2023, Retos, 50, 234-238

Gross motor coordination in schoolboys of pubertal age contrasting in futsal practice level groups
Coordinación motora gruesa de adolescentes varones con diferentes niveles de práctica de futsal

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Abstract. The aim of this study was to verify differences between boys contrasting in futsal practice level groups on gross motor coordination and growth indicators. A sample of 196 boys aged 11 to 14 years was measured for anthropometric variables and Körperkoordinationstest für Kinder (KTK). Results revealed that there were no significant associations of the futsal practice level on growth parameters. On the other hand, ANCOVA results (chronological age as a covariate) indicated that boys participating in futsal practice ≥ 2 days/week had significantly better performances in jumping sideways, hoping for height, and total score of KTK than their less practicing counterparts. These findings encourage the most frequent practice of sports for the development of gross motor coordination.
Keywords: Motor skills; Adolescent; Maturation; Sport.

Resumen. El objetivo de este estudio fue examinar niños con diferentes niveles de práctica de futsal en habilidades motoras e indicadores de crecimiento. En una muestra de 196 niños de 11 a 14 años se midió lo Körperkoordinationstest für Kinder (KTK) y antropometría. Los resultados revelaron que no hubo asociación del nivel de práctica de futsal sobre los parámetros de crecimiento. Por otro lado, los resultados de ANCOVA (edad cronológica como covariable) indicaron que los niños que jugaban futsal ≥ 2 días a la semana tenían un rendimiento significativamente mejor en el salto lateral, saltos monopedales y la puntuación total de KTK que sus compañeros. Estos hallazgos brindan una justificación para la práctica más frecuente de deportes para el desarrollo de la coordinación motora gruesa.
Palabras clave: Motricidad; Adolescente; Maduración; Deporte.

Fecha recepción: 18-01-23. Fecha de aceptación: 27-06-23
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Introduction

Motor competence refers to the human capacity to move proficiently in distinct contexts and for different purposes (Robinson et al., 2015). It is a complex concept that encompasses a variety of other terms used in scientific investigations, such as motor performance, motor proficiency, motor skill, motor ability, and gross motor coordination (Luz et al., 2016; Robinson et al., 2015). The association between motor competence and different health outcomes and leisure time activities has been well-documented in adolescence and adulthood (Herlitz et al., 2021; Oñate-Navarrete et al., 2021). Improvements in motor competence, obtained in the prepubertal years, are also considered as crucial prerequisites to sport-specific skills (Hulteen et al., 2018). Furthermore, combined with biological maturation, morphology, and fitness, motor competence is considered part of the strategic marks in the search and selection of international youth athletes (O'Brien-Smith et al., 2019).

Sports practice is one of the main contexts of physical activity in childhood, both as a curricular and extracurricular component in school, as well as in clubs and others spaces (Batista et al., 2019). Cross-sectional (Drenowatz & Greier, 2019; Marinho & Chagas, 2022) and longitudinal (Moura et al., 2021; Vandorpe et al., 2012; Henrique et al., 2016) studies have shown that children who regularly practice sports show higher motor competence than children who don't regularly participate in sports. However, the link between motor competence with specificity and the frequency of sports practice has been little debated. Gross motor coordination is commonly used as an indicator of motor competence (Luz et al., 2016) and Körperkoordinationstest für Kinder (KTK) is widely used as an instrument for the assessment of the gross motor coordination of youth people (Hulteen et al., 2020). In a recent systematic review, O'Brien-Smith et al. (2019) suggested that the KTK can successfully distinguish between athletes of different sports and competitive levels. Furthermore, the authors concluded that gross motor coordination was not affected by maturation and did not differ between sexes or playing positions.

Research studies investigating futsal have increased significantly over the past two decades. However, current literature provides limited evidence regarding the effect of the systematic practice and the frequency of futsal training on the motor competence of its practitioners (Cortis et al., 2009). Although, Fransen et al. (2012) have shown that 6–12 year-old children who spend many hours a week in sports had higher gross motor coordination than those with a few hours a week of practice, there are few data available specifically on gross motor coordination among young futsal practitioners. Therefore, the purpose of this study was to examine differences between schoolboys contrasting in futsal practice level groups on gross motor coordination and growth indicators.

Material and method

Procedures and sample

This was a school-based cross-sectional study carried out

in public schools from the area of Arapiraca, a city in the Northeast Region of Brazil. The research project was approved by the Ethics Committee of the Federal University of Alagoas (CAAE 50352015.9.0000.5013). The study was conducted in accordance with the Declaration of Helsinki for research with humans of the World Medical Association (Declaration of Helsinki, 2014). After obtaining institutional permission from the schools, parents, or legal guardians signed informed consent (response rate 80%) and participants were informed about the study goals and that participation was voluntary. The final sample comprised 196 boys aged 11.05-14.88 years (60 subjects with futsal practice ≥ 2 days/week, 85 subjects with futsal practice for 1 day/week, and 51 non-practitioners of sports) who met two inclusion criteria: (i) neither injured nor affected by a limitation to the performance on gross motor coordination test; (ii) enrolled in the physical education classes involved in the study. Absence on the day of the data collection, or practice another sport was considered to study exclusion criteria.

Growth indicators and maturation

The common anthropometric protocol was adopted (Lohman et al., 1988). Height and sitting height were measured to the nearest 0.1 cm using a portable stadiometer (Sanny Caprice, São Paulo, Brazil). Body mass was recorded using a digital scale (Techline, São Paulo, Brazil) to the nearest 0.1 kg. Waist circumference (WC) measurement was performed using a non-elastic tape. The triceps and subscapular skinfolds were measured to the nearest 1.0 mm using a Lange skinfold caliper (Beta Technology, Santa Cruz, California, USA). Body Mass Index (BMI; $kg \cdot m^{-2}$), leg length (height minus sitting height), and the sum of skinfolds were calculated. Age at peak height velocity (PHV) was estimated with the maturity offset protocol (Mirwald et al., 2002).

Futsal Practice frequency

Children were requested to identify the sports they engaged in during the previous 12 months, and additional information was obtained by Baecke Questionnaire (Baecke et al., 1982): a) Do you practice sport?; b) What sport do you practice?; c) How many days do you play sports?; d) If you practice sport, where do you practice?; e) How many minutes do you practice?. A similar procedure was already adopted in the literature (Soares et al., 2013). In the present study, the futsal practice level was divided into three groups: group 1 (no practice sports), group 2 (futsal practice 1 day/week), and group 3 (futsal practice ≥ 2 days/week), considering at least 60 minutes by session, either in the context of unstructured futsal practice or in organized sessions under the supervision of a teacher (school) or coach (club).

Gross motor coordination

Different tools to assess movement performance in youth are available (Andreu, 2023; Cools et al., 2009). Gross motor coordination was assessed using the KTK test battery (Kiphard & Schiling, 1974). This test is a reliable and valid instrument for use in children aged 5–14 years. Psychometric characteristics of KTK showed a test-retest reliability coefficient for each item ranging between 0.80 and 0.96. The battery includes four items: walking backward on balance beams (WB), jumping sideways across a wooden slat (JS), moving sideways on boxes (MS), and hopping for height on one leg (HH) (Kiphard & Schiling, 1974). The KTK is now used as a measure for gross motor coordination for various research purposes in children with different development in multiple contexts (Iivonen et al., 2015; O'Brien-Smith et al., 2019). The present study analyzed the performance in gross motor coordination using the raw score for each test and the total score of KTK (WB+JS+MS+HH). A similar procedure was adopted in previous studies (Luz et al., 2016; Luz et al., 2018).

Statistical Analysis

Descriptive statistics (range, means, standard errors, standard deviations, and 95% confidence intervals) were calculated for the total sample. Kolmogorov–Smirnov was used to test normality, and appropriate log transformations were adopted to normalize distributions on five variables (maturity offset, BMI, WC, WB, and HH). Subsequently, descriptive statistics (means and standard deviations) were calculated for groups contrasting in futsal practice level groups. Additionally, the effect of futsal practice frequency on growth characteristics and KTK items scores were examined using a multivariate analysis of covariance (MANCOVA) (chronological age as a covariate). When MANCOVA detected a statistically significant effect, subsequent analysis of covariance (ANCOVA) was used to detect the contribution of the single dependent variables to the multivariate solution. Between-group differences were analyzed using Bonferroni *post hoc* tests respectively. Effect sizes were verified with partial eta squared (η^2p). Data were analyzed using IBM SPSS 22.0 (SPSS, Inc., Chicago, IL). Values of $p < 0.05$ were considered statistically significant for all analyses.

Results

In total, 51 schoolboys (26%) do not practice sports, while 85 (43%) were futsal practitioners 1 day/week, and 60 schoolboys (31%) were involved with a practice ≥ 2 days/week. Among boys who practice futsal (n=145), 8.2% were involved in an organized context, with the supervision of a coach at least 1 day/week. Descriptive statistics for chronological variables, anthropometric data, KTK items and total score of KTK for the total sample are given in Table 1.

Results for boys contrasting in futsal practice groups controlling for chronological age are presented in Table 2. No significant differences were observed for growth measures. However, the MANCOVA showed a significant effect of futsal practice frequency on KTK total score and some tests. Subsequent ANCOVA results (chronological

age as a covariate) indicated that boys participating in futsal practice ≥ 2 days/week had significantly better performances in jumping sideways (F=5.91, p<0.01, η^2p=0.06), hopping for height (F=4.37, p<0.05, η^2p=0.04), and total score of KTK (F=6.14, p<0.01, η^2p=0.06) than their less practicing counterparts.

Table 1.
Descriptive statistics (range, mean value, 95% confidence limits of the mean, and standard deviation) for the total sample of schoolboys aged 11.05–14.88 years (N=196)

Variables	Range		Mean		Standard deviation
	Min	Max	Value	(95%CL)	
Chronological age (years)	11.05	14.88	13.13	(12.98; 13.28)	1.04
Age at PHV (years)	12.86	15.81	14.40	(14.32; 14.49)	0.63
Maturity offset (years)	- 3.60	1.60	- 1.27	(- 1.43; - 1.11)	1.14
Height (cm)	131.0	181.0	158.1	(156.6; 159.6)	10.8
Body mass (kg)	25.6	79.9	48.4	(46.8; 50.0)	11.4
Body mass index (kg.m^{-2})	13.2	27.7	19.2	(18.7; 19.6)	3.1
Waist Circumference (cm)	54.0	81.0	66.1	(65.2; 67.0)	6.4
Sum of skinfolds (mm)	14	55	29.4	(28.1; 30.6)	8.8
Walking backward (#)	15	72	53.7	(52.1; 55.4)	11.8
Jumping sideways (#)	13	92	57.3	(55.4; 59.3)	13.8
Moving sideways (#)	22	66	42.0	(40.9; 43.2)	8.1
Hoping for height (#)	18	76	57.4	(55.7; 59.2)	12.1
Total score of KTK (#)	114	297	210.5	(205.9; 215.2)	33.1

95%CL (95% confidence limits); PHV (peak height velocity); Sum of skinfolds (Sum of triceps and subscapular skinfolds); # (no measurement unit).

Table 2.
Means and standard deviations for boys contrasting in futsal practice level groups, and results of multivariate analyses of covariance (MANCOVA with chronological age as covariate) to examine the association beetween futsal practice level on growth characteristics and gross motor coordination.

Dependent variables	Futsal practice level groups			Futsal practice level					
	1 No practice (n=51)	2 1 day/Week (n=85)	3 ≥ 2 days/Week (n=60)	Test	Wilks'λ	F	p	η^2p	Post-hoc comparisons
Chronological age (years)	13.31±1.04	12.84±1.04	13.39±0.96						
				MANCOVA	0.33	1.91	0.06	0.43	
Age at PHV (years)	14.29±0.68	14.43±0.59	14.47±0.63						
Maturity offset (years)[a]	-0.99±1.22	-1.59±1.05	-1.08±1.10						
Height (cm)	161.9±10.6	156.1±10.6	158.5±11.0						
Body mass (kg)	51.4±12.6	46.5±10.7	48.7±10.8						
Body mass index (kg.m^{-2})[a]	19.6±3.5	18.9±2.9	19.2±2.9						
Waist Circumference (cm)[a]	67.0±7.6	65.2±6.2	66.8±5.3						
Sum of skinfolds (mm)	31.6±10.0	27.9±8.1	29.6±8.5						
				MANCOVA	0.90	1.87	<0.05	0.05	
Walking backward (#)[a]	50.7±11.8	53.9±12.0	56.2±11.2	ANCOVA		2.76	0.07	0.023	-
Jumping sideways (#)	53.5±13.1	56.1±13.0	62.3±14.2	ANCOVA		5.91	<0.01	0.06	Groups 1 and 2 < Group 3
Moving sideways (#)	40.7±8.4	41.4±7.1	44.0±9.0	ANCOVA		2.32	0.101	0.02	-
Hoping for height (#)[a]	54.7±14.0	56.5±11.4	61.1±10.4	ANCOVA		4.37	<0.05	0.04	Groups 1 and 2 < Group 3
Total score of KTK (#)	199.6±34.2	207.9±29.7	223.6±32.9	ANCOVA		6.14	<0.01	0.06	Groups 1 and 2 < Group 3

η^2p (partial eta square); PHV (peak height velocity); [a]Test of equality of means was performed on log-transformed variable; Sum of skinfolds (Sum of triceps and subscapular skinfolds); # (no measurement unit); ANCOVA (analyses of covariance); Group 1 (no practice sports), Group 2 (futsal practice 1 day/week), and Group 3 (futsal practice ≥ 2 days/week).

Discussion

Our results highlight the positive effects of weekly volume of futsal practice on gross motor coordination in boys, i.e., participants who have a futsal practice frequency of at least 2 days/week had significantly better performances in jumping sideways, hoping for height, and total score of KTK than their less practicing counterparts; what can be indicative that futsal systematic practice may have a positive effect on the gross motor coordination of adolescents regardless of chronological age effect.

There is growing evidence showing that motor competence plays an important role in engagement in physical activity throughout the lifespan, as well as early involvement in active play, sports, and exercise may contribute positively to the acquisition and refinement of motor competence (Robinson et al., 2015; Oñate-Navarrete et al., 2021). Although not a sport-specific test battery (Iivonen et al., 2015), the KTK has been widely used to evaluate the gross motor coordination of young athletes in various sports, such as soccer (Lovell et al., 2018; Dirik et al., 2021), gymnastics (Vandorpe et al., 2012), tennis (Söğüt, 2017), among others (Pion et al., 2015; Norjali et al., 2018). Most of these highlighted the superiority of children competing at elite level over their sub-elite counterparts on KTK. Furthermore, due to its discriminative characteristics, the KTK battery should be implemented for the identification and selection of talents.

Lovell et al. (2018) investigated the KTK performances of children aged 10-16 participating in a school-based soccer program and observed better gross motor coordination scores for players with higher playing levels. Our findings indicated that boys who have a higher frequency of futsal practice (≥ 2 days/week) exhibited better KTK scores than their less practicing counterparts. Because it is a high-intensity intermittent sport, with numerous physical, technical, and tactical demands, and that requires great high-intensity efforts from players, such as sprinting, acceleration, deceleration and changes of direction (Spyrou et al., 2020), differences found only in tasks that involve jumping, such as jumping sideways and hopping for height on one foot, may be directly related to the specific requirements of the modality. This result is also in line with previous findings (Vandorpe et al., 2012; Fransen et al., 2012), showing higher values in player with longer weekly practice time. These findings are particularly because the participation in sports, independently if to involve specific instruction and guidance for technical and tactical development (Vandorpe et al.,

2012) also favor, when practiced in greater volume, elements of gross motor coordination.

The current study has some limitations that should be addressed for future research. Cross-sectional designs preclude any statements on causality, which prevents knowing which factors of futsal practice influence gross motor coordination or whether those who already had greater gross motor coordination are those who practice futsal systematically. However, it is plausible to expect that the content of the practices (e.g. technical and tactical foundations and physical aspects), as well as learning variables (e.g., feedback, practice schedule, etc.) can influence gross motor coordination and need to be addressed in future studies. Nevertheless, results appeared generally consistent with other studies that evaluate the motor competence of young practitioners in various sports. Future research should include indicators of physical activity and fitness to improve the understanding of the interrelationships among chronological age, growth, maturation, gross motor coordination, fitness, and physical activity.

In conclusion, our study indicated that boys who have a higher frequency of futsal practice exhibited better gross motor coordination than their less practicing counterparts. These findings provide a rationale for physical education teachers and youth sport coaches to improve curricula for children's physical education, as well as to encourage the most frequent practice of futsal for the development of gross motor coordination, which may promote positive trajectories of health behaviors.

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