

# Developmental coordination disorder in children enrolled in part time and full time Public Schools

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## Abstract

**Introduction:** Children with Developmental Coordination Disorder (DCD) are characterized by low motor proficiency unrelated to neurological disorders or severe intellectual impairment, which results in difficulties to perform tasks of daily living.

**Objective:** This study investigated the prevalence of potential DCD in children with a mean age of  $8.1 \pm 0.35$  years in part-time and full-time public schools.

**Methods:** The sample consisted of 159 children, both sexes, being 48.4% of partial time and 51.6% from full time school. Movement Assessment Battery for Children, Second Edition (MABC-2) was used to assess aiming and catching skills, manual dexterity, and static and dynamic balance. Children were classified into: typical motor development, risk for DCD or potential DCD. For data analysis we used the Kolmogorov-Smirnov test. For comparisons of variables, the Mann Whitney U Test and analysis of variance were used to identify which skills evidenced the best levels of motor proficiency among the children.

**Results:** The results indicated that 2.5% of full-time school children were diagnosed with potential DCD and no occurrence among part-time school children, but with no statistically significant differences comparing skills according to daily school hours.

**Conclusion:** The sum of the prevalence of children at risk and potential DCD (18.3%) reports a concern, indicating a need for early motor development assessments to establish interventions to reverse or minimize motor deficit.

**Keywords:** children, motor development, motor difficulty, full-time school.

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## Authors summary

### Why was this study done?

In Brazil, full-time school is a recent project with great potential to be implemented in the public school system. The opportunities for learning motor skills should be improved with the greater availability of activities due to the increase of daily school hours. Thus, this study aimed to identify the prevalence of probable Developmental Coordination Disorder (DCD) in children enrolled in both partial and full time schools. The research is part of the master's dissertation "Comparison of children's motor performance between part-time and full-time public schools" by Ricardo Henrique Bim, under the guidance of Prof. Dr. José Luiz Lopes Vieira developed within the scope of the State University of Maringá (UEM) in the Associated Graduate Program in Physical Education (UEM / UEL).

### What did the researchers do and find?

The research analyzed 159 children from part-time and full-time public schools and compared the prevalence of CDC between children from part time and full time schools. The Movement Assessment Battery for Children Second Edition (MABC-2) by Henderson, Sugden and Barnett (2007) was used to assess the skills of throwing and catching, manual dexterity and static and dynamic balance. Test performance allows children to be classified into: typical motor development, risk for DCD or potential DCD.

### What do these findings mean?

We found 1.3% of children in the total sample (n = 159) with potential DCD. Among children in full-time schools the rate was 2.5% and no occurrence was found among children in part-time schools, however, with no significant difference in the comparison between groups. Out the total sample 17% of children were at risk for DCD (14.3% in children enrolled part-time and 19.5% enrolled full-time). There was no statistically significant difference in the prevalence of probable DCD and risk of DCD among children enrolled in part-time and full-time public schools.

## INTRODUCTION

Children with Developmental Coordination Disorder (DCD) are characterized by low motor proficiency unrelated to neurological disorders or severe intellectual impairment<sup>1</sup>, which results in difficulties in performing daily life tasks (eg holding objects, writing, jumping, running, walking)<sup>1,2</sup>.

Difficulties in motor skills have a strong impact on the individual's development, with motor delay being the first manifestation of possible developmental disorders<sup>3</sup>. Thus, children with atypical motor development, or who are at risk of delay, deserve attention and specific actions, since the problems of coordination and control of movement may extend into adulthood<sup>4</sup>. Motor difficulties can interfere in several domains, compromising social, emotional and affective aspects of the subject<sup>5</sup>.

Worldwide, the prevalence of DCD in children aged 5 to 11 years is estimated at between 2% and 9%<sup>6</sup>. In Greece, the prevalence has been reported in 5.4% of children<sup>7</sup>. In Canada, 7.5%<sup>8</sup>; in England 1.8%<sup>9</sup>. In Brazil, a study<sup>10</sup> conducted in the southern region of the country identified 19.9% with DCD. In Florianópolis, Santa Catarina, Brazil, the reported prevalence was 6.1%<sup>11</sup>. In Manaus, Amazonas, Brazil, 11.8% in the urban area and 4.4% in the rural area<sup>12</sup>; and in the city of Maringá, Paraná, Brazil, 11.4%<sup>13</sup>.

So far, in the national literature available only a study<sup>14</sup> investigated the influence of full time schools on the prevalence of DCD in school-age children. Scholars have identified a prevalence of 8% when assessing 50 children (25 from a full time educational program and 25 from part time program) aged 7 to 10 years. No significant relationship was observed between the variables "type of education" and motor performance in children, suggesting that the full time education program may not be influencing children's performance, as expected.

It is observed that Brazil has a gap of research on this relevant theme in the different regions of the country as well as in their different social contexts. There is a demand to raise awareness about DCD and encourage changes in public policies related to the care of children affected,

hence this study aimed to investigate the prevalence of probable Developmental Coordination Disorder (DCD) in children aged 7 to 8 years from part time and full time public schools.

## METHODS

This is a descriptive, cross sectional study. The sample consisted of 159 children of both sexes, with an average age of  $8.1 \pm 0.35$  years enrolled in the 3rd year of elementary school from four public schools of the municipality of Maringá, Paraná, Brazil, 77 children (48.4%) from partial time educational program and 82 children (51.6%) from full time program.

The "n" sample was determined considering the first two schools that implemented the full-time day school in the municipal school system of Maringá, Paraná, Brazil, with the "Programa Mais Educação" (More Education Program). Then, two other schools located in the same region of the city that had not yet expanded their daily school hours were randomly selected, seeking to evaluate children with equivalent characteristics in relation to their context and socioeconomic level.

## Data collection

The Movement Assessment Battery for Children - Second Edition (MABC-2)<sup>15</sup> validated for Brazilian children was used as a measuring instrument<sup>16</sup> to assess children's manual dexterity, static and dynamic balance skills, and aiming and catching abilities

The Band 2 test was used only for children from 7 to 10 years old, which brings together 8 motor tasks divided into three areas: motor skill of manual dexterity, ability to aim and catch and static and dynamic balance ability. From the final test score, we have the percentile in which each child fits and the descriptive classification in the test battery, indicating the level of motor performance.

For the classification of children according to motor performance in the MABC-2 test, the cut-off points and nomenclature already established in the national and

interactional literature were adopted, which establish atypical and probable DCD motor performance for a score equal to or below 5th percentile; at risk for DCD for score between 6th and 15th percentile; and typical motor development for 16th or above percentile score<sup>10,16,17</sup>.

The MABC-2 test was applied using its specific material kit with its protocol and instruction manual. Data was collected at the facilities of each participating school according its availability, following the criteria required in the protocols. The assessment environment was previously organized to ensure children’s safety, test reliability and data confidentiality. Four Physical Education teachers from the Universidade Estadual Maringá (Maringá State University)/Universidade Estadual de Londrina (Londrina State University) Associate Postgraduate Program in Physical Education, both located in Paraná, Brazil, participated in the data collection.

Data were organized and analyzed using the SPSS 20.0 Software program. First, a descriptive statistical analysis of the study variables was performed by frequency and percentage. The Kolmogorov-Smirnov test was applied for analyzing numerical variables and to verify the normality of the data distribution. The data did not present normal distribution, so we used median (Md), first and third quartiles (Q1; Q3). For comparisons of motor performance variables between daily school hours, the Mann Whitney U Test was used. In order to identify in which dimension the children presented better levels of motor proficiency, the repeated-measures analysis of variance (ANOVA) was

performed, fulfilling the sphericity assumption, which was observed through the Mauchly test. The level of significance adopted for performing inferential statistics tests was  $\alpha = 0.05$ .

**Ethical aspects**

The research was approved by the Standing Committee on Ethics in Research involving Human Beings of the State University of Maringá (COPEP), under opinion No. 297/201. Also it obtained authorization from the Maringá City Department of Education (SEDUC) and the schools selected to perform the study. Subsequently, parents and guardians of the children received the Free and Informed Consent Form (FICF) for signature as well as they signed the respective authorization of their children’s participation in the study.

**RESULTS**

Illustrates that 85.7% (n=66) of children enrolled in part-time schools had typical motor development. A total of 14.3% (n=11) were at risk of DCD, and none had a potential DCD. Regarding children enrolled in full-time schools, 78% (n=64) showed typical development, 19.5% (n=16) were at risk for DCD and 2.5% (n=2) were diagnosed with probable DCD. However, there were no statistically significant differences (p <0.05) when classifications were compared according to the daily school hours (Table 1).

**Table 1:** Motor performance (MABC-2) of students enrolled in partial and full time daily school hours.

MABC-2 classification	Daily School Hours					
	Partial		Full time		Total	
	(n)	%	(n)	%	(n)	%
Typical development	66	85.7	64	78.0	130	81.7
Risk of DCD	11	14.3	16	19.5	27	17.0
Probable DCD	-	-	2	2.5	2	1.3
Total	77	100.0	82	100.0	159	100.0

DCD: Developmental Coordination Disorder.

When comparing the motor skills of children enrolled in part-time schools with the skills of children from full-time schools (Table 2), there was a statistically significant difference in the motor ability to aiming and catching (p=0.029), in the tasks of aiming a beanbag onto mat (p=0.016), jumping on mats (p=0.041) and on the total test score (p=0.038). The results indicate that children who study in part-time daily schools showed better motor performance in these skills and tasks compared to children who study in full-time schools.

Table 3 shows a statistically significant difference between the manual ability and aiming and catching skills of children enrolled in the part-time schools (p=0.000) and between the manual skills and balance skills of children enrolled in the full time schools (p=0.005) The performance of children in both groups (partial and full-time) in the MABC-2 test revealed greater motor difficulties in the manual dexterity. In contrast, children enrolled in part-time schools outperformed in the ability of aiming and catching and children enrolled in part-time schools outperformed in balancing ability.

**Table 2:** Comparison of children's motor performance (MABC-2) in skills and tasks according to daily school hours.

MABC-2 abilities	Daily School Hours				p
	Partial (n=77)		Integral (n=82)		
	Md (Q1; Q3)		Md (Q1; Q3)		
Manual dexterity	9.00	(8.00; 12.00)	9.00	(7.00; 11.00)	0.224
Placing pegs	9.00	(7.00; 12.00)	8.00	(6.00; 11.00)	0.085
Threading Lace	10.00	(8.00; 12.00)	11.00	(8.00; 12.00)	0.817
Drawing trail	10.00	(6.00; 12.00)	10.00	(5.00; 12.00)	0.627
Aim and Catch	11.00	(9.00; 14.00)	10.00	(8.00; 12.00)	0.029*
Catching with two hands	12.00	(10.00; 15.00)	10.00	(9.00; 15.00)	0.129
Throwing beanbag onto mat	9.00	(8.00; 11.00)	8.00	(6.00; 11.00)	0.016*
Balance	10.00	(9.00; 11.00)	10.00	(9.00; 12.00)	0.490
One Board Balance	9.00	(7.00; 11.00)	9.50	(8.00; 12.00)	0.130
Walking heel to toe forward	11.00	(11.00; 12.00)	11.00	(11.00; 12.00)	0.611
Hooping on Mats	12.00	(12.00; 12.00)	12.00	(9.50; 12.00)	0.041*
Total Score	80.00	(73.00; 88.00)	76.00	(69.00; 86.00)	0.038*

\*Significant difference  $p < 0.05$ .

**Table 3:** Comparison of means and standard deviation of manual dexterity scores, aiming and catching, and balance (MABC-2) of children according to the daily school time.

MABC-2 abilities	Daily School Hours			
	Partial (n=77)		Full-time (n=82)	
	$\bar{x} \pm Dp$	p	$\bar{x} \pm Dp$	p
1 Manual dexterity	9.64±2.94	0.001* (1 and 2)	9.02 ± 3.07	0.051 (1 and 2)
2 Aiming&Catching	11.23±2.97	0.213 (2 and 3)	10.08 ± 3.19	1.000 (2 and 3)
3 Balance	10.44±2.44	0.101 (3 and 1)	10.35 ± 2.83	0.005* (3 and 1)

\*Significant difference  $p < 0.05$ .

## DISCUSSION

Results showed that two children or 1.3% of the 159 children were diagnosed with probable DCD. As these children were enrolled in full-time schools the rate for this group was 2.5%, whereas among the children from part-time schools none was diagnosed with possible DCD. The risk rate for DCD was 19.5% (16 children) among the integral-time school children and 14.3% (11 children) among part-time school children. Typical motor development was 78% of full-time school children and 85.7% of part-time school children. It is observed that the proportion of children with probable DCD, at risk for DCD and typical motor development was similar when compared according to the daily school routine.

It is noteworthy that out of 159 children of the total sample 27 were diagnosed with a risk of CDD, it is alarming that almost one in five children are at risk of presenting such a compromising disorder for overall development and quality of life of young people<sup>10</sup>.

The comparison between the motor performance of children in the motor skills and tasks that make up the MABC-2, according the daily school hours showed that children enrolled in part-time schools had better motor performance in relation to the children from full-time schools in motor skill of aiming and catching, in the tasks

of aiming the bean bags onto mats, hooping on mats beyond the total test score. These results support the findings<sup>14</sup> that contradict the hypothesis that with more time spent in school, children increase the development of their motor skills. It is noticed that the index of children with probable DCD assessed in this study is below what is commonly found in the national literature, however, the proportion of children at risk of DCD was similar to the results published in previous studies conducted in the country.

In the three states of southern region of Brazil, an assessment 10 of 1,587 children from 4 to 12 years of age from public schools identified 19.9% of students with probable DCD and 16.8% at risk of such disorder. The authors showed that difficulties in manual dexterity tasks had a stronger impact on the diagnosis of probable DCD and on the risk of such disorder. The boys presented worse performance in the manual dexterity and balance tasks, while the girls showed a higher deficiency in the ball skills. Impaired motor performance was more prevalent in the age group of older children.

In the city of Florianópolis, Santa Catarina, Brazil, a study with 380 public school children, aged 7 to 10 years, diagnosed 6.1% with probable DCD and 5.5% at risk of DCD<sup>11</sup>. Also in Florianópolis, studies<sup>18</sup> with 417 children

aged 7 and 8 years indicated the prevalence of 10.8% of children with DCD and 12% at risk of DCD. In the city of Manaus, Amazonas, Brazil, a survey conducted with 240 children of 7 and 8 years of age, of both sexes, enrolled in schools of the municipal network of the city revealed that 11.8% of children in the urban area had DCD and 10.3% were at risk for DCD. In the rural area, 4.4% of children were classified as DCD and 11.1% at risk of movement difficulties<sup>12</sup>. In the city of Maringá, Paraná, Brazil<sup>13</sup> of 581 children aged 7 to 10 years enrolled in public schools, 11.4% had DCD and 10.5% were at risk for DCD.

On the other hand, the index of children diagnosed with probable DCD found in this study corroborates the results of a study from England, in which a large research<sup>9</sup> with 6,990 children from 7 to 8 years old reported that 1.8% had DCD and 4.9% was at risk for DCD.

The trend reported in national studies, with the exception of two studies<sup>11,12</sup>, points to a prevalence of DCD above 10%, which is different from international studies reporting rates below 10%, as in a study<sup>7</sup> conducted in Greece with 412 children from 4 to 6 years old which evidenced a prevalence of 5.4% of DCD among children and 6.3% were at risk for. Similarly, in Canada a research<sup>8</sup> with 578 children aged 9 to 14 years, reported a prevalence of DCD in 7.5% of the sample. These studies support the claims that the worldwide prevalence of DCD in children aged 5 to 11 years is estimated to be between 2% and 9%<sup>6</sup>. However, it is clear that there is a wide variation in the results for the prevalence of this disorder in Brazil and worldwide.

Early diagnosis of DCD is essential for the referral of children to compensatory programs that minimize the problems arising from the disorder in the child's life<sup>19</sup> who needs assessment and continued intervention by the school and family members<sup>10</sup>. In this sense, Silva *et al.*<sup>20</sup> implemented a motor intervention program for students with DCD, based on the Developmental Physical Education approach. The sessions were held individually, with two 45-minute weekly classes. After 20 intervention sessions for each student, there were significant differences in children's motor performance, especially in balancing ability, confirmed by the performance of pre and post-test evaluations using MABC-2.

The results of this study indicated that 78% of children enrolled in full-time public schools had typical motor development, this rate is lower compared to the percentage of children enrolled in public part-time schools, where 85.7% showed typical motor development. In the scientific literature, the results indicate that the proportion of children with typical motor development is higher in other countries (88.4% to 93.3%) compared to Brazil (47% to 88.4%)<sup>7-13</sup>.

A research<sup>21</sup> which compared the motor performance of 255 children aged 4 to 6 years in Hong Kong with the performance of 493 children in the United States found that eastern children performed significantly better in manual dexterity and balance skills while American children were better at aiming and catching skills, showing also cultural differences in some MABC test items.

In our study, comparison of children's performance in each MABC-2 motor skill revealed that both groups (part and full time) had bigger motor difficulties in manual dexterity. In contrast, children enrolled in part-time schools outperformed in the ability to aiming and catching and children enrolled in part-time schools outperformed in balancing ability.

These results support that difficulties in manual dexterity tasks have a stronger impact on the diagnosis of probable DCD and to be at risk of such disorder regardless of gender and age<sup>10,22,23</sup>. Among students with DCD, it was also found that lower scores occurred in the ability of aiming and catching<sup>11</sup>. Regarding children with typical motor development, it was found<sup>13</sup> that manual skill was the biggest motor difficulty observed, while for children identified with probable DCD and at risk of DCD occurred in ball skills. The studies reveal a tendency for poorer motor performance in manual dexterity skills, which, in the MABC-2 test, encompasses the tasks of placing pegs, threading lace and drawing a trail with a pen on a sheet of paper, activities that refer to fine motor skills.

We emphasize that when added the prevalence of the school population at risk of DCD and potential DCD is highly worrying, analyzing the damage that may occur in social, emotional, affective and school relationships of children, and also considering the few resources in the country for the interventional care of them<sup>13</sup>. The lack of detection of DCD in the early school years and the lack of compensatory programs that can remedy restrictions on motor skills end up aggravating the motor limitations of children transitioning between the risk of DCD and normal developmental trajectory<sup>10</sup>.

This study advances to investigate the prevalence of probable DCD in children from part-time and full-time public schools, however, it is limited to only one Brazilian municipality and without including assessment of processes with family members, educators and health professionals from other areas that would allow an irrefutable diagnosis.

The findings of this study may contribute to broaden the understanding of DCD and encourage changes in public policies related to the care of children affected by this condition, further suggesting the need for continuity and expansion of studies in order to broaden the understanding of DCD and its consequences.

Diagnostic assessments of children's motor development status are essential for early identification of their motor condition. Continuous follow-up enables the necessary actions to be taken to reverse or minimize motor deficits through specific intervention programs. Need to structure the proposed activities for children from full-time school as only staying more hours at school does not guarantee better motor development. The results indicated that, in terms of motor development, the opportunity for motor activities at home, in the neighborhood or any other environment outside the school seems to be more instigating of motor development.

## CONCLUSION

Our findings show that there was no significant difference in the prevalence of probable Developmental Coordination Disorder (DCD) among children enrolled in part-time and full time public schools, contradicting the hypothesis that more time spent in school increases the development of motor skills.

One in five children were diagnosed with a risk of DCD or potential DCD. This is alarming, indicating the need for early assessment of children's motor development status and intervention programs that can reverse or minimize motor deficit.

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## Resumo

**Introdução:** Crianças com Desordem Coordenativa Desenvolvimental são caracterizadas pela baixa proficiência motora não relacionada a patologias neurológicas ou prejuízos intelectuais severos, a qual resulta em dificuldades na realização de tarefas de vida diária.

**Objetivo:** Este estudo investigou a prevalência de potencial Desordem Coordenativa Desenvolvimental em crianças com média de idade de  $8,1 \pm 0,35$  anos de escolas públicas de tempo parcial e integral.

**Método:** A amostra foi composta por 159 crianças, de ambos os sexos, sendo 48,4% do ensino parcial e 51,6% do ensino integral. Utilizou-se a Bateria de Avaliação do Movimento para Crianças-2 (MABC-2) para avaliar as habilidades de lançar e receber, destreza manual e equilíbrio estático e dinâmico. As crianças foram classificadas em: desenvolvimento motor típico, risco para Desordem Coordenativa Desenvolvimental ou potencial Desordem Coordenativa Desenvolvimental. Para análise dos dados utilizou-se o teste de Kolgomorov-Smirnov. Para comparações das variáveis utilizou-se o Teste U de Mann Whitney e análise de variância para identificar em quais habilidades as crianças apresentaram melhores níveis de proficiência motora.

**Resultados:** Os resultados indicaram que 2,5% das crianças de escolas de tempo integral foram diagnosticadas com potencial Desordem Coordenativa Desenvolvimental e nenhuma ocorrência foi verificada entre as crianças das escolas de tempo parcial, porém, sem diferenças estatisticamente significativas na comparação entre as habilidades de acordo com a jornada escolar diária.

**Conclusão:** A soma das prevalências de crianças com risco e potencial Desordem Coordenativa Desenvolvimental (18,3%) é preocupante, indicando a necessidade de avaliações do desenvolvimento motor das crianças desde cedo visando estabelecer intervenções para reverter ou minimizar os déficits motores.

**Palavras-chave:** crianças, desenvolvimento motor, dificuldade motora, escola de tempo integral.

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