



Physical activity levels and mathematical performance. Research in a Primary Education school

Niveles de actividad física y rendimiento matemático. Análisis en un mismo centro educativo de Educación Primaria

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Abstract

The aim of this paper is to investigate the correlation between physical activity levels and mathematical performance in students from same primary education school. This research was a descriptive, non-experimental, quantitative study, with the participation of 120 children (67 boys and 53 girls), aged between 8 and 12 years old. After applying The Assessment of Physical Activity Levels Questionnaire (APALQ), maths scores from third to sixth grade students were assessed, analysing data according to their physical activity level: sedentary or active. Active students achieved higher scores in mathematics (7.92 ± 1.16 compared to 7.72 ± 1.42), although this difference was not significant ($p > 0.05$) and the correlation was weak ($r = 0.184$). According to gender, mean academic performance among active males was statistically greater than their sedentary peers (8.24 ± 1.64 vs. 7.12 ± 1.12 ; $p = 0.045$). For girls, this result was inverse. To conclude, higher levels of physical activity are positively associated with better mathematical performance in the analysed students.

Keywords: Active lifestyle; academic performance; health promotion; sedentary lifestyle; physical education.

Resumen

El objetivo de este trabajo es investigar la correlación entre los niveles de actividad física y la nota en matemáticas en alumnos de un mismo centro de educación primaria. La presente investigación parte de un estudio descriptivo, no experimental, cuantitativo, con la participación de 120 niños (67 niños y 53 niñas), con edades comprendidas entre los 8 y 12 años. Tras aplicar el Cuestionario de Evaluación de los Niveles de Actividad Física (APALQ), se evaluaron las puntuaciones en matemáticas de los alumnos de tercero a sexto de primaria, analizando los datos en función de su nivel de actividad física: sedentarios o activos. Los alumnos activos obtuvieron puntuaciones más altas en matemáticas (7.92 ± 1.16 frente a 7.72 ± 1.42), aunque esta diferencia no fue significativa ($p > .05$) y la correlación fue débil ($r = 0.184$). En función del género, el rendimiento académico medio entre los chicos activos fue estadísticamente superior al de sus compañeros sedentarios. (8.24 ± 1.64 vs 7.12 ± 1.12 ; $p = .045$). En el caso de las chicas, este resultado fue inverso. Este trabajo concluye que mayores niveles de actividad física se asocian positivamente con un mejor rendimiento en matemáticas en los estudiantes analizados.

Palabras clave: Estilo de vida; rendimiento académico; promoción de la salud; sedentarismo; Educación Física.

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Introduction

It is widely accepted that childhood is a key period to form healthy habits and acquire new knowledge, as children's personality is still developing (Dos Santos et al., 2023; WHO, 2019). Gámez-Calvo et al (2022). suggested the academic performance of school students could be influenced by variables related to their lifestyle. Lee et al. (2015) found a connection between sleeping hours and academic performance, Kristjánsson et al. (2010) linking it to eating habits or body mass index. In recent years however, there has been more focus on the potential relationship between physical exercise and better school success, which led to numerous systematic reviews confirming such a link (Barbosa et al., 2020; Kuzyc et al., 2022, Owen et al., 2022; Wassenar et al., 2020;).

Regular physical activity is necessary for our schoolchildren to reach their full potential (Aznar & Webster, 2006; Trost & Lopeinzi, 2008; Jiménez et al., 2019), while also having a significant influence on their physical and mental health. National and global organizations unanimously agree that children aged 6-12 should engage in 60 minutes of moderate to vigorous daily physical activity to enhance their health and wellbeing (Aznar & Webster, 2006; WHO, 2019).

We must ponder whether better physical health due to exercise will cause enhanced intellectual acuity generally, and better academic outcomes for our scholars in particular. Dwyer (2001) noted students who are physically active are more obedient and mindful of the regulations. Likewise, Rosa-Guillamón et al. (2019) saw increases in collaborative projects with peers as well as superior organisational skills among them. Moreover, several studies have found that children engaged in consistent exercise exhibit greater mental stimulation, increased engagement towards educational materials and elevated teaching and learning processes (Fedewa & Ahn, 2011; Cadenas-Sánchez et al., 2023; Folgado do Santos et al., 2020; Trudeau & Shepard, 2010; Vallejo & Alguacil, 2022;).

Numerous reviews of the literature have concluded that by regularly practicing physical activity, academic performance can be improved (Cid & Muñoz, 2017; Chacón-Cuberos et al., 2020; Luque et al., 2021; Kuzyc et al., 2022, Owen et al., 2022, Lambert et al., 2024). With regard to mathematical performance, Muntaner-Mas et al. (2023) found a positive relation with physical activity, after a systematic review. In studies carried out in Spain, Pizà et al. (2022) observed an improvement in the speed of solving numerical tasks in those students who were more active. Prieto & Martínez (2016) concluded that students who participated in more physical activity had better grades in mathematics and improved academic performance in research conducted with 223 primary school students from 3rd to 6th grades. Using 518 primary school students for analysis, Pros et al. (2015) concluded that extracurricular physical activity significantly affected academic performance in maths and literature. Recently, Ortíz-Sánchez et al. (2023) found a positive relationship between normal weight values and better mathematical and logical performance in a longitudinal study of 70 children over five years.

About publications out of Spain, Faught et al. (2017), after studying 4.253 pupils aged 10 and 11, found that an active lifestyle was linked to higher academic grades, particularly in mathematics. Booth et al. (2014) noted the same trend among 4.755 students classed as being 9, 10 or 11 years old, as physical activity was seen to predict better results in mathematics exams. Finally, in research conducted by Fritz et al. (2020) they found that physical exercise had a positive effect on academic performance in 338 children aged 6 to 8 years, specially in maths.

In comparison, there have been similar studies which suggest no relationship between physical exercise and improved grades in primary school students (Cladellas et al., 2015; Esteban et al., 2015; González & Ortega, 2013). Thus, it is necessary for us to investigate if participating in extracurricular activities will affect students' mathematical academic performance.

The aim of this paper is to investigate the correlation between physical activity levels and mathematical performance in students from same primary education school. Then, results from third to sixth grade students will be assessed, analysing data according to their physical activity level: sedentary or active.

Methods

Study Design

This research is a descriptive, non-experimental, quantitative study. It was undertaken in a Primary School located in the city of Murcia, Spain. 120 children (67 boys and 53 girls), aged between 8 and 12 years old were recruited for the 2021/2022 school year academic period. The head teacher of the school was made aware of the research before data collection commenced and all participants had signed parental or guardian consent prior to their involvement; these adults were previously given information about the nature of the study. In addition, it has been approved by the University of Murcia's Research Ethics Commission (November 2021).

Procedures

The Assessment of Physical Activity Levels Questionnaire (APALQ), in its Spanish version validated by Jurado-Castro et al. (2019), was applied to categorise whether or not students were physically active outside school. Those who scored 11 or more points were classified as "active". Academic tutors were referred for the report mathematical results of the first term of the academic year, calculated taking into account the evaluation criteria established by the Spanish educational legislation for the mathematics area. This arrangement enabled us to link physical activity and academic performance, while also removing potential extraneous variables resulting from a different school (including differences in teachers, methodology, textbooks or assessment systems).

Statistic Analysis

Data collected were analysed using IBM SPSS Statistics for Windows, Version 28.0 (Armonk, NY: IBM Corp). First, the normality of the data was analysed according to the different variables, using the Kolmogorov-Smirnov or Shapiro-Wilk statistic. In the presence of a normal distribution, the difference between groups was obtained using Chi-Square and Student's t-test. In those cases where the distribution was not normal, the comparison between means was carried out using the Mann Whitney U statistic. The correlation between APALQ score and mathematical performance was calculated using Pearson or Spearman test.

Results

Table 1 revealed that, when all children were taken into account, 80.8% reported engaging in physical activity outside of school, which contrasts with the 19.2% who identified as sedentary. When this variable was examined in regards to gender, 86.5% of boys reported participating in physical activity, as compared to 72.6% for girls. Despite this disparity, the Chi-square statistic indicated that the difference was not statistically significant, with a p-value of .061. This pattern was also repeated across different grades; although not showing any significant difference ($p=.603$), there were more active than sedentary pupils in each year group (third, fourth, fifth and sixth).

Table 1

Physical activity levels according to students' gender and scholar grade

Category	Sedentary	Active	Sig. (p)
All (n=120)	23 (19.2%)	97 (80.8%)	-
Gender			
Boys (n=67)	9 (13.5%)	58 (86.5%)	.061
Girls (n=53)	15 (28.4%)	35 (72.6%)	
Year			
Third (n=33)	8 (24.2%)	25 (75.8%)	.603
Fourth (n=26)	5 (19.5%)	19 (80.5%)	
Fifth (n=26)	3 (11.5%)	23 (89.5%)	
Sixth (n=35)	9 (25.7%)	26 (74.3%)	

By studying the results yearly, we observed that boys generally had higher percentages of physical activity outside school hours over all years. Especially in 5th grade primary, every male student involved in this study was deemed active. However, a chi-square statistic test gave a value above .05 for each year group and so the differences between genders were not significant.

The study examined the correlation between physical exercise and mathematical performance of participants, showing that those who engage in outdoor physical activity achieved higher academic averages than their sedentary peers (7.92 ± 1.67 vs 7.72 ± 1.42). However, this relationship was not significant ($p=.549$), with a weak correlation ($r=0.128$). (Table 2).

Table 2

Mathematical performance categorized by gender and students' year

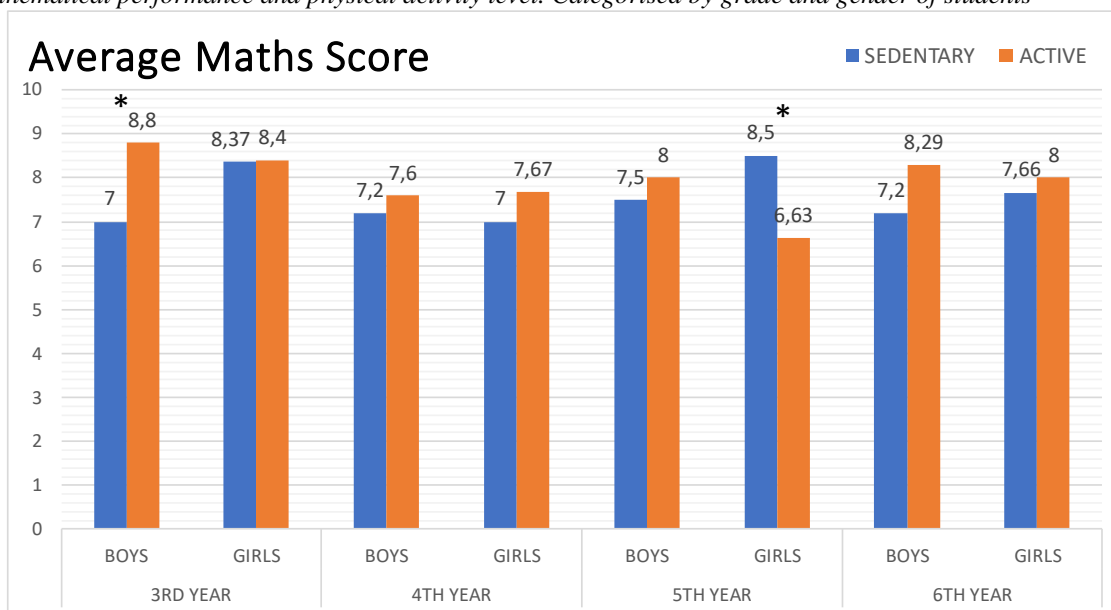
Category	Average Grade – Sedentary Students		Average Grade – Active Students		Sig. (p)	Correlation APALQ-Maths Spearman R
	Mean	SD	Mean	SD		
All (n=120)	7.92	1.67	7.72	1.42	.549	.184
Gender						
Boys (n=67)	7.12	1.12	8.24	1.64	.045*	.166
Girls (n=53)	7.92	1.32	7.57	1.78	.575	-.33
Year						
Third (n=33)	8.00	1.41	8.65	1.19	.299	.182
Fourth (n=26)	7.00	1.41	7.65	2.03	.404	-.196
Fifth (n=26)	8.50	0.70	7.31	1.98	.366	-.87
Sixth (n=35)	7.37	1.18	8.20	1.41	.141	.364

Note. *SD* = Standar Deviation; *Significant Difference $p \leq .05$

When conducting same tests and differentiating the results according to gender (Table 2), it was observed that mean academic performance among active males was statistically greater than their sedentary peers (8.24 ± 1.64 vs 7.12 ± 1.12 ; $p=.045$). In the case of girls, the result was the reverse, with those students categorised as sedentary obtaining better results in mathematics. (7.57 ± 1.78 vs 7.92 ± 1.32 ; $p=.575$) although this value was not significant after applying the Mann Whitney U statistic. The correlation in both genders was weak.

The Mann Whitney U statistic was applied to the non-normal distribution of results in order to analyse them by year. Table 2 shows that, regardless the grade analysed, there was no statistical relationship between the level of physical activity and mathematics performance. We highlight the result obtained in 6th grade, where mathematics grades were higher for active (8.20 ± 1.41) than for sedentary students (7.37 ± 1.18) where, moreover, the positive correlation between both variables was moderate ($r=0.364$).

The comparison between the gender of students (Fig.1) demonstrated that, for boys in 3rd grade, active students had better results (8.8 vs 7.00) and this difference was found significant (p-value of 0.041). Concerning the girls, active pupils managed to attain higher marks in 3rd, 4th and 6th year; nevertheless, those differences were not significant. A remarkable exception is 5th year, where passive students obtained higher average marks (8.5) compared to active ones (6.63), which was significant ($p=.035$).

Figure 2*Mathematical performance and physical activity level. Categorised by grade and gender of students**Significant Difference $p \leq .05$

Discussion

The aim of this study was to explore the link between physical activity and academic achievement among primary school students. An analysis of descriptive data from the studied school showed that 80.8% of the students are physically active outside of school hours compared to only 19.2% who engage in sedentary activities. This research is consistent with data from other studies on Spanish school populations (Latorre et al., 2022; Rodríguez-Fernández et al., 2021; Sánchez-Alcaraz et al., 2020).

In contrast to similar research, Alfonso-Rosa et al. (2018) showed that most students in their population group were sedentary, our study found that the sample from the same school demonstrated higher levels of physical activity. Our study was conducted at a school in the centre of Murcia, Spain, where many families had medium-high socio-economic status. As mentioned in previous literature (Patiño-Palma, 2021; WHO, 2019), this economic level has been associated with students' levels of physical activity. Results show that those with more purchasing power exhibit significantly higher amounts of physical activity when compared to other groups; these findings coincide with those reported by Cano-Garciñuno et al. (2011) and Ramos et al (2016).

Our evaluation found that students who are physically active after classes achieved higher scores in mathematics, which is in line with publications in Spain (Luque et al., 2021; Maureira, 2018) and also in other countries (Kuzyc et al., 2022, Muntaner-Mas et al., 2023; Owen et al., 2022) where higher levels of physical activity were associated with better results in mathematics.

In terms of studying the correlation between physical activity and maths performance, we would like to emphasize that the students involved all come from the same school. Thus, we have a uniform level of difficulty and assessment criteria, which only differ based on academic level. Since our study sample was from the same school, we wanted to compare the results with research that met this condition. Our results are similar to those obtained by Prieto y Martínez (2016), who studied 232 students from the same school and found that those with higher levels of physical activity typically achieved better average grades, particularly in maths. Similarly, Alfonso-Rosa et al. (2018) observed similar results when evaluating the achievements of 50 children from a school in Seville.

Examining studies by Hillman et al. (2008) and Ibáñez (2013) can help explain the findings presented here. As suggested by WHO (2019) and Luque et al. (2021), engaging in regular physical

activity promotes improved cognition in students which is reflected in better academic performance than those without such activities (Abalde-Amoedo & Pino-Juste, 2016).

According to students' gender, active boys were found to have better results (8.24 ± 1.64) than sedentary ones (7.12 ± 1.12), where the differences were even statistically significant ($p = .045$), which is consistent with similar research (Hernández & Pórtoles (2016) and Álvarez-Bueno et al. (2017)). In contrast, for girls, those categorised as sedentary scored higher (7.92 ± 1.32) than the actives one (7.57 ± 1.78). These results are in the line of the findings contrasted by Ávila-García et al. (2020) who, after assessing 152 pupils in year two of primary school, suggested that for females, exercise was inversely related with academic performance.

The analysis of the results according to the academic year of the students highlighted that although no significant differences were found, in the 3rd, 4th and 6th grades, physically active pupils obtained better mathematics averages than the more sedentary ones. The available literature suggests that as students' progress through higher education, the gap in mathematical performance between active and inactive individuals increases (Faught et al., 2017; Sibley & Etnier, 2003); this could be particularly true in our case as it is based on a single school which would lead to more homogenous demands, teachers and methodology across separate years.

Conclusions

Students who participated in this research with higher levels of physical activity out of school hours achieved significantly better mathematical performance than sedentary ones, specially in boys, where this positive relation was statistically significant. Additionally, the analysis by grades revealed a positive correlation between exercise and higher maths grades in three out of the four grades studied (third, fifth and sixth year of Primary Education). Therefore, promoting physical activity in the school environment could enhance academic performance in mathematics according to the findings of this research.

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References

- Abalde-Amoedo, N., & Pino-Juste, M. (2016). Influencia de la actividad física y el sobrepeso en el rendimiento académico: revisión teórica. *Sportis. Scientific Journal of School Sport, Physical Education and Psychomotricity*, 2(1), 147-161.
- Alfonso-Rosa, R. M., Álvarez Barbosa, F., & del Pozo Cruz, J. (2018). Adherencia a la dieta mediterránea, el rendimiento académico y el nivel de actividad física en edad escolar. *Sportis. Scientific Journal of School Sport, Physical Education and Psychomotricity*, 4(2), 255-268. <https://doi.org/10.17979/sportis.2018.4.2.3108>
- Álvarez-Bueno, C., Pesce, C., Cavero-Redondo, I., Sánchez-López, M., Garrido-Miguel, M., & Martínez-Vizcaíno, V. (2017). Academic Achievement and Physical Activity: A Meta-analysis. *Pediatrics*, 140(6), e20171498.
- Ávila-García M., Baena-Ogalla, N., Huertas-Delgado, F.J., Tercedor, P., & Villa-González, E. (2020). The Relationship between Physical Activity Levels, Cardiorespiratory Fitness and Academic Achievement School-Age Children from Southern Spain. *Sustainability*, 12(8), 3459. <https://doi.org/10.3390/su12083459>
- Aznar, S., & Webster, T. (2006). *Actividad física y salud en la infancia y la adolescencia. Guía para todas las personas que participan en su educación*. Ministerio de Educación y Ciencia.

- Barbosa, A., Whiting, S., Simmonds, P., Scotini, R., Mendes, R., & Breda, J. (2020). Physical Activity and Academic Achievement: An Umbrella Review. *International Journal of Environmental Research and Public Health*, *17*(16), 5972. <https://doi.org/10.3390/ijerph17165972>
- Booth, J., Leary, S., Joinson, C., Ness, A., Tomporowski, P., Boyle, J., & Reilly, J.J. (2014). Associations between objectively measured physical activity and Academic attainment in children from a UK cohort. *British Journal of Sports Medicine*, *48*(3), 265-270.
- Bull, F. C., Al-Ansari, S. S., & Biddle, S. (2020). World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *British Journal of Sports Medicine*, *54*, 1451-1462.
- Cadenas-Sanchez, C., Migueles, J.H., Verdejo-Román, J., Erickson, K.I., Esteban-Cornejo, I., Catenas, A., & Ortega, F.B. (2023). Physical activity, sedentary time, and fitness in relation to brain shapes in children with overweight/obesity: Links to intelligence. *Scandinavian Journal of Medicine & Science in Sports*, *33*, 319- 330. doi: 10.1111/sms.14263
- Calvo-Pacheco, M., Rodríguez-Álvarez, C., Moreno, P., Abreu, R., Aguirre-Jaime, A., & Arias, A. (2014). Valoración del estado nutricional de escolares de primaria de la isla de Tenerife (España). *Higiene y Sanidad Ambiental*, *14*(1), 1171-1177.
- Cano-Garcinuño, A. I., Pérez-García, I. Casares, S., Alberola, D. (2011). Determinantes del nivel de actividad física en escolares y adolescentes: estudio OPACA. *Anales de Pediatría*, *74* (1), 15-24. <https://doi.org/10.1016/j.anpedi.2010.08.009>.
- Chacón-Cuberos, R., Zurita-Ortega, F., Ramírez-Granizo, I., & Castro-Sánchez, M. (2020). Physical Activity and Academic Performance in Children and Preadolescents: A Systematic Review. *Apunts. Educación Física y Deportes*, *139*, 1-9. [https://doi.org/10.5672/apunts.2014-0983.es.\(2020/1\).139.01](https://doi.org/10.5672/apunts.2014-0983.es.(2020/1).139.01)
- Cid, F. M., & Muñoz, H. D. (2017). Physical exercise and academic performance. *MOJ Sports Medicine*, *1*(4), 90–92. <https://doi.org/10.15406/mojism.2017.01.00021>
- Cladellas, R., Clariana, M., Gotzens, C., Badia, M. & Dezcallar, T. (2015). Patrones de descanso, actividades físico-deportivas extraescolares y rendimiento académico en niños y niñas de primaria. *Revista de Psicología del Deporte*, *24*(1), 53-59.
- Dos Santos, J., Coelho, T. A., & Silva, R. (2023). Fatores que interferem na formação do hábito alimentar saudável na infância: uma revisão bibliográfica. *Revista Científica Do UBM*, *48*, 80-94. <https://doi.org/10.52397/rcubm.v0in.48.142>
- Dwyer, T., Sallis, J. F., Blizzard, L., Lazarus, R., & Dean, K. (2001). Relation of Academic Performance to Physical Activity and Fitness in Children, *Pediatric Exercise Science*, *13*(3), 225-237. <https://doi.org/10.1123/pes.13.3.225>
- Esteban, I., Martínez, D., García, L., Ortega, F.B., Delgado-Alfonso, A., Castro-Piñero, J., & Veiga, O. (2017). Objectively measured physical activity during physical education and school recess and their associations with academic performance in youth: the UP&DOWN study. *Journal of Physical Activity and Health*, *14*(4), 275-282.
- Esteban, M., Bernardo, A., Tuero, E., Cervero, A. & Casanova, J. (2014). Variables influyentes en progreso académico y permanencia en la universidad. *European Journal of Education and Psychology*, *10*(2), 75- 81. <https://doi.org/10.1016/j.ejeps.2017.07.003>
- Faught, E., Ekwaru, J., Gledlie, D., Storey, K., Asbridge, M. & Veugelers, P. (2017). The combined impact of diet, physical activity, sleep and screen time on Academic achievement: a perspective study of elementary school students in Nova Scotia, Canada. *International Journal of Behavioral Nutrition and Physical Activity*, *14*(1), 29.
- Fedewa Ahn, A.L. & Ahn, S. (2011). The effects of physical activity and physical fitness on children's achievement and cognitive outcomes: A meta-analysis. *Research Quarterly for Exercise and Sport*, *82* (3), 521-535.
- Folgado dos Santos, J. M., Patricio Duarte Petrica, J. M., Serrano, J. J. M., Batista, M. A. da S., Honório, S. A. de A., & Maia, L. A. C. R. (2020). The attention of students during physical education

- class based on academic performance (La atención de los estudiantes durante la clase de educación física basada en el rendimiento académico). *Retos: nuevas tendencias en educación física, deporte y recreación*, 38, 222–228. <https://doi.org/10.47197/retos.v38i38.74650>
- Fritz, J., Cöster, M. E., Rosengren, B. E., Karlsson, C., & Karlsson, M. K. (2020). Daily School Physical Activity Improves Academic Performance. *Sports*, 8(6), 83. <https://doi.org/10.3390/sports8060083>
- Gámez-Calvo, L., Hernández-Beltrán, V., Pimienta-Sánchez, L.P., Delgado-Gil, S., & Gamonales, J.M. (2022). Revisión sistemática de programas de intervención para promover hábitos saludables de actividad física y nutrición en escolares españoles. *Archivos Latinoamericanos de Nutrición* 72(4). <https://doi.org/10.37527/2022.72.4.007>
- González, E. R., & Ortega, A. P. (2013). Relación de sobrepeso y obesidad con nivel de actividad física, condición física, perfil psicomotor y rendimiento escolar en población infantil (8 a 12 años) de Popayán. *Revista Movimiento Científico*, 7(1), 71- 84.
- Hernández, J. G., & Portolés, A. (2016). Recomendaciones de actividad física y su relación con el rendimiento académico en adolescentes de la Región de Murcia. *Retos: nuevas tendencias en educación física, deporte y recreación*, (29), 100-104.
- Herrera Martínez, L., & Espinoza Freire, E. E. (2020). La relación familia-escuela y el rendimiento escolar. *Revista Científica Cultura, Comunicación Y Desarrollo*, 5(3), 16-20. <https://rccd.ucf.edu.cu/index.php/aes/article/view/252>
- Hillman, C. H., Erickson, K. I., & Kramer, A. F. (2008). Be smart, exercise your heart: Exercise effects on brain and cognition. *Nature Reviews Neuroscience*, 9(1), 58-65.
- Ibáñez, A. (2013). *Hábitos alimentarios y de actividad física en un grupo de adolescentes de la Comunidad de Madrid y su relación con el rendimiento académico*. Trabajo Fin de Grado, Facultad de Ciencias de la Actividad Física y del Deporte (INEF). Universidad Politécnica de Madrid.
- Isorna-Folgar, M., Albaladejo-Saura, M., Rial-Boubeta, A., & Vaquero-Cristóbal R. (2022). Relación entre práctica de actividad física en el tiempo libre y rendimiento académico en alumnos/as de 5° de Primaria a 4° de ESO. *Global Health Promotion*. doi:10.1177/17579759221113267
- Jiménez, R., Dalmau, J., Gargallo, E. & Arriscado, D. (2019). Lifestyle differences between Spanish national and migrant students. *Espiral. Cuadernos del Profesorado*, 12(25), 40-48. <https://doi.org/10.25115/ecp.v12i25.2293>
- Jurado-Castro, J.M., Llorente-Cantarero, F.J., & Gil-Campos, M. (2019). Evaluación de la actividad física en niños. *Acta Pediátrica Española*, 77(5-6), 94-99.
- Kristjánsson, Á.L., Sigfúsdóttir, I.D., & Allegrante, J. P. (2010). Health behavior and academic achievement among adolescents: the relative contribution of dietary habits, physical activity, body mass index, and self-esteem. *Health Education y Behavior*, 37(1), 51-64.
- Kuzik, N., da Costa, B.G.G., Hwang, Y., et al. (2022). School-related sedentary behaviours and indicators of health and well-being among children and youth: a systematic review. *International Journal of Behavioral Nutrition and Physical Activity*, 19 (40). <https://doi.org/10.1186/s12966-022-01258-4>
- Lambert, K., Ford, A., & Jeanes, R. (2024). The association between physical education and academic achievement in other curriculum learning areas: A review of literature. *Physical Education and Sport Pedagogy*, 29(1), 51–81. <https://doi.org/10.1080/17408989.2022.2029385>
- Latorre-Román, P. Á., Guzmán-Guzmán, I. P., Antonio Párraga-Montilla, J., Camaño-Navarrete, F., Salas-Sánchez, J., Palomino-Devia, C., Reyes-Oyola, F. A., Álvarez, C., de la Casa-Pérez, A., Cardona Linares, A. J., & Delgado-Floody, P. (2022). Healthy lifestyles and physical fitness are associated with abdominal obesity among Latin-American and Spanish preschool children: A cross-cultural study. *Pediatric Obesity*, 17(7), e12901. <https://doi.org/10.1111/ijpo.12901>

- Lee, Y. J., Park, J., Kim, S., Cho, S. J., & Kim, S. J. (2015). Academic performance among adolescents with behaviorally induced insufficient sleep syndrome. *Journal of Clinical Sleep Medicine*, *11*(01), 61-68.
- Luque, A., Gálvez, A., Gómez-Escribano, L., Escámez, J.C., Tárraga, L., & Tárraga, P. (2021). ¿Mejora la Actividad Física el rendimiento académico en escolares? Una revisión bibliográfica. *Journal of Negative and Non Positive Results*, *6*(1), 84-103. <https://doi.org/10.19230/jonnpr.3277>
- Muntaner-Mas, A., Morales, J. S., Martínez de Quel, Ó., Lubans, D., & García-Hermoso, A. (2023). Acute effect of physical activity on academic outcomes in school-aged youth: A systematic review and multivariate meta-analysis. *Scandinavian journal of medicine & science in sports*, *34*. <https://doi.org/10.1111/sms.14479>
- Oliveira, T., Pizarro, A., Costa, M., Fernandes, L., Silva, G., Mota, J., & Ribeiro, J.C. (2017). Cardiorespiratory fitness, but not physical activity, is associated with academic achievement in children and adolescents. *Annals of Human Biology*, *44*(4), 309-315.
- Ortiz-Sanchez, J. A., del Pozo-Cruz, J., Álvarez Barbosa, F., & Alfonso-Rosa, R. M. (2023). Longitudinal analysis of body composition, physical function and academic performance in children. *Retos: nuevas tendencias en educación física, deporte y recreación*, *47*, 268-274. <https://doi.org/10.47197/retos.v47.95102>
- Owen, K.B., Foley, B.C., Wilhite, K., Booker, B., Lonsdale, C., & Reece, L.J. (2022). Sport Participation and Academic Performance in Children and Adolescents: A Systematic Review and Meta-analysis. *Medicine & Science in Sports & Exercise*, *54*(2), 299-306. <https://doi.org/10.1249/MSS.0000000000002786>
- Pizà-Mir, B., Benito Colio, B., Rodríguez-García, L., & González-Fernández, F. T. (2022). Ejercicio físico basado en descansos activos sobre la función cognitiva y la competencia matemática en estudiantes universitarios de grado (Physical exercise based on active breaks on cognitive function and mathematical competence in undergraduate student. *Retos: nuevas tendencias en educación física, deporte y recreación*, *47*, 970-977. <https://doi.org/10.47197/retos.v45i0.92669>
- Prieto, J. & Martínez, C. (2016). La práctica de actividad física y su relación con el rendimiento académico. *Revista de Educación Física: Renovar la Teoría y Práctica*, *144*, 3-12.
- Pros, R. C., Muntada, M. C., Busquets, C. G. & Martín, M. B. (2015). Patrones de descanso, actividades físico-deportivas extraescolares y rendimiento académico en niños y niñas de primaria. *Revista de Psicología del Deporte*, *24*(1), 53-59.
- Ramos, P., Jiménez-Iglesias, A., Rivera, F., & Moreno, C. (2016). Physical Activity Trends in Spanish Adolescents. *Revista Internacional de Medicina y Ciencias de la Actividad Física y del Deporte*, (62). <https://doi.org/10.15366/rimcafd2016.62.010>
- Rodríguez-Fernández, J. E., Rico-Díaz, J., Neira-Martín, P. J., Navarro-Patón. (2021). Actividad física realizada por escolares españoles según edad y género. *Retos: nuevas tendencias en educación física, deporte y recreación*, *39*, 238-245. <https://doi.org/10.47197/retos.v0i39.77252>
- Rosa-Guillamón, A., Canto, E. G., & López, P. J. C. (2019). Capacidad aeróbica y rendimiento académico en escolares de educación primaria. *Retos: nuevas tendencias en educación física, deporte y recreación*, *35*, 351-354. <https://doi.org/10.47197/retos.v0i35.66769>
- Patiño, B. E., & Apolinar, L. Y. (2021). Nivel de escolaridad en padres y condición física relacionada con la salud en niños y adolescentes. *Fisioterapia*, *43*(2), 68-75.
- Sánchez-Alcaraz, B., Murcia, S., Alfonso, M., & Hellín, M. (2020). Nivel de actividad física en estudiantes en función de la edad, el género, tipo de deporte practicado y su orientación motivacional. *Espiral Cuadernos del Profesorado*, *14*(27), 160-169. <https://doi.org/10.25115/ecp.v13i27.3659>
- Sibley B. A., & Etnier J. L. (2003). The relationship between physical activity and cognition in children: A meta-analysis. *Pediatric Exercise Science*, *15*, 243-256.

- Trost, S., & Loprinzi, P. (2008). Exercise-Promoting healthy lifestyles in children and adolescent. *Journal of Clinical Lipidology*, 2(3), 162-168. <https://doi.org/10.1016/j.jacl.2008.03.001>
- Trudeau, F. & Shephard, R.J. (2010). Relationships of Physical Activity to Brain Health and the Academic Performance of Schoolchildren. *American Journal of Lifestyle Medicine*, 4 (2), 138-150.
- Vallejo, A. G., & Alguacil Jiménez, M. (2022). Influencia de la Actividad Físico-Deportiva en el rendimiento académico, la autoestima y el autoconcepto de las adolescentes: el caso de la isla de Tenerife (Influence of Physical-Sports Activity on academic performance, self-esteem and self-concept of adolescent girls: the case of the island of Tenerife). *Retos: nuevas tendencias en educación física, deporte y recreación*, 46, 120–128. <https://doi.org/10.47197/retos.v46.93496>
- Wassenaar, T. M., Wheatley, C. M., Beale, N., Salvan, P., Meaney, A., Possee, J. B., Atherton, K. E., Duda, J. L., Dawes, H., & Johansen-Berg, H. (2019). Effects of a programme of vigorous physical activity during secondary school physical education on academic performance, fitness, cognition, mental health and the brain of adolescents (Fit to Study): study protocol for a cluster-randomised trial. *Trials*, 20(1), 189. <https://doi.org/10.1186/s13063-019-3279-6>
- World Health Organization. (2019). *Global Action Plan on Physical Activity 2018–2030: More Active People for a Healthier World*. Geneva: World Health Organization.