

Executive functions mediate the relationship between cardiorespiratory fitness and academic achievement in Spanish schoolchildren aged 8 to 11 years

Visier-Alfonso M.E.

Sánchez-López M.

Martínez-Vizcaíno V.

Jiménez-López E.

Redondo-Tébar A.

Nieto-López M.

Objectives Previous research has studied the influence of physical fitness on academic achievement through executive functions. However, the nature of this relationship remains unclear. This study aimed to analyze how cardiorespiratory fitness (CRF) and executive functions are associated with academic achievement and to examine whether the relationship between CRF and academic achievement is mediated by executive functions in schoolchildren. **Methods** This was a cross-sectional study including 570 schoolchildren, aged 8 to 11 years, from Cuenca, Spain. Data were collected from September to October 2017. Sociodemographic variables, family socioeconomic status, pubertal status, academic achievement, CRF (20-meter shuttle run test) and executive functions (inhibition, cognitive flexibility and working memory, NIH Toolbox battery in Spanish, v 1.8; iPad Pro, Apple, Inc.) were measured. **Results** Overall, ANCOVA models controlling for age, gender and mother educational level showed higher scores in language and mathematics in children in higher categories of CRF, inhibition, cognitive flexibility and working memory than in children in lower categories. The effect sizes were moderate ($p < 0.05$, partial eta squared: from 0.05 to 0.12). Moreover, the mediation analysis showed that inhibition partially mediated the relationship between CRF and language ($c' = 0.058$; IC = [0.005; 0.028]) and mathematics ($c' = 0.064$; IC = [0.005; 0.030]) grades. Similarly, cognitive flexibility mediated CRF's relationship with language ($c' = 0.059$; IC = [0.003; 0.028]) and with mathematics ($c' = 0.066$; IC = [0.003; 0.029]); however, a significant relationship remained. For working memory, mediation analysis showed no

significant results ($c_0 = 0.92$; $IC = [-0.002; 0.025]$ $P > 0.05$ in language; $c_0 = 0.103$; $IC = [-0.002; 0.029]$ $P > 0.05$ in mathematics). Mediation ranged from 13.38% to 36%. Conclusions Children in higher categories of both CRF and executive function showed higher grades in mathematics and language. The findings indicated that a significant proportion of the positive influence of CRF on academic achievement was mediated by improvements in inhibition and cognitive flexibility. Thus, this study supports the hypothesis that improvements in CRF may contribute to increasing academic achievement not only through a direct mechanism but also through improvements in executive functions. Copyright: © 2020 Visier-Alfonso et al. This is an open access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.