



## Longitudinal trends in motor development and their association with academic performance and perceived motor competence in schoolchildren

*Evolución longitudinal del desarrollo motor y su relación con el rendimiento académico y la competencia motriz percibida en escolares*

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### Abstract

**Introduction:** Motor development plays a fundamental role in children's overall development and has been increasingly linked to academic performance and motivational factors. Children's perceptions of their own motor abilities may play a crucial role in shaping both their engagement in physical activity and their educational outcomes.

**Aim:** This longitudinal study examined the development of gross motor skills and motivational variables over five years in typically developing children aged 6 to 11. The research aimed to analyse the mediating role of perceived motor competence in the relationship between actual motor competence and academic performance, as well as gender differences in these variables. **Methods:** A total of 90 children from a private urban school participated, with data collected across five time points. Motor competence was assessed using the GRAMI 2 test, and academic performance and motivational variables were measured through standardized evaluations and teacher reports.

**Results:** Findings suggest a significant link between motor competence and academic achievement, mediated by perceived motor competence, and highlight gender-specific patterns in self-perception and participation in physical activities.

**Discussion:** These results support the importance of fostering motor development and self-perceived competence in school settings to enhance cognitive and academic outcomes.

### Keywords

Executive functions; gender differences; motivation; motor competence; self-perception.

### Resumen

**Introducción:** El desarrollo motor desempeña un papel fundamental en el desarrollo global de los niños y se ha vinculado cada vez más con el rendimiento académico y los factores motivacionales. Las percepciones que los niños tienen sobre sus propias habilidades motoras pueden desempeñar un papel crucial en la configuración tanto de su participación en la actividad física como de sus resultados educativos.

**Objetivo:** Este estudio longitudinal examinó el desarrollo de las habilidades motoras gruesas y las variables motivacionales durante cinco años en niños con desarrollo típico de entre 6 y 11 años. La investigación tuvo como objetivo analizar el papel mediador de la competencia motora percibida en la relación entre la competencia motora real y el rendimiento académico, así como las diferencias de género en estas variables.

**Método:** Un total de 90 niños de un colegio concertado de una gran ciudad participaron en el estudio, con datos recopilados en cinco momentos temporales. La competencia motora se evaluó mediante la prueba GRAMI-2, y el rendimiento académico y las variables motivacionales se midieron a través de evaluaciones estandarizadas e informes de los docentes.

**Resultados:** Los hallazgos sugieren una relación significativa entre la competencia motora y el rendimiento académico, mediada por la competencia motora percibida, y destacan patrones específicos de género en la autopercepción y la participación en actividades físicas.

**Discusión:** Estos resultados respaldan la importancia de fomentar el desarrollo motor y la competencia percibida en los entornos escolares para mejorar los resultados cognitivos y académicos.

### Palabras clave

Funciones ejecutivas; diferencias de género; motivación; competencia motora; autopercepción.

## Introduction

Typically developing children reach a level of competence in gross motor skills such as running, jumping, catching and keeping balance during their primary school years, motivated by the process of maturation and practice (Davies & Rose, 2000; Gabbard, 2008). These are all basic skills that are essential for children to be fully functional and independent in their environment (Pangrazi, 2007). But in addition, mastery of these has been considered a prerequisite for the development of more specific or sporting skills (Thomas, 1997; Stodden et al., 2008). However, the study of motor coordination in children has not only been limited to how its development is decisive for the acquisition of greater motor and sports competence but has also focused on how it may be related to greater benefits in terms of academic performance through an improvement in the cognitive processes of schoolchildren (Khan & Hilman, 2014).

Several studies propose executive functions (EF) as the main mediating agents in the relationship between motor coordination and academic performance in schoolchildren (Geertsens et al., 2016; Ramos-Campos et al., 2024; Schmidt et al., 2017). Thus, working memory, for example, was identified as one of the main factors in understanding the indirect effect that greater motor coordination has on children's academic performance (Rigoli et al., 2012). Other authors (Cameron et al., 2016; Pesce et al., 2016) have stated that motor play practiced deliberately by children brings with it not only benefits for their motor development but also for the visuospatial skills required when performing other academic tasks. For their part, Brujin et al. (2019) discovered that a higher level of competence in the performance of children's fundamental motor skills was directly associated with better levels of academic performance in children, due to an improvement in the cognitive processes by which executive functions are governed. This correlation between the two variables could be due to the existence of a network of neuropsychological mechanisms shared by both, that is, to how a child's motor competence is based on cognitive processes very similar to academic competence (Guillamón et al., 2020). Furthermore, several authors have suggested that children with greater motor competence also have higher levels of spatial vision, working memory and other cognitive variables that imply an improvement in their academic performance (Ballesteros-García et al., 2026; Gallotta, 2024; Lopes et al., 2013; Niederer et al., 2011; Ruiz et al., 2016; Tanineh, 2023).

On the other hand, schoolchildren show a generic motivation towards achievement during the development and learning of their motor skills, which would be expressed in their desire to learn in different physical and/or sporting contexts (for example: Physical Education classes, extracurricular sports activities), encompassing their emotional disposition, their awareness of the value of what they are going to learn, their perception of their own motor competence and the effect of their past motor experiences (Villa-de Gregorio et al., 2023). Therefore, factors such as diligence in learning, the assessment of learning, perceived motor competence or fear of making mistakes, are aspects that will influence the motivated state of schoolchildren in any type of physical and/or sporting activity (Villa-de Gregorio et al., 2023). In particular, perceived motor competence, or a child's perception of how they move, is closely related to children's participation in physical and sporting activities (Royo, 2023; Uil et al., 2022). During early childhood, this domain tends to be unrealistically high (Harter, 1999). Around the age of 8-11, they tend to incorporate a more abstract perspective into their descriptions as they grow older (Goswami, 2011). As a result, the age between 7 and 13 is an important period for the development of the regions of the brain involved in self-evaluation (Dreiskämper et al., 2022). Thus, feeling capable and competent to perform any motor task leads to a greater commitment to learning it and, consequently, participation in physical and sports activities will increase with greater academic performance associated with this increase (Barbosa et al., 2020; Okely et al., 2001; Wrotniak et al., 2006).

Furthermore, gender plays a fundamental role in the relationships between motor coordination, perceived motor competence and academic performance. In childhood and adolescence, boys tend to show higher levels of motor coordination than girls in some tasks such as the skills of controlling and manipulating objects, such as throwing or kicking them (Booth et al., 2006; Ehl et al., 2005). Regarding locomotion skills, some studies have not found gender differences (Hume et al., 2008; van Beurden et al., 2002). However, the literature indicates that, in terms of gender, girls tend to underestimate their motor competence and boys to overestimate it, which leads them to be more participative in physical and/or sporting activities, with the associated benefits in terms of academic performance (Macdonald et al., 2020).



Thus, the purposes of this study were: 1. To examine longitudinal trends in the evolution of gross motor skills and motivational variables across five years in typical development children; 2. To investigate whether perceived motor competence mediates the relationship between actual motor competence and academic performance; 3. To analyze gender differences in terms of evolution of gross motor skills, perceived motor competence, and academic achievement.

## Method

### Participants

girls) at baseline 6 years old and 11 at the last data collection. Participants were recruited and selected from one private school from a big city. All the children were evaluated by the PE teacher, previously instructed for the purpose of the study, and trained to performed and carried out the motor tasks that allowed to examine the motor coordination. All participants had no physical or mental disabilities, and the data were collected at five time points (around 5 years apart) between December 2014 and June 2019). The overall follow-up rate was 94,4% (85 / 90).

None of the participants had prior experience with the tasks involved and they were unaware of the study's purpose. The study protocol was approved by the university's ethical committee and adhered to the Declaration of Helsinki for sports science research (World Medical Association, 2024). Informed consent was obtained from parents or legal guardians, and the children provided oral assent to participate.

### Data measurement

GRAMI 2. Motor competence measurement (MCM). Participants 'tasks involved the domains measured by the GRAMI 2 (Ruiz et al., 2015)) that assess the motor competence (overall, locomotion and jump) (Table 1). In this task-oriented test children performed 5 skills (2 for locomotion and 3 for jump). For each skill children had two trials to perform the task advised in advance to try to do their best.

Tabla 1. Tasks from GRAMI test.

Medicine ball through	Movement on supports	Shuttle run	Lateral jumps	30 meters race	7-meter hopping on one leg
Distance	Time	Time	Number	Time	Time

### *The Achievement Motivation in Physical Education Test (AMPET Questionnaire)*

Motivation measurement (MM). The AMPET test, was adapted to the Spanish population on different occasions by Ruiz et al. (2004). Likewise, Ruiz et al. (2015) added to the previous version, one more dimension to the already established one of perceived motor competence, renaming it Test AMPETe-4. This evaluation instrument consists of 32 items and four dimensions, three of which are positive (self-reported motor competence, comparative motor competence and commitment to learning) and one negative (anxiety and stress in situations of failure or error). Firstly, perceived motor competence, referring to oneself (self-reported), is made up of nine items and indicates the perception that schoolchildren have of their own abilities to carry out the tasks and activities proposed in Physical Education classes, without having to compare themselves with other classmates, but only with themselves; it is therefore a clear motivational expression, oriented towards the task and learning. The most representative item of this new dimension is: 'I think I have the necessary qualities to be able to do the exercises in Physical Education class'. Secondly, the comparative motor competence analyses the perception of competence, but in comparison with others, where the key is the reference to being better than the rest of the classmates. The item representative of this dimension would be: 'I have often received congratulations for being better than others in Physical Education classes.' Thirdly, commitment to learning is made up of nine items and reflects the willingness to work seriously during Physical Education classes. The representative item would be: 'I concentrate a lot on what I have to practice in class'. Fourthly, the dimension of anxiety and overwhelm corresponds to situations in which fear and nervousness about

failing to perform the activities in front of the rest of the classmates manifest themselves. The item representative of this dimension would be: 'I often get nervous, and my performance drops when I have to do exercises in front of my classmates'.

### *Academic Achievement measurement (AAM)t*

The academic achievement was measured based on the teacher scores provided by the school. The general grade score (GGS) was calculated as the mean of the specific subject scores to indicate overall academic achievement, including native language (Spanish), foreign language (English), mathematics, sciences and arts. The scores refer to numerical assessment on a scale from 0 to 10 where 0 denotes failure and 10 refers an excellent knowledge, skills and attitude (Syväoja et al., 2019).

Besides, the PE teacher provided also his score in the physical education subject, considering the motor skill, the commitment to the subject and the social behavior.

### **Procedure**

At the beginning of the school year, children performed their PE lessons while the permissions were obtained. At the end of the first trimester participants were tested (baseline) during the PE lessons. The same pattern was done during the next years (see table 2). The motor competence measurement was conducted in the large sport hall of the school by the PE teacher already trained for the research purpose. The main researcher was assisting, guiding and helping with the data collection. For two weeks there were not normal PE lessons, the students had "free sport" activities while others were tested. For each task, each child was allowed to perform one practice trial and two assessments attempts. After completing the motor task, they fulfilled the motivation questionnaire in their class. Finally, the academic achievement was made at the end of the school year except on the fifth year that it was made when the last data collection was done.

Table 2. Timeline

Year 1		Year 2			Year 3			Year 4			Year 5			
Sep - Nov	Dec	Jan - Jun	Sep - Nov	June	Sep - Nov	June	Sep - Nov	June	Sep - Nov	June	PE	Measurement	PE	
PE	ME	PE	PE	Measurement	PE	PE	Measurement	PE	PE	Measurement	PE	PE	Measurement	PE
MCM	MM	AAM		MCM	MM	AAM		MCM	MM	AAM		MCM	MM	AAM

Motor competence measurement (MCM)

Motivation measurement (MM)

Academic Achievement measurement (AAM)

Measurement (ME)

Physical education lessons (PE)

### **Data analysis**

Descriptive statistics and all further analysis were calculated using the SPSS 30. The descriptive statistics are presented as mean and SD. Differences in the study variables between gender were tested using Student's t-test or Pearson's chi-squared test. The analysis to examine the association of actual motor competence and perceived motor competence over time, longitudinal mixed effects models with repeated measures were conducted where score outcomes (medicine ball through, lateral jumps, shuttle run, 7-meter hopping on one leg, 30 meters race, movement on supports) were confirmed to be normally distributed by Kolmogorov-Smirnov normality test.

To study the longitudinal association of the actual motor competence of each task with academic achievement, data were analyzed in two ways using structural equation modelling. Curve modelling was used to study whether the level and the development of the motor skills were associated with the GGS over time.



## Results

### Motor skill variables

The descriptive statistics of each motor skill during the 5 measurement points (mean, standard deviation and range) are shown in tables 3, 4, 5, 6, 7, and 8.

Table 3. Descriptive statistic of Movement support items

Variable	N	Minimum	Maximum	Mean	SD
Movement supports 1	85	22.14	61.20	36.03	8.02
Movement supports 2	85	12.44	59.00	26.44	8.94
Movement supports 3	85	12.88	59.02	22.46	7.44
Movement supports 4	85	12.52	55.43	19.47	5.89
Movement supports 5	85	11.20	52.30	17.05	5.02

Table 4. Descriptive statistics of Shuttle Run items

Variable	N	Minimum	Maximum	Mean	SD
Shuttle Run 1	85	12.30	23.71	16.28	2.29
Shuttle Run 2	85	12.01	21.00	14.83	1.83
Shuttle Run 3	85	10.39	18.70	13.68	1.53
Shuttle Run 4	85	10.30	16.50	13.32	1.26
Shuttle Run 5	85	10.15	15.90	12.58	1.20

Table 5. Descriptive statistics of Lateral Jump items

Variable	N	Minimum	Maximum	Mean	SD
Lateral Jump 1	85	10	33	18.13	4.40
Lateral Jump 2	85	13	40	24.18	4.87
Lateral Jump 3	85	15	51	28.82	5.80
Lateral Jump 4	85	20	48	31.48	6.31
Lateral_Jump_5	85	20	48	34.22	6.85

Table 6. Descriptive statistics of Hopping items

Variable	N	Minimum	Maximum	Mean	SD
Hopping 1	85	3.25	7.50	4.48	0.65
Hopping 2	85	2.97	6.16	3.98	0.63
Hopping 3	85	2.78	5.70	3.71	0.59
Hopping 4	85	2.47	5.40	3.46	0.54
Hopping 5	85	2.51	5.25	3.28	0.50

Table 7. Descriptive statistics of Race 30 meters items

Variable	N	Minimum	Maximum	Mean	SD
Race 30 meters 1	85	6.20	6.80	6.46	0.07
Race 30 meters 2	85	6.30	6.60	6.34	0.06
Race 30 meters 3	85	5.80	6.40	6.02	0.21
Race 30 meters 4	85	5.50	6.20	5.67	0.16
Race 30 meters 5	85	4.70	5.80	5.32	0.20

Table 8. Descriptive statistics of Medicine Ball items

Variable	N	Minimum	Maximum	Mean	SD
Medicine ball 1	85	2.80	3.30	2.86	0.07
Medicine ball 2	85	2.40	3.90	3.28	0.39
Medicine ball 3	85	3.50	3.70	3.60	0.10
Medicine ball 4	85	4.00	4.40	4.15	0.15
Medicine ball 5	85	4.70	5.60	5.06	0.35

The normality of the data was assessed using the Kolmogorov-Smirnov test. The results indicated that the motor competence and the motivation variables did not follow a normal distribution, therefore, non-parametric statistical test were used for subsequent analysis. A Friedman test was conducted to analyze the evolution of motor competence in the six motor tasks over five years. The results indicated a similar pattern for all the variables showing significant differences across de years in the medicine throwing ball ( $X^2(4) = 325.650, p < .001$ ) 30 meters race ( $X^2(4) = 335.214, p < .001$ ); hopping 7 meters ( $X^2(4) =$



272.021,  $p < .001$ ); lateral jumps ( $X^2(4) = 272.615$ ,  $p < .001$ ); Shuttle run ( $X^2(4) = 288.445$ ,  $p < .001$ ); and movement supports ( $X^2(4) = 278.2791$ ,  $p < .001$ ). This suggests that motor competence changed significantly over the time. A post hoc analysis using the Wilcoxon signed-rank test revealed significant differences between the motor competence every year in the medicine throwing ball task, 30 meters race, hopping 7 meters, lateral jumps, shuttle run and movements supports.

### **Gender differences in the motor skills performance**

Besides, a Mann-Whitney U test was conducted to compare the motor performance between boys and girls in all time points. The results showed that there was a significant difference between boys and girls in medicine throwing ball in year 1 ( $p < .001$ ), year 3 ( $p < .001$ ), year 4 ( $p < .001$ ) and year 5 ( $p < .001$ ) scoring higher every year the boys (2,90 – 3,70 – 4,30 – 5,40) than the girls (2,82 – 3,50 – 4,00 – 4,75). Same patten appeared in the 30 meters race (Year 1  $p < .001$ ; year 3  $p < .001$ ;

year 4  $p < .001$ ; year 5  $p < .001$ ) being the boys faster (6,40 – 5,80 – 5,50 – 5,17) than the girls (6,50 – 6,21 – 5,80 – 5,45).

### **Motivational variables**

Regarding the motivation variables, a Friedman test was conducted to analyze its evolution over five years. The results indicated a similar pattern for all the variables showing significant differences across de years in the different factors of the questionnaire: Commitment for learning ( $X^2(4) = 43.361$ ,  $p < .001$ ); perceived motor competence ( $X^2(4) = 53.581$ ,  $p < .001$ ); comparative motor competence ( $X^2(4) = 48.651$ ,  $p < .001$ ); anxiety when errors ( $X^2(4) = 65.270$ ,  $p < .001$ ) and in the general score ( $X^2(4) = 28.719$ ,  $p < .001$ ).

Figure 1. Estimated marginal means of Perceived motor competence

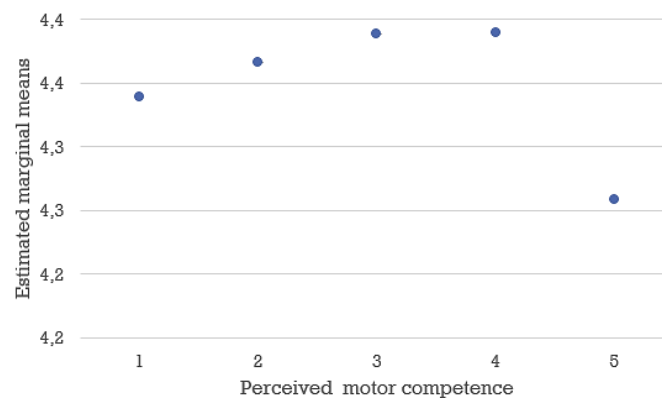


Figure 2. Estimated marginal means of Commitment

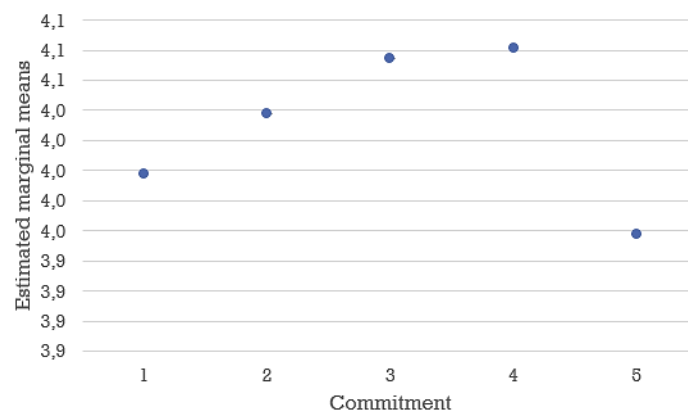


Figure 3. Estimated marginal means of compared motor competence

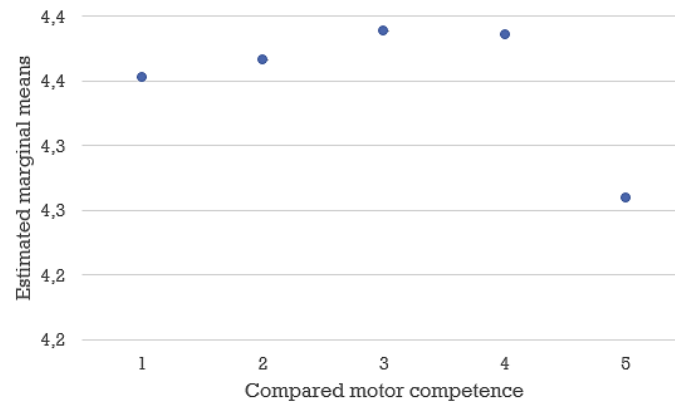
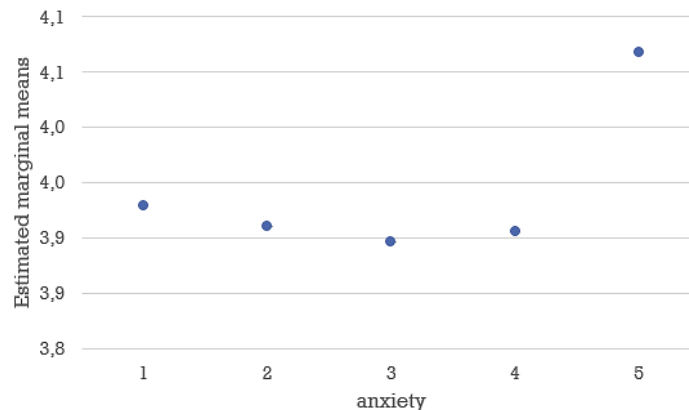


Figure 4. Estimated marginal means of Anxiety



### ***Gender differences in motivation aspects***

Besides, a Mann-Whitney U test was conducted to compare the motivation factors from the AMPET questionnaire between boys and girls in all time points. The results showed the same patten for all the factors and general score showing significant difference between boys and girls every year in commitment for learning: year 1 ( $p < .001$ ), year 2 ( $p < .001$ ) year 3 ( $p < .001$ ), year 4 ( $p < .001$ ) and year 5 ( $p < .001$ ) scoring higher every year the girls (4,39 – 4,45 – 4,47 – 4,51 – 4,38) than the boys (3,54 – 3,57 – 3,60 – 3,59 – 3,48); perceived motor competence: year 1 ( $p < .001$ ), year 2 ( $p < .001$ ) year 3 ( $p < .001$ ), year 4 ( $p < .001$ ) and year 5 ( $p < .001$ ) scoring higher every year the boys (4,70 – 4,76 – 4,75 – 4,73 – 4,69) than the girls (4,01 – 4,01 – 4,06 – 4,08 – 3,87); comparative motor competence: year 1 ( $p < .001$ ), year 2 ( $p < .001$ ) year 3 ( $p < .001$ ), year 4 ( $p < .001$ ) and year 5 ( $p < .001$ ) scoring higher every year the boys (4,70 – 4,76 – 4,75 – 4,73 – 4,69) than the girls (4,03 – 4,01 – 4,06 – 4,07 – 3,87); anxiety when errors: year 1 ( $p < .001$ ), year 2 ( $p < .001$ ) year 3 ( $p < .001$ ), year 4 ( $p < .001$ ) and year 5 ( $p < .001$ ) scoring higher every year the girls (4,41 – 4,39 – 4,36 – 4,40 – 4,58) than the boys (3,38 – 3,36 – 3,37 – 3,35 – 3,48); and the general score: year 1 ( $p < .001$ ), year 2 ( $p < .001$ ) year 3 ( $p < .001$ ), year 4 ( $p < .001$ ) and year 5 ( $p < .001$ ) scoring higher every year the girls (4,21 – 4,21 – 4,24 – 4,26 – 4,17) than the boy (4,08 – 4,11 – 4,12 – 3,98 – 4,08).

## Discussion

The results of this five-year longitudinal study provide valuable insights into the evolution of motor competence and motivational variables in typically developing children. Furthermore, the study explores the mediating role of perceived motor competence in the relationship between actual motor competence and academic performance, as well as gender differences in these variables over time.

### *Evolution of Motor Competence*

The results indicate significant improvements in all motor skill tasks over the five-year period, supporting previous research suggesting that motor skills develop through both maturation and practice (Davies & Rose, 2000; Gabbard, 2008). Recent studies have corroborated this even further, demonstrating that motor competence in children aged 4 to 8 years shows considerable development over time, and that structured physical education programs play a fundamental role in fostering these skills (Koolwijk et al., 2024). Likewise, according to Lemos et al. (2012), the experiences that Physical Education provided to children between 7 and 8 years of age significantly improved the evolution of their levels of motor competence during the Primary Education stage, assuming the fundamental pillar for their participation in future physical and sports activities, as well as for the development and acquisition of specific and/or specialised motor skills. In line with the above, some authors emphasised that if children of these ages begin to receive stimuli from a quality, well-organised and structured basic physical education, it is very likely that they will learn and perfect their motor skills throughout their school years (D'Hont et al., 2013; Eather et al., 2018; Lorás, 2020; Sirghi & Leuciuc, 2022).

On the other hand, the results obtained in the present study coincide with other longitudinal research. Thus, De Meester et al. (2016) demonstrated that, throughout the years of the study, the participants who were receiving Physical Education classes improved their level of motor competence, as well as their level of participation in physical and/or sports activities. Similarly, these improvements in motor competence in children have been demonstrated over the years not only by their participation in Physical Education classes, but also by their participation in extracurricular physical and/or sporting activities. As an example, the study by Cenizo-Benjumea et al. (2024) is cited in which children aged between 6 and 11 years old, who participated in extracurricular sports activities over several years, consistently showed significant improvements in their motor competence. The steady progression observed in the movement supports, shuttle run, side jumps, skipping, 30-metre run and medicine ball throw is in line with the notion that childhood represents a critical window for the acquisition of motor skills in which the factors of maturation, growth and practice play fundamental roles (Pangrazi, 2007; Stodden et al., 2008). The application of Friedman's test confirmed these longitudinal changes, underlining the impact of structured physical education programs in promoting motor development, results that, once again, are supported by longitudinal studies, such as the one developed by De Meester et al. (2016), in which these researchers demonstrated that, over the years of the study, the participants who were receiving Physical Education classes improved their level of motor competence, as well as their level of participation in physical and/or sporting activities.

### *Gender Differences in Motor Performance*

The gender-based analysis revealed that boys consistently outperformed girls in tasks requiring object control and speed, such as medicine ball throwing and the 30-metre run. These findings could be in line with Duncan et al. (2018) who observed that, in general, school-age boys scored higher on tests assessing motor competence than their peers of the opposite sex. These significant differences could be attributed to several reasons: 1. In terms of maturation, from certain ages close to sensitive phases or critical periods of growth, children tend to show tendencies towards physical and/or sporting activities that require certain basic physical capacities, such as strength and speed, essential for the development of their gross motor skills. However, girls tend to favour physical activities and/or sports that demand flexibility and/or balance (Barnett et al., 2016). This could be justified by the fact that boys tend to be more involved in physical and/or sporting activities, showing a social preference for participation of a competitive nature (Rodrigues et al., 2019), generally associated with ball games and the handling of implements or objects (Booth et al., 2006; Ehl et al., 2005). It is very likely that this reason can be articulated in how social expectations that revolve around gender roles cause boys to have greater motor



baggage and, therefore, a greater number of experiences that could undoubtedly justify the aforementioned gender differences in terms of motor competence. (Rodrigues et al., 2019) However, the results of the present study in relation to locomotion skills, such as jumping and jumping sideways, did not show significant gender differences, which is supported by previous studies that suggested that locomotor skills may develop more equally between genders (Hume et al., 2008; van Beurden et al., 2002). Likewise, recent studies have further elucidated these patterns. For example, a cross-sectional survey of 2024 preschool children in the city of Jinhua, China, found that boys outperformed girls in ball skills, including underhand throwing, catching, two-handed hitting and kicking, while no significant overall gender differences in locomotor skills were observed. However, a more in-depth analysis revealed that boys excelled in tasks related to running, while girls performed better in tasks related to jumping (Chen et al., 2024). These findings highlight the need for personalized interventions in physical education that address gender disparities in the development of motor skills. In this sense, several researchers suggest that Physical Education programmes should be designed to enable both boys and girls to experience success in each of the motor skill domains (Lee et al., 2020; Sheng & Maharkan, 2024).

Finally, the gender differences in terms of motor competence found in the present study could be attributed to factors that transcend the eminently motor. Thus, several researchers have shown that psychological aspects, such as the perception of their motor competence, which is usually lower than that of boys, directly influence participation in physical and/or sports activities (Lalor et al., 2015; Rose et al., 2016).

### ***Motivation and its Evolution Over Time***

The study observed significant changes in all motivation-related variables, including commitment to learning, perceived motor competence, comparative motor competence, and anxiety when making errors. The general trend indicated a decline in perceived motor competence over time, particularly among girls. This is consistent with prior findings indicating that children initially overestimate their motor abilities but develop a more realistic self-assessment as they age (Harter, 1999; Goswami, 2011). Given that motivation is a critical determinant of participation in physical activities (Royo, 2023; Uil et al., 2022), these results underscore the importance of fostering self-confidence in motor skills to sustain engagement in physical activity and enhance academic outcomes.

### ***Gender Differences in Motivation***

A Mann-Whitney U test revealed that girls showed a significantly greater commitment to learning, but also reported greater anxiety in error-prone situations, while boys consistently reported greater perceived and comparative motor competence. These findings are consistent with previous research indicating that boys tend to overestimate their abilities, leading them to participate more in physical activities, while girls often underestimate their competence, which can limit their participation (Macdonald et al., 2020; Masci et al., 2018). Recent studies have highlighted these disparities. For example, a survey conducted in the UK in 2024 revealed that girls as young as two years old play less outdoors than boys, a trend that could negatively affect their physical and mental health by reinforcing gender norms and reducing levels of physical activity (Dodd and Hesketh, 2024). These patterns suggest that interventions aimed at reducing performance-related anxiety in girls and encouraging greater participation in physical activities could be beneficial. However, the results obtained in each of the motivational variables that were analyzed are discussed below.

### ***Perceived or self-reported and comparative motor competence***

The results obtained in the present study are in line with other studies in which it was stated that boys generally show a higher motor performance in the performance of gross motor skills than girls, which translates into higher levels of perceived or self-reported motor competence compared to girls (Kwon & O'Neill, 2020). Similarly, other authors have observed that improvements in perceived or self-reported motor competence are closely related to improvements in gross motor performance (Morano et al., 2011). Otherwise, a kind of feedback loop is generated in such a way that the perception of motor incompetence leads to less participation in physical and/or sports activities and, in turn, the range of opportunities that would make up the motor background of the schoolchild is closed, thus interfering with fewer opportunities for the development and acquisition of motor skills, especially among girls (Kalemoglu-Varo, 2015).



### ***Commitment to learning in physical education***

In this sense, girls showed higher values for this variable and more consistently than boys. Contrary to what is observed in the results of the present study, the scientific literature indicates that it is they who tend to show lower levels of commitment to learning in Physical Education classes, since there are still many social and cultural norms that distance them from aggressive and competitive games, leading them to express lower levels of self-confidence and commitment to Physical Education classes (Piek et al., 2013; Temple et al. 2014). However, it is very likely that the results of the present study are conditioned by, as we will see later, the general achievement motivation scores of girls were higher than those of boys.

### ***Anxiety and stress in situations of failure***

The results of the present study show that girls showed higher levels of anxiety about failure than their peers of the opposite sex. These results may be in line with previous studies that revealed that girls' levels of anxiety and somatic symptoms during physical education classes were higher than those of boys (Kalemoglu-Varol, 2015). Similarly, Danthony et al. (2019) saw how girls' anxiety during assessment tests in physical education classes affected their motor performance. As a result, girls may feel a greater burden during competitive motor tasks, reinforcing gender stereotypes once again. Likewise, the girls in the present study showed lower values of comparative motor competence than their peers of the opposite sex, which could have influenced the high levels of anxiety expressed about failing, since the way they believe they are seen by their classmates could cause them to experience higher levels of anxiety in a context (Physical Education classes) in which they feel observed and evaluated (Gutiérrez & López, 2012).

### ***Association Between Motor Competence, Motivation, and Academic Achievement***

A significant positive correlation between motor competence and motivation was observed, further supporting the hypothesis that children with higher perceived motor competence are more likely to engage in physical activities and, consequently, demonstrate better academic outcomes (Candia-Cabrera et al., Guillamón et al., 2020; Lopes et al., 2013). The findings also suggest that perceived motor competence mediates the relationship between actual motor performance and academic achievement, reinforcing previous research highlighting the role of executive functions in linking motor and cognitive development (Geertsen et al., 2016; Sánchez-Martín et al., 2025; Schmidt et al., 2017). Recent studies have further elucidated this relationship. For instance, a 2024 study found that both fitness and executive function partially mediate the relationship between gross motor competence and academic achievement in children aged 9-11, with variations observed between boys and girls (Fernández-Sánchez et al., 2024). These findings underscore the importance of developing motor competence to enhance both physical fitness and cognitive functions, ultimately contributing to improved academic performance.

### ***Implications and Future Directions***

The study's findings highlight the importance of integrating motor skill development with motivational strategies in physical education programs. Given the gender disparities observed in both motor competence and motivation, interventions should be designed to encourage girls' participation while reinforcing boys' engagement in diverse motor activities. Moreover, educators should focus on building students' perceived motor competence to foster sustained motivation and participation in physical activities, ultimately contributing to improved academic performance.

Future research should explore additional mediating variables, such as cognitive functions and socio-environmental factors, to gain a deeper understanding of the complex interplay between motor competence, motivation, and academic success. Additionally, investigating interventions that can mitigate gender-based disparities in motor and motivational development remains a crucial area for further study.

## **Conclusions**

This longitudinal study confirms that motor competence and motivation play significant roles in children's academic achievement. The findings highlight the need for structured physical education pro-



grams that enhance both actual and perceived motor competence while addressing gender-specific differences. By fostering a supportive and inclusive learning environment, educators can contribute to the holistic development of children, promoting both physical and cognitive growth throughout their schooling years.

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