

ROLE OF PHYSICAL ACTIVITY AND FITNESS IN THE PROMOTION OF METABOLIC AND OVERALL HEALTH

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ABSTRACT

In the present *viewpoint*, the authors provide an overview of the current evidence supporting the positive influence of practicing physical activity regularly and improving physical fitness, mainly cardiorespiratory fitness and muscular strength, on metabolic and overall health. The evidence on this regard is strong and consistent, and in the different age groups. Likewise, enhancing cardiorespiratory fitness by means of physical activity has the potential of attenuating the negative effect of obesity on future health, as well as improving the prognosis of the metabolically healthy obesity phenotype. Collectively, the existing evidence strongly supports the recommendation of being active and enhancing cardiorespiratory fitness and muscular strength as a powerful public health strategy.

Keywords: physical activity, exercise, fitness, metabolic health, mortality, adults, children, adolescents

PAPEL DE LA ACTIVIDAD FÍSICA Y LA CONDICIÓN FÍSICA EN LA PROMOCIÓN DE LA SALUD METABÓLICA Y LA SALUD EN GENERAL

RESUMEN

En el presente *punto de vista*, los autores presentan su visión sobre la evidencia actual que sostiene la importancia de la práctica regular de actividad física, así como de la mejora de la condición física, especialmente la capacidad cardiorrespiratoria y la fuerza muscular, para promover una mejor salud metabólica y mejor salud en general. La evidencia existente en esta temática es fuerte y consistente, y aplicable a los diferentes grupos de edad. Además, la mejora de la capacidad cardiorrespiratoria ha demostrado tener un efecto atenuador del riesgo de enfermedad asociado a la obesidad, mejorando también el pronóstico futuro de las personas con obesidad, pero metabólicamente sanas. Teniendo en cuenta todo ello, la evidencia existente sostiene y apoya la recomendación de un estilo de vida activo, y la importancia de la mejora de la capacidad cardiorrespiratoria y muscular, como una potente estrategia de salud pública.

Palabras clave: actividad física, ejercicio, fitness, salud metabólica, mortalidad, niños, adultos, adolescentes

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INTRODUCTION

Physical fitness is a powerful marker of health in youth (Ortega, Ruiz, Castillo, & Sjostrom, 2008; Ruiz et al., 2009) and also in adulthood (Ross et al., 2016). The two components that have been more frequently and strongly related to health are cardiorespiratory fitness (CRF) and muscular fitness. Although physical fitness has a strong inherited influence, as any other trait in humans (e.g. obesity, hypertension, etc.), it is modifiable, being physical activity and exercise the major environmental influencing factors. In this *viewpoint*, four authors with extensive experience in the field of physical activity, fitness and health point out their views on how improving fitness through physical activity/exercise can improve the metabolic profile and overall health in young and adult individuals.

Physical activity, fitness and metabolic and overall health in children and adolescents

Physical activity and cardiorespiratory fitness. Physical activity and CRF have been widely studied in relation to their positive effects on insulin resistance, leptin levels, obesity, cardiometabolic profile and other metabolic disorders (Jimenez-Pavon et al., 2012; Miguel-Berges, Reilly, Moreno Aznar, & Jimenez-Pavon, 2018; Oliveira & Guedes, 2016; Zaqout et al., 2016). Particularly, physical activity intensities able to promote improvements in CRF have been highly recommended. It has been suggested that children and adolescents should engage in at least 60 min/day of moderate-to-vigorous physical activity with special focus on vigorous intensity (Piercy et al., 2018). However, it has been proposed that this minimum amount of time should be higher in boys and include at least 20 min of vigorous activity (both sexes) for a lower cardiometabolic risk score (Jiménez-Pavón et al., 2013).

Furthermore, during the last years, an interesting connection of some metabolic disorders such as insulin resistance, diabetes and obesity with health-related problems of brain (i.e. Alzheimer or cognitive impairment) has been identified (Luciano et al., 2015; Stillman, Weinstein, Marsland, Gianaros, & Erickson 2017). Both physical activity and CRF have also shown to benefit cognitive performance, to mediate the influence of adipocitoquines and myokines on cognition and to promote a healthier brain later in life (Esteban-Cornejo et al., 2017; Esteban-Cornejo et al., 2018; Kivipelto, Mangialasche, & Ngandu 2018). It has been suggested that several molecular mechanisms link aerobic exercise and CRF with the overall health including both dimensions, metabolic disorders and brain health problems. In particular, the fibronectin type III domain-containing protein-5 (FNDC5) activity has a direct influence on

brain-derived neurotrophic factor (BDNF) level, which in turn has an influence on cognition (Wrann et al., 2013).

Muscular strength. Research on fitness and health in children and adolescents has recently paid attention to muscular fitness, thereby balancing decades of almost exclusive dedication to CRF (Artero et al., 2012; Lloyd et al., 2014; Smith et al., 2014). The term 'muscular fitness' represents not only muscular strength (the ability to generate force), but also muscular endurance (the ability to perform repeated contractions under sub-maximal load) and muscular power (the rate at which muscles perform work) (Smith et al., 2014). Muscular fitness in children and adolescents has been positively associated with several physiological and psychological health outcomes, independently of CRF (Artero et al., 2012; Lloyd et al., 2014; Smith et al., 2014), thereby highlighting the importance of supervised and appropriate strength training at these ages (Lloyd et al., 2014; Piercy et al., 2018). As an example, the systematic review and meta-analysis by Smith et al. (2014) showed that 15 out of 20 studies found an inverse association between muscular fitness and cardiovascular diseases and metabolic risk factors, including lipids, glucose, insulin resistance and inflammatory biomarkers.

Likewise, data from the huge Swedish conscription database on more than 1-million male participants strongly support the idea that moderate to high levels of muscular strength in adolescence predict a lower risk of cardiovascular disease mortality and all-cause mortality independently of classical risk factors such as body mass index and blood pressure (Ortega et al., 2012). In fact, data from this cohort have recently contributed to this field by showing a consistent link between levels of muscular strength in adolescence and the risk of future chronic disease 30-years later, as indicated by a disability pension (Henriksson, Henriksson, Tynelius, & Ortega 2018). Strength exercise can be particularly relevant for overweight and obese youths, not only because of their "at-risk" situation, but also because for them it has been suggested to result in greater adherence, satisfaction, motor coordination and confidence, compared to more aerobic demanding activities (Lloyd et al., 2014; Smith et al., 2014). Interestingly, no great improvements are needed, as the greatest benefits are achieved by increasing muscular fitness levels from low to moderate (Smith et al., 2014).

Physical activity, fitness and metabolic and overall health in adults

Physical activity, cardiorespiratory fitness and muscular strength. The seminal studies by Jeremy Morris in London, in the 1950s on bus-conductors and mailmen were among the first to show a link between habitual physical

activity and coronary heart diseases. Research on health and the functional effects of physical activity has since then progressed. The relationship between physical activity and health is complex. There is strong evidence showing that regular physical activity at a certain dose has health benefits for everyone, regardless of sex, age or ethnicity. Regular physical activity benefits fitness, and therefore, such improvements in fitness are likely to have favourable effects on overall health. A large amount of data shows that some health benefits are derived from being physically active even though there may be little or no associated gain in fitness (Piercy et al., 2018). A large body of evidence documents the effects of regular physical activity on health, which include decreases in mortality from all causes, cardiovascular mortality and morbidity (including coronary heart disease), the risks of colon and breast cancer and type 2 diabetes. This evidence-based knowledge has led to public health recommendations on physical activity (Table 1).

TABLE 1
Development of physical activity recommendations.

Organization	Year	Recommendation	Rational
National board of health and welfare, (Sweden)	1971	Be active on moderate intensity every day in combination with more intense exercise 2-3 times per week.	Health and fitness
ACSM	1978 1990	3-5 times per week, 15-60 min per occasion, 60-90% HRmax on aerobic exercise. In 1990, strength training was added.	Maintain and improve fitness
Health Education Authority (England)	1994	30 min of daily moderate intensity physical activity.	Health
Pate. et al. (1995) and CDC, Surgeon General (US)	1995 1996	30 min of at least moderate intensity on most, preferably all, days of the week (150 kcal per day), accumulated in several bouts of at least 10-min duration.	Health
ACSM	1998	3-5 times per week, 15-60 min per occasion, 55-90% HRmax on aerobic exercise plus add strength and flexibility training.	Maintain or improve fitness
IASO	2003	For prevention: 45-60 min per day of at least moderate intensity. For maintenance: 60-90 min per day.	Prevent obesity or maintain weight loss
ACSM, AHA	2007	30 min of at least moderate intensity daily or 20 min of vigorous 3 times per week. On top of these, strength training twice a week.	Health and fitness
2008 Physical Activity Guidelines for Americans	2008	150 min of moderate intensity or 75 min of vigorous intensity. Muscle strengthening activities.	Health and fitness
2018 Physical Activity Guidelines for Americans	2018	150-300 min of aerobic moderate intensity or 75-150 min of vigorous intensity. In addition, muscle-strengthening activities of moderate or greater intensity that involve all major muscle groups on 2 or more days a week.	Health

ACSM: American College of Sports Medicine (Haskell et al., 2007).

CDC: Centre for Disease Control and Prevention (U.S. Department of Health and Human Services, 1996).

IASO: International Association for the Study of Obesity (Saris et al., 2003).

AHA: American Heart Association (Haskell et al., 2007).

HRmax: Heart Rate maximum.

Cardiorespiratory fitness has been established as one of the most important independent predictors of cardiometabolic health as well as all-cause mortality and, in particular, of cardiovascular death. Cardiorespiratory fitness provides strong and independent prognostic information about the overall risk of illness and death in both men and women across a broad spectrum of ages, irrespective of body weight. This applies for apparently healthy individuals, and for those with diabetes mellitus, hypertension, metabolic syndrome and several types of cancer. A number of important prospective studies have shown that VO₂max is the most important predictor of all-cause mortality, and in particular of cardiovascular death (Kodama et al., 2009). This is true both for apparently healthy persons and for those with diabetes mellitus, hypertension, metabolic syndrome and several types of cancer, and for both men and women of different ages. An almost linear reduction in mortality is seen as VO₂max increases. Each increase of 1 metabolic equivalent (MET) is associated with 13% and 15% decrements in risk of all-cause mortality and cardiovascular disease, respectively (Kodama et al., 2009).

The role of muscle mass and of muscular strength in the performance of activities of daily living and exercise, as well as in the prevention of chronic diseases is being increasingly recognized. Resistance exercise training increases muscular strength and has a strong impact on metabolic abnormalities such as insulin resistance. Resistance training is currently prescribed by major health organizations to improve cardiometabolic health and fitness (Piercy et al., 2018). A recent meta-analysis shows that adults with high muscular strength levels, as measured by handgrip, have a 31% lower all-cause mortality risk as compared with those with low muscular strength, with a slightly stronger association and lower heterogeneity in women than men (Garcia-Hermoso et al., 2018). Conversely, those with higher knee extension strength levels, had a 14% lower risk of death than those in lower levels (Garcia-Hermoso et al., 2018). Overall, low muscle strength levels should be considered as a risk factor for all-cause mortality in adults.

Interactions with fatness and metabolic-obesity phenotypes. As previously mentioned, physical activity as well as CRF and muscular strength play a major role in the metabolic profile and future risk of cardiovascular disease. In this context, it is interesting to discuss the interactions between physical activity and fitness with fatness in relation to cardiovascular disease briefly, particularly the fat but fit paradox. Likewise, it is important to study the interactions between fatness and metabolic profile, the so called metabolically healthy obesity (MHO) phenotype and the role of physical activity and fitness in it, for a better risk classification. The fat but fit paradox refers to the notion that

fitness can modify the risks associated with obesity to such extent, that if a person has obesity but is fit, defined as having a moderate to high CRF level (i.e. 2nd to 5th quintiles) then the risk of cardiovascular disease and all-cause mortality is dramatically reduced (Ortega et al., 2016). The role of CRF is so important that a fat but fit person can even have a lower risk of cardiovascular disease mortality than a thin but unfit person (i.e. 1st quintile), regardless of whether obesity was defined using body mass index, body fat percent or waist circumference (Ortega et al., 2018b). The public health message derived from these studies is that obesity remains as one of the major health problems of modern societies, and there is a great awareness of this, however, there is consistent evidence supporting the fact that having a low CRF is at least as strong predictor of future disease as obesity, but society is less aware of this fact.

Another interesting phenotype is the MHO, defined as the subset of individuals that besides having obesity are otherwise metabolically healthy. The definition of the MHO is usually linked to the absence of the metabolic risk factors included in the metabolic syndrome, particularly the absence of diabetes/high glycaemia, hypertension and hyperlipidemia (Lavie et al., 2018). The role of physical activity and CRF in the characterization and prognosis of MHO individuals has recently been systematically reviewed and meta-analysed, and the conclusions are that: 1) MHO individuals are more active (more time spent doing moderate-to-vigorous physical activity) and fitter (higher CRF) than the rest of obese individuals; 2) Higher levels of physical activity and CRF seem to benefit cardiovascular health and therefore to reduce all-cause prognosis of MHO individuals, yet evidence in some cases is still limited (Ortega et al., 2018a).

CONCLUSIONS

Promoting an active lifestyle is related to a better metabolic profile and to a better overall health in people of any age. Moreover, regular practice of physical activity is the strongest non-genetic determinant of physical fitness, both cardiorespiratory and muscular fitness, which have shown to be powerful predictors of metabolic and overall health in the future. The power of fitness as a health marker is such that there is evidence supporting that having a low fitness level might be a similar, if not even stronger, risk factor than the well-known obesity and metabolic profile. In fact, this *viewpoint* highlights that the fitness level has the potential to largely attenuate the future risk associated with obesity. Therefore, the take-home message of this *viewpoint* is that being active and enhancing CRF and muscular strength through physical activity is a powerful public health strategy.

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