Editorial

Fitness Equals Longer Life-Expectancy Regardless of Adiposity Levels

Brief title: fitness and life-expectancy

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Abbreviations

BF%	Body fat percentage
BMI	Body mass index
CRF	Cardiorespiratory fitness
CVD	Cardiovascular disease
PA	Physical activity
SCORE	Systematic Coronary Risk Evaluation
WC	Waist circumference

Editorial

Cardiorespiratory fitness (CRF), an index of habitual physical activity (PA), integrates human body function under demanding physiological states, and reflects an individual's functional capacity.[1] Substantial literature attests to the fact that objective indices of physical performance (for example,, hand grip strength, walking speed, among others) both evaluate physical capability and reflect health status.[2] Indeed, poor physical fitness (comprising of low CRF and muscle strength) and obesity are the major hallmarks of an unhealthy lifestyle and may worsen morbidity and mortality.

Obesity as determined by body mass index (BMI) and CRF share an inverse relationship,[3] and are each associated with cardiovascular disease (CVD) risk. Though conventional CVD risk prediction models, such as Framingham or Systematic Coronary Risk Evaluation (SCORE), do not consider BMI in their equation,[4, 5] BMI may prove superior to serum cholesterol in predicting CVD risk.[6] Almost 3 decades after the first discussion on "fitness vs fatness," Lavie and coworkers suggested that CRF may be as significant as BMI in CVD risk assessment.[7, 8] Some others have suggested that the finding of poor clinical outcomes in those with low body fat % and low BMI may reflect a "lean paradox" of even greater significance than the obesity paradox. The importance and use of CRF in CVD risk stratification have been disregarded, despite consistent evidence showing CRF to accurately predict the risk of CVD.[9] Enhanced CRF may offset the harmful consequences of excess body fatness and other CVD risk factors, thereby enabling individuals to be "fat but fit". Higher levels of CRF are accompanied by a lower risk of CVD outcomes, regardless of levels of BMI.[10] Several reports have also observed that the association of obesity with adverse outcomes is reduced when factored for CRF levels.[11] These observations suggest that the association between obesity and increased CVD risk may reflect low CRF, and that adverse consequences of obesity on CVD may be offset by improved levels of CRF.[12]

Despite the minefield of evidence on the relationship between physical fitness, obesity, and adverse health outcomes, this interplay is still not well understood and is still debated. In the current issue of the journal, Zaccardi and his research group[13] reported new evidence on the extent to which two physical fitness-related measures (walking pace and handgrip strength) are associated with life expectancy across different levels of obesity, as measured by BMI and other adiposity indices, such as waist circumference (WC) and body fat percentage (BF%). The rationale for conducting this study is based on limitations of previous studies as pointed out by Zaccardi and colleagues[13] and which include (i) not investigating the associations across different BMI levels; (ii) failure to explore interactions between CRF and BMI; and (iii) reporting hazard ratios describing associations, which lack a relationship with survival probabilities and make it difficult to interpret direct comparison between the importance of one factor with another. Given that the absolute risk of adverse outcomes depends largely on age, employing a single relative metric does not allow quantification of absolute risk differences across increasing ages. The authors suggested that a better approach to evaluate the interplay was to estimate residual life expectancy across CRF levels and BMI. Utilizing the large UK Biobank cohort based on 474 919 participants, the authors[13] demonstrate that participants with a brisk self-reported walking pace have a longer and similar life expectancy across the spectrum of BMI or other adiposity indices, providing further evidence that walking pace is an easily available marker of overall health status. They found that coexistence of a low BMI and a slow walking pace was associated with the lowest life expectancy. We applaud this new study which is clinically valuable and employed robust study methodologies in addition to the large sample size. The authors initially plotted the shapes of the associations of walking pace, handgrip strength, BMI, WC and BF% with all-cause mortality. In addition to using conventional Cox regression hazard models, the authors conducted analyses of life expectancy and residual life time based on BMI, waking pace and grip strength. Mortality rates were modelled using Poisson regression methods. Several sensitivity analyses were also performed to confirm the robustness of the results. Their findings showed that participants with brisk walking pace had a longer life expectancy across all categories of BMI compared to slow walkers; women and men reporting a brisk walking pace had a life expectancy of over 86 and 85 years, respectively. Women and men with low BMI and slow walking pace had the lowest life expectancy estimated at 72 and 65 years, respectively. Participants with slow walking pace had shorter life expectancy across all categories of BMI. The difference in life expectancy between brisk and slow walkers at BMI levels of less than 20 kg/m^2 was quite substantial - 15 years and over 21 years for women and men respectively. Absolute differences in life expectancy were minor between average and brisk walking pace in women but it was clearly seen in men with low (<20 kg/m^2) BMI, with around 5 years difference between subjects with brisk and average walking pace. The same pattern of results was observed for WC and BF%. These findings support the concept that brisk walking speed, which was easily measured by a single item questionnaire (slow, average or brisk pace), and muscle strength are key components that should be maintained by regular physical exercise. The recent study is well in line with the previous concept by Lavie and coworkers indicating that higher levels of CRF may be at least as important as lower BMI in the prevention of CVDs.[7, 8] There were some limitations of the current study which the authors failed to acknowledge and include (i) lack of data on PA patterns during follow-up and (ii) that the assessment of walking pace was based on self-reports, which may be prone to recall or misclassification bias.

The current findings of Zaccardi *et al.*[13] are very important as they shed more light on the inter-relationship between fitness levels, adiposity, and life expectancy. People with good CRF have prolonged life expectancy across all levels of adiposity. Additionally, they have shown that self-reported walking pace more accurately predicts life expectancy than objectively assessed handgrip strength. A slow walking pace and low BMI are each markers of frailty;[14, 15] hence it is possible that the interplay among slow walking pace, low BMI, and short life expectancy indicates pronounced frailty, poor nutritional status, body weakness, and loss of muscle mass, as postulated by the authors.[13] Frailty reflects impaired functional capacity across multiple organ systems and is often attended by fatigability, diminished muscle strength, and an enhanced predisposition to chronic disease. Previous studies of the associations between indices of functional capacity (and adverse outcomes such as CVD and mortality have not been entirely consistent. For example, muscle strength is associated with a salutary effect on CVD independent of the level of CRF. A meta-analysis revealed that indices of muscle strength associate inversely with all-cause mortality in populations residing in the community.[2] In younger men, a diminished grip strength predisposes to incident coronary heart disease,[16] and enhanced isometric muscle strength is attended by less risk of mortality from CVD.[17] Handgrip strength and chair-rise test performance, individually, are associated with the risk of all-cause and CVD mortality, irrespective of the frequency of physical exercise.[18] This prospective analysis of seemingly healthy older women indicated that two readily applied tests of arm strength (handgrip strength) and leg strength (chair-rise test) served as a valid predictor of all-cause mortality, CVD, and stroke.[18] A number of other studies including the UK Biobank have however reported positive associations between grip strength and adverse health outcomes.[14, 19] Indeed, further research is needed to evaluate the associations between changes in functional capacity with age and CVD outcomes and mortality: Age has a powerful adverse impact on disease outcomes, and a decline in physical capability with age may more accurately predict mortality than the level of physical capability itself at a specific timepoint. Muscle mass diminishes with age, and this is a major determinant of the well documented age-dependent diminution in muscle strength.

Overall, the UK Biobank findings are of particular significance, as the favourable impact of brisk walking pace on life expectancy was evident for the whole population, regardless of BMI category. It is known in general that strenuous PA or high volume or intensity exercise are not well-tolerated by the obese individuals; however, walking is an attractive and feasible alternative for this population. The findings also add to the plentiful evidence on the health benefits of PA. Indeed, this is no longer a disputed issue, but majority of populations do not achieve levels recommended by established guidelines - 150-300 min/week of moderate-intensity or 75-150 min/week of vigorous-intensity aerobic PA/exercise for adults.[20] To echo Zaccardi and colleagues,[13] further research is needed to examine the phenotypic characteristics of individuals with low BMI and slow walking pace and the effectiveness of targeted strategies to increase CRF and physical function in low BMI groups.

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