

Cardiorespiratory fitness improves grades at school

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Recent studies indicate a link between children's cardiorespiratory fitness and their school performance: the more athletic they are, the better their marks in the main subjects—French and mathematics. Similarly, cardiorespiratory fitness is known to benefit cognitive abilities, such as memory and attention. But what is the real influence of

such fitness on school results? To answer this question, researchers at the University of Geneva (UNIGE), Switzerland tested pupils from eight Geneva schools. Their results, published in the journal *Medicine & Science in Sport & Exercise*, show that there is an indirect link with cardiorespiratory fitness influencing cognitive abilities, which in turn, influence school results.

Charles Hillman, a professor at Northeastern University in Boston and co-author of this study, has suggested in previous research that there is a link between children's [cardiorespiratory fitness](#) and their [academic performance](#), as well as a beneficial effect of cardiorespiratory fitness on executive functions. "There are three main executive functions," explains Marc Yangüez, a researcher at the UNIGE's Faculty of Psychology and Educational Sciences (FPSE) and first author of the study. "The first is inhibition, i.e., our ability to inhibit intrusive or irrelevant behavior or thoughts. The second is cognitive flexibility, which is often called multitasking, and refers to our ability to flexibly move between tasks or responses based on task demands. Finally, the third is working memory, which is our ability to maintain information in our minds and manipulate it."

However, the link between fitness and academic skills does not seem obvious at first sight. This is why researchers at the UNIGE wanted to analyze it and observe how one influences the other and whether a specific cognitive process plays a predominant role.

Testing the physical and cognitive abilities of Geneva students

The Geneva investigators teamed up with eight schools in the canton of Geneva to conduct cognitive and physical tests on 193 pupils aged 8 to 12. First of all, children took a physical test known as the "shuttle run

test": the children had to run back and forth between two lines 20 meters apart at an increasingly fast pace. "Combined with height, weight, age and sex, this test allows us to assess the child's cardiovascular fitness," says Marc Yangüez. "Following this, we used nine tasks that allow us to assess children's abilities in the three main executive functions—inhibition, cognitive flexibility and working memory—and we measured different indicators such as the precision and speed of their responses," explains Julien Chanal, researcher at the FPSE of the UNIGE. For example, one of the tests of inhibition presents students with images of fish swimming. The central fish can either swim in the same direction as the others or in the opposite direction. The students have to indicate as quickly and accurately as possible the direction in which the central fish is swimming when they are only shown the picture for 200 milliseconds. To measure cognitive flexibility, the students took three tests as well, one of the tests asked the students to connect in ascending order numbers and letters (1-A-2-B-3-C, etc.). In one of the working memory tests, the students had to memorize a sequence of numbers, such as 2 6 4 9 7, and then repeat them in the reverse order. In addition, at the end of the year, the teachers, with the parents' consent, transmitted the students' marks for the three terms of the year in mathematics, French 1 (comprehension and expression of text) and French 2 (grammar, spelling and vocabulary).

An indirect link between cardiorespiratory fitness and school results

By combining the data obtained, the psychologists found that there was a link between better cardiorespiratory fitness and higher marks in mathematics and French 2. "French 1 is probably less directly concerned, because the evaluation of the text and the writing depend more on subjective factors, which is less the case for mathematics or grammar, for which there is little subjectivity in the right or wrong

answers," explains Marc Yangüez. In addition to the existence of a link between cardiorespiratory fitness and [school](#) results, the data obtained also confirm a link between cardiorespiratory fitness and executive functions. But does good cardiorespiratory fitness affect academic performance directly or indirectly through executive functions?

"By decomposing these effects via a statistical mediation model, we established that the link between cardiorespiratory fitness and academic performance was indirect. In fact, physical [fitness](#) is related to better executive functions, and it is indeed executive functions that influences [school performance](#), more specifically [cognitive flexibility](#)," emphasizes Julien Chanal.

Important results for the planning of physical education in schools

The results of this study are important for the organization of school planning. "By demonstrating the link between physical capacities, such as [cardiorespiratory](#) capacity, [cognitive abilities](#) and grades, it underlines the importance of not reducing physical activity (and in particular physical education hours) in favor of other subjects, as this could ultimately have a negative impact on the development of the child as a whole," says Marc Yangüez. This study also challenges the idea of forcing children to study more and spend more time at their desks in order to succeed at school, depriving them of physical exercise. Finally, and all the more so in times of a pandemic, the Geneva psychologists stress the importance of not depriving children of movement, which would be detrimental to both their physical health and their cognitive health. "We would now like to carry out an intervention study into schools in different regions of Switzerland, in order to demonstrate on a large scale that when children's weekly physical activity increases, it has a positive impact on the development of [executive functions](#), leading to a

significant improvement in school results," concludes Julien Chanal.

More information: Marc Yangüez et al, The Indirect Role of Executive Functions on the Relationship between Cardiorespiratory Fitness and School Grades, *Medicine & Science in Sports & Exercise* (2021). [DOI: 10.1249/MSS.0000000000002630](https://doi.org/10.1249/MSS.0000000000002630)

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