

Physical exercise and academic performance

Abstract

The practice of physical exercise has been classically associated with improvements in metabolic functions such as cardiovascular, ventilator, hormonal, etc. However, in the last decades, it has increased the number of studies that relate physical exercise, cognitive functions and academic performance. In recent years, many studies have reported the relationship between physical exercise and grades obtained at primary, secondary and university levels, which may be influenced by the improvement of attention, work memory and executive functions after the increase of blood vessels and neurogenesis influenced by the practice of physical exercise.

Keywords: Physical exercise, aerobic exercise, academic performance, cognitive functions

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Introduction

The continuous practice of physical exercise has been shown to have positive effects on various metabolic functions such as cardiovascular capacity, pulmonary ventilation, secretion of certain hormones, platelets function and coagulation, renal function, etc.^{1,2} as well as being associated with a decrease in chronic non-contagious diseases such as diabetes, cardiovascular diseases and respiratory diseases.^{3,4} But in the last decades, physical exercise has been linked to improvements in brain structures, which leads to an improvement in cognitive functions such as attention, memory, planning, inhibition, etc.⁵ This last situation has allowed establishing a relation between the practice of physical exercise and the academic performance.⁶⁻⁸

The academic performance corresponds to a system that measures the achievements and the construction of knowledge in the students. In many educational systems this concept is often associated with a rating scale (1 to 10, 1.0 to 7.0, 0 to 100, etc.) with an approval value (for example, on a scale of 1 to 10, a value of 6 indicates the student's approval). Artunduaga⁹ establishes the importance of demographic variables (age, sex, work, etc.), cognitive (abilities, intelligence, etc.) and attitudinal variables (interest, motivation, self-concept, etc.). For its part, Barahona¹⁰ shows that variables such as gender, conformity to studied area and qualifications in verbal and mathematical tests, are excellent predictors of general academic performance. Other authors such as Pérez & Castejón¹¹ establish that verbal self-concept and verbal fluency are the best predictors of language performance, whereas numerical aptitude and mathematical self-concept better predict mathematical outcomes. Finally, Tejedor¹² establishes gender, age, personality, intelligence, motivation, study habits, teaching methods, evaluation strategies, parental studies, etc., as representing important elements that can determine academic performance.

Most models that account for factors influencing qualifications include cognitive variables such as attention, memory and executive functions.^{13,14} In addition, numerous studies establish the relationship between practicing physical exercise and cognitive function improvement.¹⁵⁻¹⁸ This fact allows establishing a relation between the practice of physical exercise, the improvement of cognitive functions and the increase of the academic performance of the students.

Discussion

A study by Dubuc et al.¹⁹ evaluated 100 women (24.4±4.6 years) of the University of Quebec in Canada, showing a relationship between the academic results and $\text{VO}_{2\text{max}}$ ($r=0.32$; $P=0.001$). Another study by Anderson & Good²⁰ studied the relationship between BMI, problem solving and qualifications of 279 college students (73% female and 27% male). The results show a negative and low relationship between BMI and student qualifications averages ($r = -0.190$, $p = 0.001$) and a positive relationship between problem solving and university performance ($r=0.357$, $p=0.001$). The authors propose the relationship between healthy body weight and academic achievement.

On the other hand, an investigation of Beck et al.²¹ applied a 6-week intervention to 165 Danish children (7.5± 0.02 years old) where he associated motor work with performance in mathematics. The control group received conventional math classes, the intervention group 1 (G1) received a math class integrated with gross motor movements and intervention group 2 (G2) received an integrated math class with fine motor movements. The children were examined before, immediately after and 8 weeks after the intervention. It was used a standardized mathematical test to evaluate mathematical performance. The results show an improvement in the results of the math test immediately after the intervention, with better results for G1. In addition, there were no significant differences between the pre-intervention measurement and the 8-weeks later measurement.

A study by Kao et al.²² analyzed the relationship between aerobic capacity, muscle capacity, working memory and academic performance in 79 children between 9 and 11 years old. The results show that, after controlling for socio-demographic variables, there is a relation between aerobic capacity and working memory and performance in mathematics. In the same way the muscular capacity is related to the working memory. Other research²³ studying children aged 6 to 8 years, showed that moderate to vigorous physical activity was related to reading fluency ($p<0.05$) and better reading comprehension ($p<0.05$). A study by Esteban et al.²⁴ with 1146 students (12.5±2.5 years old) related sedentary behavior (surfing the internet, listening to music and sitting down quietly) associate negatively with academic achievement ($p>0.05$) Maureira et al.⁸ evaluated 309 secondary school students,

analyzing the relationship between physical exercise and language, math, history and science, finding a positive relationship only with mathematics, possibly due to the common elements of this discipline with the motor execution.

Contrary to previous results, a study by Esteban et al.²⁵ with 1780 subjects between 6 and 18 years of age (48.5% female and 51.5% female) did not show a relation between physical activities and the academic performance. The authors conclude that the time devoted to physical activity is not sufficient in time and intensity to provoke substantial changes in the school environment.

The studies carried out in recent years provide more and more evidence of the beneficial effects of physical exercise on brain functions, which have an impact on an improvement in academic performance. This improvement is usually associated with the development of new cerebral blood vessels, increased synaptic density, increased glia and neurogenesis.^{26,27}

Conclusion

Recent studies report the positive relationship between physical exercise practice and academic performance of primary, secondary and university students. The sedentarism seems to be a risk factor for the cognitive functions, which represent fundamental elements for the correct school performance. These data give account of the physical exercise as a new tool for cognitive improvement and gives the responsibility to the professional of the physical activity, not only be aware of the improvement of the physical qualities and motor capacities, but also of an active and concomitant role in the academic improvement of the students.

Future research is needed to establish more precisely what type of physical activities or exercises are most appropriate and when is the ideal time to stimulate brain functions, in addition to applying interventions in different school contexts and different populations.²⁸

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Conflict of interest

Author declares there is no conflict of interest in publishing the article.

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