DOI: 10.4025/jphyseduc.v30i1.3024

Original Article

THE ROLE OF SPORT PARTICIPATION AND BODY MASS INDEX IN PREDICTING MOTOR COMPETENCE OF SCHOOL-AGE CHILDREN

O PAPEL DA PARTICIPAÇÃO ESPORTIVA E DO ÍNDICE DE MASSA CORPORAL NA PREDIÇÃO DA COMPETÊNCIA MOTORA DE CRIANÇAS EM IDADE ESCOLAR

Luciana Ferreira[1], José Luiz Lopes Vieira[2], Pâmela Norraila da Silva[1], Raquel Nichele de Chaves[3], Romulo Araújo Fernandes[4], Francielle Cheuczuk[1], Francielli Ferreira da Rocha[1] and **Priscila Caçola[5]**

[1]Universidade Estadual de Maringá, Maringá-PR, Brasil.
[2]Universidade Católica del Maule, Talca, Chile.
[3]Universidade Tecnológica Federal do Paraná, Curitiba PR. Brasil.
[4]Universidade do Estadual Paulista, Presidente Prudente-SP, Brasil.
[5]University of Texas. Arlington-TX, United States of America.

ABSTRACT
The purpose of this study was to investigate the association between Sport Participation (SP) and Motor Competence (MC) in school-age children, and to assess the mediation role of Body Mass Index (BMI) on this association. 707 children (332 boys, 375 girls) aged between 6- to 10 years participated in the study. Motor competence was determined using the Bruininks-Oseretsky Test of Motor Proficiency (BOT-2). Parents were asked about organized SP, categorized as 1) no participation, 2) partial participation and 3) consistent participation, and BMI was calculated based on the child's height and weight. The results indicated significant differences for all MC components and total score for SP categories, all $p < .05$, with higher results for consistent participation in sports. For BMI, significant differences occurred in all components, with the exception of fine manual control and manual coordination. Our findings showed that SP was associated with MC, and BMI was not an important factor in these relationships. However, a small mediation of BMI was found, but only for obese children. In summary, we conclude that sport participation plays a relevant role in the development of motor competence in school-age children, and that association is, in general, not mediated by weight status.
Palavras-chave: Motor competence. Body mass index. Sport participation. School-age children.

RESUMO
O objetivo deste estudo foi investigar a associação entre Participação Esportiva (PE) e Competência Motora (CM) em crianças em idade escolar e avaliar o papel da mediação do Índice de Massa Corporal (IMC) nesta associação. Foram avaliadas 707 crianças (332 meninos, 375 meninas) com idades entre 6 e 10 anos participaram do estudo. A competência motora foi determinada usando o Teste Bruininks-Oseretsky de Proficiência Motora (BOT-2). Os pais foram questionados sobre a SP organizada, categorizada como 1) sem participação, 2) participação parcial e 3) participação consistente, e o IMC foi calculado com base na altura e no peso da criança. Os resultados indicaram diferenças significativas para todos os componentes do CM e escore total para as categorias de PS, todos $p <0{,}05$, com resultados mais altos para a participação consistente nos esportes. Para o IMC, ocorreram diferenças significativas em todos os componentes, com exceção do controle manual e da coordenação manual. Nossos achados mostraram que a SP estava associada à CM, e o IMC não foi um fator importante nessas relações. No entanto, uma pequena mediação do IMC foi encontrada, mas apenas para crianças obesas. Concluímos que a participação esportiva desempenha um papel relevante no desenvolvimento da competência motora em crianças em idade escolar, e essa associação, em geral, não é mediada pelo status de peso.
Palavras-chave: Competência motora. Índice de massa corporal. Participação esportiva. Crianças em idade escolar.

Introduction

Motor competence (MC) is defined as proficiency in fundamental motor skills including locomotor and object control skills[1], and represents the degree of skilled performance in a wide range of motor tasks as well as the movement quality, coordination and control underlying a particular motor outcome[2]. Most importantly, MC has been established as one of the most significant predictors of health-related fitness[3]. In school-age children, the role of motor competence in several important health outcomes has been recognized, such as physical activity, cardiorespiratory fitness [4] and adiposity[1,3]. However, it is a well-known fact that most children show poor levels of motor competence across a range of ages, in early childhood[5], school age[6], and adolescence[7].

Good health-related fitness is maintained through consistent participation in physical activity. There is compelling evidence suggesting that a physically active lifestyle in early life prevents the development of chronic diseases in adulthood[8]. Many studies have already explored the relationship between motor competence and physical activity levels, generally finding positive, significant associations between the two variables[9]. Furthermore, recent research has shown that organized interventions and participation in physical education[10] can improve motor skills. However, little is known about the influence of organized sports and the mediation of other factors on the development of motor competence in school-age children[11].

Sport participation can be characterized as involvement in organized practical sessions specific to a sport[12], which provides opportunities to be physically active as well as favors psychosocial development and the acquisition of life skills[13]. Several studies have reported a positive relationship between sport participation and MC[12]. However, this relationship seems weak in terms of magnitude. Moreover, the impact of potential confounding variables in this relationship have not been explored. For example, body mass index (BMI) is a good indicator of health-related fitness[14], and most studies show that children with high BMI tend to have lower MC[15,16]. Recently, Cairney and Vedhuizen[17] demonstrated an association between sport participation and BMI, but the prediction effects of this relationship were small.

While it is known that sport participation can affect MC in children, little has been done to understand how sport participation is associated to motor competence when mediated by BMI. Most studies have looked at the effects of MC on physical activity, even though the relationship is considered cyclical or reciprocal[2]. Furthermore, no studies have examined motor competence from a general motor proficiency perspective – most use the Test of Gross Motor Development, 2nd edition (TGMD-2), an assessment of fundamental motor skills[16]. Very few studies utilized an assessment such as the Bruininks-Oserestsky Test of Motor Proficiency – 2nd edition[18] (BOT-2). The BOT-2 is considered one of the most comprehensive assessments of motor proficiency, and is also one of the most widely used test of motor skills[19]. Cools et al.[20] report that the BOT-2 is a very detailed instrument that provides information on skill mastering: beneath and above skill level, while accounting for qualitative and quantitative aspects of movement behavior.

Therefore, the purpose of the present study is to investigate the relationship between Sport Participation (SP) and MC in school-age children, as well as to assess the mediation role of BMI on this relationship. More specifically, we were interested in determining what components of motor competence are associated with sport participation (components determined by the BOT-2 assessment, Fine Manual Control, Manual Coordination, Body Coordination and Strength & Agility). We also looked at those relationships in children categorized in all groups based on weight status (normal weight, overweight, obesity) when mediated by BMI.

Methods

Participants

A total random sample of 707 children (332 boys, 375 girls) aged 6- to 10 years and one of their parents participated in the study. Mean age was 8.21±1.25 for girls and 8.24±1.18 for boys. All children were recruited from public schools in a large urban area in southern Brazil (Maringá – Paraná State). This sample was selected based on the following steps: At the time of the study, there were a total of 16.335 children between 6 and 10 years of age enrolled in the 49 public schools that make up the school district in Maringá. According to the sample size calculations, the minimum sample size for a 95% confidence interval was of 579 children. To account for attrition, we handed 869 consent forms in 12 schools randomly chosen in all geographical areas of the city (north, south, east, and west). We received 750 forms back, and were able to test 725 children with the BOT-2 test (25 children missed school on the testing days). Of those, it was only possible to schedule appointments for the other assessments with 707 families, and that was our final sample.

The sample included a wide range of socioeconomic classifications based on family income and parental education. Data were collected in two phases. In Phase 1, researchers assessed motor competence (BOT-2) and body composition (BMI) at the child's school. In Phase 2, parents were visited at home according to their availability and administered the Sport Participation (SP) questionnaire. The University Institutional Research Board approved all procedures. Written informed consent from parents as well as verbal assent from the child were provided prior to data collection.

Measures

Sport Participation (SP). Information about organized Sport Participation (SP) was obtained through a questionnaire answered by children's parents during an interview. In this questionnaire, the parents or guardians answered whether children did or did not participate in any organized sport (e.g., sports, dance and martial arts). Organized sports involved regular classes, training, or competition (structured or formal), as well as had a coach, instructor, or teacher associated with the practice. Children were divided into three groups: 1) "no participation": not actively involved in an organized sports club during the last two years; 2) "partial participation": has participated in organized sport activities for less than two years; 3) "consistent participation": consistent engagement in sport activities for at least 1 h/week during the last two years (adapted from[12]).

Body Mass Index (BMI). After removing shoes and heavy clothing, children's height and weight were measured in the facilities of the school. A portable stadiometer was used to measure standing height with the value recorded to the nearest centimeter. Body mass was measured using an electronic calibrated scale, with weight recorded to the nearest tenth of a kilogram. BMI was calculated as weight in kilograms divided by the square of the height in meters (expressed as kg/m^2). BMI was classified according to Sisvan guidelines:[21] (a) underweight (less than the 3th percentile), (b) healthy weight (3th percentile to less than the 85th percentile), (c) overweight (85th to less than the 97th percentile), obese (97th to less than the 99th percentile), and (e) high obese (equal to or greater than the 99th percentile). No children in our sample was considered underweight, and we combined the two higher categories (obese and high obese) into one category (obesity) due to the small number of children being categorized as "high obese".

Motor Competence (MC). All children were administered the Bruininks-Oseretsky Test of Motor Proficiency, 2nd edition (BOT-2)[18]. The BOT-2 is a standardized test that measures motor proficiency in individuals ages 4- to 21 years. It assesses both fine- and gross motor skill performance using 53 items divided in four motor composite areas including fine manual control, manual coordination, body coordination, and strength and agility. The composite scores are derived from eight subscales. The BOT-2 was administered on a one-to-one basis in a location free from distraction for the child and took about 40- to 60 minutes to complete. For each test item, the assessor introduced the task and then observed the child's performance to determine a raw score based on specific rating criteria. For the purposes of this study, norms for each gender were used. Here, we used standard scores and descriptive categories based on standard scores (well-above average [70 or greater], above average [60-69], average [41-59], below average [31-40], well-below average [30 or less]).

Data analysis

Chi-square analysis was used to investigate the association between frequencies for each group of motor competence. To determine the relationship among numerical variables, Pearson correlations were used.

To look at differences on MC based on SP groups and BMI groups, a 3-way Analysis of Variance (ANOVA) was conducted (SP – no participation, partial participation, consistent participation) (BMI – healthy weight, overweight, obesity), using BOT-2 standard scores as the dependent variable for the BOT-2 subtests, and total motor composite for total MC scores. Tukey post-hoc analyses were conducted if necessary.

General Structural equation modeling (GSEM) was used to assess: a) the impact of SP on MC, b) the to analyze the impact of BMI on MC and c) the possible mediation effects of BMI on relationship between SP and MC. The results were presented in three different components: direct association (SP-MC) - straight association coefficient between two variables; indirect association - association between two variables that is mediated by a third variable (SP-BMI-MC) and total association - the sum of the direct and indirect association between variables. GSEM expressed all measures of relationship as standardized coefficients (*r*).

All analyses were conducted using SPSS Version 19.0 (SPSS Inc., Chicago, IL) and Stata version 13.0 (GSEM).

Results

The distribution of the children and their BMI and some selected demographic variables was shown in Table 1.

Table 1. Demographic characteristics

Mean Age		8.22±1.17
Gender	Boys	332 (47%)
	Girls	375 (53%)
Socioeconomic status	Low	107 (15%)
	Middle	417 (59%)
	High	183 (26%)
Parental education (completed)	Middle school	92 (13%)
	High school	443 (63%)
	College degree	172 (24%)
Body Mass Index	No participation	18.91±3.90
	Partial participation	18.16±3.34
	Consistent participation	17.93±3.01
	Total	18.35±3.47

Source: Authors

General motor classification, SP and BMI

According to total BOT-2 scores, 75% of children were classified as average and above (n = 494 for average; n = 36 above average, n = 2 well-above average), and 25% scored below average (n = 165 below average; n = 10 well-below average). For BMI, 52.6% (n = 372) of the children were considered within healthy weight, 16.7% (n = 118) were considered overweight, and 30.7 % (n = 217) were identified as obese.

In regards to SP, 33% (n = 237) were classified as "no participation", 39% (n = 273) we considered "partial participation", and 28% (n = 197) "consistent participation". Chi-square analysis shows a significant difference between MC x SP ($X^2(8) = 351.20$, $p < .00$) and MC x BMI ($X^2(8) = 22.65$, $p < .01$).

Association between SP and BMI

Of children with *healthy weight*, 29.3% (*n*= 109) were categorized as “no participation”, 41.7% (*n* = 155) as “partial participation”, and 29.0% (*n* = 108) as “consistent participation”. Of the children classified as *overweight*, 33.1% (*n* = 39) were categorized as “no participation”, 35.6% (*n* = 42) as “partial participation”, and 31.4% (*n* = 37) as “consistent participation”. Of the *obese* children, 41.0% (89) were categorized as “no participation”, 35.0% (*n* = 76) as “partial participation”, and 24.0% (*n* = 52) as “consistent participation”. Chi-square analysis shows a significant association between SP and BMI, $X^2(4) = 9.403$, $p<.00$.

Correlations

Pearson correlation analysis determined inverse and low relationships between most components of the MC and BMI, with the exception of Manual Coordination. Correlation coefficients for the MC components and SP were positive and moderate, ranging between .41 and .48, with .62 for the BOT-2 total score and SP. Table 2 shows all correlation coefficients.

Table 2. Relationship between sport participation, body mass index and motor competence (*n* = 707)

Variables	Body Mass Index Correlation (*r*)	Sport participation Correlation (*r*)
Fine Manual Control	-.10*	.41**
Manual Coordination	-.05	.48**
Body Coordination	-.16*	.46**
Strength and Agility	-.23*	.48**
Total Score	-.18*	.62**

Note: *= $p < .05$; **= $p < .01$
Source: Authors

Group differences

Table 3 shows means and standard deviations for MC standard scores and results of the ANOVA for BMI and SP. Results indicated significant differences for all MC components and total score for SP, all $p < .05$. For BMI, significant differences occurred in all components, except for Fine Manual Control and Manual Coordination. All post-hoc differences are listed on Table 3. The interaction between SP and BMI was not significant.

Table 3. Motor competence according to BMI classification and sport participation in school-age children

Variables	Healthy weight	Overweight	Obesity	*p*	F
	Body Mass Index				
	Mean ± SD	Mean ± SD	Mean ± SD		
Fine Manual Control	40.53 ± 6.67	39.65 ± 5.73	39.97 ± 6.26	.17	1.77
Manual Coordination	49.62 ± 8.65	50.65 ± 9.40	48.87 ± 9.86	.14	1.94
Body Coordination	51.99 ± 8.52	51.31 ± 8.84	49.45 ± 9.19[b]	.00	7.71
Strength and Agility	50.75 ± 8.10	50.44 ± 7.94	46.83 ± 8.40[a.b]	.00	18.53
Total Score	47.25 ± 7.88	46.99 ± 7.53	44.81 ± 8.27[a,b]	.00	8.60
	Sport Participation				
Variables	Consistent	Partial	None	*p*	F
	Mean ± SD	Mean ± SD	Mean ± SD		
Fine Manual Control	44.41± 6.60	39.87 ± 5.37	37.20 ± 5.47[1,2,3]	.00	77.39
Manual Coordination	56.09 ± 9.28	49.74 ± 6.65	44.11 ± 8.16[1,2,3]	.00	110.88
Body Coordination	56.78 ± 8.17	51.81 ± 6.92	45.68 ± 8.22[1,2,3]	.00	97.14
Strength and Agility	55.01 ± 8.26	50.24 ± 6.60	44.19 ± 6.96[1,2,3]	.00	110.97
Total Score	53.90± 7.64	46.56 ± 4.13	40.35 ± 6.52[1,2,3]	.00	231.58

Note: [a]Healthy weight versus overweight. [b]Healthy weight versus obesity. [1]Consistent participation versus partial participation. [2]Consistent participation versus no participation. [3]Partial participation versus no participation
Source: Authors

Mediation

SP and BMI were negatively related to each other (r = -.11 [95% CI= -.18 to -.03]; p = .00). In the mediation analysis, the association of SP with all components of motor competence remained significant ($p < .01$), independent of BMI mediation (correlation coefficients slightly varied). On the other hand, there was a negative association of BMI with MC and the components Body Coordination and Strength and Agility (regardless of SP) (Table 4).

Table 4. Relationship between sport participation and motor competence mediated by BMI (n = 707)

Variables	Sport Correlation (*r*)	BMI Correlation (*r*)	Mediation [§] Sport x BMI Correlation (*r*)
Fine Manual Control	.41**	- .05	- .11*
Manual Coordination	.48**	- .00	- .11*
Body Coordination	.45**	- .10*	- .11*
Strength and Agility	.46**	- .18*	- .11*
Total Score	.61**	- .11*	- .11*

Note: *= $p < .05$; **= $p < .01$; BMI= body mass index
Source: Authors

In the final GSEM analysis, the association of SP with MC (also mediation effect attributed to BMI) was stratified into three groups based on weight status (and adjusted by age and sex) in order to understand the actual influence of BMI on these relationships. Among healthy weight and overweight school-age children, the mediation of BMI and SP was not significant, but was significant for the obese group (r = -.15 [95% CI = -.28 to -.02]; p = .02). In all GSEM, the positive association of SP and MC occurred despite of BMI group status. However, BMI and MC were not significantly associated (except in the component Strength and Agility for the overweight group, r = -.23 [95% CI= -.47 to -.00]; p = .04) (Table 5).

Table 5. Relationship between sport participation and motor competence mediated by BMI classification (GSEM adjusted by sex and age)

	Healthy weight (*n* = 372)			Overweight (*n* = 118)			Obesity (*n* = 217)		
	Sport	BMI	Mediation § Sport x BMI	Sport	BMI	Mediation § Sport x BMI	Sport	BMI	Mediation § Sport x BMI
Fine manual control	**.39***	-.03	.04	**.30***	-.18	-.04	**.40***	.01	**- .15***
Manual coordination	**.48***	-.00	.04	**.50***	.03	-.04	**.47***	.01	**- .15***
Body coordination	**.39***	-.04	.04	**.61***	-.02	-.04	**.46***	- .06	**- .15***
Strength and agility	**.45***	-.01	.04	**.45***	**-.23***	-.04	**.43***	- .05	**- .15***
Total Score	**.58***	-.01	.04	**.68***	-.12	-.04	**.58***	- .04	**- .15***

Note: *= $p < .05$; **= $p < .01$; BMI= body mass index; §= Mediation analysis
Source: Authors

Discussion

The purpose of the present study was to investigate the association between SP and MC in school-age children, and the potential mediation of BMI on this relationship. Our findings indicated that SP was associated with MC, and in general, the impact of SP on MC was not mediated by BMI values. However, when splitting children into groups, a small mediation of BMI occurs for obese children. These results reinforce the notion that sport participation is crucial for the development of motor competence[2]. In addition, it shows that BMI is not relevant for these relationships, except in extreme cases such as the obese group.

First and foremost, it is important to highlight the notion that MC needs instruction to be developed and improved[22]. Motor skill development, which leads to motor competence, needs instruction, practice, and experience. Our results show that consistent participation in organized activities leads to better scores in MC (components and total) more so than partial participation, which showed better results than no participation at all. Along the same line, work by Robinson et al.[5] found that children who are directed by specialists to learn motor skills display greater increases in MC than children who engage in free play. Robinson et al.[5] also notes that the instructional approach used to teach motor skills along with basic learning principles and the amount and context of experiences influence the stability of MC. Thus, it is important to foster continued learning and development of MC through practice and participation in developmentally appropriate activities that demand more advanced movement patterns and higher levels of performance in a variety of movement contexts[22].

Our findings confirm a trend showing that SP has an important association with MC, and extended these results by using an assessment of general motor proficiency. For example, Vandorpe et al.[12] found that children who consistently practiced sports in a club environment displayed better coordination levels than children who only partially participated or did not participate in a club environment at all. Fransen et al.[23] found that children with a relatively high MC are more involved in sports than children with a lower MC. Both studies evaluated gross motor coordination via a product-oriented assessment (Körperkoordinationstest für Kinder–KTK). One of the main difficulties of this type of measure is that skill outcomes do not necessarily highlight the developmental process (i.e., qualitative movement pattern development) that results in the achieved score. Other studies have utilized the BOT-2, but many used only the Short Form of the assessment[9,24]. To the best of our knowledge, this is the only study to date that used the BOT-2 complete form to investigate motor competence and its associations with both sport participation and BMI.

Here, we established the direction of the relationship between the variables (as in sport participation affecting motor competence), but it is important to highlight the fact that motor competence and physical activity are related in a dynamic and synergistic way[1]. Stodden's model[1] suggests that physical activity (as in participation in activities, including sports) in early childhood will initially promote the development of MC as basic motor patterns are developed through a variety of exploratory movement experiences. Seeing sport as a special context for the acquisition of motor skills in young children may help promoting long-term adherence to physical activity[25]. This relationship becomes more cyclical in middle and late childhood, when a high level of motor competence is expected for children to engage in physical activities. This progression fosters continued participation in a variety of physical activities as children enjoy success and are motivated to continue to improve motor competence[1].

While our results emphasize the significant association between SP and MC, it is important to note that BMI showed significant differences for body coordination, strength and agility, and total MC (the higher the weight, the lower the motor competence of children). Even though these differences were not as strong as SP, we can infer that children with higher BMIs tend to have lower motor competence. In general, research shows negative low to moderate correlations between weight status and MC[24,26], with coefficients usually ranging from 0.05 to 0.49[15].

It is important to mention that in the final GSEM analysis, weight did not mediate the relationship between SP and MC in children with healthy weight and overweight. Mediation was only significant for the obese group, although small. This implies that only in extreme cases BMI seems to be a factor for the development of motor competence. D'Hondt and colleagues[27] have also demonstrated that childhood obesity is associated with lower scores on the Movement Assessment Battery for Children (MABC). In their study, no differences between children with healthy weight and overweight children were found, against their expectations. This suggests the existence of a certain weight cut-off from which movement difficulties appear[27]. However, it is possible to change this with a focused program for overweight and obese children. D'Hondt et al.[28] showed that children in these categories are able to improve their motor competence after participating in a regular physical activity program, and can partially catch up to their healthy weight peers.

The limitations of the study should be recognized. Initially, we investigated specific patterns between gender and age – an initial look at the data showed no significant differences between gender and age and all variables (MC, SP, and BMI). However, we acknowledge that it is possible that the fact that we adjusted scores to gender and age with the BOT-2, and the calculation of BMI was also adjusted to these two factors, may have influenced the results. While we accounted for participation in sports or lack of, we did not measure engagement and enjoyment in sport participation. We also only tested children up to age 10, and it is possible that SP decreases after this age[29]. Another factor to be considered is that the questionnaire used to assess SP was not validated, as well as the BOT-2 test, which is currently not validated to use with the Brazilian population. However, it is important to note that this assessment has been frequently used in studies in Brazil[30,31,32]. This study, as many others, is cross-sectional. However, the results do not outweigh the fact that our large sample size and clear results provide several answers that can move our understanding of associations among the three study variables.

Conclusion

In terms of practical applications, our findings highlight that is fundamental to promote community-based and school-based programs to enhance motor competence of all children.

Teachers and coaches need to offer the children a challenging, non-competitive environment with appropriate equipment (e.g. monkey bars, tires, ropes, etc.) and need to build structured skill learning/enhancement routines into their classes. Obviously, weight status should not be overlooked. But our results emphasize that is necessary for children to participate in physical/motor activities where the instruction of skills is prioritized. In summary, it is possible to conclude that sport participation plays a relevant role in the development of motor competence in school-age children, and that association is generally not mediated by weight status.

References

1. Stodden DF, Goodway JD, Langendorfer SJ, Roberton MA, Rudisill ME, Garcia C, et al. A developmental perspective on the role of motor skill competence in physical activity: An emergent relationship. Quest 2008;60:290–306. Doi:10.1080/00336297.2008.1 0483582
2. Robinson LE, Stodden DF, Barnett LM, Lopes VP, Logan SW, Rodrigues LP, et al. Motor competencae and its effect on positive developmental trajectories of health. Sport Med 2015;45(9):1273–1284. Doi:10.1007/s40279-015-0351-6
3. Cattuzzo MT, Henrique SH, Ré AH, Oliveira IS, Melo BM, Moura MS, et al. Motor competence and health related physical fitness in youth: a systematic review. J Sci Med Sport 2016;19(2):123-129. Doi:10.1016/j.jsams.2014.12.004
4. Hardy LL, Reinten-Reynolds T, Espinel P, Zask A, Okely AD. Prevalence and correlates of low fundamental movement skill competency in children. Pediatrics 2012;130(2):e390–e398. Doi:10.1542/peds.2012-0345
5. Robinson LE, Wadsworth DD, Peoples CM. Correlates of school-day physical activity in preschool students. Res Q Exerc Sport 2012;83(1):20-26. Doi:10.1080/02701367.2012.10599821
6. Lopes VP, Rodrigues LP, Maia JAR, Malina RM. Motor coordination as predictor of physical activity in childhood. Scand J Med Sci Sports 2011;21(5):663-9. Doi:10.1111/j.1600-0838.2009.01027.x
7. Barnett LM, Beurden E, Morgan PJ, Brooks LO, Beard JR. Gender differences in motor skill proficiency from childhood to adolescence. Res Q Exerc Sport 2010;81(2):162-170. Doi:10.1080/02701367.2010.10599663
8. World Health Organization. Population-based approaches to childhood obesity prevention. WHO Consulation on obesity; 2012.
9. Wrotniak BH, Epstein LH, Dorn JM, Jones KE, Kondilis VA. The relationship between motor proficiency and physical activity in children. Pediatrics 2006; 118(6):e1758-e1765. Doi:10.1542/peds.2006-0742
10. Loprinzi PD, Davis RE, Fub YC. Early motor skill competence as a mediator of child and adult physical activity. Prev Med Rep 2015; 2:833–838. Doi:10.1016/j.pmedr.2015.09.015.
11. Kohl HW, Cook HD. Physical activity and physical education: relationship to growth, development, and health. Committee on physical activity and physical education in the school environment; food and nutrition board; institute of medicine; educating the student body: Taking physical activity and physical education to school. Washington (DC): National Academies Press (US); 2013.
12. Vandorpe B, Vandendriessche J, Vaeyens R, Pion J, Matthys S, Lefevre J, et al. Relationship between sports participation and the level of motor coordination in childhood: a longitudinal approach. J Sci Med Sport 2012;15(3):220-205. Doi:10.1016/j.jsams.2011.09.006
13. Fraser-Thomas J, Côté J. Youth sports: Implementing findings and moving forward with research. Athletic Insight 2006; 8(3):12-27.
14. Ramírez-Vélez R, Rodrigues-Bezerra D, Correa-Bautista JE, Izquierdo M, Lobelo F. Reliability of health-related physical fitness tests among Colombian children and adolescents: The FUPRECOL Study. Plos One 2015;10(10):e0140875. Doi:10.1371/journal.pone.0140875
15. Lopes V, Stodden D, Bianchi M, Maia J, Rodrigues L. Correlation between BMI and motor coordination in children. J Sci Med Sport 2012;15(1):38-43. Doi:10.1016/j.jsams.2011.07.005
16. Spessato BC, Gabbard C, Robinson L, Valentini NC. Body mass index, perceived and actual physical competence: the relationship among young children. Child Care Health Development 2013;39(6):845-850. Doi:10.1111/cch.12014.
17. Cairney J, Veldhuizen S. Organized sport and physical activity participation and body mass index in children and youth: A longitudinal study. Prev Med Rep 2017;13(6):336-338. Doi:10.1016/j.pmedr.2017.04.005
18. Bruininks R, Bruininks B. Bruininks–Oseretsky test of motor proficiency, second edition. Minneapolis: NCS Pearson, 2005.

19. Brown T, Lane H. Comparing a parent-report and a performance-based measure of children's motor skill abilities: are they associated? Occup Ther Health Care 2014;28(4):371-381. Doi:10.3109/07380577.2014.933381
20. Cools W, Martelaer K, Samaey C, Andries C. Movement skill assessment of typically developing preschool children: A review of seven movement skill assessment tools. J Sports Sci Med 2009;8(2):154-168.
21. Brazilian Nutritional Guidelines. Protocolos do Sistema de Vigilância Alimentar e Nutricional – SISVAN na assistência à saúde. Brasília: Departamento de Atenção Básica; 2008.
22. Clark J, Metcalfe J. The mountain of motor development: A metaphor. In: Clark JE, Humphrey J, editors. Motor development: Research and reviews, 2. NASPE Publications: Reston; 2002, p. 163-190.
23. Fransen J, Deprez D, Pion J, Tallir IB, D'Hondt E, Vaeyens R, Lenoir M, Philippaerts RM. Changes in physical fitness and sports participation among children with different levels of motor competence: a 2-year longitudinal study. Pediatr Exerc Sci 2014;26(1):11-21. Doi:10.1123/pes.2013-0005
24. Chowdhury SD, Wrotniak BH, Ghosh T. Association Between Body Mass Index and Motor Competence in Santal Children of Purulia District, India. J Motor Behav 2016;49(3):349-354. Doi:10.1080/00222895.2016.1219308
25. Queiroz DR, Ré AHN, Henrique RS, Moura MS, Cattuzzo MT. Participation in sports practice and motor competence in preschoolers. Motriz 2014;20(1):26-32. Doi:10.1590/S1980-65742014000100004
26. Hamilton M, Liu T, ElGarhy S. The relationship between body weight and motor skill competence in Hispanic low-SES preschool children. Early Child Educ J 2017;45(4):529-535. Doi:10.1007/s10643-016-0785-y
27. D'Hondt E, Deforche B, De Bourdeaudhuij I, Lenoir M. Relationship between motor skill and body mass index in 5- to 10-year-old children. Adapt Phys Activ Q 2009;26(1): 21–37. Doi:10.1123/apaq.26.1.21
28. D'Hondt E, Deforche B, Gentier I, De Bourdeaudhuij I, Vaeyens R, Philippaerts R, Lenoir M. A longitudinal analysis of gross motor coordination in overweight and obese children versus normal-weight peers. Int J Obes 2013;37(1):61–67. Doi:10.1038/ijo.2012.55
29. Eime RM, Harvey JT, Charity MJ, Casey MM, Westerbeek H, Payne WR. Age profiles of sport participants. BMC Sports Sci Med Rehabil 2016; 8(6):1-10. Doi:10.1186/s13102-016-0031-3
30. Ferreira L, Godinez I, Gabbard C, Vieira JLL, Caçola P. Motor development in school age children is associated with the home environment including socioeconomic status. Child Care Health Dev 2018;44:801-806. Doi: 10.1111/cch.12606
31. Zanella LW, Sousa MS, Bandeira PFR, Nobre GC, Valentini NC. Crianças com sobrepeso e obesidade: intervenção motora e suas influências no comportamento motor. Motricidade 2016;12(S1):42-53.
32. Cacola PM, Bobbio TG, Arias AV, Gonçalves VG, Gabbard C. Limitations of the Neurological Evolutional Exam (ENE) as a motor assessment for first graders. Rev Bras fisioter 2010;14(5):372-376.

Aknowledgements: This research was supported by the Coordination for Improvement of Higher Education Personnel (CAPES-BR) agency

Author's **ORCID**:
Luciana Ferreira: 0000-0001-5808-2334
José Luiz Lopes Vieira: 0000-0003-0453-8185
Pâmela Norraila da Silva: 0000-0001-7277-6084
Raquel Nichele de Chaves: 0000-0001-6244-2080
Romulo Araújo Fernandes: 0000-0003-1576-8090
Francielle Cheuczuk: 0000-0003-2391-7332
Francielli Ferreira da Rocha: 0000-0001-7866-6070
Priscila Caçola: 0000-0003-2713-5733

Received on Oct, 20, 2018.
Reviewed on Dec, 10, 2018.
Accepted on Jan, 20, 2019.

Author address: Luciana Ferreira. Avenida Londrina, 934. Torre Veneza, Aotp 902. Maringá-PR. C.E.P. 87050.730. e-mail: luferreira.ed@gmail.com