Journal of Physical Education and Sport ® (JPES), Vol. 25 (issue 3), Art 48, pp. 432 - 439, March 2025
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

A cross-sectional study of how environmental and school variables shape schoolchildren's motor competence

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Published online: March 31, 2025
Accepted for publication: March 15, 2025
DOI:10.7752/jpes.2025.03048

Abstract
Motor competence is an important component of children's physical development, influencing their participation in many physical activities and long-term health outcomes. Environmental affordances also influence motor behavior levels, especially in young children, but limited investigations still explore their specific impact on school-aged children in underrepresented regions. This cross-sectional investigation examined the relationship between motor competence and affordances in home and school environments among 117 children aged 6 to 10 years in North Brazil, with a particular focus on sex differences. The Affordances for Motor Behavior of Schoolchildren (AMBS) questionnaire assessed environmental opportunities, while the Motor Competence Assessment (MCA) evaluated stability, locomotion, and manipulation skills. The Kolmogorov–Smirnov test did not confirm the data normality. Spearman correlations, Mann-Whitney U tests, and multiple linear regressions were applied to determine associations between affordance levels and motor competence scores. Findings revealed weak-to-moderate positive correlations between home and school affordances and motor competence components, particularly in girls. Regression analysis indicated that body mass index negatively impacted motor competence (B = -1.269, p = 0.02), suggesting that higher levels of body mass index may decrease performance levels. Interestingly, while boys typically outperform girls in motor skills, no significant sex differences were found in motor competence levels, possibly due to increased sedentary behavior and screen time post-pandemic. The results underscore the importance of fostering enriching environmental conditions that promote motor skill development, especially for girls. These findings highlight the need for targeted interventions that enhance environmental affordances in both home and school settings to improve children's motor competence.
Keywords: motor behavior; motor skill competence; children; assessment

Introduction

During childhood, children are influenced by various settings, including their home, community, parental employment, friends' homes, school, sports contexts, and culture (Bronfenbrenner, 1995). While it is well-established in the literature that environments with favorable affordance conditions foster motor behavior (Gabbard & Rodrigues, 2007; Koller, 2004; Pereira et al., 2016), disparities in access to enriching environments remain a concern, particularly in developing regions. Therefore, the current investigation extends this understanding by exploring the degrees in how different affordance types contribute to motor competence (MC). Bronfenbrenner (1995) identified these environments frequently attend to children as mesosystems. Previous research has shown that exploring different environments (microsystems) can facilitate children's motor development and MC (Flôres, Rodrigues, & Cordovil, 2021; Haydari et al., 2009; Valadi & Gabbard, 2018; Mardiansyah et al., 2023; Thomaidou et al., 2021). For example, Thomaidou and colleagues (2021) found that an eight-week creative dance and movement program significantly improved preschoolers' motor creativity, but differences were found concerning MC between the experimental and control groups. However, author findings also suggest that age influence motor creativity and competence, highlighting the need to consider age differences when assessing young children's motor skills.

Bronfenbrenner & Ceci (1993) observed that environmental characteristics can encourage, facilitate, or inhibit the reciprocal adjustment towards progressively more complex interactional activities in the immediate settings (proximal processes). Gibson's Theory of Affordances also pointed out the relationship between the person and their immediate environment. Affordances are a set of opportunities that are provided inside the immediate environments attended (Gibson, 1979, 1986). Therefore, distinct objects, surfaces, events, and other individuals lie within each setting; each offering varied action opportunities. This concept underscores that

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children perceive their surroundings based on functionality, detecting environmental attributes that pertain to them (Heft, 2012). Consequently, delving into the impacts of these microsystems and their affordances becomes paramount for a comprehensive understanding of MC (Flôres, Rodrigues, & Cordovil, 2021).

It is well established that MC is required to perform a variety of physical activities that involve basic motor skills, such as locomotor (i.e., galloping, leaping, vertical and horizontal jumping), stabilization (i.e., dynamic and static balance), and manipulative skills (i.e., catching, throwing, or kicking) (Luz et al., 2016; Sá, Luz, Rodrigues, et al., 2021). Hence, MC involves developing and executing human movements, which is essential for mastering specialized abilities throughout life, making MC a comprehensive term synonymous with movement development and performance (Rodrigues et al., 2021; Silva et al., 2022). Recent evidence has emphasized the influence of MC in promoting healthy lifestyles at all ages (Pombo et al., 2020, 2022; Stodden et al., 2009). Other investigations have consistently shown that MC is associated with increased levels of physical activity (Barnett et al., 2009; Lopes & Rodrigues, 2021; Stodden et al., 2009), improved movement quality, increased energy expenditure, and refined object control skills (Sacko et al., 2021). MC has also been associated with increased participation in sports (Flôres et al., 2020). In addition, Sá and colleagues (2021) showed that children without vision problems presented better results than children with amblyopia, especially in stability and locomotion.

In North Brazil, the prevalence of childhood overweight and obesity has risen in recent years, raising concerns about declining physical activity levels and limited opportunities for motor skill acquisition (Farias et al., 2020; Nilson et al., 2025; Ribeiro et al., 2009). Those investigation also highlight the Stodden model (Stodden et al., 2009). Even though MC is an essential topic regarding its relation to locomotor, stability, and manipulative abilities, limited studies have assessed the relationship between schoolchildren's mesosystem and MC. Therefore, as far as we know, no other investigation has tried to evaluate children in North Brazil regarding their MC and the affordances provided in their mesosystems. Therefore, the present investigation assessed the association between affordances in the home and school and 6- to 10-year-old children's MC. Additionally, it was also verified this association is controlled by sex. It was expected that better motor affordances would provide higher levels of MC and that boys would present better levels than girls.

Material and Methods

Sample

The sample size was determined using the G*Power v 3.1.9.7 software (Kiel University, Kiel, Germany)(Faul et al., 2007), considering the following parameters: Cohen's effect size of 0.35 for correlation bivariate normal model, error probability $\alpha = 0.05$, and $\beta = 0.95$. This calculation resulted in a sample size of 115 participants. Therefore, one hundred and seventeen children and their parents or guardians (mean age 8.44 ± 1.44 years) were randomly recruited in North Brazil to participate in the investigation (Table 1). The inclusion criteria were as follows: (a) children between 6 to 10 years old; (b) children without any physical limitation or injuries. Participants with any developmental condition or who did not follow the procedures correctly were excluded from the final sample.

Instruments and procedures

ral assent was obtained from all participants, and written consent was obtained from their parents/guardians before beginning the experiment. The university ethics committee approved the research (CAAE: 51565821.9.2004.5537) and followed all the Declaration of Helsinki guidelines (General Assembly of the World, 2014). The data was collected Between March 1st, 2023, and November 30th, 2023.

Affordances for Motor Behavior of Schoolchildren (AMBS)

The AMBS tool assesses the variety of motor opportunities available to children across different environments. It consists of 73 items, categorized into 11 variables. These variables include areas like Indoor Space A, Indoor Space B, and Outdoor Space, as well as various materials such as Sedentary Items, Pretend Play Toys, Educational Toys, Manipulative Materials, and Stability Materials. This tool also considers spaces allocated for movement, distinguishing between Space for Movement, Free Space for Movement, and Sedentary Space. These categories are further grouped into three major subscales: Home Environment, Materials, and School Environment. All procedures follow the original investigation (Flôres et al., 2022).

The raw scores obtained from each subscale are converted into standardized scores, ranging from 1 (indicating very low availability of affordances) to 4 (indicating very high availability). The final AMBS score is calculated by summing the standardized scores of all the subscales, providing an overall picture of the motor affordances available to a child. Parents or guardians of the children involved in the study were fully informed about the research objectives and provided their consent. They participated by completing an online version of the AMBS questionnaire (https://questionarioambs.com), which was available in Brazilian Portuguese, with all responses securely stored in a cloud database.

Motor Competence Assessment (MCA)

The evaluation of children's MC was carried out using the MCA (Luz et al., 2016), and on the same day, their parents completed the AMBS questionnaire. The MCA was conducted under the supervision of trained evaluators, with each child spending approximately 20 minutes on the assessment. The MCA was designed to

assess MC across three domains: Stability (measured by tests like Jumping Sideways and Shifting Platforms), Locomotor Skills (evaluated through the Standing Long Jump and Shuttle Run), and Manipulative Skills (examined by Ball Kicking Velocity and Ball Throwing Velocity tests).

The MCA's validity and reliability have been established for individuals from early childhood to young adulthood. It has also been adapted for Brazilian children to ensure cultural relevance (Sá, Luz, Rodrigues, et al., 2021). This assessment tool consists of simple, quantitative tests that minimize errors in observation and ensure consistency over time.

Each test score was converted into age- and sex-specific percentiles (Rodrigues et al., 2019), which were then used to calculate scores for each of the abovementioned domains. Finally, the total MCA was calculated as the average of the three MCA subscales (Luz et al., 2016; Rodrigues et al., 2019). The test descriptions are provided below:

a. Jumping Sideways Test: Children were instructed to jump sideways over a wooden beam (60 cm long, 4 cm high, and 2 cm wide) using both feet together. They had to complete as many jumps as possible within 15 seconds. The best performance from two trials was recorded.

b. Shifting Platforms Test: Children moved laterally between two wooden platforms (25 cm x 25 cm x 2 cm) for 20 seconds. Each successful movement scored two points, one for each step, and the highest score from two trials was recorded.

c. Standing Long Jump Test: Children performed a standing long jump with maximum effort, beginning with both feet together. The jump distance was measured from the take-off point to the heel of the nearest foot at landing. The best of three attempts was used for analysis.

d. Shuttle Run Test: Children sprinted to retrieve a block from a 10-meter distance, returned it across a line, and repeated the process for a second block. The time for the fastest of two trials was recorded.

e. Ball Kicking Velocity Test: Children kicked a football (64 cm in circumference, 360 g in weight) against a wall with maximum force. The speed of each kick was measured with a radar gun, and the fastest of three attempts was recorded.

f. Ball Throwing Velocity Test: Children threw a tennis ball (6.5 cm in diameter, 57 g) against a wall using an overarm throw. The speed of the throw was measured using a radar gun, with the highest speed from three attempts being recorded.

Before starting each test, a proficient demonstration was provided to familiarize the children with the tests, and they were given a practice attempt. Motivational feedback was offered throughout the tests, although the specific test results were not shared with the participants.

Data Analysis

Descriptive analysis with mean and standard deviation was used to characterize general data and AMBS and MCA results. The Kolmogorov–Smirnov test did not confirm the data normality; therefore, the Spearman correlation was used to analyze the relationship between the MCA and the AMBS instruments. Correlation coefficients <0.30 were considered weak, those between 0.30 and 0.70 were considered moderate, and coefficients >0.70 were considered strong (Field, 2005). The Mann-Whitney test was used for boys and girls MC, and the Kruskal-Wallis's test was used to find whether the AMBS classification (high, medium, or low) was related to the MCA. The multiple linear regression was performed using the MCA total score as a dependent variable and the AMBS subscales as independent variables. The model was verified through the Nagelkerke R2 (adjusted) (the higher the R2, the better adjusted the model). The Statistical Package for Social Sciences (SPSS; IBM corporation), version 29.0, was used, adopting an alpha significance level of 5%.

Results

Table 1 shows sample characteristics regarding boys and girls. Results also showed that only 17.1% had normal levels of body mass index (BMI) (Boys – 11.5%; Girls – 23.2%).

Table 1. Sample characteristics.

	Boys + Girls			Boys			Girls		
	N	**M**	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**
Age (yrs)	117	8.44	1.44	61	8.44	1.4	56	8.44	1.5
Weight (kg)	117	31.06	11.03	61	30.98	12.33	56	31.14	9.65
Height (m)	117	1.32	0.12	61	1.32	0.10	56	1.32	0.12
BMI (kg/m^2)	117	17.34	3.59	61	17.26	4.07	56	17.42	3.04

Table 2 displays the information about boys' and girls' AMBS and MCA scores. Results showed only statistically significant differences between boys and girls regarding materials (U = 1193.0; p = 0.00), with girls reporting higher access to materials than their counterparts.

Table 2. Descriptive values of the affordances and children's MC levels.

Instrument	Subscales	Boys + Girls		Boys		Girls	
		M	**SD**	**M**	**SD**	**M**	**SD**
AMBS	School	3.09	1.04	3.18	1.04	3.00	1.04
	Home	215	098	2.18	0.87	2.11	1.09
	Materials	256	104	2.28	1.07	2.86	0.92
	AMBS total score	1.68	0.71	1.66	0.63	1.70	0.78
MCA	Stabilization	27.95	22.26	30.20	24.53	25.50	19.42
	Locomotion	44.19	26.02	46.89	26.67	41.25	25.19
	Manipulation	37.20	21.83	35.36	22.20	39.20	21.43
	MCA total score	36.39	19.05	37.49	21.04	35.20	16.73

Bivariate correlations were used to test the relation between the affordances and children's MC (Table 3). Our findings showed weak positive associations between home and stabilization (p = 0.01) and locomotion (p = 0.00) subscales.

Table 3. Association between AMBS and MCA.

	Stabilization	Locomotion	Manipulation	MCA total score
School	0.095	0.080	-0.119	0.033
Home	0.235*	.0242**	-0.138	0.151
Materials	0.061	-0.014	-0.061	-0.016
AMBS total score	0.166	0.120	-0.149	0.071

Note: *p <0.05

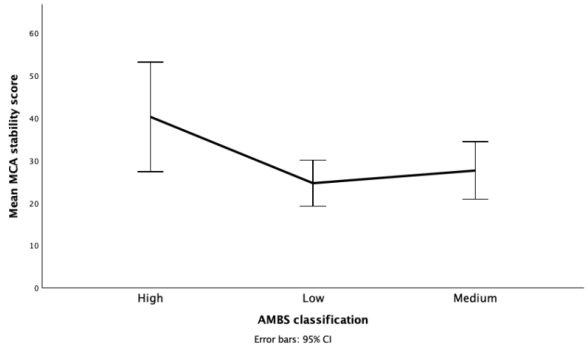
For girls (see Table 4), home and school affordances correlated positively with locomotion and stability components, supporting the hypothesis that these environments might promote better levels of fundamental motor skills. However, our results showed weak positive associations between school and stabilization (p = 0.03), locomotion (p = 0.03), and MCA total score (p = 0.04) only regarding girls. Weak positive associations were also found between girls' home and stabilization (p = 0.02) and locomotion (p = 0.01) subscales. No significant associations were found regarding boys.

Table 4. Association between AMBS and MCA controlling by sex.

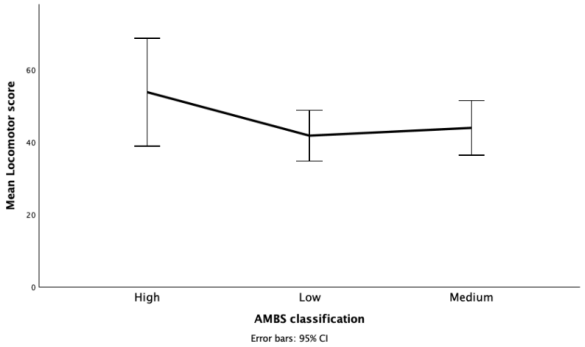
		Stabilization	Locomotion	Manipulation	MCA total score
Boys	School	-.038	-.114	-.226	-.159
	Home	.180	.120	-.073	.095
	Materials	.115	-.017	-.108	-.005
	AMBS total score	.120	-.005	-.218	-.044
Girls	School	.288*	.290*	.010	.267*
	Home	.305*	.343**	-.228	.182
	Materials	.053	.058	-.101	.007
	AMBS total score	.249	.257	-.110	.203

Figure 1 shows that children with higher levels of affordances also presented higher levels of MC in the stability and locomotor components of the MCA. In addition, they also had better levels of MC (MCA total score). Nevertheless, it is essential to highlight that the pattern for the manipulative component was not the same as the other components.

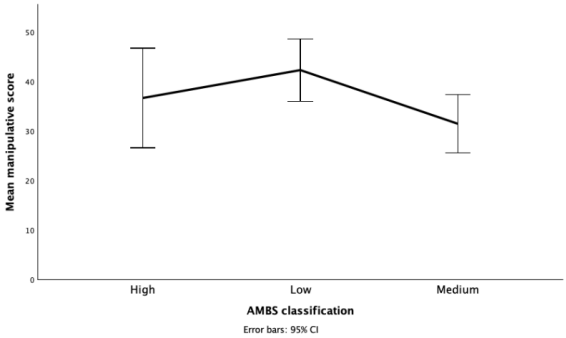
Figure 1. ABMS classification groups regarding MCA values.



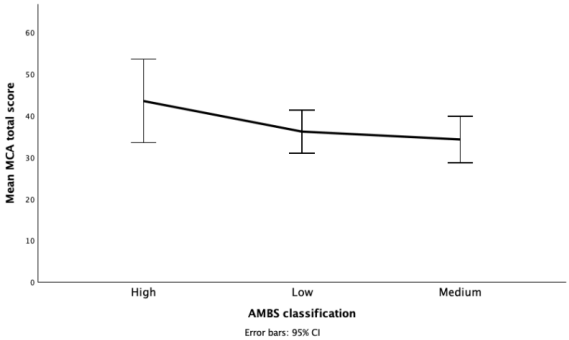
a) Mean scores of the AMBS in the stability component of the MCA.



b) Mean scores of the AMBS in the locomotor component of the MCA.



c) Mean scores of the AMBS in the manipulative component of the MCA.



d) Mean scores of the AMBS in the MCA total score.

Finally, to test the differences in MC affordances, the Kruskal-Wallis test for each MCA subscale and total score were performed using the terciles of the AMBS classification (low, medium, and high) (Table 5). Results showed that low affordances in the mesosystems provided higher MC stability. Conversely, higher levels of manipulative MC were found in the mesosystems that offer higher levels of affordances.

Table 5. Comparisons between MCA components and AMBS classification.

MCA	AMBS classification						Kruskal Wallis H test
	Low (T1)		Medium (T2)		High (T3)		
	M	**SD**	**M**	**SD**	**M**	**SD**	
Stability	24.61	19.85	27.60	23.20	40.25	24.25	H (2) = 4.597; p = 0.10 T1 = T2; T1 > T3; T2 = T3
Locomotor	41.69	25.66	43.83	25.59	53.69	27.95	H (2) = 2.604; p = 0.27 T1 = T2 = T3
Manipulative	42.33	23.13	31.47	20.09	36.69	18.94	H (2) = 5.047; p = 0.08 T1 = T2; T1 < T3; T2 = T3
MCA total score	36.15	18.95	34.26	19.07	43.50	18.823	H (2) = 2.923; p = 0.234 T1 = T2 = T3

The regression model explains approximately 12.7% of the variance in the MCA total score (adjusted $R^2 = 0.127$). The Durbin-Watson was 0.70, indicating potential autocorrelation in the residuals. Despite that, the model was statistically significant (see Table 6). Therefore, at least one of the predictor variables significantly influences the MCA total score.

Table 6. ANOVA results

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	5366.058	6	894.343	2.677	.018[b]
Residual	36743.857	110	334.035		
Total	42109.915	116			

a. Dependent Variable: MCA total score

b. Predictors: (Constant), age, BMI, Materials, School, Home

Multicollinearity diagnostics showed no severe issues, with Variance Inflation Factor values all below 10. Cook's distance values were small, with a maximum of 0.17, indicating no influential outliers. In addition, the standardized residuals against predicted values revealed a random pattern, supporting the assumption of homoscedasticity. Table 7 exhibits the regression coefficients. The most influential predictor was BMI (B = -1.269, 95% CI [-2.217, -0.221], $p < 0.02$), indicating that higher BMI values are associated with lower MCA total scores that hinder children's performance. The other predictors, such as age, did not show statistical significance. This suggests that these variables do not reliably predict MCA total scores in this model.

Table 7. Coefficients of the Multiple Linear Regression

Model	Unstandardized Coefficients		Standardized Coefficients	t	p	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	75.718	13.534		5.595	0.00		
Age	-1.936	1.301	-.146	-1.488	0.14	0.82	1.21
BMI (kg/m^2)	-1.269	.524	-.239	-2.422	0.02	0.81	1.23
School	-.055	2.262	-.003	-.024	0.98	0.52	1.93
Home	3.963	3.275	.203	1.210	0.23	0.28	3.55
Materials	-2.071	2.243	-.113	-.924	0.36	0.53	1.88
AMBS total score	-2.400	6.109	-.089	-.393	0.70	0.16	6.44

a. Dependent Variable: MCA total score

When analyzing the data regarding sex, separate multiple linear regression analyses were conducted for boys and girls to examine the relationship between the abovementioned predictors and the dependent variable. Results showed that, for boys, the model explained 19.0% of the MCA total score variance (adjusted R^2 = 0.190), but it was marginally statistically significant ($F(6,54) = 2.117$, $p = 0.06$). For girls, the model explained only 14.4% of the variance (adjusted $R^2 = 0.144$) and was not statistically significant ($F(6,49) = 1.374$, $p = 0.24$).

Discussion

The purpose of the present investigation was to investigate the relationship between the affordances in children's mesosystems and their levels of MC. Our central premise was that affordances and MC scores would be related, which was partially confirmed in our results. It was expected that more affordances (higher values of AMBS) in the mesosystem would provide better levels of physical activity, affording higher levels of MC, as found in the literature (Flôres, Rodrigues, & Cordovil, 2021).

The proximal processes proposed in the theoretical models (Bronfenbrenner & Ceci, 1993) suggest that the interaction between a person and their environment could promote MC. Nevertheless, it is important to point out that, as powerful as can be expected, several other characteristics of children (i.e., genetic or biological conditions, etc.) undoubtedly influence children's MC (Flôres, Rodrigues, & Cordovil, 2021; Krebs, 1995). Therefore, the positive correlations found (Tables 3 and 4), although weak/moderate, suggest that the affordances in girls' mesosystems, especially regarding home and school, can promote their competence development. As mentioned, although the environment is not the only determinant (i.e., heredity, family, culture, society, development, and socioeconomic condition are also important to be analyzed), children's MC seems to be related to the affordances provided in their everyday lives. However, it is also important to notice that the affordances provided to boys present fewer associations with their MC, which is surprising. One of the possible explanations for the fewer associations between affordances and children's MC can be the lack of physical activity and the enhanced screen time in children after the COVID-19 pandemic (Pombo et al., 2021; Wolińska et al., 2023).

Unlike what was expected and shown in previous literature (Flôres, Rodrigues, Luz, et al., 2021; Rodrigues et al., 2019), boys and girls presented similar MC levels despite the component of the MCA. However, Luz et al. (2019) report that the results are still controversial and need further investigation to be generalized. Therefore, the leveling of boys' and girls' MC levels could also be influenced by the COVID-19 pandemic since investigations indicate an increase in children's screen time, leading to a decrease in physical activity levels and a considerable increase in the number of children with overweight or obesity (Wolińska et al., 2023). The Durbin-Watson results indicated potential autocorrelation in the regression residuals, suggesting that some unexplored variables might also influence MCA scores, such as the family SES (Noble et al., 2012; Soares et al., 2015; Troller-Renfree et al., 2022), the educational level of the parents (Catale et al., 2012; Saccani et al., 2013), or the type of extracurricular activities provided to children (Barnett et al., 2013). In fact, Zi et al. (2023) corroborate with the previous findings, showing that the home environment also plays an essential role in early motor development, despite highlighting that genetic factors also explain the individual differences in the timing of motor milestone achievement.

Since our sample was collected after the pandemic, the MC scores might reflect lifestyle shifts caused by the COVID-19 outbreak, reducing the opportunities for physical activity and increasing screen time (Pombo et al., 2023). These results are also being found in other studies in Portugal (Flôres et al., 2024; Lopes & Mendes, 2022). Although this investigation has some pitfalls, it is important to note that the AMBS is a valid and reliable assessment tool. Thus, an in-loco assessment of the microsystems could provide even better information regarding the affordances available to children. It is also important to remember that the AMBS is a parental self-report questionnaire and cannot provide data on the frequency or the significance of children's interactions, nor the time spent in physical inactivity (i.e., screen time, etc.).

Future investigations should analyze the association of affordances provided inside each microsystem with an assessment battery that includes fine motor skills or levels of physical activity (i.e., GPS or accelerometers, for example). Also, future studies should incorporate additional predictors, such as parental levels of physical activity or socioeconomic status, to address this limitation and amplify the understanding regarding this topic. Finally, analyzing the association between affordances and motor skill levels and academic performance could be primordial in understanding how affordances shape children's behavior.

Conclusion

This investigation highlights the significant influence of affordances in shaping children's MC and underscores the need of promoting enriching environments to support their behavior. Our findings suggest that home and school affordances positively influence stability and locomotion components of MC, particularly in girls. However, contrary to expectations, boys and girls displayed similar MC levels, challenging traditional assumptions of sex-based differences. This unexpected result may reflect the post-pandemic decline in physical activity and increased screen time, emphasizing the need for interventions that reintegrate movement-based activities into children's daily routines. Therefore, we strong believe that schools must optimize physical

education programs and playground environments, while parents should be encouraged to provide opportunities for free play and structured activities at home. Practically, these findings support the implementation of targeted interventions in educational and community settings to improve MC, which is a key determinant of lifelong physical activity engagement and overall health.

Acknowledgments

To the National Council for Scientific and Technological Development (CNPQ) and the Federal University of Rio Grande do Norte (UFRN) for the scholarships granted to the project. To the Department of Education of the State of Rio Grande do Norte and the schools for authorizing the data collection. No funding was received for this project. And to the parents/guardians and the children and adolescents who allowed the project's data collection and development to occur.

Conflicts of interest - The authors have no conflicts of interest to declare.

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