

Relationship Between Physical Activity and Physical Fitness in Children and Adolescents

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Physical activity in adults is associated with a lower risk of obesity, cardiovascular disease, high blood pressure, diabetes, cancer, and premature death. There is considerable evidence that cardiovascular disease has its origins in childhood and adolescence. Lipid and lipoprotein profiles, blood pressure, and adiposity in young people tend to persist over their lifetimes (tracking).¹ There is also evidence that behavioral patterns of physical activity in childhood are maintained throughout adulthood.² Childhood and adolescence are therefore key to the primary prevention of cardiovascular disease and other conditions associated with a sedentary lifestyle. This is particularly true when we take into account the difficulty involved in modifying adult lifestyles.

Although it is usually assumed that more active children will have higher levels of physical fitness, and that the relationship is causal, the assumption may no longer be valid in the light of current knowledge. Only a small amount of the variation in different measures of physical fitness in children and adolescents can be attributed to physical activity. Measures of physical activity and physical fitness also show great variability. In order to examine the relationship between these 2 concepts in more detail, it is perhaps best to start by defining them.

The terms “physical activity,” “physical exercise,” and “physical fitness” are often confused. Although they are closely related, they should not be treated as synonyms. “Physical activity” refers to any bodily movement produced by skeletal muscle which requires consumption of energy. “Physical exercise,” on the other hand, is defined as any planned, structured, and systematic physical activity designed to improve or maintain one or more components of physical fitness. “Physical fitness” in turn can be interpreted as a measure of the capacity to perform

physical activity and/or physical exercise that integrates the majority of the bodily functions (skeletal-muscular, cardio-respiratory, hematocirculatory, endocrine-metabolic, and psycho-neurological) involved in bodily movement. Physical fitness has historically been conceptualized as comprising 3 components: cardio-respiratory capacity (CRC), strength, and agility. Over time, the focus has shifted from strength and agility to aspects which are more directly related to health, and has led to the coining of the term “health-related physical fitness.” Although the tests used to determine health-related physical fitness are somewhat heterogeneous, they include cardio-respiratory capacity, strength and muscle resistance, flexibility, and body composition (particularly adiposity). In children, they also include speed and agility.

Although a large part of the variability in physical fitness is genetically determined, environmental factors, and particularly physical exercise, also influence physical fitness. In children, the relationship between physical activity and physical fitness is less clear. It has been argued that physical activity in children and younger adolescents is unlikely to modify physical fitness because it is largely unpredictable and non-systematic, and occurs in relatively short bursts. The lack of agreement between studies which have examined the relationship between physical activity and physical fitness in children and adolescents could be due to the variety of methods used to measure both physical fitness and physical activity. When trying to evaluate the effects of physical activity, it is important to take into account the difficulty of obtaining valid and precise measurements.

Results from the European Youth Heart Study published in the current issue of *Revista Española de Cardiología* by Ortega et al³ support the hypothesis that adolescents who can be considered active, ie, those that perform at least 60 min of moderate to intense physical activity daily, have greater cardiovascular capacity. It is a meticulous and rigorous article which tackles a topic which is of particular relevance at a time when sedentary behavior and poor physical fitness are increasingly prevalent among adolescents in the majority of industrialized countries. These tendencies are paralleled by increases in the frequency of overweight and obesity to alarming

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proportions in some Mediterranean countries. The study's main contribution is to suggest that, although there is a well-established association between physical activity and CRC, it is not clear that compliance with current recommendations on the quantity and intensity of physical activity in adolescents will be sufficient to achieve a healthy CRC. In order to investigate this aspect further, they used accelerometers to measure the frequency and intensity of physical activity and VO_{2max} with a cycloergometer to measure CRC. They conclude that adolescents who perform at least 60 min of moderate to intense physical activity daily are more likely to have a healthy CRC, independently of the degree of sexual maturity and adiposity.

As the study's contributions are of great practical importance, it is worth examining certain aspects of the relationship between physical activity and physical fitness in more detail, as well the relationship of these with health.

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It is usually assumed that physical activity is related to physical fitness and that physically active children will therefore be in better physical condition. For some authors, although they may not make it explicit, this relationship is also causal, and it is often alleged that the evidence indicates that only high intensity physical activity (over 6 MET) improves physical fitness. To date, although the data from the study in question seem to point in that direction, such affirmations have no solid scientific basis, as we will see below. In the first place, it should be pointed out that the relationship between physical activity and physical fitness is only weak or moderate and in some studies it is not significant. Furthermore, daily physical activity explains only a relatively small proportion of aerobic capacity.⁴

Several reasons have been put forward to explain this weak association, including the fact that measures of physical activity and physical fitness vary greatly in terms of their validity and reliability, that moderate-high intensity physical activity in children and young people is not maintained over prolonged periods, and that the relationship between physical fitness and physical activity in children and adolescents can be masked at least in part by the heterogeneity of the samples in studies of children and adolescents.⁵

It is true that the measurement of physical activity in children and young people is subject to several conditioning factors which threaten validity and reliability. The limitations of measuring physical activity using scales and questionnaires have been dealt with in excellent reviews so it is not necessary to go into detail on that aspect here.⁶ It is worth pointing out, however, that although the measurement of physical activity using accelerometers is undoubtedly the most objective method,

it is not exempt from serious limitations which also threaten its validity and reliability. In the first place, accelerometers are poor at recording certain movements which involve minimal vertical displacements, such as pedaling. These form a significant proportion of children and adolescents' leisure-time physical activities in some European countries, including Sweden, where data for the current study were collected. In the second place, the cut-points used to categorize the intensity of physical activity were defined under laboratory conditions and are not very representative of the movements children and adolescents make under natural conditions. Finally, whilst there is a stringent requirement to provide data on non-response when studies use questionnaires to measure physical activity, and it may even be necessary to analyze differences between responders and non-responders, this is not the case when accelerometers are used to measure physical activity. The proportion of measurements which are discounted because they do not meet inclusion criteria (at least 3 days with a minimum of 10 h of records per day in the Ortega et al study) is often not reported. Our experience in measuring physical activity in children and adolescents using accelerometers leads us to suspect that there may be differences between those who meet inclusion criteria and those who do not in terms of patterns of physical activity.

Physical Activity and Physical Fitness. The Role of Obesity and Genetic Determinants

Several studies have shown that adult individuals who regularly perform physical activity are less likely to develop health problems. Likewise, there is evidence of an inverse relationship between physical fitness and the risk of becoming ill and of dying. It has been reported that physical fitness better predicts health outcomes in adults than physical activity.⁷ In children, data from cross-sectional⁸ and prospective⁹ studies have been used to suggest increasing physical activity is insufficient, as future cardiovascular risk is more dependent on physical fitness than on the amount of physical activity performed. Nevertheless, some arguments might lead us to question this affirmation.

Firstly, the relationship between physical activity and physical fitness, and the relationship between the latter and several cardiovascular risk factors cannot be analyzed without taking into account several confounding factors, particularly adiposity and genetic determinants. The results of an intervention study¹⁰ indicate that only high intensity physical exercise has any effect on CRC in obese adolescents, and that both moderate and high intensity physical exercise modifies adiposity. On the other hand, a more recent cross-sectional study¹¹ showed that both the total amount of physical activity and intense physical activity were associated with a better CRC, although only intense physical activity reduced adiposity. Our opinion is that, given that both physical fitness and adiposity have

a marked hereditary component, adolescents who are genetically predisposed to poor physical condition or obesity are less likely to get involved in intense physical activity. To further complicate the situation, genetic inheritance can also affect the relationship between CRC and cardiovascular risk. This has been shown to be the case in studies which have linked polymorphisms of the angiotensin converting enzyme and CRC on the one hand, and others which have shown an association between low birth weight (which is in part genetically determined) with a low CRC in childhood and adolescence.

The aforementioned studies also raise questions about the directionality of the association between physical activity and physical fitness. For example, after 23 years of follow-up, researchers from the Amsterdam Growth and Health Longitudinal Study concluded that there is a significant though weak association between physical activity and aerobic capacity during adolescence, although the direction of the relationship was not clear. They also concluded that physical activity in adolescence was not associated with aerobic capacity in adulthood, which suggests that genetic factors could be more important than environmental factors in determining the relationship between physical activity and aerobic capacity.¹² Some of our team's recently published data¹³ from the evaluation of a program to promote leisure-time physical activity in school-age children showed a reduction in adiposity and an improvement in lipid profiles without substantial change in physical fitness. The program was addressed to children aged 9-10 years from 20 schools in the Cuenca province (Spain). Physical activity was quantified by comparing counts per minute recorded by accelerometer during each of 3 weekly 90 min sessions versus those days on which there was no session (available at: www.movidavida.org).

Another noteworthy aspect of the study by Ortega et al are the differences in the strength of the association between physical activity and physical fitness when gender is taken into account. The authors suggest that these results could stem from the socio-cultural differences between boys and girls. Although we recognize that there is some difficulty in explaining this finding, we believe, as mentioned earlier, that genetic factors should be considered as a possible explanation for a substantial amount of the variability in physical fitness. This may be due to the way genetics influence fat distribution and aerobic capacity, as well as their effect on the levels of testosterone and other hormones related with strength and flexibility. As the authors indicate, future studies in this area should attempt to clarify the causes of differences in physical activity and CRC between boys and girls.

In summary, the study by Ortega et al is noteworthy for its rigor and precision in measuring physical activity and physical fitness, as well as the fact that it provides data on the relationship between recommendations for physical activity and physical fitness, and on the importance of gender in that relationship. The results of

this study suggest hypotheses regarding the role of gender, genetics, and, possibly, other environmental determinants in the relationship between physical activity and CRC. It also highlights the much lower prevalence of low CRC among adolescent boys in Sweden compared to Spain (9% vs 19%, respectively). The figures are similar in females (20% and 17%, respectively).

The Best Preventive Strategy in Adolescents: Provide Opportunities for Physical Activity

Nonetheless, although we undoubtedly need to further explore the relationship between physical activity and physical fitness, we should not lose sight of the horizon. Physical activity is a behavior and physical fitness, a state. It is within our means to promote active behaviors which can help modify the level of physical fitness. Physical fitness is a result not only of genetic conditioning but also of individual and social determinants. As we are presently unable to modify genetic determinants, we need to focus on modifying individual and social determinants of physical activity. Despite some authors' doubts that physical exercise below recommended levels will influence physical fitness, exercise at these levels may nevertheless still lead to improvements in self-esteem, academic performance, or bone density.

There is, then, an urgent need to provide more opportunities for physical activity in adolescents. These might include the provision of "cycle lanes" to access educational and leisure centers, easy access to sports facilities, parks with "fun" jogging circuits, pedestrian-safe cities, physical activity during free-time in educational centers, and the promotion of out-of-school, non-competitive physical exercise programs, and games. At the same time, we need to ensure that the doing of physical exercise is something to be valued and appreciated in the adolescents' environment. To do that we need to increase awareness among families, educators, and other social agents that promoting competitive and, particularly, non-competitive physical exercise is the best way to ensure a healthier future for the young people of today.

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