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Original Article

VARIABLES THAT MAY EXPLAIN MOTOR PERFORMANCE CHANGES IN CHILDREN WITH DEVELOPMENT COORDINATION DISORDER AND TYPICAL DEVELOPMENT

VARIÁVEIS QUE PODEM EXPLICAR MUDANÇAS NO DESEMPENHO MOTOR DE CRIANÇAS COM DESORDEM COORDENATIVA DESENVOLVIMENTAL E DESENVOLVIMENTO TÍPICO

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ABSTRACT

The aim this study is investigate the relations among important factors regarding to motor development, body mass index and daily activities of children with Developmental Coordination Disorder, at risk of DCD and typically developing children before and after an motor intervention. Participants were 48 children (5 to 7 year-old) designed in intervention group (n=24) and control group (n=24) assessed using the MABC-2, MABC-2 Checklist, body mass index (BMI) and abdominal circumference. At pre test were found significant and positive correlation between motor development and BMI for all participants and for children with DCD. At the post test, for all children and for children in risk of DCD, significant and positive correlations were found between motor development and section B of check list. Intervention programs contribute to minimize the influence of risk factors in the achievement of motor proficiency of children with and without motor delays.

Keywords: Motor skills disorders. Child. Intervention Studies.

RESUMO

O objetivo desse estudo foi investigar associações entre o desempenho motor, estado nutricional e atividades cotidianas de crianças com Desordem Coordenativa Desenvolvimental, risco de DCD e desenvolvimento típico antes e após uma intervenção motora. Participaram do estudo 48 crianças (5 à 7 anos), distribuídas em grupo interventivo (n=24) e grupo controle (n=24) avaliadas com MABC-2, MABC-2 Checklist, Índice de Massa Corporal (IMC) e circunferência abdominal . Na pré-intervenção correlações significativas e positivas foram encontradas entre desempenho motor e IMC para o total da amostra e para as crianças com DCD. Na pós-intervenção correlações significativas e positivas foram encontradas entre o desempenho motor e seção B do check-list para o total de crianças da amostra e para as crianças com risco de DCD do grupo interventivo. Programas interventivos contribuem para minimizar a influência de fatores prejudiciais para o alcance da proficiência motora de crianças com e sem atrasos motores.

Palavras-chave: Transtorno das habilidades motoras. Criança. Estudos de intervenção.

Introduction

Mastery of a wide variety of motor skills, simple or complex, is a requirement for children to engage in physical activities. In addition to intervening motor development factors, there are situations in which the child may present characteristics that deviate from normal motor behavior[1]. Among these cases are children identified with Developmental Coordination Disorder (DCD). To diagnose DCD, the identification of 4 criteria is recomended: (1) a significantly lower than expected ability to perform tasks involving motor coordination; (2) the observed motor impairment affects day-to-day activities (home and school achievements); (3) the exclusion of other causes or medical reasons for the motor delays; (4) if learning difficulties coexist, the motor difficulty exceeds what would be expected[1]. For children with DCD, the movement dificulties that are considered are those of

gross and/or fine motor coordination that the child presents in the absence of neurological diseases or mental retardation that would justify these difficulties[1].

The prevalence of DCD is estimated to be between 2% and 9% of children ages 5 to 11 years[1] and to be more frequent in boys[1,2]. In Brazil, however, previous research reports a higher prevalence (19.9%) of DCD in children aged 4 to 12 years and with a higher frequency of DCD among girls[3]. In relation to age, for children with DCD and in risk of DCD (r-DCD)[3,] the difficulties seem to be accentuated in older children, so it is considered that delays do not decrease over time. Similar results have been reported in children with typical development with motor delays[2,4]; although, in general, it is observed that older children tend to develop more proficient skills compared to younger children[5].

When motor difficulties become very pronounced, children with DCD, r-DCD[6] and typical development (TD) [7] tend to limit their participation in physical activities by choosing a sedentary lifestyle. As a consequence, they may be subject to overweight[6] and motor performance lower than their healthy-weight peers with DCD and r-DCD[6]. Low levels of motor performance have also been reported in overweight children with TD[8]; establishing overweight and obesity in childhood as predictors of inactivity, overweight, or obesity in adulthood[9].

Considering that the lack of proficiency in motor skills limits the practice of physical activities, generate few opportunities for children to develop healthy habits[10], and that physical activity is a protective factor for health[11], children with DCD and r-DCD fit into risk groups and are targets for compensatory intervention programs. Motor interventions with different methodological approaches have the potential to lead children with motor delays to more proficient levels of performance[12]. However, the impact of motor interventions with a mastery-oriented motivation climate to mediate positive changes for children of different skill levels with and without disabilities[13,14] in motor, cognitive and social parameters[15-18] is highlighted. Moreover, interventions with mastery motivational climate can promote greater engagement in physical education classes and help reduce the body mass index of schoolchildren[15]. The efficiency of this methodology has been mainly linked to its inclusive and mediating characteristic of the autonomy of children[19]. This climate is established through diversified activities in small groups, with varied materials, different levels of difficulty in the same activity and participation of the children in the decision making regarding the organization and execution of the classes. Children, participants of classes based in these climates, become more motivated and engaged in practice, regardless of motor difficulties, delays or deficiencies[19].

Specifically, in children with DCD, interventions with different methodologies have been shown to be effective in promoting motor proficiency[20-23]; however, they are distibguished by groups of only children with DCD or r-DCD, not including children with typical development in the same environment. In this perspective, the mastery motivational climate, recognized in the literature to have the potential to mediate positive effects in different aspects of motor, cognitive and social development of children with and without motor difficulties and with or without disabilities, can constitute an interventional alternative for children with DCD and r-DCD. This is a methodology that may favor the inclusion of children with DCD in physical education classes of the intervention programs, since all children, regardless of their level of ability, are able to carry out the activities. Children with DCD, like other children with motor delays, are constantly excluded[24] and/or excluded themselves[25,26] from physical and motor activities. This climate with its inclusive potential makes more engagement possible in function of the autonomy, diversity, and levels of difficulty in the same activity that are routinely employed.

To date, no research has been identified that has investigated the benefits of inclusive intervention with this methodology for children identified with DCD and r-DCD. Given the high prevalence of children with DCD, and even more so, the increased odds of children with DCD to become overweight[6], there is a need to develop research to increase understanding about this disorder. The need to understand the factors that can interfere in the motor acquisition of children in general, such as in daily activities, is also observed. Therefore, the objective of this study was to investigate the associations between motor performance, nutritional status, and daily activities of children with DCD, r-DCD, and typical development before and after an intervention implemented with the mastery motivational climate. The following hypotheses were adopted for this study: (1) in the preintervention, nutritional status will be a factor associated with motor performance; (2) in post-intervention, nutritional status will not be a factor associated with motor performance; (3) in the post-intervention, daily activities will be associated with motor performance.

Methods

Participants

Participants included 48 children organized in a intervention group (24 children) and a control group (24 children) (12 girls and 12 boys in each group), aged between 5 and 8 years. All children were evaluated at the pre-intervention stage with Movement Assessment Battery for Children- Second Edition (MABC-2)[27], school performance with the School Performance Test (SPT)[28] and performance in daily activities at school and at home through the MABC-2 Checklist[29]. The evaluations allowed the formation of three subgroups, children with DCD, r-DCD and typical development (DT) (Table 1). Medical diagnoses were obtained from the children who presented low scores in all three domains evaluated (motor $\leq$5% in MABC-2, low school performance and high difficulty in daily activities). A negative medical diagnosis of the disorder (motor or cognitive) allowed the identification of children with DCD, meeting the criteria proposed by the American Psychology Association[1]. Children who had an intermediate motor performance level (6 to 15th percentile) and some school or daily activity difficulties were identified as having DCD risk. Children with motor performance scores in the percentile> 16%, and without school or daily activity difficulties were identified as children of TD.

The sample was selected based of the interest of the parents, the schools in which the children studied, the availability of the teachers, and the children's interest in participating in the research. The parents and/or legal guardians of all children signed a Informed Consent Term. This research was authorized by the Ethics Committee of the university of origin (2003109). The socioeconomic level of the families of the children was identified by application of a questionnaire of economic classification for the Brazilian population[30] and was completed by the parents or legal guardians. The average family income was R$ 2,038.25 for the children in the intervention group and R$ 2,771.69 for the children in the control group.

Instruments and Procedures

The MABC-2[27], validated for Brazilian children[31], has been widely used to identify DCD in children ages 3 to 16[3]. The test allows the identification of specific difficulties in motor coordination through 3 test batteries specific to age groups called Age Bands (AB). Three AB make up the test battery (AB I: children between 3 and 6 years old, AB II: children between 7 and 10 years old, AB III: children between 11 and 16 years of age). In this study

AB I and II were used. Each AB is composed of eight tasks that correspond to 3 subtests (manual dexterity, ball skills, and balance). The gross values obtained in each of the subtests are converted into gross scores and a subsequent standard score. The sum of the scores for each domain gives the value of the Total Motor Impairment Score, which is converted to a percentile. The authors propose cutoff points indicated in the test manual: ≤5% atypical motor performance, indicative of DCD; 6th to 15th percentile as r-DCD; any percentile higher than 16% equivalent to TD. The motor evaluation followed the protocol proposed by the author of the test, performed in a silent space and isolated from possible distractions organized by the researchers. The test was applied individually, with an approximate duration of 20 minutes for each child. Two trained examiners conducted the test application.

The *Movement Assessment Battery for Children – Checklist*[29], validated in Brazil[32], is a screening tool administered by adults to identify motor difficulties in children aged 5 to 12 years. The MABC *Checklist* consists of 3 sections that list motor behaviors observed in the child's daily life at home and at school: (1) Section A of the *Checklist* (SAC) observes motor behavior with the child standing in a predictable environment; (2) *Checklist* Section B (SBC) observes motor behaviors with the child moving and in a dynamic environment; (3) Section C of the *Checklist* (SCC) contains information that adversely affects movement and is organized into dichotomous responses. The scores in sections A and B are organized on a *likert* scale with values of 0, 1, 2 and 3 referring to the quality of the execution of the movement. Firstly it is decided if the child performs the task; and whether he did it very well (score 0) or only well (score 1). If the child is not able to perform the movement, it should be observed if the child is close to performing (score 2) or not close to performing (score 3) the tasks. The MABC *Checklist* was delivered to the parents along with a direct explanation of the issues. The families answered the questions at home and returned the questionnaire in a later class.

The School Performance Test was applied to all children who presented motor performance below the 15th percentile. This tool was used to aid in the categorization of children with DCD and r-DCD following the prepositions of the *American Psychology Association*[1] to identify children with or in risk of motor disorder. The SPT[8] was generated according to the reality of Brazilian schools and allows the evaluation of the school performance of children ages 6 to 13 years in reading, arithmetic, and writing. The test is divided into (1) writing subtest (it includes the writing of proper nouns and of isolated words presented in the form of dictation); (2) arithmetic subtest (corresponds to oral solution of problems and calculation of arithmetic operations in writing): and (3) reading subtest (evaluates the recognition of words isolated from the context). Each of the subtests presents an increasing level of difficulties comprising from the first to the seventh school year. All items are presented to the student independent of the series or year in which they are, however, for each phase there is a different pattern of comparison, and the higher the score, the better the performance in the test. There are three classifications for school performance: superior, middle, and inferior, the latter being an indicative of learning difficulties, which may be specific (difficulty in writing, reading, or arithmetic) or general. The application of each subtest can be interrupted at the moment the resolution of the items becomes impossible for the child. SPT was applied in a quiet place free of noise or other possible distractions, following the test application protocol.

Body Mass Index (BMI) was used to evaluate the nutritional status of the children with the CDC *(Center of Desease Control*)[33] curves and the waist circumference (WC). The BMI and CDC classify the child's nutritional status as low weight (percentile less than 5), healthy weight (percentile between 5 and 84), overweight (percentile between 85 and 94), and obese (percentile equal or greater to 95). Body mass was measured with a digital scale and

height with a portable stadiometer. waist circumference was obtained with a flexible and inelastic tape measure, without compressing the skin. The children were evaluated individually in a maximum of 10 minutes. The necessary material was organized by the researcher in a calm environment. To assess height, the child was positioned with his back to the stadiometer, with their feet parallel and with the lower part of the eye socket aligned to the outer ear. The body mass measurement was obtained barefoot, with arms loose along the body and in light clothing (pants and t-shirt).

Motor Skill Intervention Program Implementation Procedures

The Motor Intervention Program lasted 26 weeks (32 sessions). The classes took place two days a week, not during school hours, with a duration of approximately 70 minutes. The classes were elaborated, organized, and ministred by the teachers/researchers and had an emphasis on the development and improvement of fundamental motor skills.

The mastery-oriented motivation climate, which emphasizes the autonomy and active participation of the child in the learning process[18], was implemented in the motor intervention through the TARGET structure. The acronym TARGET refers to the six dimensions of daily classroom activities, for which the teacher organizes intervention strategies. In the present intervention the following strategies were adopted in each dimension: (1) TASK: It involved the content and sequence of the motor activities, as well as the level of difficulty of these tasks and significant experiences compatible with the individual abilities; (2) AUTHORITY: Involved the effective and cooperative participation of the children in the establishment of rules, choice of activity, planning of stations, and organization of tasks; (3) RECOGNITION: It involved appreciation and recognition for the efforts and achievements of the children through a support system of significant people in the lives of the children, parentes, and teachers; (4) GROUP: Groups were flexible and constantly changing, with each session offering opportunities to train groups with heterogeneous characteristics such as gender, age, race, skill level, and physical abilities; (5) EVALUATION: Individualized assessment standards were established, respecting the development pace and the characteristics of each student; children also had self evaluating opportunities; (6) TIME: The practice time of the physical activities in class was established considering the initial assessment of the group, and more time was established for the practice of skills that the children presented greater difficulties. With the use of strategies consistent with the real needs of all children, it was possible to create practice conditions with high demands on levels of participation (since individualities were respected) and consequently creating conditions for greater motor engagement and caloric expenditure.

Statistic Analysis

Descriptive analysis were used (mean and standard deviation). The *Shapiro Wilk* test showed a nonparametric distribution for the dependent variables (BMI, waist circumference, Section A and Section B of the *checklist*) (“p” values between 0.002 and <0.001). In these variables, *Mann Whitney's* "U" test was used to verify possible differences between the intervention and control groups. *Spearman* correlations were used to determine the extent and direction of linear relationships between motor performance and variables gender, age, waist circumference, BMI and everyday situations (section A and section B of the *checklist*). *Backward* linear regression analysis was used to investigate the relationship between sex, age, abdominal circumference, BMI and daily situations (section A and section B of the *checklist*) and motor performance (gross score of MABC-2) in general in the sample and by categorization (DCD, r-DCD and TD). The analysis were performed in the Statistical Package

for Social Science (SPSS) 21.0, values of $p \leq 0.05$ were considered statistically significant. Correlations up to 0.30 are considered weak, between 0.30 and 0.60 moderate, and above 0.60 strong[34].

Results

Categorization of the Groups and Subgroups

Table 1 shows the descriptive analysis (mean and standard deviation), the number of participants in the groups and subgroups in the variables investigated in the pre- and post-intervention moments.

Table 1. Characteristics of the participating groups and subgroups in the investigated variables in the pre- and post- intervention moments

	General Sample				Intervention Group				Control Group			
Moment	Total (n=48)	DCD (n=14)	r-DCD (n=9)	DT (n=25)	Total (n=24)	DCD (n=7)	r-DCD (n=5)	DT (n=12)	Total (n=24)	DCD (n=7)	r-DCD (n=4)	DT (n=13)
Pre												
Age	6,5(0,6)	6,4(0,6)	6,3(0,5)	6,6(0,6)	6,6(0,6)	6,3(0,7)	6,5(0,5)	6,8(0,6)	6,3(0,5)	6,5(0,5)	6,0(0,0)	6,3(0,6)
WC	63,3(9,2)	65,4(10,2)	66,1(10,1)	61,1(8,0)	64,3(10,0)	66,0(10,0)	69,3(12,4)	61,3(8,7)	62,3(8,4)	64,8(11,2)	62,2(5,7)	60,9(7,7)
BMI	20,8(22,8)	28,9(41,8)	19,3(3,4)	16,7(2,8)	24,6(32,0)	18,5(2,9)	20,1(4,2)	17,0(3,2)	16,9(2,3)	16,9(1,7)	18,3(2,2)	16,5(2,6)
MABC	62,2(13,3)	46,2(9,5)	59,9(2,8)	72,0(6,6)	61,7(14,4)	44,6(12,3)	60,4(3,4)	72,2(6,4)	62,8(12,5)	47,8(1,7)	59,2(2,2)	72,0(7,1)
SAC	7,8(6,6)	8,4(8,9)	8,0(6,4)	7,4(5,3)	9,0(7,4)	11,3(11,0)	10,2(7,5)	7,2(4,7)	6,6(5,6)	5,6(6,1)	5,2(4,3)	7,6(6,0)
SBC	12,7(7,4)	13,4(10,1)	12,5(6,1)	12,3(6,3)	13,3(8,2)	15,7(12,6)	14,2(6,8)	11,5(5,5)	12,0(6,6)	11,1(7,2)	10,5(4,8)	13,0(7,1)
Pos												
Age	6,9(0,7)	6,7(0,8)	6,7(0,5)	7,1(0,6)	7,0(0,8)	6,5(0,8)	7,2(0,8)	7,3(0,6)	6,8(0,7)	7,0(0,8)	6,1(0,0)	7,0(0,6)
WC	64,3(8,4)	65,4(9,2)	67,6(11,2)	62,5(6,5)	65,7(9,4)	67,7(10,8)	70,6(13,5)	62,4(5,6)	62,9(7,1)	63,1(7,7)	63,8(7,6)	62,5(7,4)
BMI	20,4(18,8)	17,9(2,4)	19,4(3,9)	22,4(26,1)	23,7(26,4)	18,5(2,9)	20,5(4,6)	17,2(2,3)	17,1(2,2)	17,2(1,8)	18,2(2,9)	16,8(2,2)
MABC-2	65,5(15,9)	54,8(19,5)	68,4(11,3)	70,5(12,3)	69,8(16,9)	62,0(23,7)	71,2(13,7)	73,7(13,0)	61,2(13,8)	47,6(11,8)	65,0(7,9)	67,5(11,3)
SAC	7,7(7,2)	9,5(9,4)	8,4(7,4)	6,6(5,6)	9,3(8,3)	10,7(12,3)	13,0(6,8)	7,1(5,7)	6,2(5,6)	8,3(6,1)	2,7(3,2)	6,1(5,8)
SBC	8,7(6,8)	10,3(8,4)	9,4(5,9)	7,6(6,1)	9,1(6,3)	10,0(8,8)	12,6(4,0)	7,1(5,1)	8,4(7,3)	10,7(8,8)	5,5(5,9)	8,1(7,1)

Note. WC: waist circunference; BMI: body mass index; MABC-2: Movement Assement Batery for Children-2; SAC: Section A of the checklist; SBC: Section B of the checklist.
Source: Authors

Associations between variables

Table 2 shows the correlations between motor performance and the variables investigated in the general sample, by groups (intervention and control) and by subgroups (DCD, r-DCD and DT).

General Sample

At the pre-intervention moment a negative, moderate, and significant correlation between motor performance and BMI (p = 0.001) was found for the total number of children; for these children, no significant correlations were observed between motor performance and other variables (WC: p = 0.412, SAC: p = 0.160, SBC: p = 0.119). In regard to the subgroup analysis, a strong, negative, and significant correlation between motor performance and BMI (p = 0.001) was observed for children with DCD. The other correlations between motor performance and variables investigated were not significant (WC: p = 0.228 ; SAC: p = 0.182; SBC: p = 0.264). There were no significant correlations between motor performance and other variables for children in r-DCD (WC: p = 0.654, BMI: p = 0.348, SAC: p = 0.862, SBC: p = 0.732) and choldren with TD (WC: p = 0.924, BMI: p = 0.968, SAC: p = 0.232, SBC: p = 0.064).

At the post-intervention moment, there were no significant correlations between motor performance and the variables investigated for all of the children (WC: p = 0.911, BMI: p = 0.191, SAC: p = 0.459, SBC: p = 0.019), for children with DCD (WC: p = 0.649, BMI: p = 0.316, SAC: p = 0.961, SBC: p = 0.171), for children in r-DCD (WC: p=0.811; BMI: p=0.966; SAC: p=0.461; SBC: p=0.403), and children with TD (WC: p = 0.607, BMI: p = 0.221, SAC: p = 0.938, SBC: p = 0.357).

Intervention Group

At the time of pre-intervention, for all of children in the intervention group, no significant correlations were observed between motor performance and the variables investigated (WC: p = 0.271, BMI: p = 0.128, SAC: p=0.428; SBC: p = 0.377). Similarly, in the subgroups, no significant correlations were observed between motor performance and the variables investigated for children with DCD (WC: p = 0.337, BMI: p = 0.939, SAC: p = 0.819, SBC: p = 0.939), children in r-DCD (WC: p=0.322; BMI: p=0.253; SAC: p=0.741; SBC: p=0.573) and children with TD (CA: p = 0.504, BMI: p = 0.661, SAC: p = 0.917, SBC: p = 0.965).

At the time moment of post-intervention, no significant correlations were observed between the motor performance and the variables investigated (WC: p = 0.631, BMI: p = 0.968, SAC: p = 0.966, and SBC: p = 0.523) for all of the children in the intervention group. In the subgroups, only a negative, Strong, and significant correlation was observed for the intervention group of children with r-DCD between motor performance and SBC (p = 0.041); for these children, no significant results were found between motor performance and other variables (WC: p = 0.624, BMI: p = 0.624, SAC: p = 0.188). There were no significant correlations between motor performance and the other variables analyzed in the subgroups of children with DCD (WC: p = 0.879, BMI p = 0.760, SAC: p = 0.728, SBC: p = 0.554) and children with TD (WC: p = 0.262, BMI: p = 0.965, SAC: p = 0.229, SBC: p = 0.650).

Control Group

At the time of pre-intervention, no significant correlations were observed between the motor performance and the variables investigated (WC: p = 0.340, BMI: p = 0.302, SAC: p = 0.947, and SBC: p = 0.707) for the total number of children in the control group. In the r-DCD subgroup of the control group, positive, significant, and strong correlations were observed between motor performance and SAC (p<0.001) and motor performance and SBC (p<0.001) in children with r-DCD. For the other variables, in the subgroups of the control group, no significant correlations were observed between motor performance and the variables investigated for the group of children with DCD (WC: p = 0.129, BMI: p = 0.574, SAC p = 0.599, SBC : p = 0.574), children in r-DCD (WC: p = 0.600, BMI: p = 0.684), and for children with TD (WC: p = 0.617, BMI: p = 0.790, SAC: p = 0.105, SBC : p = 0.072).

Positive, moderate, and significant correlation between motor performance and SAC (p = 0.025) was observed in the post-intervention moment for the total of children in the control group; for these children, no significant results were found between motor performance and other variables (WC: p = 0.609, BMI: p = 864, and SBC: p = 0.055). In the subgroups, a significant negative correlation was observed for children in r-DCD between motor performance and SAC (p = 0.050), for these children there were no significant correlations between motor performance and other variables (WC: p = 0.200; BMI: p = 0.200; SBC: p = 0.400). There were no significant correlations between motor performance and the other variables investigated in the subgroups of children with DCD (WC: p = 0.582, BMI: p = 0.728, SAC: p = 0.711, SBC: p = 0.379), and for children with TD (WC: p = 0.986, BMI: p = 0.914, SAC: p = 0.105, SBC: p = 0.288).

Table 2. Correlation Data between motor performance and environment and individual variables

	Pre-intervention				**Post-intervention**			
Groups	WC	BMI	SAC	SBC	WCA	BMI	SAC	SBC
General Sample								
Total	-0,12	-0,48**	-0,21	-0,23	-0,02	0,13	0,09	-0,11
DCD	0,34	-0,78**	-0,38	-0,32	0,19	0,29	-0,02	0,25
r-DCD	-0,17	-0,35	0,07	-0,13	-0,11	-0,01	-0,28	0,02
TD	-0,02	0,01	-0,25	-0,37	-0,34	-0,39	-0,32	-0,19
Intervention Group								
Total	0,23	0,32	0,17	0,19	0,10	0,01	0,01	0,14
DCD	0,43	-0,04	-0,11	0,04	0,07	0,14	-0,16	-0,27
r-DCD	-0,56	-0,63	-0,20	-0,34	0,30	0,30	-0,70	-0,89*
TD	0,21	0,14	-0,03	-0,01	-0,35	0,01	0,38	0,15
Control Group								
Total	0,20	0,22	0,14	0,08	0,11	0,04	0,46*	0,40
DCD	0,63	0,26	-0,24	-0,26	-0,25	0,16	-0,17	-0,40
r-DCD	0,40	0,32	0,99**	0,99**	-0,80	-0,80	-0,95*	-0,60
TD	-0,15	-0,08	-0.40	-0,51	-0,01	0,03	-0,47	-0,32

Note. WC: waist circunference; BMI: body mass index; MABC-2: Movement Assement Batery for Children-2; SAC: Section A of the checklist; SBC: Section B of the checklist.

Significant Results: ** p < 0.001; * p < 0.050

Source: Authors

Linear Regression for the Intervention Group

Table 3 presents the results of the linear regression models between motor performance in MABC-2 and children's factors and performance in daily activities for the

intervention group and its subgroups (DCD, r-DCD and TD) at the pre- and post-stages of intervention. The results of the linear regression indicated that for both the intervention group and the subgroups, no significant models were observed in the pre- and post-intervention moments.

Linear Regression for the Control

Table 4 presents the results of the linear regression models between motor performance in MABC-2 and children's factors and performance in daily activities for the control group and its subgroups (DCD, r-DCD and TD) at pre- and post-stages of intervention. At the pre-intervention moment, for children with TD from the control group, there were two significant models, Model 3 and Model 4, with Model 4 maintaining SBC as a predictive variable, explaining 63.6% of the motor performance variation for these children [$R = 0.636$, $F(1.11) = 7.469$, $p = 0.019$]. No significant models were observed for the total sample and in the subgroups of children with DCD and r-DCD. At the post-intervention moment, for the total sample of the control group, there were two significant models, Model 3 and Model 4, with Model 4 maintaining the SBC as a predictive variable, explaining 48.8% of the motor performance variation in this group [$R = 0.488$, $F(1.24) = 6.884$, $p = 0.016$]. No significant models were found for the subgroups of children with DCD, r-DCD and TD.

Table 3. Linear regression models between motor performance in the MABC-2 and children's factors (WC and BMI) and the daily activities in the pre- and post-intervention moments for the intervention group and the subgroups (DCD, r-DCD e DT)

	Linear Regression Models: Intervention Group												
	Total				**DCD**				**r-DCD[1]**	**TD**			
	M1	**M2**	**M3**	**M4**	**M1**	**M2**	**M3**	**M4**	**M1**	**M1**	**M2**	**M3**	**M4**
Pre-Intervention													
R	0,36	0,36	0,36	0,32	0,48	0,48	0,46	0,31	1,00	0,16	0,16	0,09	0,06
F	0,72	1,01	1,58	2,46	0,15	0,30	0,55	0,52	-	0,05	0,07	0,03	0,04
p	0,588	0,410	0,229	0,131	0,947	0,826	0,617	0,500	-	0,995	0,970	0,966	0,85
β WC	0,08	0,07	-	-	0.89	0,87	0,95	0,38	1,24	0,03	-	-	-
β BMI	-0,94	-0,93	-0.74	-	-2,37	-2,29	-2,43	-	-4,50	-0,51	-0,44	-0,18	-0,12
β SAC	-0,50	-0,56	-0.58	-0.62	0,03	-	-	-	-0,63	-0,34	-0,36	-	-
β SBC	-0,06	-	-	-	-0,15	-0,13	-	-	0,95	0,35	0,37	0,08	-
Post-Intervention													
R	0,41	0,37	0,36	0,26	0,79	0,65	0,61	0,31	1,00	0,48	0,48	0,47	0,34
F	0,95	1,04	1,52	1,55	0,85	0,74	1,18	0,50	-	0,52	0,78	1,30	1,27
p	0,455	0,394	0,241	0,227	0,605	0,594	0,396	0,512	-	0,73	0,537	0,320	0,286
β WC	-0,81	-0,17	-	-	-4,12	-0,58	-	-	-3,70	-1,62	-1,74	-1,71	-0,77
β BMI	1,97	-	-	-	13,28	-	-	-	9,57	2,12	2,33	2,27	-
β SAC	0,72	0,85	0,84	-	2,38	2,46	2,06	-	9,62	0,14	-	-	-
β SBC	-1,57	-1,58	-1,56	-0,68	-4,35	-3,97	-3,33	0,81	-20,76	-0,20	-0,13	-	-

Legend. M: Model; [1]Only 1 linear regression modelwas found for children in r-DCD from the intervention and control group; WC: waist circunference; BMI: body mass index; SAC: Section A of the checklist; SBC: Section B of the checklist.
Source: Authors

Table 4. Linear regression models between motor performance in the MABC-2 and children's factors (WC and BMI) and the daily activities in the pre- and post-intervention moments for the control group and the subgroups (DCD, r-DCD e DT)

	Linear Regression Models: Control Group												
	Total				DCD				r-DCD[1]	TD			
	M1	M2	M3	M4	M1	M2	M3	M4	M1	M1	M2	M3	M4
Pre-Intervention													
R	0,16	0,16	0,15	0,13	0,84	0,71	0,65	0,52	1,00	0,74	0,69	0,66	0,64
F	0,13	0,18	0,25	0,37	1,20	1,01	1,49	1,87	-	2,43	2,71	3,90	7,47
p	0,969	0,908	0,779	0,547	0,501	0,495	0,327	0,229	-	0,133	0,107	0,050*	0,019*
β WC	-0,11	-0,08	-	-	0,76	0,53	0,28	0.22	0,65	-0,85	-0,39	-	-
β BMI	0,19	-	-	-	2,15	-	-	-	-1,31	3,14	1,52	0,51	-
β SAC	0,20	0,19	0,25	-	1,46	0,72	-	-	-	0,59	-	-	-
β SBC	-0,36	-0,35	-0,39	-0,24	-0,90	-0,73	-0,35	-	0,45	-1,03	-0,67	-0,67	-0,64
Post-Intervention													
R	0,51	0,51	0,50	0,49	0,95	0,91	-	-	1,00	0,49	0,48	0,48	0,36
F	0,17	0,32	3,43	6,88	5,04	4,91	-	-	-	0,63	0,90	1,48	1,62
p	0,199	0,110	0,050*	0,016*	0,172	0,112	-	-	-	0,653	0,478	0,273	0,229
β WC	-0,50	-0,43	-	-	-1,42	-1,73	-	-	-2,21	-0,43	-0,16	-	-
β BMI	1,93	1,77	0,56	-	9,02	7,37	-	-	4,10	3,03	2,22	1,76	-
β SAC	-0,21	-	-	-	1,35	-	-	-	-	-0,50	-	-	-
β SBC	-0,80	-0,94	-0,95	-0,92	-1,30	-0,81	-	-	-1,16	-0,42	-0,79	-0,80	-0,57

Note. M: Model; [1]Only 1 linear regression modelwas found for children in r-DCD from the intervention and control group; WC: waist circunference; BMI: body mass index; SAC: Section A of the checklist; SBC: Section B of the checklist.
Source: Authors

Discussion

The objective of this research was to investigate the relationship between motor performance, nutritional status, waist circumference, and daily activities of children with DCD, r-DCD and TD before and after an the implementation of a intervention with the mastery motivational climate.

The results of the present study indicated that in pre-intervention, in the general sample, and for children with DCD, motor performance was influenced by BMI. These results partially confirm the first hypothesis of the study regarding the negative association between motor performance and BMI. The results of this study corroborate previous research reports that overweight and childhood obesity may be harmful to the motor performance of children[7,14,35,36]. The difficulties presented by overweight and obese children in their motor performance may be related to less possibilities in the execution of movements, since the increase of corporal mass can result in a smaller amplitude of the articulations, or even related to the fatigue or physical exhaustion, that makes these children opt for more sedentary activities. A longitudinal study developed by D'Hont *et al.*[36] reports a strong, negative, and significant correlation between motor performance and BMI in children over two years. Other research developed by Spessato, Gabbard and Valentini[11] reports negative, moderate, and significant correlations between BMI and motor performance only in younger children (6 and 7 years). The two studies present similar results to the present study.

In regard to the children with DCD, these results strengthen previous research observations, which report that DCD may be a risk factor for overweight and obesity[37,39]. In Canada, a study by Cairney *et al.*[37] with the participation of 578 children, reports that DCD may be a risk factor for overweight and obesity in childhood, and may extend to adolescence. Similar results were also found in a longitudinal study, developed by Green *et al.*[38] with 4,331 children. In a study developed with a large sample (2029 children) in Taiwan, the researchers observed that the prevalence of obesity was higher in the group of boys with DCD. The researchers point out that the movement difficulties faced by children with DCD are a potential risk factor for overweight and obesity[40], a plausible explanation for the findings of the present study.

At the pre-intervention moment, for the control group of children with r-DCD, in the post-intervention moment for the general sample, and for the intervention group with r-DCD, the results of the present study indicated that motor performance was influenced by daily activities, specifically by the SB of the *checklist* (intervention group) and the SA and SB of the *checklist* (control group). For children with DCD from the control group, a correlation between motor performance and the SA of the *checklist* was found. SB of the *checklist* deals with everyday situations related to a dynamic environment, with tasks typically experienced by children at home and/or at school. Based on the results of this study it is possible to infer that good resourcefulness in these situations has influences on better motor performance. Proper motor performance in everyday situations and in stable environments suggests that motor acquisition depends on a favorable, challenging, and variable environment at home and at school[41].

The results regarding daily activities should be emphasized since motor performance is strongly influenced by the environment. Neto *et al.*[41] investigated this association in Brazilian children aged 6 and 7 from private schools and the results showed strong associations between locomotion and manipulation skills and the environment in which they were inserted (physical education classes in clubs or frequent street games). In this sense, in addition to the individual aspects of the child, the different

environments in which the child is inserted (which offer opportunities for movement and exploration) should be considered when investigating children's motor performance[41].

In the present study, it was possible to observe that the correlations between the tasks related to the environment with motor performance provide even more support for the mastery motivational climate. The study of motivational climates in educational contexts has been investigated in the literature in recent years[42-45] and has sought effective space in the literature of physical education[7,19,46-49]. However, to date, no records of implementation of this methodology have been found with specific groups of children with DCD or r-DCD, therefore, this study advances in the current knowledge evidencing new support to these climates.

Considering that the theoretical perspective of the mastery motivational climate is based on the accomplishment of goals elaborated according to the level of development of each child, the possibilities of frustration caused by errors or comparisons of the children themselves with the disorder in relation to the children of TD are minimized. The organization of the climate in stations with differentiated tasks (eg when a child is kicking others are jumping rope, balancing on boards, and/or other tasks) which allows the child to focus on his own practice. These strategies are adopted aligned with the methodology that is student-centered and considers that the competences are specific and that the effort is focused on the individual achievements of each child. Individual characteristics and diverse situational factors lead to different forms of behavioral engagement in tasks of achievement[50], making this environment conducive to individual achievements and goals, potentializing development and respecting the rhythm of each child. During classes, strategies are used that include, for example, a large number of diversified motor options, as well as providing attractive materials that constantly challenge the child, it is in this environment of respect that the differences that children with motor difficulties may experience shelter and feeling of belonging.

For children with motor disorders, persistence in physical activity is not always prolonged. This may occur due to the difficulties of motor coordination, which leads to preference for easier, sedentary activities or the exclusion of this group of children. The opportunity to participate in a program that provided a challenge in the exploration of movements; education, and feedback appropriate to their developmental level; the appreciation of colleagues; and the encouragement of adults, allows a greater persistence of these children in physical activities, therefore, factors of extreme importance for any child[17-19,51], even more for children with DCD or in r-DCD. Children with DCD or TD have faced moderate levels of challenge, which can be overcomed with effort, an essential factor to increase motor skills. In this way, attention is not directed at the motor delays caused by the disorder, but rather to the increasing levels of challenges that each child imposes on himself[52], with or without any disorder. Therefore, in addition to providing attractive materials, which constantly challenged the child and respect the individualized pace of motor practice; the fact of having a site with adequate instruction and feedback favored the development and improvement of motor skills, reflecting in the motor performance of this group in other aspects besides the intervention environment.

Conclusion

Several factors concomitantly with DCD are considered as risks for poorer motor performance. In the present study, overweight was an associated and therefore worrying factor since it can provoke a cycle that includes rejection of physical activities and reduction of social interactions. Furthermore, daily activities also explained part of the observed

variability in the motor performance of children with r-DCD and DCD, noting that in order to understand the difficulties and potentialities of these children, teachers and researchers should cross school walls and interact in other spaces.

From this data, it can be inferred that when children participate in motor intervention programs, motor proficiency changes potentially being the intervention protective factor for children with DCD, r-DCD and TD. Opportunities for participation in differentiated and individual-level physical activity combined with the appropriate instruction of Physical Education teachers who understand the problems faced by children and can contribute to improved motor performance. An intervention program involving meaningful learning can help children, especially overweight and with DCD, to reduce the difficulties they face in daily activities, as well as to help them engage in physical activities in other settings (leisure or sports). Understanding the motor performance determinants of children with DCD is essential for the development of interventional programs and motor acquisition.

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