Rev Bras Cineantropom Desempenho Hum

original article

https://doi.org/10.1590/1980-0037.2025v27e107491

Effectiveness of a motor intervention program in students with probable Developmental Coordination Disorder

Efetividade de um programa de intervenção motora em estudantes com provável Desordem Coordenativa Desenvolvimental

Luciana Ferreira[1]
https ://orcid.org/0000-0001-5808-2334
Ana Julia Salinas Verri[1]
https ://orcid.org/0009-0009-8698-4998
Brian Alvarez Ribeiro de Melo[1]
https ://orcid.org/0000-0002-8217-114X
Larissa Lucca Marção[1]
https ://orcid.org/0009-0001-0374-1053
Fernanda Carrosi Donato[1]
https ://orcid.org/0000-0002-4544-6431
José Luiz Lopes Vieira[2]
https ://orcid.org/0000-0003-0453-8185
Vânia de Fátima Matias[1]
https ://orcid.org/0000-0003-4631-1245

[1] Maringá State University. Maringá, PR. Brazil.
[2] Universidad Católica del Maule. Talca. Chile.

Received: June 13, 2025
Accepted: September 04, 2025

How to cite this article
Ferreira L, Verri AJS, Melo BAR, Marção LL, Donato FC, Vieira JLL, Matias VF. Effectiveness of a motor intervention program in students with probable Developmental Coordination Disorder. Rev Bras Cineantropom Desempenho Hum 2025, 27:e107491. DOI: DOI: https://doi.org/10.1590/1980-0037.2025v27e107491

Corresponding author
José Luiz Lopes Vieira.
Faculdad de las Ciencias de la Salud, Universidad Católica del Maule – UCM
Rua Marcílio Dias, 1011, 87020-150, Maringá (PR), Brasil.
E-mail: jllopesvieira@gmail.com

Scientific Editor: Diego Augusto Santos Silva

Abstract – This study aimed to evaluate the effectiveness of a motor intervention program in children aged 6 to 10 years with motor development below expectations and probable Developmental Coordination Disorder (DCD), using a quantitative experimental design. A total of 203 students from a state school in Maringá (Paraná state – PR) participated in the study, of which 39 were selected for more detailed evaluations. They were divided into experimental and control groups; the experimental group participated in a motor intervention program based on fundamental movements lasting 12 weeks. The following instruments were used: Bruininks-Oseretsky Motor Proficiency Test (BOT-2) and the Movement Assessment Battery for Children - Second Edition (MABC-2), in addition to measuring Body Mass Index (BMI) and abdominal circumference. The results showed a positive and significant effect on the total motor development score in the motor intervention group, with improvements in manual dexterity and balance skills. BMI was identified as a factor that negatively influenced the balance score. It is concluded that the motor intervention was effective in promoting the motor development of children, especially in manual dexterity and balance skills, highlighting the importance of adapted programs to support comprehensive development in school environments.

Key words: Disorder; Motor activity; Academic failure.

Resumo – *O presente estudo objetivou avaliar a efetividade de um programa de intervenção motora em crianças de 6 a 10 anos com desenvolvimento motor abaixo do esperado e provável Developmental Coordination Disorder (DCD), utilizando um delineamento experimental quantitativo. Participaram do estudo 203 alunos de um colégio estadual em Maringá (no estado do Paraná – PR), dos quais 39 foram selecionados para avaliações mais detalhadas. Estes alunos foram divididos em grupos experimental e controle, e o grupo experimental participou de um programa de intervenção motora com base nos movimentos fundamentais com duração de 12 semanas. Foram utilizados os seguintes instrumentos: Bruininks-Oseretsky Test de Proficiência Motora (BOT-2) e o Movement Assessment Battery for Children - Segunda Edição (MABC-2) além da mensuração do Índice de Massa Corporal (IMC) e da circunferência abdominal. Os resultados mostraram um efeito positivo e significativo no escore total de desenvolvimento motor no grupo de intervenção motora, com melhorias nas habilidades de destreza manual e equilíbrio. O IMC foi identificado como um fator que influenciou negativamente o escore de equilíbrio. Conclui-se que a intervenção motora foi eficaz em promover o desenvolvimento motor das crianças, especialmente em habilidades de destreza manual e equilíbrio, ressaltando a importância de programas adaptados para apoiar o desenvolvimento integral em ambientes escolares.*

Palavras-chave: *Desordem; Atividade motora; Fracasso escolar.*

INTRODUCTION

Developmental Coordination Disorder (DCD) is a neurodevelopmental condition affecting 5% to 6% of school-aged children, which can significantly impact early development and lifelong functioning[1]. Evidence support interventions as fundamental tool to help children with DCD, but this disorder continues under-recognized and under-diagnosed[2]. DCD impairs a child's ability to perform coordinated motor movements, leading to slow, clumsy, or imprecise movements and difficulties in learning new motor skills[3].

Among fundamental motor skills, children with DCD demonstrate lower mechanical efficiency in walking, increasing energy expenditure[4] and show more prominent difficulties when motor coordination is more challenging[5]. Additionally, they exhibit significantly lower physical fitness, particularly in aerobic and anaerobic capacity and muscular strength[6].

Regarding psychosocial development, children with DCD are at higher risk of developing symptoms of anxiety and depression than their typically developing peers[7]. For instance, Brazilian children with DCD reported more depressive symptomatology compared to typically developing children[8]. In cognitive development, children with DCD reported lower scores in perceived self-efficacy and goal setting, making it concerning that children with low motor coordination report lower perceived motor skills, even at very young ages[9].

To mitigate the effects of DCD on children's holistic development, skill-based intervention programs have shown improvements in motor skills and parental stress[10]. Furthermore, increasing efficiency in daily activities could improve physical function[2,11]. Different characteristics in intervention programs may be necessary depending on the nature and severity of both motor and non-motor characteristics in children with DCD[12]. An example is an intervention program that showed significant improvements in actual motor competence and perceived motor competence[13].

The presented studies provide evidence of the positive effect of intervention on motor and health parameters, but there is a gap in the literature regarding the use of intervention programs with children with low motor proficiency or probable DCD. Therefore, the objective of this study was to analyze the influence of a motor intervention program on students aged 6 to 10 years with low motor proficiency and probable DCD.

METHODS

Study design

This was a quantitative, quasi-experimental study, and the participants were students enrolled in the early years of Elementary School, aged between 6 and 10 years, of both sexes (106 girls and 97 boys), totaling 203 students.

Instruments

Motor competence was assessed using the full version of the Movement Assessment Battery for Children - Second Edition (MABC-2)[14]. The MABC-2 activities are organized into subscales that vary by age: manual dexterity, aiming and catching, balance and the total score of motor development. Results are converted into percentiles, where a percentile < 5 indicates that the child has significant motor difficulties; a percentile between 6 and 15 suggests that the child may be at risk of developing motor difficulties; and a percentile > 15 indicates that the child has adequate motor skills.

In addition, the children's height and weight for Body Mass Index (BMI) calculation were measured using a digital scale and a measuring tape. The digital scale was calibrated and adjusted to ensure measurement accuracy, recording weight in kilograms (kg) with a precision of 100 grams. For height measurement, a measuring tape was used, fixed to a vertical wall, where a 1-meter height mark had been previously made on the wall, ensuring ease and reducing the probability of measurement error. Abdominal circumference was measured with an inelastic tape from the midpoint between the last rib and the upper border of the iliac crest (hip bone).

Procedures

Ethical approval was obtained from the Human Research Ethics Committee of the Maringa State University number 6.421.089, and the protocol was written in accordance with the standards set out in the Declaration of Helsinki.

Based on the MABC-2 results, students who obtained scores below the expected average for their age were organized into two non-probabilistic intentional groups: the control group and the experimental group. The control group consisted of students who remained without any additional stimulus, following their daily routine. The experimental group, comprised students selected to participate in the motor intervention program. The selection of students for both groups followed specific criteria to ensure a balanced division regarding age range, allowing for more precise comparisons of results.

Students selected for the experimental group participate in a motor intervention lasting 12 weeks, with three 50-minute sessions per week. The motor intervention program incorporating activities that promoted both gross and fine motor coordination, with a focus on balance and spatial orientation. Sessions initially utilized playful activities; followed by activities involving obstacle courses, integrating jumps and throws; activities involving the use of balls for aiming and catching; and for fine motor coordination, manipulation activities were used, such as screwing lids, assembling puzzles, modeling clay, and using tweezers to move small objects. At the end of the 12 weeks of motor intervention, the MABC-2 test was reapplied to both groups.

Data analysis

A descriptive analysis of the database was performed using anthropometric measures of BMI and abdominal circumference. Boxplots were used to evaluate motor performance indices as a function of treatment (control or experimental) and time (pre-intervention and post-intervention). Subsequently, a mixed linear model was fitted for each outcome, as a function of treatment and time, to verify if the differences observed in the descriptive analysis were significant. In these adjustments, the age, sex, BMI, and abdominal circumference of the students were controlled, and a significance level of 5% was considered. The assumptions of the adjusted models were verified through residual analysis, and no violations were found. All analyses were performed using R software[15] version 4.1.2.

RESULTS

Table 1 presents the profile of the schoolchildren in terms of age, weight, height, BMI, abdominal circumference, and motor performance on the MABC-2 subscales (manual dexterity, balance, throwing and catching, and total motor score).

Table 1. Descriptive profile of schoolchildren considering age, weight, height, BMI, abdominal circumference and MABC-2 subscales pre- and post-intervention.

Variables	Mean / Standard deviation	
Age (years)	8.5 ± 1.5	
Weight (kg)	43.8 ± 17.7	
Height (cm)	140.0 ± 10.0	
Body mass index(Kg/cm2)	21.4 ± 6.0	
Abdominal circumference(cm)	72.8 ±14.9	
Subscales	Pre-test	Post-test
	Mean/Standard deviation	Mean/Standard deviation
Manual dexterity	6.3 ± 2.3	8.2 ± 2.7
Balance	7.7 ± 1.9	9.1 ± 1.5
Catching and aiming	5.2 ± 2.3	8.4 ± 3.0
Total motor development	5.6 ± 1.3	8.2 ± 2.4

Kg: Kilograms; Cm: Centimeter; Cm2: Square Centimeters.

It is noted that the children's age ranged from 5.9 to 11.9 years, with a mean age of 8.5 years. The average weight of the children was 43.8 kg, and the average BMI was 21.4 Kg/cm². The results were higher across all four MABC-2 subscales after the motor intervention program. Figure 1 presents the boxplots of motor performance indices as a function of time and treatment.

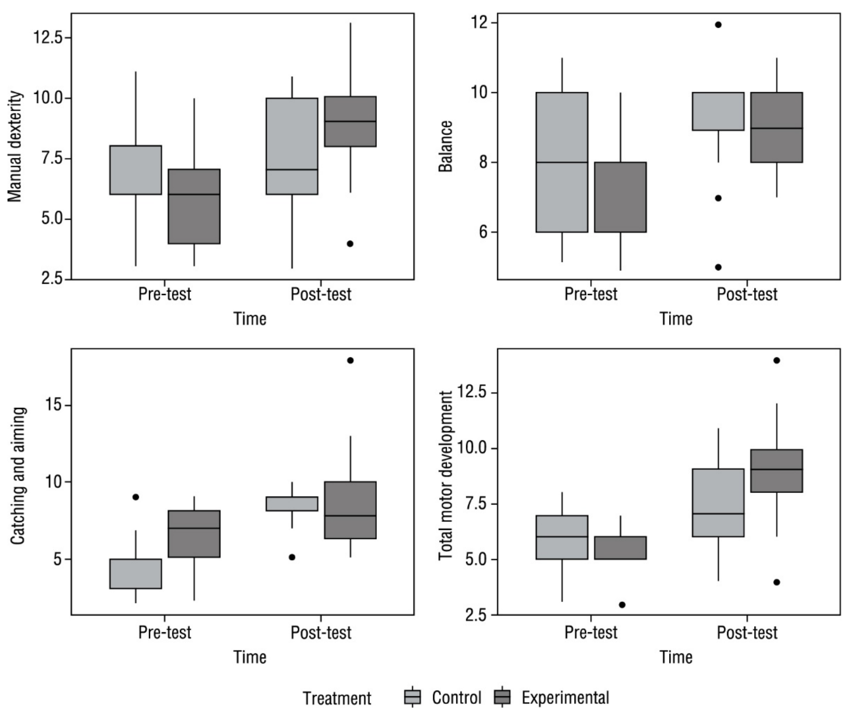

Figure 1. Boxplots of motor performance indices as a function of time and treatment.

Considering the manual dexterity subscale after the intervention, the experimental group was superior to the control group (8.5 points to 7.5 points, respectively). For the balance and aiming and catching subscales, both groups increased scores after the motor intervention program. After the motor intervention, there was an increase in the total motor development score for both groups however, the increase for the experimental group was superior to the control group, indicating a general positive effect of the intervention.

Next, linear mixed models were adjusted using the lme4 package[16] of the R software. Tables 2 and 3 present the estimates of the models adjusted to all subescale scores. In all adjustments, the interaction between time and treatment was considered, as predicted in the descriptive analysis, controlling for the possible effects of sex, age, BMI and abdominal circumference of the children.

Table 2. Estimates of the mixed linear model for the manual dexterity and aiming and catching subscales.

Manual dexterity				
Effect	Estimated	SE	z	*p value*
Intercept	5.952	3.349	1.777	0.090
Sex 2	-0.398	1.379	-0.289	0.776
Age	0.000	0.028	0.016	0.988
BMI	-0.167	0.139	-1.199	0.244
Abdominal circumference	0.067	0.053	1.275	0.217
Experimental group	-1.292	1.031	-1.253	0.218
Time Post-test	0.692	0.782	0.885	0.385
Experimental group: Time Post-test	2.308	1.106	2.087	0.048*
Aiming and catching				
Intercept	11.407	2.558	4.460	0.000
Sex 2	-2.694	1.044	-2.581	0.013
Age	-0.061	0.021	-2.906	0.006
BMI	0.001	0.105	0.005	0.996
Abdominal circumference	0.017	0.040	0.424	0.674
Experimental group	2.207	0.913	2.418	0.020*
Time Post-test	3.923	0.893	4.394	0.000*
Experimental group: Time Post-test	-1.385	1.263	-1.097	0.279

BMI: Body Mass Index; SE: Standard Error.

Table 2 shows, for the Manual Dexerity, a positive effect of time, as the score of both groups increases after the motor intervention. Furthermore, the interaction between time and treatment was significant, confirming that students who participed the twelve-week motor intervention program experienced a superior increase compared to control group students. More specifically, the average score of this subscale increased by 2.3 units more in the experimental group than in the control group.

Evaluating the values of aiming and catching, only the individual effects of time and treatment were statistically significant. Thus, both groups showed an increase in the aiming and catching score after the motor intervention program, with the average increase for both groups being 3.9 points. The estimate associated with the experimental group was 2.2 points, indicating that experimental group students had aiming and catching score, on average, 2.2 points higher than control group students.

Table 3. Estimates of the mixed linear model for the balance and total motor development score subscales.

Balance				
Effect	Estimated	SE	z	*p value*
Intercept	10.968	1.862	5.890	0.000
Sex	-0.326	0.764	-0.427	0.674
Age	-0.001	0.015	-0.073	0.943
BMI	-0.228	0.077	-2.965	0.008*
Abdominal circumference	0.030	0.029	1.020	0.320
Experimental group	-0.338	0.602	-0.562	0.577
Time Post-test	1.154	0.509	2.268	0.033*
Experimental group: Time Post-test	0.462	0.720	0.641	0.527
Motor development				
Intercept	8.222	2.551	3.222	0.001
Sex	-0.660	0.957	-0.690	0.490
Age	-0.012	0.021	-0.560	0.575
Abdominal circumference	-0.010	0.028	-0.360	0.719
Experimental group	-0.214	0.794	-0.270	0.788
Time Post-test	1.692	0.610	2.775	0.006
Experimental group: Time Post-test	1.846	0.862	2.141	0.032

BMI: Body Mass Index; SE: Standard Error.

Table 3 presents the results obtained for the balance subscale and this outcome was the only one where the effect of BMI was significant, causing a decrease in balance. Specifically, for every unit increase in a student's BMI, there is an average drop of 0.228 points in the balance score. Furthermore, there was no treatment effect, but there was a significant effect of time. This implies that both the control and experimental groups showed an increase of 1.15 units in the balance score after the motor intervention program. Finally, Table 3 presents the results for the model adjusted for the total motor development score, the interaction between treatment and time was significant, indicating that the total motor development score of students increased in both groups (control and experimental), but the increase in the experimental group was greater than in the control group (Figure 1). Specifically, the average increase in total motor development score for control group students was 1.69 points, while for the experimental group, this increase was 3.54 points.

DISCUSSION

The primary finding of this study was that following the motor intervention, there was an increase in the total motor development score for both groups; however, the score increase in the intervention group was superior to that of the control group, indicating a positive effect of the motor intervention. This improvement in the total motor development score suggests that the motor intervention had a positive impact, which corroborates with existing motor intervention studies involving children with DCD[17]. Generally, motor interventions have significantly improved the results of standardized motor tests, with task-oriented strategies proving highly effective in enhancing motor skills, balance, cognitive function, and activity performance, while combined task- and process-oriented approaches also improved general motor skills[18].

Specifically, in the manual dexterity subscale, a positive effect was noted after the motor intervention, confirming that students who participed the twelve-week motor intervention program showed a superior increase compared to control group students. This result is consistent with studies demonstrating that regular practice of physical activities and structured games can improve specific skills such as manual dexterity and balance[19]. Saidmamatov et al.[20] concluded that a 10-week motor skills training program can enhance the quality of children's motor competence and represents a valuable procedure for physical education specialists to improve motor competence in children with DCD. Similar results were found by Navarro-Patón et al.[17], whose motor competence-based program contributed to the improvement of manual dexterity, aiming and catching, and balance, as well as a better percentage in children's overall motor competence.

Regarding the balance subscale after the intervention, despite potential improvement, children with DCD exhibit poorer performance across different balance domains compared to their typically developing peers, and comprehensive information on which balance domains are affected is still lacking in the literature[21]. According to Johnson et al.[22], there is a continuum of balance performance in children with DCD, but with significant inter- and intra-individual heterogeneity. Thus, children with DCD struggle with tasks requiring anticipatory postural adjustments and rapid reactive responses, implying that these children must rely on slow, conscious feedback-based control instead of fast feedforward control and rapid automatic feedback[22].

Another important finding related to balance was that an increase in BMI emerged as a negative factor in improving balance, consequently affecting the performance of children's fundamental motor skills. This observation was highlighted by Nobre et al.[23] and the authors confirmed that BMI negatively and significantly explained motor coordination for children with DCD. This negative association between higher BMI and lower motor proficiency is linked to obesity and overweight in children with DCD, and this association increases with age[24].

An interesting finding was observed concerning the covariates present in the study, such as sex, age, and abdominal circumference, which did not show statistical significance in the analyzed models. This indicates that while these variables may generally influence motor development, the intervention effect was sufficiently strong to outweigh their influences. In this regard, Noordstar et al.[25] found large intra-group variability in the change in motor performance and self-perceptions in children with DCD, therefore, to better understand why some children with DCD improve and others do not after a motor intervention more studies are needed, and Saidmamatov et al.[20] found that the efficacy of an intervention program applied to children with DCD was similar across both sexes.

In summary, motor intervention programs for children with DCD promote overall increases in motor performance and children's engagement in class. Motor intervention improves performance in ball skills, engagement with success, and active play[23,26]. Motor skill interventions are effective in improving motor competence and cognitive, emotional, and other psychological aspects in children with DCD. A systematic review highlighted the effectiveness of activity-oriented interventions focused on enhancing motor skills and functioning, emphasizing the need for interventions aligned with children's real-world activities with DCD[27] and is effective as care-as-usual in children with DCD[28].

Expanding beyond the typical focus on motor challenges, these results highlight DCD's broad influence on the daily life of schoolchildren. School environmental contexts increase challenges during adolescence, including the greater complexity of physical education classes and high school elective subjects. In this sense, motor intervention programs are indispensable for providing the basic conditions for individuals with DCD to face the challenges that arise during adolescence.

Despite promising results, this study presents some limitations that should be considered: the relatively small sample size may limit the generalization of results to other populations. Additionally, the 12-week intervention period may not have been sufficient to observe long-term changes in motor development. Research with longer interventions can provide a deeper understanding of sustainable effects. External factors, such as physical activities performed outside the controlled study environment, were not monitored, which may have influenced the results.

CONCLUSION

The main contribution of this study was to advance a motor activity program that promoted improvements in the total motor development score of students from the first to fifth grades of elementary school. The motor intervention resulted in a significant increase in the scores for aiming and catching objects, as well as movements involving the ability to balance.

The motor intervention, based on a program of fundamental movements, identified that an increase in students' BMI negatively interferes with their ability to balance, making it difficult to perform movements requiring this motor capacity. Similarly, the results of the motor intervention program were not influenced by factors such as age and sex, which showed no statistical significance in the performance of fundamental movements in the 6 to 10-year age group.

The results strengthen the need to change the perception that students with low motor competence or probable DCD do not improve over time. Instead, adequate stimuli with an emphasis on fundamental movements can aid the improvement of their motor development, promoting effective participation in physical and motor activities that enable a better quality of life in this phase of holistic development.

COMPLIANCE WITH ETHICAL STANDARDS

Funding

The development of this research received financial support from the Institutional Program to Support the Recruitment of Young Doctors (Notice No. 032/2022 – PPG), from the Araucária Foundation – Science, Technology and Innovation of Paraná, linked to the State University of Maringá, granted to researcher Luciana Ferreira.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

Ethical approval

Ethical approval was obtained from the local Human Research Ethics Committee – Maringa State University and the protocol (no. 6.421.089) was written in accordance with the standards set by the Declaration of Helsinki.

Conflict of interest statement

The authors have no conflict of interests to declare.

Author Contributions

Conceived and designed the experiments: LF, VFM, JLLV; Performed the experiments: AJSV, BARM, LLC, FCD; Analyzed the data: BARM, JLLV, FCD; Contributed reagents/materials/analysis tools: AJSV, BARM, LLC; Wrote the paper: LF, VFM, JLLV.

REFERENCES

1. APA: American Psychiatriac Association. Diagnostic and statistical manual of mental disorders (DSM-5-TR). 5th ed. Washington, D.C.: APA; 2022. http://doi.org/10.1176/appi.books.9780890425787.
2. Santos VAP, Vieira JLL, Souza VFM, Ferreira L. Transtorno do Desenvolvimento da Coordenação: desconhecido por pais e professores. Ensaio 2022;30(116):598-619. http://doi.org/10.1590/s0104-40362021002902921.
3. Smits-Engelsman B, Verbecque E. Pediatric care for children with developmental coordination disorder, can we do better? Biomed J 2022;45(2):250-64. http://doi.org/10.1016/j.bj.2021.08.008. PMid:34482014.
4. Ito T, Sugiura H, Ito Y, Nakai A, Narahara S, Noritake K, et al. Decreased walking efficiency in elementary school children with developmental coordination disorder trait. Clin Rehabil 2023;37(8):1111-8. http://doi.org/10.1177/02692155221150385. PMid:36604801.
5. Goetschalckx M, Moumdjian L, Feys P, Rameckers E. Interlimb coordination and spatiotemporal variability during walking and running in children with developmental coordination disorder and typically developing children. Hum Mov Sci 2024;96:103252. http://doi.org/10.1016/j.humov.2024.103252. PMid:39018699.
6. Cavalcante JL No, Draghi TTG, Santos IWPD, Brito RDS, Silva LSO, Lima UDS. Physical fitness in children with developmental coordination disorder: a systematic review. Phys Occup Ther Pediatr 2024;44(5):626-55. http://doi.org/10.1080/01942638.2024.2327354. PMid:38587180.
7. Draghi TTG, Cavalcante JL No, Rohr LA, Jelsma LD, Tudella E. Symptoms of anxiety and depression in children with developmental coordination disorder: a systematic review. J Pediatr 2020;96(1):8-19. http://doi.org/10.1016/j.jped.2019.03.002. PMid:31029680.
8. Draghi TTG, Cavalcante JL No, Tudella E. Symptoms of anxiety and depression in schoolchildren with and without developmental coordination disorder. J Health Psychol 2021;26(10):1519-27. http://doi.org/10.1177/1359105319878253. PMid:31556324.

9. Le T, Graham JD, King-Dowling S, Cairney J. Perceptions of ability mediate the effect of motor coordination on aerobic and musculoskeletal exercise performance in young children at risk for Developmental Coordination Disorder. J Sport Exerc Psychol 2020;42(5):407-16. http://doi.org/10.1123/jsep.2019-0155. PMid:33017803.

10. Hatanaka R, Higuchi Y, Imaoka M. Improving motor skills in five children with Developmental Coordination Disorder Traits and its impact on parenting stress: a case series. Cureus 2024;16(6):e61691. http://doi.org/10.7759/cureus.61691. PMid:38975406.

11. Wilson DM, Clark JL, Thompson AB. Efeitos de programas de intervenção motora na função física e na marcha de crianças com dificuldades motoras. Dev Med Child Neurol 2020;62(1):45-52.

12. McQuillan VA, Swanwick RA, Chambers ME, Schlüter DK, Sugden DA. A comparison of characteristics, developmental disorders and motor progression between children with and without developmental coordination disorder. Hum Mov Sci 2021;78:102823. http://doi.org/10.1016/j.humov.2021.102823. PMid:34051667.

13. Sánchez-Matas Y, Hernández-Martínez A, Gutiérrez D, Rudd YJ. Actual and perceived motor competence in children with motor coordination difficulties: effect of a movement-based intervention. Res Dev Disabil 2024;151:104797. http://doi.org/10.1016/j.ridd.2024.104797. PMid:38981211.

14. Sudgen H, Barnett A. Movement assessment battery for children. 2nd ed. San Antonio: Harcourt Assessment; 2007.

15. R Development Core Team. R: a language and environment for statistical computing. Vienna: R Foundation for Statistical Computing; 2021.

16. Bates D, Mächler M, Bolker B, Walker S. Fitting linear mixed-effects models using lme4. J Stat Softw 2015;67(1):1-48. http://doi.org/10.18637/jss.v067.i01.

17. Navarro-Patón R, Martín-Ayala JL, Martí González M, Hernández A, Mecías-Calvo M. Effect of a 6-week physical education intervention on motor competence in pre-school children with Developmental Coordination Disorder. J Clin Med 2021;10(9):1936. http://doi.org/10.3390/jcm10091936. PMid:33946206.

18. Gao J, Yang Y, Xu X, Huang D, Wu Y, Ren H, et al. Motor-based interventions in children with Developmental Coordination Disorder: a systematic review and meta-analysis of randomised controlled trials. Sports Med Open 2025;11(1):59. http://doi.org/10.1186/s40798-025-00833-w. PMid:40419841.

19. Haga M. Physical activity and motor skills in children: a review of the literature. J Sports Sci Med 2008;7(1):1-10.

20. Saidmamatov O, Raximov Q, Rodrigues P, Vasconcelos OA. Ten-week motor skills training program increases motor competence in children with Developmental Coordination Disorder. Children 2021;8(12):1147. http://doi.org/10.3390/children8121147. PMid:34943343.

21. Verbecque E, Johnson C, Rameckers E, Thijs A, van der Veer I, Meyns P, et al. Balance control in individuals with developmental coordination disorder: a systematic review and meta-analysis. Gait Posture 2021;83:268-79. http://doi.org/10.1016/j.gaitpost.2020.10.009. PMid:33227605.

22. Johnson C, Hallemans A, Meyns P, Velghe S, Jacobs N, Verbecque E, et al. A continuum of balance performance between children with developmental coordination disorder, spastic cerebral palsy, and typical development. Eur J Phys Rehabil Med 2024;60(6):956-69. http://doi.org/10.23736/S1973-9087.24.08472-7. PMid:39441111.

23. Nobre GC, Ramalho MHDS, Ribas MS, Valentini NC. Motor, physical, and psychosocial parameters of children with and without Developmental Coordination Disorder: a comparative and associative study. Int J Environ Res Public Health 2023;20(4):2801. http://doi.org/10.3390/ijerph20042801. PMid:36833496.

24. Gambra L, Cortese S, Lizoain P, Romero DR, Paiva U, Gándara C, et al. Excessive body weight in developmental coordination disorder: a systematic review and meta-analysis.

Neurosci Biobehav Rev 2024;164:105806. http://doi.org/10.1016/j.neubiorev.2024.105806. PMid:38986892.

25. Noordstar J, van der Net J, Voerman L, Helders P, Jongmans M. The effect of an integrated perceived competence and motor intervention in children with developmental coordination disorder. Res Dev Disabil 2017;60:162-75. http://doi.org/10.1016/j.ridd.2016.12.002. PMid:27984818.

26. Souza MS, Nobre GC, Valentini NC. Effect of a motor skill-based intervention in the relationship of individual and contextual factors in children with and without Developmental Coordination Disorder from low-income families. Psychol Sport Exerc 2023;67:102406. http://doi.org/10.1016/j.psychsport.2023.102406. PMid:37665867.

27. Alghadier M, Alhusayni AI. Evaluating the efficacy of gross-motor-based interventions for children with Developmental Coordination Disorder: a systematic review. J Clin Med 2024;13(16):4609. http://doi.org/10.3390/jcm13164609. PMid:39200751.

28. Noordstar JJ, van der Net J, Voerman L, Helders PJ, Jongmans MJ. The effect of an integrated perceived competence and motor intervention in children with developmental coordination disorder. Res Dev Disabil 2017;60:162-75. http://doi.org/10.1016/j.ridd.2016.12.002. PMid:27984818.