DOI: 10.4025/jphyseduc.v31i1.3174

Original Article

ASSOCIATION BETWEEN MOTOR PERFORMANCE, COGNITIVE MATURITY AND SOCIO-DEMOGRAPHIC ASPECTS IN PRESCHOOLER CHILDREN

ASSOCIAÇÃO ENTRE DESEMPENHO MOTOR, MATURIDADE COGNITIVA E ASPECTOS SOCIODEMOGRÁFICOS EM CRIANÇAS PRÉ-ESCOLARES

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RESUMO

A identificação da baixa proficiência motora em crianças na idade pré-escolar permite que programas de intervenção sejam propostos, para minimizar os prejuízos nas atividades escolares, relações sociais e aulas de Educação Física. Dessa forma, identificar os fatores subjacentes ao baixo desempenho motor é fundamental, na tentativa de reduzir possíveis desordens motoras. Objetivou-se investigar a associação entre desempenho motor, maturidade cognitiva e aspectos sociodemográficos em crianças pré-escolares paranaenses. Participaram 357 pré-escolares de 3,5 a 5 anos. Foram utilizados: Escala de Maturidade Mental Colúmbia, teste *Movement Assessment Battery for Children* - 2 e uma ficha de dados sociodemográficos. Análise estatística: teste *Kolmogorov-Smirnov*, *Friedman* (*Wilcoxon)* e Regressão logística binária ($p<0,05$). Verificou-se alta prevalência de baixa proficiência motora (16,8%), maturidade cognitiva (MC) na média para a idade (67,2%) e nível socioeconômico >R$1.500,00 (45,5%). Observou-se associação significativa entre MC superior e baixa proficiência motora, indicando a MC superior como um fator de proteção (OR 0,513 IC 95% 0,266-1,000). Os fatores sociodemográficos não se mostraram intervenientes no desempenho motor (DM). Concluiu-se que a MC superior em crianças na primeira infância atua como fator de proteção à baixa proficiência motora e que os fatores sociodemográficos da família não se associaram ao DM e a MC dos pré-escolares.

Palavras-chave: Desenvolvimento infantil. Destreza motora. Pré-escolar.

ABSTRACT

The early identification of low motor proficiency in preschoolers may grant school intervention programs to be proposed as an effort to minimize the losses in school activities, social relationships, and physical education classes. Hence, identifying the factors underlying low motor performance in children is essential to reduce risks of motor disorders. The objective of this study was to investigate the association between motor performance, cognitive maturity, and sociodemographic aspects in preschoolers from the state of Paraná, Brazil. The sample size analyzed (i.e., 357 children) ranged in age from 3,5 to 5 years old. Data utilized in this study had its sources based on the Columbia Mental Maturity Scale, the Movement Assessment Battery for Children-2 test, and a sociodemographic assessment form. The following statistical tests were used to analyze our data: the Kolmogorov-Smirnov, Friedman (Wilcoxon), and binary logistic regression tests ($p < 0.05$). There was a high prevalence of low motor proficiency (i.e., 16.8%), cognitive maturity (CM) on average age (i.e., 67.2%), and families (e.g., sociodemographic factors) had an income below R$1.500,00 (i.e., 45.5%). A significant association was observed between high CM and low motor proficiency, indicating that CM was a protective factor for low motor proficiency. The sociodemographic factors were not related to motor performance (MP). We concluded here that higher CM in early childhood acted as a protective factor for low motor proficiency, whereas the sociodemographic factors were not associated with MP or CM in preschoolers.

Keywords: Child development. Motor skills. Child preschool.

Introduction

Some children may present characteristics of deviation from the normality of motor behavior for their age[1], which may indicate motor disorders such as Developmental Coordination Disorder (DCD). It is estimated that potentially one child in each classroom meets the criteria to be considered to have a motor disorder[2,3] and based on this estimative, it

is believed that 50% of children may persist with the characteristics of the condition during their adolescence or adulthood[4,5].

Developmental Coordination Disorder (i.e., DCD) is defined as a neurodevelopmental motor disorder characterized by a late and immature gross and fine motor development without any straightforward intellectual or medical origins[3,6]. The physical and mental consequences of this condition, when they are evident, can cause significant long-term consequences[3] such as poor motor skills performed at work, social isolation, and limitation of social activity and restrictions related to the inability to perform motor tasks[2,7].

In this sense, previous studies have pointed out several factors related to the protection and risk of child development. We can point out here the economic[8-10] and physical aspects of a household[11], the availability of toys[12], and the educational level of the parents[11]. Hence, various factors have been associated with low motor development or even motor disorders, and amongst them, one can find the cognitive performance[12,13] and the socioeconomic status of the family[8-10], which seems to reveal that children from families with low socioeconomic status are frequently more affected by learning difficulties at school and motor performance[12]. However, there is a gap in studies seeking to investigate these three latter factors together, attempting to examine associations between motor performance, cognitive maturity, and sociodemographic aspects of children with motor impairment. Thus, this study intended to advance in the field of motor development studies on children and to achieve new insights into the research of DCD.

Researchers in the field of motor behavior studies have pointed out that the early identification of motor disorders during childhood is essential since such behavior can interfere with the involvement of the child in the quotidian, sports, and leisure activities. Hence, the sooner the motor disorder is identified, the greater the possibilities for intervention[1,3,4,7,14], because the childhood presents periods sensitive to learning[15], which makes early intervention assistance more effective. However, the neurodevelopmental motor disorder is still recognized as a latent health issue[3]. It is currently among the most neglected problems in the entire field of medical studies related to child motor development.

Regarding the identification of a motor disorder, the high prevalence of children with motor issues in schools having a low socioeconomic status has been of concern among researchers[3,4,7]. Clarifications on the relationship between the individual and the environment have indicated that individual characteristics are a sum of the aspects of a person and the environment throughout life[16]. In this sense, according to the bioecological perspective of Urie Bronfenbrenner[18], family members and caregivers play an important role in the development process of a child, since the family is the first and one of the most important social contexts in which the child is inserted, being considered an essential aspect for the children concerning their motor development[17]. Consequently, during childhood a family plays the central role in providing critical characteristics in relationships meaningful for the motor development of children in their "home" microsystem. Based on this, associations between children development and environmental factors are of great importance and, thus, suggesting that the surrounding environment might be able to balance the risks in which children are exposed[19,20].

Given this scenario, this study aimed to analyze the association between motor performance, cognitive maturity, and sociodemographic aspects of families of children in preschool age from the state of Paraná-Brazil, where we specifically were searching for: 1) identifying children motor and cognitive performance according to the age of preschoolers; 2) comparing preschoolers motor skills according to their motor ability (i.e., high and low proficiency); and 3) examining the association between personal characteristics (i.e., age, sex, and cognitive maturity) and sociodemographic features (i.e., parents educational level and family income) related to the motor performance of children in preschool .

Methods

Population sample size

The population surveyed consisted of 6,278 children of both sexes, with age ranging from three to five years old, and children enrolled and regularly attending the Municipal Center for Early Childhood Education (CMEI) at the municipality of Maringá (state of Paraná-Brazil), Data was provided by the Education Center of Maringá (SEDUC). To obtain a representative sample size (i.e., considering 5% error and 95% reliability), at least 362 children would be needed (e.g., minimum sample size) to perform our analysis. Terms of consent were delivery to the target group of children. Also, the number of terms refused and lost were calculated. Altogether, 543 terms of consent were delivered to the children. Out of these, 403 terms were returned, and yet 46 children missed the day of collection or refused to perform the test. (i.e., motor and cognitive tests). The total sample size of this study was of totaling 357 children.

Out of this sample size (i.e., 357), 172 individuals were girls and 185 were boys. In addition, 214 children were considered at 3 years old age (i.e., ranging from 3 years and 6 months to 3 years and 11 months), being 100 of these girls and 114 boys. Children considered at 4 years old age (e.g., 94 children) were divided by 49 girls and 45 boys; and 49 children were considered at 5 years old age (i.e., 23 girls and 26 boys). Altogether, children were enrolled in 24 CMEIs (i.e., six CMEIs from each region of the city: northwest, northeast, southwest and southeast). Children were chosen to participate in this study by random lottery drawing.

Assessment instruments

The collection of sociodemographic data from families of preschoolers was performed through an identification form that was sent out to the parents or guardians to gather information about: the educational level of fathers and mothers as well as the familiar monthly income. The Movement Assessment Battery for Children - 2 (MABC-2) test was applied to assess children motor performance. This test has been validated for Brazilian children[21], and it has been widely used to identify signs of DCD. The test was composed of three sets of tasks appropriate for children at specific age groups: Age Group 1 (i.e., 3 to 6 years); Age Group 2 (i.e., 7 to 10 years), and Age Group 3 (i.e., 11 to 16 years)[1,22]. The test allowed for identifying difficulties in motor coordination using a set of age-specific sections. Section 'Age Group 1'covered eight motor tasks (i.e., three of which evaluated manual dexterity, two tasks estimated ball skills, and three assessed static and dynamic balance). Each task resulted in a standard score and the scores of the skill were thus added to generate a total score for the whole test (which can also be interpreted on a percentile scale), classifying thus the child according to the degree of motor difficulty.

The cutoff points were applied as suggested in the test manual, following the classification: ≤ 05% for atypical motor performance (i.e., indicative of DCD); percentiles ranging from six to 15% represented risk of DCD, while percentiles ≥ 16% demonstrated typical development (TD). However, it is important to highlight that the motor assessment based on the MABC Test itself does not conclusively determine children having DCD21. Hence, it is recommended also the evaluation of the four criteria for DCD diagnosis, as indicated by the DSM-IV (e.g., Diagnostic and Statistical Manual of Mental Disorders[1,3]). Thus, based on previous studies, it is recommended the use of the term indicative of DCD instead[23-27]. In our study as a criterion of analysis, we have chosen combining the risk dimensions of DCD (e.g., percentiles ranging from six to 15%) and the indicative of DCD (e.g., ≤ 05% atypical motor performance), since we aimed to identify children with few movement difficulties. Therefore, we did not use other criteria for evaluation or diagnosis of

DCD. To comply with the assumptions found in the literature, we assigned and classified the children as "low motor proficiency" (i.e., 15% percentile) and as "high motor proficiency (i.e., 16% percentile).

To assess the cognitive maturity (CM) of children, the Columbia Mental Maturity Scale test (i.e., EMMC[28]) was utilized (translated and adapted into Portuguese) covering the age group of three years old. This scale consisted of 92 items of pictorial and figurative classification, organized in a series of eight scales or overlapping levels, ranging from 55 to 66 items. Each child took the test segment most appropriate for their chronological age. In our study, level "A" was used for children aged at three years old and with a set of 55 cards; level "B" for children aged at four to five years a half old and with a set of 62 cards; and level "C" for children aged over five and a half years old and a set with 64 cards. The results were presented by percentiles, which corresponded to the number of correct answers given by the children and categorized the child among the following levels: high, upper medium, medium, lower medium, and low. The application and interpretation of the EMMC test was assisted by a psychologist.

Procedures

This study was approved by the Committee of Ethics and Research involving human beings at the State University of Maringá (protocol number: 0127.0.093.000-11). After authorization given from the parents or guardians and the return of the terms of consent, the children available to perform the tests took part in the study. The tests (e.g., motor and cognitive) were applied at the school environment and during class hours that have been previously scheduled with the principals of CMEIs. Both tests were carried out by the graduate students with experience on these tests. The motor test was carried out at the CMEIs facilities, while the cognitive test was performed individually in a room far from external interference and under the supervision of a psychologist, lasting in 30 minutes to perform the tasks. It is worthy to highlight that, firstly, the children received verbal instructions followed by demonstrations and practicing before the recording of results have started, as pointed out by the test protocols.

Statiscal analysis

Initially, the distribution of data was checked using the Kolmogorov-Smirnov test. As the data did not show a normal distribution, Medians (Md), Quartiles (Q1; Q3), relative (%) and absolute (n) frequency were used to report the results. When comparing the motor skills of children showing indicative of DCD and DT, the Friedman Test was utilized followed by the Wilcoxon test. Binary Logistic Regression (non-adjusted and adjusted analysis) was used to examine the associations between independent variables (i.e., age, sex and CM) and the sociodemographic characteristics of parents (i.e., education and family income) related to the motor performance of preschoolers (e.g., an indicative of DCD). All variables were included in the adjusted regression model regardless of the p-values of the non-ajusted analysis, since the variables selected showed substantial theoretical evidence that justified their inclusion in the model. Additionally, previous studies have recommended the use of conventional techniques as firstly to perform an univariate analysis to check the relationship with each predictor variable one at a time, and then use the variables that meet a predefined threshold to run a multivariate model. Additionally, other thresholds of significance are suggested by the literature, e.g., $p < 0.10$ instead of $p < 0.05$[29]. The model fit was verified using the Hosmer-Lemeshow test. The significance level of $p < 0.05$ was adopted in this study. All analyses were performed using SPSS software (version 22.0).

Results

Table 1 showed the description of children motor performance and cognitive maturity related to age. The results referring to the level of cognitive maturity pointed out that most children (i.e., 240 individuals; 67.2%) had an average MC for their age. Regarding the motor performance, children had low motor proficiency (i.e., 60 individuals; 16.8%; < 15% percentile), and highlighted a higher prevalence in three-year-old children (18.2%), while 297 individuals (83.2%) had high motor proficiency.

Table 1. Frequency of motor and cognitive performance related to the age of preschoolers

Variables	Classification	3 years f (%)	4 years f (%)	5 years f (%)	Total f (%)
CM	Medium	170 (79,4)	52 (55,31)	18 (36,7)	240 (67,2)
	High	44 (20,6)	42 (26,3)	31 (26,5)	117 (32,8)
	Total	214 (100,0)	94 (100,0)	49 (100,0)	357 (100,0)
MP	↓MP	39 (18,2)	16 (17,0)	5 (10,2)	60 (16,8)
	↑MP	175 (81,8)	78 (83,0)	44 (89,8)	297 (83,2)
	Total	214 (100,0)	94(100,0)	49 (100,0)	357 (100,0)

Note: CM= Cognitive Maturity; MP= Motor Performance; ↓MP= Low motor proficiency; ↑MP= High motor proficiency
Source: The authors

Table 2 displayed comparisons between motor skills and motor classification of preschoolers (i.e., low and high motor proficiency). The results revealed a significant difference in motor skills (p = 0.001) related to low motor proficiency. Also, low motor performance was found in manual skills, while the best performance was observed in throwing and receiving.

Table 2. Comparisons between motor skills and motor competence (i.e., high and low motor proficiency) of preschoolers

MP	**Manual dexterity**	**Throwing and Receiving**	**Balance**	***p***
	Md (Q1;Q3)	Md (Q1;Q3)	Md (Q1;Q3)	
↓MP	5,0 (1,0; 14,2)	25,0 (16,0;37,0)	9,0 (6,0;25,0)	0,001**
↑MP	75,0 (37,0;87,5)	50,0 (25,0;75,0)	63,0 (37,0;84,0)	0,001**

Note: *Significance ($p < 0.05$) – *Friedman test*. DCD: Manual Dexterity in Throwing and Receiving ($p = 0.001$); Manual Dexterity with Balance ($p = 0.004$); Throwing and Receiving with Balance (p = 0.001); DT: Manual Dexterity in Throwing and Receiving ($p = 0,001$); Manual Dexterity with Balance ($p = 0,001$); Throwing and Receiving with Balance (p = 0.909); ↓MP= Low Motor Proficiency ; ↑MP= High Motor Proficiency ; MD= Motor Proficiency
Source: The authors

Table 3 demonstrated the personal and sociodemographic characteristics of preschoolers with high and low motor proficiency. Paternal and maternal education in both groups was centered in high school level (43.8 and 54.5%, respectively). Regarding the monthly family income, it was observed that 45.5% of the families of preschoolers with high motor proficiency had an income below R$ 1,500.00, while for 48% of preschoolers with low motor proficiency it ranged from R$ 1,500.00 to 2,500.00.

Table 3. Personal and sociodemographic characteristics of the family of preschoolers with high and low motor proficiency

Sociodemographic characteristics		↓MP	↑MP
		f (%)	*f* (%)
Sex	Female	29 (48,3)	143 (48,2)
	Male	31 (51,7)	154 (51,8)
Cognitive Maturity	Medium	47 (78,3)	193 (65,0)
	High	13 (21,7)	104 (35,0)
Scholastic level father	Fundamental	21 (35,0)	119 (40,0)
	High school	27 (45,5)	130 (43,8)
	Academic	7 (11,7)	38 (12,8)
Scholastic level mother	Fundamental	13 (21,7)	86 (28,9)
	High school	31 (51,7)	162 (54,5)
	Academic	13 (21,7)	41 (13,8)
Income	<1.500	22 (36,7)	135 (45,5)
	1.500 a 2.500	29 (48,3)	106 (35,7)
	2.500 a 3.500	9 (15,0)	56 (18,8)

Note: ↓MP= Low Motor Proficiency ; ↑MP= High Motor Proficiency ; f = Absolute Frequency; % = Relative Frequency
Source: The authors

The association between sociodemographic characteristics (i.e., education, income, and socioeconomic level) and personal factors (i.e., age, sex, and cognitive maturity) of children with low motor proficiency are shown in Table 4. According to the results of the non-adjusted analysis, there was a significant association between high CM (p = 0.047) with low motor proficiency, demonstrating that a higher MC should be a protecting factor for low motor proficiency.

Table 4. Personal and sociodemographic characteristics associated with low motor proficiency in preschoolers

Variáveis		$OR_{non\text{-}adjusted}$ [I.C. 95%]	*p*	$OR_{ajusted}$ [I.C. 95%]	*p*
Age		0,700 [0,451-1,087]	0,112	0,884 [0,549-1,424]	0,613
CM	Medium	1,00		1,00	
	High	**0,513 [0,266-1,000]**	**0,047***	0,597 [0,290-1,232]	0,215
Sex	Female	1,00		1,00	
	Male	0,993 [0,570-1,729]	0,979	0,982 [0,543-1,777]	0,953
Scholastic level father	Fundamental	1,00		1,00	
	High school	1,177 [0,632-2,192]	0,608	0,961 [0,482-1,917]	0,910
	Academic	1,044 [0,412-2,646]	0,928	0,652 [0,226-1,886]	0,430
Scholastic level mother	Fundamental	1,00		1,00	
	High school	1,266 [0,630-2,545]	0,508	1,327 [0,597-2,948]	0,487
	Medium	0,098 [0,893-4,927]	0,089	2,577 [0,916-7,244]	0,073
Income	<1.500	1,00		1,00	
	1.500-2.500	1,679 [0,912-3,089]	0,096	1,725 [0,879-3,387]	0,113
	2.500-3.500	0,986 [0,428-2,275]	0,974	0,959 [0,382-2,411]	0,929

Note: *Significance $p < 0.05$: Binary Logistic Regression. $OR_{adjusted}$ = adjusted for all variables of the non-adjusted analysis ($OR_{non\text{-}adjusted}$) regardless of *p* values. OR = *Odds Ratio*; CI= Confidence Interval; CM= Cognitive Maturity
Source: The authors

However, when the analysis was adjusted for all variables, the results did not show a significant association of low motor proficiency with any of the variables. Thus, these results might suggest that CM itself should act as protecting factor upon low motor proficiency in

48.7% of the cases. Nevertheless, when using other personal and sociodemographic variables, such as gender, age, educational level and family income, the protecting factor for low motor proficiency was not evident, revealing thus the interaction between different individual characteristics (or variables) and their surrounding environment.

Discussion

This study aimed to investigate the association between motor performance, cognitive maturity (CM), and sociodemographic aspects in preschool children from the State of Paraná, Brazil. The results showed that high CM was a protecting factor for low motor proficiency in 48.7% of children surveyed (Table 4). Although preschoolers demonstrated poor motor proficiency and therefore increasing the risk of motor disorder, they did not show any cognitive impairments. The sociodemographic aspects of the families did not demonstrate to be related to motor performance.

Such findings followed a previous study performed by Rocha et al.[13], in which they investigated the motor and cognitive assessment in children (e.g., age ranging from four to five years) from the state of Paraná. These authors have found that both children showing typical development and children classified as having a motor disorder had higher average rating in cognitive assessment. Although there is a greater tendency for children with motor disorders to show cognitive development below the average for their age[4], previous studies have pointed out that motor disorders may be associated but not explained only by intellectual delay[30]. Based on this, low motor proficiency manifested as a motor disorder may be linked to several factors, such as those related to the individual limitations, the conditions of the surrounding environment (i.e., housing environment and possible exploitation), and limiting factors related to the task being performed[4].

In this sense, the authors Cantell, Smyth, and Ahonen[31] suggested several causes as the roots of motor performance, such as low rate in development and or maturation, low motor learning, restrictions resulting from lack of strength, micro-injury, inaccuracy of vision, and environmental restrictions (e.g., food, housing, and financial issues). It appears that motor delay or low motor proficiency of children investigated in this study was not accentuated due to the impairments in cognitive mechanisms, since they are suitable for their age. On the other hand, it was inferred that the low motor proficiency showed by preschoolers in Paraná might be linked to other intervening factors such as the low availability of opportunities to practice motor activities, levels of stimulation, types of activities performed, and social relationships established[1]. Even though these aspects have been previously pointed out by the literature, they were not the focus of our study.

Additionally, our results might indicate that cognitive stimulation should be an important factor concerning motor stimulation at environments in which children were integrated (e.g., home and school). The results demonstrated that all children assessed in this study were identified as having medium to high cognitive maturity for their age (Table 1). A possible explanation for such phenomenon might be related to the fact that the preschool environment is considered to be favorable to the development of cognitive skills and supporting abilities that proved to be significant predictors of late literacy in children[32]. Hence, this might indicate that the preschool fulfilled its role and acted in a positive way regarding the children cognitive development, although the trigger to the development of motor skills was not entirely influential.

Despite being identified as a protecting factor upon low motor proficiency (in 48% of preschoolers), high cognitive maturity has lost its effects when inspected using sociodemographic variables (i.e., education, income, and socioeconomic level) (Table 4). This result may be better explained by the relationship between personal and environmental

features. According to Bronfenbrenner[18], there seems to be an inseparability between the individual under development and the context in which this individual is inserted, so that the development process becomes dependent on the interaction and influence between the "person-context" components[18], as it has been shown in previous studies[11,19].

There is evidence in the literature regarding the importance of the family home scenario in child development[11,19,20]. However, in our study it was observed that the sociodemographic variables related to family were not associated with the low motor performance of preschoolers (Table 4). Reflecting on these results, we considered that children who have taken part in the survey spent most of their day (e.g., about 8 hours) in early childhood education centers, a fact that allowed us to infer that the school environment might have a greater impact on child development than their family home scenario itself. This inference is supported by the literature which also pointed out that motor activities in family environments were not much stimulating. Also, there is a lack of patterns in the literature favoring the motor development of children utilizing practices that involve active motor habits stimulated by the parents[17].

When looking at this context, we have the city of Maringá-Paraná being recognized for the second consecutive year as the best city to live in Brazil (data published by MacroPlan). According to information of the "Municipal Management Challenges Index", the city has a high concept when considering the indicators of education, health, safety, and basic sanitation[33]. In view of these aspects, the scenario is positive for the development of children, considering that they have access to high quality public education offered by the Municipal Centers for Early Childhood Education (CMEI), a factor which seemed to neutralize the effects of the low socioeconomic level presented by families (Table 3).

Borba, Pereira, and Valentini[11] have corroborated this assertion by demonstrating in their study that babies of adolescent mothers in southern Brazil had an influence of environmental factors over biological ones. However, in line with the results of our study, the environmental factors included in the motor and cognitive development of children were related to the age of parents age and their level of education. Also, they were associated with whether the parents were living together or apart, the fact of the mother did not go out to work, and the characteristics of the household environment (e.g., space and toys). Moreover, we highlight that the age group of the children in the study cited above was ranging from 0 to 18 months old, and due to the evidenced importance of the context in which the child was inserted we were able to demonstrate that this matter enabled to the intervening in children developmental trajectory.

In addition to understand the factors associated with motor performance, the objective here was to compare the motor skills of preschoolers related to their motor competence (e.g., high and low proficiency). In this sense, the results displayed in Table 2 indicated that the group assigned to low motor proficiency had greater difficulty in performing manual skills. Such results are in line with previous studies[34-36], which have indicated that children with motor disorder may have a low performance in combined control tasks as well as speed and precision skills[34-36]. In contrast, for children classified as having high motor proficiency, manual skills were the ones with the best performance (Table 2). According to Turco, Cymrot and Blascovi-Assis[37], the dexterity of the fingers requires the handling of small objects and the ability to perform certain manipulations, which is more refined in children who do not have deficits in motor coordination or low motor proficiency. Thus, those children have found it easier to perform precise and fine movements like those required in activities of daily self-care and school tasks such as writing, cutting, drawing, or coloring.

Based on the evaluations carried out in our study, the relevance of identifying children with low motor proficiency, and most likely, having risks of motor disorders such as DCD during the pre-school age (initial years of life) allowed us to suggest that these evaluations

should be inserted in school intervention programs aiming to minimize children motor issues and the differences among their peers. Moreover, these evaluations should help to improve and increase self-esteem, reflecting thus on the children quality of life[4]. In the absence of adequate motor stimulation, children may have limited participation in physical activities and might end up adopting a sedentary lifestyle[1,24], which is the leading cause of impacting health status and quality of life in children.

Our results shed light on the knowledge of child motor proficiency and associated factors in children of preschool age, providing relevant information for parents and teachers who develop skills and activities with these children. However, we should point out to a few limitations in our study. The first limitation concerns to the utilization of the motor battery in assessing children motor performance, in which the criteria recommended by DSM-IV for diagnosing DCD or other motor disorders were not fully met. In this sense, the need for future studies that thoroughly evaluates all the criteria recommended by DSM-IV, adopting clinical evaluations, and having a multidisciplinary team available are made necessary. A second limitation is related to the design of the cross-sectional study that did not allow the monitoring and a second investigation of children with low motor proficiency at around six years of age, a point in children life when the diagnosis of the disorder is consolidated as it has been reported in the literature[30].

Motor delays and difficulties are usually observed in the early stages of life; therefore, it is recommended to start interventions and motor stimulation even before the diagnosis of a motor disorder. Hence, we suggest that future studies should utilize a longitudinal to monitor the development of children with low motor proficiency as well as their progress and limitations in school activities and daily life. Also, this study was limited to investigating the family sociodemographic characteristics of children utilizing the education and socioeconomic level of the parents only. We understand that other factors might be relevant to improve the understanding of the phenomena here investigated. Thus, we suggest that future studies should focus on more "in-depth investigations" features related to children motor disorders.

Conclusions

Based on our results we found that a high cognitive maturity was demonstrated itself as a protecting factor upon low motor proficiency, whereas the sociodemographic characteristics of the family were not shown to be related to the low motor proficiency of preschoolers in the state of Paraná, Brazil. Children with low proficiency have demonstrated greater difficulty in the performance of motor skills. In contrast, for children with high motor proficiency, these were the skills identified with the highest performance. The results of this study have important implications regarding the need for early identification of signs of motor disorder, pursuing a suggestive view to directing future investigations and emphasizing that school activities having manual skill should be included as a learning requirement in order to minimize the losses which children is submitted at preschool age, both for academic purposes and for the improvement of child motor skills and self-care activities.

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Received on Jun, 04, 2019.
Reviewed on Apr, 23, 2020.
Accepted on Jun, 20, 2020.

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