it can be posited that daily PA/exercise engenders both the "Arrival of the Fittest" as well as the "Survival of the Fittest". Although investigators in Davidson's study and elsewhere attempt to separate the benefits of PA and CRF, it may not be possible to completely separate PA and CRF biologically since much of CRF probably depends on current levels of PA. Therefore, their study is unable to definitively answer the question of whether the health-related effects of PA and CRF are derived from independent, inter-dependent or merely inter-related metabolic pathways. However, their study also supports that although PA may be a mediator, CRF is the clinical factor associated with a positive prognosis. Whether this relationship between CRF and survival is causal or merely associated cannot be answered by this or similar studies, but clearly CRF is predictive of prognosis and survival.[1-9] This study also raises the possibility that PA mediates its benefits via improving CRF and that although any PA may be superior to no PA, it can be posited that PA that does not effectively improve CRF may not be especially effective. Certainly, higher intensity PA more effectively increases CRF than does low intensity PA,[3,10,11] and PA associated with significant increases in heart rate is more effective to improve CRF and survival than is PA at low heart rates. [12] In fact, we recently demonstrated that a Personalized Activity Intelligence (PAI) with PA at higher heart rates predicts survival considerably better than did PA meeting national guidelines.[12]

Although assessment of CRF in clinical settings may seem ideal, often this is considered impractical from a time and cost perspective. Obviously, if CRF could be assessed quickly (in seconds or minutes as opposed to 15-30 minute stress tests) and inexpensively (e.g. $50-100 as opposed to clinical stress tests that currently typically cost > $1,000), routine CRF testing could be possible throughout clinical medicine. However, this is certainly not the case presently. Nevertheless, non-exercise assessments of CRF have been published from the ACLS,[14] NHANES,[15] and HUNT[16] databases, and others,[8] demonstrating the predictive value of estimated CRF without more precisely measuring it by treadmill or other exercise assessments. These estimated CRF assessments could easily be included in future clinical evaluations and electronic medical records to help clinicians further stratify risk in their patients.

Although the efforts of Davidson and colleagues[9] is noteworthy, this study is not without limitations. While they provide a strong analysis of the existing data, the use of self-reported (memory-based) data on PA and dichotomization of a continuous variable (i.e. CRF) limits their conclusions. As we demonstrated recently in the field of nutrition, there are often large and significant clinically relevant differences between self-reported lifestyle behaviors (e.g. diet and exercise) and objective measures.[17,18] Fortunately, exercise scientists now have objective and accurate measures to quantify PA, and further efforts should eventually and precisely define the relative contributions of PA and CRF to health and well-being.[19-23] Second, determining CRF by treadmill speed and incline is not the same as precise measurements of oxygen consumption (VO_2) determined with gas exchange.[24] Third, PA and CRF are continuous variables and to reduce this to discreet cut-points results in a potential enormous loss of information. Finally, the arbitrary cut-off of CRF for Fit versus Unfit ≥ 7 METs introduces potential measurement and classification errors. For example, does a 6.9 MET measurement on a fitness test really represent lower fitness than a 7.1 MET level? And while 7 METs may not be very fit for a 30-40 year-old male, it may represent a quite good level of fitness for an 80 year old.

Despite these potential study limitations, we think that this study is a valuable contribution to the field of exercise sciences in this area. Although it would be ideal to be able to instruct a patient to obtain a higher level of CRF, we have no control over genetic or inherited traits. Therefore, without having a "Fitness Pill,"[25],the best current approach is to recommend not only PA, but more effective PA to improve levels of CRF, including higher intensity PA that effectively increases heart rates.[10-12] Finally, efforts are desperately needed throughout the healthcare systems in the United States and throughout the world to increase the PA of the population. [1-3,26,27] Increasing PA is a cost-effective strategy[28] to improve CRF, resulting in reduction of healthcare costs as well as CVD and all-cause mortality in our patients and the global population.[29]

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Table 1. Potential Benefits or Associations of Cardiorespiratory Fitness with Improved Prognosis.

Physiological Benefits	
Reduced blood pressure	Improved insulin sensitivity
Improved heart rate variability	Decreased myocardial oxygen demands
Improved myocardial function	Maintain lean mass
Improved endothelial function	Reduced visceral adiposity
Reduced blood and plasma viscosity	Increased capillary density
Increased mitochondrial density	Improved mood and psychological stress
Reduced systemic inflammation	Improved sleep
Reduced Risk of Developing:	
Hypertension	Osteoporosis
Depression	Osteoarthritis
Metabolic syndrome	Dementia and Alzheimer's disease
Diabetes mellitus	Breast, colon, and other cancers