Influence of sports specificity on motor coordination in brazilian children

Influencia de la especificidad deportiva en la coordinación motora de niños brasileños

Authors

Lucas Savassi Figueiredo [1]
Rodrigo Fábio Bezerra da Silva [2]
Lucas De Castro Ribeiro [3]
Thaís da Silva Sérvio [2]
João Vtor Alves Pereira Fialho [4]
Juliane Venturelli Silva Lima [5]
Henrique de Oliveira Castro [6]
Fabiano de Souza Fonseca [2]

[1] Universidade Federal de Juiz de Fora (Brazil)
[2] Universidade Federal Rural de Pernambuco (Brazil)
[3] Universidade de Tras-Os-Montes and Alto Douro (Portugal)
[4] Olympico Club (Brazil)
[5] Centro de Instrução e Adaptação da Aeronáutica (Brazil)
[6] Universidade Federal de Mato Grosso (Brazil)

Corresponding author:
Lucas Savassi Figueiredo
savassi88@hotmail.com

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Abstract

Objective: this study analyzed the influence of the specificity of sports practice on Brazilian children's motor coordination levels.
Methodology: the sample consisted of 80 male children with an average age of 10.4 (standard deviation = 1.3 years), engaged in different sports modalities (futsal, handball, and capoeira) and school physical education, and children not participating in extracurricular systematic sports training. Motor coordination level was assessed using the KTK (general motor coordination) and TECOBOL (motor coordination with a ball) tests.
Results: the results revealed that, for general motor coordination, children practicing capoeira ($p = 0.016$) and futsal ($p = 0.004$) showed a higher overall score than the physical education group. The futsal group also scored higher overall than the handball group ($p = 0.025$). In motor coordination with a ball, the handball group outperformed the physical education ($p < 0.001$), capoeira ($p = 0.001$), and futsal ($p = 0.004$) groups in the dribbling test.
Conclusions: the findings suggest that the specificity of sports practice influences motor coordination, and engaging in systematic sports improves children's motor coordination.

Keywords

Children; motor coordination; movement; sports; young.

Resumen

Objetivo: este estudio exploró la influencia de la especificidad de la práctica deportiva en el nivel de coordinación motora en niños brasileños.
Metodología: la muestra consistió en 80 niños varones con una edad promedio de 10.4 años (desviación estándar = 1.3), quienes practicaban diversas modalidades deportivas (futsal, balonmano y capoeira), además de participar en educación física escolar y niños que no participaban en entrenamiento deportivo extracurricular sistematizado. La coordinación motora se evaluó mediante los tests KTK (coordinación motora general) y TECOBOL (coordinación motora con pelota).
Resultados: los resultados mostraron que, en términos de coordinación motora general, los niños que practicaban capoeira ($p = 0.016$) y futsal ($p = 0.004$) obtuvieron puntajes globales superiores al grupo que solo participaba en educación física. Además, el grupo de futsal también obtuvo un puntaje global superior al grupo de balonmano ($p = 0.025$). En cuanto a la coordinación motora con pelota, el grupo de balonmano fue superior a los grupos de educación física ($p < 0.001$), capoeira ($p = 0.001$) y futsal ($p = 0.004$) en la prueba de dribbling.
Conclusiones: estos resultados sugieren que la especificidad de la práctica deportiva influye en la coordinación motora y que la práctica de deportes sistematizados puede potenciar mejoras en la coordinación motora de los niños.

Palabras clave

Coordinación motora; deportes; jóvenes; movimiento; niños.

Introduction

In Sports Sciences, coordination is defined as organizing motor actions in response to individual and environmental constraints (Lages et al., 2021). The development of coordinative structures facilitates the learning of sports skills and enables fast and precise execution of complex actions in such environments (Turvey, 1990). Thus, motor coordination is the harmonious interaction between the muscular, nervous, and sensory systems to achieve balanced and precise motor actions (Schilling & Kiphard, 1974; Lopes et al., 2003).

Motor coordination underlies the future development of motor and sports skills (Castro et al., 2017; Greco et al., 2015) and enhances athletes' effectiveness in tactical-technical actions within sports contexts (Aburachid et al., 2021). It is also considered essential for performance (Ljach & Witkowski, 2010; Vaeyens et al., 2008) and is influenced by strength, agility, and speed (Dos Santos et al., 2018). Emphasis on motor coordination training during childhood is suggested, particularly between six and 12 years of age (Fransen et al., 2012), as coordination is the foundation for enhancing sports techniques later in an athlete's development (Castro et al., 2017). Therefore, it is crucial to identify the optimal timing for introducing motor coordination training, given that young individuals' motor development is modulated by age (Lambert & Bard, 2005).

Studies have explored the relationship between motor coordination and various factors, including sports practice, intervention programs, length of experience, physical education classes, competitive experience, and lifestyle (Lima et al., 2023). Fransen et al. (2012) highlighted that engaging in multiple sports before age 12 fosters the development of strength and motor coordination. Lages et al. (2021) conducted 20 sessions of a teaching-learning program for team sports based on the Universal Sports Formation model (Greco, 1998; Ribeiro et al., 2023), observing significant improvements in motor coordination post-program. Similarly, Vaz et al. (2021) examined the effects of a 12-week intervention using the Ball School teaching model (Kroger & Roth, 2002) on the motor coordination of 73 schoolchildren aged five to ten years, finding that the program notably enhanced participants' motor coordination levels.

Research has also examined the impact of sports practice on the motor coordination of Brazilian students. Aburachid et al. (2021) compared the level of ball-specific motor coordination in futsal players aged 10 to 12. They found that practice settings and the length of competitive experience were not determinants of motor coordination performance. Pelozin et al. (2009) assessed 145 schoolchildren aged nine to 11 and found no differences in motor coordination levels between those who practiced sports outside of school and those who did not. Conversely, Castro et al. (2017) evaluated the motor coordination of futsal players with varying experience levels and concluded that more experienced participants demonstrated superior ball control. These results may be influenced by the longer practice duration among the more experienced group.

Nakai et al. (2021) compared the motor coordination of 40 ten-year-old children who spent their free time primarily playing digital games or engaging in outdoor activities. The results indicated that outdoor children exhibited better motor coordination than those who mainly played digital games. Da Silva Pereira and De Andrade (2018) suggested that specific sports experiences can influence practitioners' motor development. In line with this, Mazzardo et al. (2022) conducted a training program comprising 20 handball sessions based on the Teaching Games for Understanding model with 43 children aged 14 to 15. The children were divided into two groups: one participated solely in training based on the model above, while the other had additional activities focused on motor coordination training. The study found improved motor coordination levels in both groups, with greater improvements in the group that received additional motor coordination training. These findings suggest that sports practice positively influences motor coordination development.

Although sports practice suggests improved coordination levels, little is known about the specific impacts of different sports on motor coordination Understanding these impacts is crucial because coordination forms the motor foundation necessary for developing motor and sporting skills (Castro et al., 2017; Greco et al., 2015). The results of this research will assist teachers and coaches in planning their sessions more effectively, aligning with the characteristics of their students, and determining which pedagogical tools to employ in their practices. This involves controlling the teaching-learning process and considering the practice contexts in which they operate (Lima et al., 2023). Therefore, this

study aims to analyze the influence of the specificity of sports practice on children's general motor and ball coordination levels. We hypothesize that children involved in systematized extracurricular sports training will exhibit higher levels of general and ball motor coordination compared to those who only participate in school physical education classes. Additionally, we anticipate that handball and futsal practitioners will perform better in their respective specific tests, reflecting the specificity of their training experiences.

Method

Sample

The sample included 80 male children aged between nine and 13 years (M = 10.4 years, SD = 1.3 years). Participants were involved in structured sports training, including futsal, handball, and capoeira, or attended only school physical education classes without participating in extracurricular sports training. The sample was subdivided into four groups (n = 20) for the analysis: 1) futsal group (M = 10.5 years, SD = 1.1), 2) handball group (M = 10.9 years, SD = 1.1), 3) capoeira group (M = 11.1 years, SD = 1.0), and 4) school physical education group (M = 10.4 years, SD = 1.3). All participants had been regularly practicing sports for at least one uninterrupted year and attended school physical education classes at least once a week. Their legal guardians authorized the children's participation in the study through signed informed consent forms, and the children also provided their assent to participate in the study.

Motor Coordination Level Assessment

Global and motor coordination with a ball were assessed using two different instruments. Overall motor coordination was evaluated using the *Körperkoordination Test für Kinder* (KTK), an instrument extensively utilized in the literature (Ribeiro et al., 2012). Motor coordination with a ball was measured using the short version of the ball coordination test battery (TECOBOL) proposed by Silva (2015).

Körperkoordination Test für Kinder

The *Körperkoordination Test für Kinder* (KTK) protocol consists of four subtests: 1) Walking on the equilibrium bar: The child walks backward on wooden bars measuring 4.2 meters in length and varying widths (6 cm, 4.5 cm, and 3 cm). The number of steps each attempt takes is counted (three attempts per bar width). The maximum score for each attempt is eight points, resulting in a maximum score of 24 points per bar and 72 points for the entire subtest.; 2) one-legged jumping: The child jumps with one leg over foam boards (50 cm x 20 cm x 5 cm), gradually overlapping. Jumps for the right and left legs are assessed separately. A score of 3, 2, or 1 point is awarded for successfully performing the test on the first, second, and third attempts, respectively. The maximum score is 30 points per foot, totaling 60 points for the entire subtest; 3) Jumping sideways: The child jumps sideways as quickly and as many times as possible for 15 seconds, with both feet simultaneously, over an area of 100 cm x 60 cm, divided by a wooden ruler (60 cm x 4 cm x 2 cm). Two attempts are made, and the final score is the sum of the jumps in both attempts; 4) Lateral transposition: The child moves on two wooden platforms (25 cm x 25 cm x 1.5 cm), interspersed. Standing on one platform, they must move to the other platform, positioned next to them, with both hands to the opposite side, and then move to this platform successively for 20 seconds. Two attempts are made, resulting in the sum of both attempts. One point is scored for each platform transposition and one point is scored for each body transposition. After obtaining the raw values for each task, these values are adjusted according to a normative table that provides the Motor Quotient of the tasks based on the sex and age of each individual (Kiphard & Schilling, 1974). From these Motor Quotients, the General Motor Quotient is calculated and used for further analysis.

The ball coordination test battery (TECOBOL)

The short version of the ball coordination test battery (TECOBOL) consists of two subtests: 1) Hitting the target: The participant throws or kicks the ball at the wall to hit one of the targets. They perform 15 kicks or throws, aiming to hit one of the targets as quickly as possible—five times with the dominant limb, five times with the non-dominant limb, and five times again with the dominant limb. The score is determined by the time taken to complete the task; 2) Carrying the ball: The participant dribbles or

carries the ball continuously, using their preferred method, while simultaneously tapping their hand on squares affixed to the wall in order from 1 to 9. They then navigate around a cone and return. This process is repeated four times, varying the limb controlling the ball and the hand touching the squares on the wall. Scores are awarded based on the time taken to complete the task.

Data analysis

The KTK analysis involved comparing the General Motor Quotient values across the groups. In contrast, the TECOBOL analysis focused on comparing the results of each subtest, given that this test does not provide a composite measure of coordination. Descriptive statistics were calculated, including mean and standard deviation and Pearson's correlation coefficient. Boxplot graphs were utilized to visualize the distribution of scores.

One-way analyses of variance (ANOVA), accompanied by Tukey's post hoc test, were employed to identify differences in mean motor coordination among the groups of interest. The Shapiro-Wilk test was used to verify the normality of residuals, while the Levene test assessed the homogeneity of variances. Minor deviations from normality or heteroscedasticity were disregarded, as they typically exert negligible effects on the validity of ANOVA hypothesis tests (Cohen, 1988, p. 274). The effect size (η^2) was also reported, indicating the distance from the null hypothesis (Cohen, 1988, p. 10). According to Cohen, an effect size is considered small when η^2 is approximately 0.01, medium when it is around 0.06, and large when it is 0.14 or higher. However, these definitions are arbitrary and should be interpreted cautiously and in context (Cohen, 1988, p. 113).

When variables exhibited significant deviations from normality, the Kruskal-Wallis (K-W) test and Dunn's post hoc test with the Bonferroni method were used. The effect size based on the K-W test (η_H^2) was calculated following Cohen (2008, p. 750). A significance level of 0.05 was adopted for all tests. All statistical analyses were conducted using the software R version 4.3.2.

Results

KTK

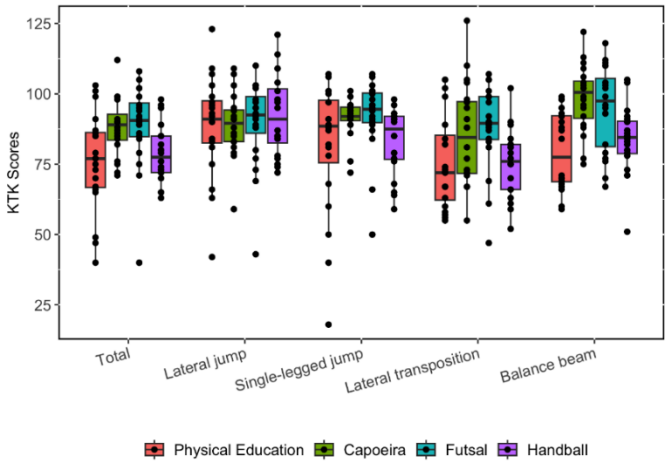
Due to the identification of an outlier in the futsal group (KTK score = 40, Figure 1) and an outlier in the capoeira group (KTK score = 112, Figure 1), the winsorization technique was applied, replacing the outliers with the second most extreme KTK score within the respective group. ANOVA revealed statistically significant differences among the mean scores of the groups for the KTK ($F(3.76) = 6.116$, $p < 0.001$, $\eta^2 = 0.19$). Tukey's post hoc tests indicated that the capoeira group achieved significantly higher mean scores than the physical education group ($p = .021$). Additionally, the futsal group demonstrated significantly higher mean scores than the physical education group ($p = .003$) and the handball group ($p = .022$). The residual analysis confirmed an approximately normal distribution (Shapiro-Wilk test, $p = .600$) and homogeneity of variances (Levene's test, $p = .052$).

Table 1. Mean and Standard Deviation (SD) of Total Scores and KTK Subtest Scores by Sport Modality

Test	Physical Education		Capoeira		Futsal		Handball		Overall	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Balance beam	79.7	13.8	98.4	11.8	95.0	15.1	83.6	12.0	89.2	15.2
Lateral jump	88.6	17.9	88.8	11.3	89.4	15.3	92.4	14.4	89.8	14.7
Lateral transposition	75.4	16.8	85.2	18.0	88.2	15.1	75.4	12.0	81.1	16.4
Single-legged jump	81.6	23.6	91.3	6.88	92.0	13.4	83.2	11.8	87.0	15.6
Total	76.1	17.3	88.2	10.2	88.6	15.0	78.8	10.2	82.9	14.4

Fuente: authors

Figure 1. Boxplots of the KTK total and subtests scores by Sport Modality



Fuente: authors

TECOBOL

The mean dribbling time showed statistically significant differences among the groups ($\chi^2(3) = 19.207$, $p < .001$, $\eta_H^2 = .213$). Notably, the handball group demonstrated a significantly lower mean dribbling time compared to the physical education group ($p < .001$), the capoeira group ($p = .001$), and the futsal group ($p = .004$) (see Figure 2).

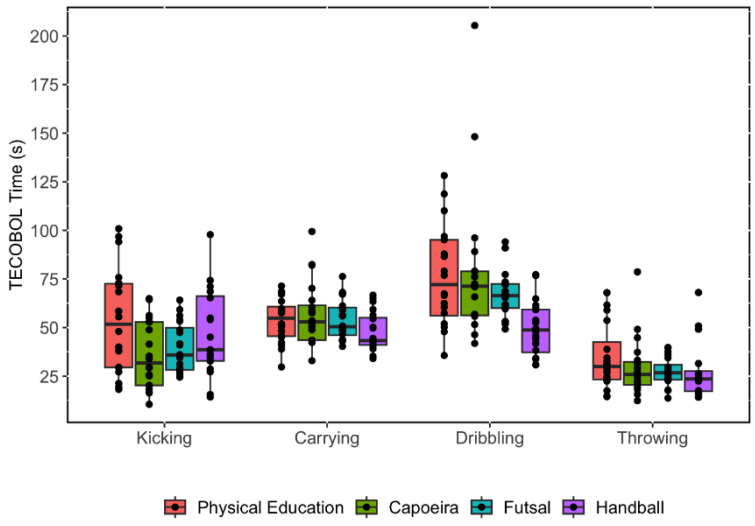
Regarding shooting time ($\chi^2(3) = 6.708$, $p = .082$, $\eta_H^2 = .048$), carrying time ($\chi^2(3) = 6.569$, $p = .087$, $\eta_H^2 = .047$) and throwing time ($\chi^2(3) = 3.440$, $p = .329$, $\eta_H^2 = .006$) no statistically significant differences were observed among the groups (see Figure 2).

Table 2. Mean and Standard Deviation (SD) of TECOBOL Times (in seconds) by Sport Modality

Test	Physical Education		Capoeira		Futsal		Handball	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Throwing	35.1	17.3	29.3	14.9	27.4	7.27	27.9	14.8
Kicking	53.8	26.7	35.9	17.4	39.5	12.8	47.0	22.1
Dribbling	76.3	25.5	77.7	37.9	67.5	12.9	49.5	14.1
Carrying	53.8	11.3	56.8	16.3	54.0	10.2	47.4	10.2

Fuente: authors

Figure 2. Boxplots of the TECOBOL subtests times by Sport Modality



Fuente: authors

Discussion

The present study aimed to analyze the influence of sports practice specificity on general and ball-specific motor coordination. The main findings partially corroborate the study's hypotheses. Regarding general motor coordination, as expected, children involved in capoeira and futsal training demonstrated superiority over those who only participated in school physical education classes. However, children practicing handball did not exhibit superior general motor coordination compared to those only engaged in school physical education and were inferior to the children practicing futsal, which contradicts our hypotheses. Concerning ball-specific motor coordination, the results indicated that children practicing handball performed better in the dribbling test than those practicing capoeira, futsal, and those only involved in school physical education. However, contrary to the initial expectations, no differences were observed between the groups in the other ball-related tests.

The analysis of general motor coordination revealed significant differences among the groups in this study, with children practicing capoeira and futsal exhibiting superior performance compared to those only participating in physical education classes. The observed benefits are likely attributable to the specific experiences inherent in capoeira and futsal practices (Da Silva Pereira & De Andrade, 2018; De Paula & Bezerra, 2014), which provided additional opportunities to expand the children's motor repertoire beyond what is typically achieved through physical education classes alone. In addition to the specificity of these practices, the increased duration of physical activity also plays a crucial role, as it is positively associated with the development of general motor coordination. The current frequency of physical education classes is likely insufficient to achieve satisfactory motor coordination in children. According to the National Education Guidelines and Framework Law (LDB), physical education is a mandatory component of the elementary school curriculum in Brazil (Brasil, 1996). However, the law does not specify a minimum number of hours for this subject, which could hinder the development of general motor coordination in children. Physical education classes offer a structured environment for children to engage in diverse physical activities that enhance various aspects of motor coordination. Therefore, these classes should be adequately valued and potentially expanded within the school curriculum.

Continuing with the analysis of general motor coordination, the children practicing futsal demonstrated superiority over those practicing handball. Additionally, the handball group performance was worse than the school physical education group. These results are unexpected, particularly given the characteristics and demands of handball. The sport requires various types of displacements, throws, and jumps coordinated with teammates and opponents in a highly unpredictable context, which should contribute to the development of general motor coordination (Mazzardo et al., 2022). The observed results may be related to the methodology applied in handball training. Training methodologies that emphasize sports technique may contribute less to motor coordination compared to those that prioritize coordinative abilities and the expansion of motor repertoire (Araújo et al., 2021).

The analysis of ball-specific motor coordination tests (TECOBOL) revealed differences only in the dribbling test, with the handball group outperforming the other groups. This result can be attributed to the specificity and contextual influence of dribbling on motor skills. Although dribbling is a fundamental motor skill, like other skills included in TECOBOL (such as kicking and throwing), its practice seems more limited compared to the other skills in the test. Dribbling is a core element of handball (Greco & Romero, 2011), which provides more opportunities for children practicing this sport to develop this motor skill. In contrast, dribbling may be infrequently practiced in capoeira and futsal training and school physical education classes. The specificity of capoeira and futsal practices contributes to understanding such findings, as capoeira does not involve ball-handling actions. In futsal, manual actions are limited to the goalkeeper and do not include dribbling. In school physical education classes, evidence indicates a predominance of few sports/motor contents during classes in Brazil (Farias & Hartmann, 2014), restricting opportunities for motor coordination development.

Unlike the dribbling test, the TECOBOL tests for carrying, kicking, and throwing showed no differences between the groups. Despite these three skills being present in futsal, the children practicing this sport did not demonstrate superiority in the tests compared to the other groups. This might be attributed to the cultural significance of soccer in Brazil. Soccer and futsal are deeply rooted in Brazilian culture (Macagnan & Betti, 2014). They are widely practiced outside of school, factors that also influence their

prevalence in school physical education classes (Boni et al., 2021). Numerous studies report that futsal is the most frequent content in physical education classes across various regions of Brazil (Farias & Hartmann, 2014; Porreti et al., 2020). This could lead to more opportunities to practice motor skills such as carrying and kicking the ball, which are fundamental to the sport (Bezerra-Santos et al., 2023). The same logic applies to the throwing skill, which is widely experienced in physical education classes through games like *queimada* (a similar game to dodgeball), one of the most popular games in Brazil and one of the most common contents in physical education classes (Da Silva Machado et al., 2010; Dos Santos & Borher, 2017).

The present study is characterized as a cross-sectional investigation and has several limitations. Due to its design, it is challenging to establish a direct relationship between motor coordination development and the specific sports practices examined. Therefore, longitudinal studies are recommended to explore the long-term effects of different sports modalities on the motor coordination development of children and adolescents. Another limitation is the need for more detailed information on the training sessions for each sport, including children's training frequency, content covered, and the methodologies employed by coaches, which are critical for interpreting the findings. Furthermore, the study included children from a single geographic location with similar socioeconomic backgrounds, limiting the generalizability of the results. Hence, future research should consider more diverse samples to enhance the generalizability of findings.

Overall, the results of this study underscore the established correlation between opportunities for sports participation and the development of motor coordination (Fisher et al., 2005; Fransen et al., 2012). From a practical standpoint, it highlights the significance of children engaging in extracurricular sports to enhance their motor coordination (Luna Villouta et al., 2024). Our findings emphasize the importance of promoting children's involvement in extracurricular sports within the school setting. It is essential to educate parents and students about the critical role of motor coordination development, ensuring they recognize the lifelong benefits of physical activity. For school physical education teachers, it underscores the value of offering diverse motor and sports activities during physical education classes to expand children's motor skills repertoire and foster motor coordination (Araújo et al., 2021; Boaretto et al., 2024). Lastly, there is a crucial need to prioritize establishing extracurricular sports opportunities for children, ideally through cost-free initiatives as part of health promotion policies.

Conclusions

Children involved in systematic training in various sports disciplines demonstrated superior general motor or ball-specific coordination in the dribbling skill compared to children who did not participate in extracurricular sports training. These findings highlight the importance of extracurricular sports for developing children's motor coordination. Therefore, allowing children to engage in diverse sports practices throughout their development is crucial, considering that extracurricular sports offer potential benefits for motor coordination development.

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Authors' and translators' details:

Lucas Savassi Figueiredo	savassi88@hotmail.com	Author/Translator
Rodrigo Fábio Bezerra da Silva	rodsilva754@gmail.com	Author
Lucas De Castro Ribeiro	rlucasdecastro@hotmail.com	Author
Thaís da Silva Sérvio	thaisservio15@gmail.com	Author
João Vitor Alves Pereira Fialho	dr.j.fialho@gmail.com	Author
Juliane Venturelli Silva Lima	juliane.venturelli@gmail.com	Author
Henrique de Oliveira Castro	henriquecastro88@yahoo.com.br	Author
Fabiano de Souza Fonseca	fabiano.fonseca@ufrpe.br	Author