

Adolescence, Physical Activity, and Metabolic Cardiovascular Risk Factors

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Cardiovascular Risk at Early Ages

Cardiovascular events that occur before or during the fifth decade of life in men and the sixth in women are considered to be early; however, the initial atherosclerotic lesions that lead to clinical events occur much earlier and can be seen in childhood.¹ Metabolic cardiovascular risk factors, such as dyslipidemia or obesity, can be seen in the first and second decades of life. Studies in autopsies of children correlating artery morphology with cardiovascular risk factors have shown that after age, dyslipidemia (both increased cholesterol of low-density lipoproteins [LDL-C] or decreased cholesterol of high-density lipoproteins [HDL-C]) is an extremely important factor for the development of arteriosclerosis between the second and third decades and later decades.² The relationship between insulin resistance and diabetes with early development of fatty streaks in arteries has also been demonstrated.³

Given the proven relationship between cardiovascular risk factors in childhood and adolescence and its continuance into adulthood, and screening prevention should be started as early as possible.

Physical Activity and Cardiovascular Risk Prevention

The beneficial effects of physical activity in preventing cardiovascular risk related to metabolic factors are well demonstrated. Various epidemiologic and intervention

studies have shown that regular physical activity increases HDL-C concentrations and reduces LDL-C and triglycerides.⁴ Physical activity improves glucose control in patients with type 2 diabetes⁵ and, when combined with weight loss, has been shown to prevent the onset of type 2 diabetes in subjects at risk of developing this condition, with a greater effect than that achieved with drugs such as metformin.⁶

However, the relationship between the type, intensity and frequency of physical activity and cardiovascular risk factors continues to be a subject of debate, as aptly commented by Elosúa in a recent editorial in the *Revista Española de Cardiología*.⁷ It has been shown that regular lengthy, strenuous physical activity is the most effective tool for controlling cardiovascular risk factors. Nevertheless, this type of physical activity is not common, even in children or adolescents. Fortunately, low to moderate physical activity (aerobic walking, light jogging, swimming, cycling—even on a static bicycle—) also has a favorable effect on the metabolic profile if done for long sessions (>30 min/session).⁸ Although quantitative changes in lipid parameters may be modest with this type of physical exercise, qualitative changes (in size and composition) which significantly decrease the atherogenic capacity of low (LDL), intermediate (IDL), and very low (VLDL) density lipoproteins and enhance the antiatherogenic role of high-density lipoproteins (HDL) are also obtained.⁸ Accordingly, this type of physical exercise, which is recommended for the adult population and involves no greater danger than skeletal muscular lesions, is highly effective in preventing lipid-related cardiovascular risk. The recommendations are similar for children and adolescents, but the duration of physical activity is extended to 1 hour a day of moderate or strenuous exercise.

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What is the Current Situation in Our Adolescents?

The study conducted by Artero⁹ and published in the current issue of the *Journal* presents data on the metabolic profile of adolescents of both sexes in relation to physical fitness. The data were obtained in a representative

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subgroup of the AVENA study. This study defines the reference values for physical fitness parameters in adolescents, which have been previously published in the *Revista Española de Cardiología*.¹⁰

The metabolic index developed by the authors combines some of the biochemical parameters implicated in the metabolic syndrome, such as glucose, HDL-C, LDL-C and triglyceride concentrations. Abnormal levels of these parameters have proved to be related to increased cardiovascular risk, and improvements have been related to decreased risk. The authors evaluated the subjects' aerobic capacity and strength using the EUROFIT test battery and computed their overall physical activity using an activity questionnaire.

The lipid profile data obtained in this AVENA subgroup are representative of our population. The mean lipid concentrations found, except for LDL-C in adolescent girls, correspond to the 50th percentile reported by the DRECE study in a group of approximately 900 adolescents of similar age.¹¹ There is no clear reason for a higher mean LDL-C concentration in adolescent girls than boys (99 vs 92 mg/dL, respectively); however, the metabolic profile of the was significantly better than that of boys since they had lower blood glucose and triglyceride levels, and LDL-C/HDL-C quotient, as well as higher HDL-C. These data are consistent with the results of several studies, and it is only necessary to mention that the LDL-C to HDL-C ratio is a more accurate evaluator of the lipid profile than these components separately.

The metabolic index used to summarize blood glucose, HDL-C, LDL-C and triglyceride concentrations is useful as an overall assessment of the highly inter-related metabolism of lipids and carbohydrates. It has also been reported that the use of such indexes decreases the bias caused by biological variation in these metabolic parameters.¹² However, two potential sources of bias in the calculation of the metabolic index should be mentioned: first, the mean triglyceride concentration is used in the calculation to standardize the values found: $\text{standardized value} = [(\text{observed value} - \text{mean}) / \text{standard deviation}]$; triglyceride concentrations show a non-Gaussian distribution in any population, and referencing the concentrations to the mean, rather than the median or log-transformed mean, can bias the standardized values; secondly, the population analyzed included both adolescent boys and girls between 13 and 18.5 years of age. From 14 years, sex-related differences can be seen in the lipid profile, which up to then is similar in both sexes. In women, HDL-C concentrations increase and triglycerides decrease due to the influence of estrogen; in men, there is some decrease in total cholesterol levels, but at the expense of decreased HDL-C, also due to androgenic influence. As in the case of triglycerides, using a mean value to represent the adolescents' values at different stages of sex hormone secretion and, therefore, with differences in their lipid profile, could contribute to biases in metabolic index values.

Physical Activity and Physical Condition. How Do They Relate to Metabolic Cardiovascular Risk Factors?

Whereas physical activity is assessed as the expenditure of energy in the subject's physical activities, physical fitness summarizes the cardiopulmonary capacity for exercise, muscle strength, body composition, and flexibility. It is evident that physical activity is required for fitness.

The results of the study on the relationship between the physical activity index and certain physical fitness parameters were interesting, but controversial. The physical activity index showed a modest relationship with peak oxygen consumption (peak VO_2) calculated from the Course-Navette test ($r=0.182$ in men and 0.259 in women), but did not correlate with the strength index (a summary of three tests) or with the metabolic index. The logical conclusion is that the measurement of physical activity is unreliable as a predictor of aerobic capacity, physical strength or the metabolic profile.

This conclusion had already been discussed by Elosúa in his editorial on the previous article on the AVENA study.⁷ Aerobic capacity and physical strength correlate more closely with strenuous physical activity than with moderate physical activity; therefore, the intensity of the study subjects' physical activity should first be known to properly interpret the conclusion indicated. It should also be taken into account that physical activity was assessed by a survey, an approach that reduces the accuracy of calculating metabolic equivalents expended in physical activity. A study in 681 European adolescents (The European Youth Heart Study) of the same age as the mean in Artero's study calculated the metabolic index calculated the metabolic index from more parameters, measured physical activity by accelerometry and found a significant decrease in metabolic risk as the measured physical activity increased. Blood glucose and triglyceridized, and total cholesterol concentrations, but not HDL-C concentrations, showed a significant correlation with the physical activity measurement.¹² Thus, objectively measured physical activity correlates with an improvement in the metabolic profile. The authors of the European study indicate that the measure of physical activity by accelerometry, even when underestimating exercises such as cycling, swimming or weightlifting, provides a more reliable assessment of physical activity than surveys, since children or adolescents tend to underestimate moderate physical activities carried out in their free time.

The authors report that peak VO_2 in men and the strength index in women correlate with the calculated metabolic index. Peak VO_2 and strength index are parameters of physical fitness, which positively correlates with a more healthy cardiac metabolic profile^{13,14}; hence, Artero's results are consistent with those obtained among other populations. However, it is interesting that the

metabolic index correlates differently according to sex, in particular, with aerobic capacity parameters in men and strength parameters in women.

Frequent light to moderate aerobic exercise improves the lipid profile, with a significant decrease in triglycerides and moderate increases in HDL-C. With higher volumes of aerobic work, major benefits are observed, including greater increases in HDL-C and decreases in LDL-C.⁸ Therefore, it is not surprising that the metabolic index (calculated mainly from lipid parameters) of the men in the study was related to their aerobic capacity. Among women, the lack of association between the metabolic index and aerobic capacity and the association with strength parameters may be surprising. The most plausible explanation for this finding may lie in the status of sex hormone secretion among adolescents analyzed. Because of their age, many of these young women will have greater estrogen production and therefore, improvements in the lipid profile. The HDL-C concentrations among the adolescent girls enrolled in the study were higher than those of boys, whereas triglyceride levels were lower. It has been shown that young, menstruating women need considerable amounts of aerobic exercise to significantly increase HDL-C above the values observed in sedentary women of the same age.¹⁵

Therefore, the potent effect of estrogens in women can mask the relationship between aerobic capacity and metabolic profile, particularly if the women are not very physically active. The reason why muscle strength is correlated with metabolic index in women and not in men could be the greater relative strength observed in women. The reference percentiles published by the authors for the physical condition parameters,¹⁰ show that young men's mean values for the strength tests were near or below the 50th percentile, whereas women's values were above this percentile, particularly for hanging strength which corresponded to the 70th percentile. Referring to the results obtained by the authors, both in the case of strength tests and aerobic capacity, to the percentiles would be extremely useful for better understanding of the results.

Finally, a key aspect for interpreting the overall results should not be neglected: the effect of weight, or even better, of the body fat content. Body mass index (BMI) is not as closely related to the parameters (blood glucose, lipids) included in the metabolic index used as a measurement of body fat, particularly if waist circumference is assessed. In addition, BMI physiologically increases with age; although the mean value for the complete group of men and women enrolled in the study was near the 50th percentile for the respective BMI of each sex in the Spanish population,¹⁶ this mean value would be higher for younger adolescents. Consequently, it would be interesting to reassess the relationships of the metabolic profile if the effects of weight or adiposity and their relative ratio with respect to values according to age were included in the analysis.

What Measures Should We Take in the Future for Our Adolescents?

One particularly worrisome finding of the present study regarding the physical activity in adolescents is that 41.4% (32% of men and 51.2% of women) were physically inactive. In 2001, the percentage of inactive adolescents in Spain was 33% according to the European Heart Network.¹⁷ Therefore, physical inactivity is increasing among our adolescents.

The lipid profile of Spanish adolescents is still heart-healthy, since it is characterized by an LDL-C / HDL-C ratio below 2.0 according to the study results. However, the strong dependence of HDL-C concentrations on weight and body fat in particular can adversely affect this favorable lipid profile. The prevalence of obesity increased by 14% among male adolescents between 1992 and 1998-2000, although it remained steady in women.¹⁶ The current prevalence of excess weight in Spanish adolescents (14-17 years) is 21%, one of the highest in Europe,¹⁸ and the data are even more worrisome in the prepubertal population, since 34% of Spanish children 7 to 11 years old are overweight; moreover, childhood obesity from 3 years of age is predictive of adult obesity.¹⁹

Physical inactivity is one of the main factors implicated in weight gain, whereas the practice of physical activity at early ages is significantly associated with physical activity in adulthood.²⁰ Therefore, encouraging regular physical activity in childhood and adolescence should be a priority for cardiovascular risk prevention in adults.

Promoting physical activity should not be restricted only to the recommendations made by health care professionals; a broad, intensive population strategy is required to reverse the current trend toward increased inactivity. In the school setting, physical exercise should play a more important role in the academic coursework. At present, physical activity is limited to 2 mandatory sessions of 50 minutes per week up to the last 2 years of high school and becomes optional in these last 2 years, at an age similar to that of the adolescents analyzed in this study. Educational centers should maximize access to school sports facilities after hours. The population strategy should also include training to help parents recognize the need to encourage physical activity and reduce their children's after-school sedentary activities.

Only when health professionals and all others involved in the issue become aware that physical activity improves both physical fitness and health, as well as current and future cardiovascular health, can measures be taken to reverse the adverse trends currently observed among our children and adolescents.

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