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Original Article

GLOBAL MOTOR COORDINATION AND SPORTS PRACTICE IN MULTI-SPORT CHILDREN AND ADOLESCENTS

COORDENAÇÃO MOTORA GLOBAL E A PRÁTICA ESPORTIVA EM CRIANÇAS E ADOLESCENTES PARTICIPANTES DE MULTESPORTE

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RESUMO

A relação entre a participação esportiva (PE) e a Coordenação Motora Global (CMG) se associa à idade. No entanto, o tempo envolvido na PE pode ser outro mediador. Assim, o objetivo foi investigar a relação entre a CMG e a PE em crianças e adolescentes envolvidos na PE, controlados pelo tempo de prática. Para isso, foram analisados 111 meninos (88 de 6 a 9 anos; 23 de 10 a 12 anos) com PE de duas a quatro modalidades esportivas e com o tempo de prática entre um e seis anos. A CMG foi auferida pelo *Körperkoordinationstest Für Kinder* e a PE mediante entrevista semiestruturada com os responsáveis legais. Os coeficientes de Spearman indicaram que para as crianças dos 6 aos 9 anos de idade não houve correlação entre a CMG e a PE ($p > 0,05$), mesmo quando controladas pelo tempo. Já para o grupo dos 10 aos 12 anos houve correlação moderada ($\rho = 0,515$, $p < 0,01$). Essa informação permite ao profissional de Educação Física entender que a experiência motora das crianças mais jovens é fundamental para potencializar o desenvolvimento motor e que sua implicação na manutenção da participação em atividades esportivas ocorrerá somente nas fases avançadas da infância.

Palavras-chave: Crianças. Adolescentes. Prática. Modalidades esportivas. Desenvolvimento motor.

ABSTRACT

The relationship between sports participation (SP) and Global Motor Coordination (GMC) is related to age. However, the time spent on SP might be another mediator. This study aimed at investigating the association between the GMC and SP in children and adolescents engaged in SP, controlled by the time spent on practice. Thus, 111 boys were assessed (88 aged 6 to 9 years; 23 aged 10 to 12 years) whose SP varied from two to four sport modalities and time spent on practice was between one and six years. The GMC was assessed by using the *Körperkoordinationstest Für Kinder*, and the SP by applying a semi-structured interview to the legal guardians. The Spearman's coefficients showed no correlation between GMC and SP ($p > 0.05$) for the 6-9-year-old children, even when controlled according to the time spent. The 10-12-year-old group showed a moderate correlation ($\rho = 0.515$, $p < 0.01$). Such information enables the Physical Education professional to understand that the motor experience of younger children is essential to enhance motor development and that its implication in maintaining participation in sport activities will only occur in the advanced stages of childhood.

Keywords: Children. Adolescents. Practice. Sport modalities. Motor development.

Introduction

Global motor coordination (GMC) has been understood as a construct that underlies the development of basic and specific motor skills[1-3]. It is noteworthy that when investigating the GMC and basic motor skills, there is evidence in favor of their differentiation and a proposal to consider them as two dimensions that express different facets of motor competence[3].

The relevant study by Vandorpe[2] identified that the children who continuously spent more time to practice sports over two years were the ones who had the highest GMC at the beginning of the study. On the other hand, the study identified that these two years of systematic sports practice did not influence the development of GMC, when considering the children who systematically practiced and those who did not. This suggests that the initial GMC predicts sports participation, but sports participation does not have an effect on GMC.

Following this line of research, Fransen and collaborators[4] found evidence that children who have higher GMC are those who systematically practice several sports (two or more), but this effect only appears after 10 years of age. The authors suggested the hypothesis that there would be a latent effect of GMC on sports participation (SP), that is, it would not be noticeable in younger children, but it would appear after a few years of practice. However, such a hypothesis only considered the analysis of children with SP in one sport versus several sports, without controlling the length of time spent on these sport modalities[4].

It is worth highlighting that the time spent on practice is another parameter of sports participation clearly associated with GMC[4-6]. Opstoel and collaborators, for example, showed that 9-11-year-old children who had below-average GMC were those who played sports less frequently per week, compared to children with average or above-average GMC[6].

Due to the importance of the experimentation phase of basic or combined movements, it is expected that most children are engaged in SP by practicing different modalities – multi-sports[7]. Thus, the relevance of the present study lies in the attempt of clarifying how a specific motor variable, that is, the GMC, behaves in relation to multi-sports practice, depending on the age of children and adolescents.

Therefore, this study aimed at investigating whether the latent effect of the GMC on SP is persistent when assessing a sample of children who practice different sports, all of them engaged in multi-sports and controlled by the time spent on SP.

Methods

Participants

The sample consisted of 111 boys, divided into two age groups: 6 to 9 years old (88 children) and 10 to 12 years old (23 adolescents). The present study used secondary data extracted from the project entitled "Project for Monitoring the Performance of Children and Young People from *Pinheiro* Club throughout the Sports Training Process", which is the result of a partnership between the School of Physical Education and Sport at the University of São Paulo and *Pinheiros* Sport Club, both from the city of São Paulo, Brazil. Regarding sports, it is worth mentioning that all the children used to perform two or more sports throughout the week, and that each sport was taught by different professionals, but whose purpose was to teach social, cultural, psychological and motor aspects related to sport modalities.

As the sample belonged to a larger sport training project, the only inclusion criteria adopted for the sample were the following: being 6-12 years old and completing the entire test for the GMC analysis.

This project was approved by the Ethics Committee of the University of São Paulo (Opinion number 4.242.321). The consent form to approve the volunteers' participation was duly signed by the parents/legal guardians.

Procedures

The GMC collection and analysis protocol was carried out based on the Körperkoordinationstest Test für Kinder (KTK) manual[8]. This is an instrument with validation indicators for collecting data in children and adolescents, including in Brazil[9].

The KTK has quantitative measures of movement that comprise four tasks: balancing backwards, single-leg jumps, jumping sideways and moving sideways. The sum of the scores of the four tasks allows calculating the general motor quotient (GMQ) based on the norms regarding the age and sex of the child, subsequently enabling the classification of the subject regarding GMC into 5 coordinating levels, as follows: (1) $56 \leq GMQ \leq 70$, insufficient coordination; (2) $71 \leq GMQ \leq 85$, poor coordination; (3) $86 \leq GMQ \leq 115$, normal coordination; (4) $116 \leq GMQ \leq 130$, good coordination; and (5) $131 \leq GMQ \leq 145$, high coordination[8]. In this article, the GMQ was used as

a factor for analyzing the GMC.

Information on the number of sports practiced and time spent on practice was obtained through a semi-structured interview applied to the children's parents/legal guardians (while they waited for the class/collection to take place), guided by the following questions: "Which are the sports your child played/has been playing throughout his life?" and "How long did he/has he been practicing each of them?". Regarding the number of sports, all children included in this study practiced 2 or more sports (Figure 1). Considering the time spent on practice, the children who had already been practicing two sports for at least 1 year were included.

Martial Arts	Individual Sports	Collective Sports	Water Sports	Other Activities
Judo	Tennis	Football	Swimming	Ballet
Capoeira	Gymnastics	Handball	Sailing	
Karate	Chess	Volleyball	Water Polo	
Jiu-jitsu	Skating			
Fencing				

Figure 1. General list of sports practiced by the sample.
Source: the authors.

The invitation, as well as the availability of consent forms for carrying out data collection was made when students enrolled in sports classes at the sports club. The collections took place during the class period of one of the modalities (Judo) in 2018 and 2019. The collection team comprised five evaluators and the class teacher. Each evaluator performed a task from KTK with two children at a time, alternating children in a circuit format. Thus, all of them went through the four stations related to the test tasks. During collection, parents and legal guardians remained in the sports club environment. At that moment, the fifth evaluator applied the semi-structured interview about the history of sports participation of the children and adolescents.

Statistical Analysis

For assessing data distribution, the Kolmogorov-Smirnov and Shapiro-Wilk tests were used, in addition to the analysis of histogram and simple dispersion graphs. With data normality not assumed, the Spearman correlation test was used to understand the correlation between the study variables (GMC and number of sports) for each age group of children (6-9 and 10-12 years old). Furthermore, Spearman's partial correlation test was used to analyze the association between the study variables controlled by the time spent on practice and the age of the children for each group. The effect size of the coefficients varied from -1.0 to 1.0. The values represented the respective strengths: weak (r=0.10-0.39); moderate (r=0.40-0.69); and strong (r=0.70-1.0)[10]. All analyzes were carried out by using the Statistical Package for the Social Sciences (SPSS) version 22, with a significance level of 5%.

Results

Considering the 111 boys evaluated, 48 played 2 sports, 45 played 3 sports and 18 played 4 sports. The descriptive values of the GMC are shown in Table 1. Both groups expressed a normal coordination level (GMQ>85). The other distributions stratified per age groups, the number of sports and sample size are also shown in Table 1.

Table 1. Description of the sample regarding global motor coordination (GMC) depending on sports practice (number of sports and time spent), and age groups.

Sports Practice	Category	6 to 9 years old		10 to 12 years old		Total	
		n	M_d GMQ (IQR)	n	M_d GMQ (IQR)	N	M_d GMQ (IQR)
Number of sports	2 sports	43	96.0 (27.0)	5	90.0 (7.0)	48	95.0 (26.0)
	3 sports	33	99.0 (26.0)	12	106.0 (13.0)	45	100.0 (23.0)
	4 sports	12	94.0 (13.5)	6	108.5 (6.0)	18	99.0 (20.0)
Time spent on practice	1 year	6	94.0 (21,0)	0	0.0 (0.0)	6	94.0 (21.0)
	2 years	17	99.0 (16.0)	2	102.0 (24.0)	19	99.0 (28.0)
	3 years	25	93.0 (17.0)	2	86.5 (7.0)	27	93.0 (20.0)
	4 years	28	93.5 (24.0)	6	106.0 (13.0)	34	99.0 (24.0)
	5 years	8	107.0 (27.0)	8	107.0 (8.0)	16	107.0 (13.0)
	6 years	4	111.0 (23.0)	5	100.0 (16.0)	9	110.0 (18.0)
Total		88	97.0 (22.5)	23	105.0 (18.0)	111	99.0 (22.0)

Note: Category = categories of the variables 'number of sports' and 'time spent on practice'; n= sample size; Md GMQ = GMQ median value; GMQ = global motor quotient; IQR= median interquartile range value (3rd percentile – 1st percentile)
Source: the authors

Table 2 shows the correlation coefficients. Considering the total sample, the GMC was weak and positively associated with the time spent on practice ($\rho = 0.199$, $p < 0.05$). There was no significant association between GMC and SP ($p > 0.05$) for children aged 6 to 9 years. Regarding the older group, that is, 10-12-year-old children, the GMC was moderately and positively associated with the number of sports practiced ($\rho = 0.499$, $p < 0.01$), even when this relationship was controlled according to the time spent on practice and age ($\rho = 0.515$, $p < 0.01$), which indicates that the association is not affected by the time spent on practice.

Table 2. Inferential data referring to Spearman's correlation coefficient and the respective partial correlation coefficient between GMC and SP (number of sports and time spent) for 6-12-year-old children.

	Age Group (years old)					
	6 – 9		10 – 12		Total	
	Rho	Partial Rho#	Rho	Partial Rho#	Rho	Partial Rho#
GMC	-0.142 β	-0.206 β	**0.499** β **	**0.515** β **	**0.199** † *	-0.093 β

Note: Rho = Spearman's correlation coefficient; Partial Rho= Spearman's partial correlation coefficient with time spent on practice and age as control variables; † Correlation indicator with time spent on practice; β Correlation indicator with the number of sports practiced; bold = it indicates significant correlation. *The correlation is significant at the level of 0.05; ** The correlation is significant at the 0.01 level.
Source: the authors.

Discussion

The present study aimed at assessing whether the latent effect of GMC on SP is persistent when assessed in children engaged in multi-sports, controlled by the time spent on SP.

Based on the results it was possible to infer that GMC is not associated with the number

of sports practiced by younger children (6 to 9 years old), regardless of the stratification into 2, 3 or 4 sports. However, for older children, aged 10 to 12 years, this relationship gains strength and significance. The significance of the older sample was what made the total sample to show a weak and positive association.

The result seen in the 6-9-year-old boys refutes the hypothesis proposed that stratifying the number of sports could reveal variances in GMC when considering 2, 3 or 4 sports ($p > 0.05$). Some studies interested in this theme and the childhood stage have identified that sport participation seems to have positive effects on GMC when compared to non-systematized practices, such as school Physical Education[2,11]. However, when the comparison parameter is directed only to groups that practice sports, different results emerge in the literature. Some data have shown a difference for younger children, such as the example in which gymnasts had a higher GMC compared to ice hockey players[12]. On the other hand, there are inferences that identified no differences in GMC, regardless of the sport practiced[6,13]. The lack of consensus in the literature makes the present discussion worth paying attention to.

The inconclusive results regarding differences in GMC among sports or based on the number of sports practiced by this age group might reflect the training method whose practice focus may not be technical or tactical sport performance, but rather global motor activities related to the combination of fundamental motor skills, so that specific skills of the sport in question can be achieved later[14]. Furthermore, this association appears to change throughout life, so that greater motor coordination during childhood may subsequently affect the involvement in sporting activities, which could be beneficial for sustainable participation in sport throughout adolescence and adulthood[15].

Corroborating the previous assumption, the present study identified that for 10-12-year-old boys, regardless of age and time spent on practice, the GMC was moderate and positively associated with the number of sports ($\rho = 0.515$, $p < 0.01$), that is, the common variance of time spent and age did not affect the unique variance of the number of sports in relation to GMC. This result allows reasoning from two different premises. The first suggests that sports participation can enhance the acquisition of GMC,[4,16] and the second assumes that a higher GMC can predict sports participation[2,17].

The first premise is based on the principle that practicing a variety of sports, as suggested by the diversification stage of the developmental model of sport participation, establishes a range of positive motor experiences essential for the acquisition of individual aspects, such as GMC[16]. Thus, the data obtained by the present study allow us to infer that the boys who played more sports were those engaged in different motor challenges and who acquired higher GMC. However, this benefit becomes apparent at the end of the diversification stage, that is, from the age of 10 to 12 years, due to the accumulation of positive experiences.

On the other hand, the second premise proposes that the data do not imply that better GMC is directly associated to the greater number of sports played, but rather that children need greater GMC to engage in a greater number of sports, regardless of the length time they have been practicing or the age. Likewise, it was longitudinally seen that children with the highest GMC at 6 years of age were those with the greatest participation at 10 years of age[2,17]. From this perspective, the GMC is considered as a condition that underlies the acquisition of fundamental motor skills and, when greater, can predict greater sports participation at later ages[2]. Based on the present sample, it can be inferred that 10-12-year-old boys who played more sports were those with the highest GMC.

GMC and motor skills can be considered as part of a whole called motor competence (3). Therefore, GMC as an underlying and necessary ability for the acquisition of fundamental motor skills, might subsequently influence the breaking of the "proficiency barrier"[2,18]. This "barrier" suggests that children may not achieve proficiency in sport skills because they have not acquired fundamental motor skills due to some reasons, such as lack of opportunity for learning and developing them[18]. Thus, children with higher GMC might be those with greater proficiency in the execution of motor skills and, as a result, they will have sufficient motor repertoire to be engaged in the sports that interest them, which results in participating in a greater number of sports and spending more time on practice.

Therefore, the premises presented may indicate a circular causality between GMC and sports participation at this stage of life. The circular causality suggests that the components of the present article, GMC and SP, are feedback, that is, they can act and interact continuously[19]. However, longitudinal studies with more details on the dynamics of sports practice will be necessary to clarify whether there is a causal relationship between GMC and SP after 10 years of age, in addition to assessing different age groups, time spent on practice, and number of sports practiced. For example, assessing how the activities carried out by practitioners are, that is, global ones (various movements with feet and hands) or specific activities that depend only on the sporting practice in question.

Furthermore, it is clear that more information about children's lifestyle habits can help clarify the association between GMC and sports. For example, the time children spend on screen, an activity highly present in their current routine, which, depending on high usage, it appears to have a negative influence on motor competence[15] in this age group, the period when the acquisition of good motor development is so important.

Assessing and discussing this topic can help the Physical Education professional to conduct motor experiences so that future involvement with practices is enhanced, even if this involvement is recreational. In addition, if the goal of the children and their guardians is high performance, the information provided by the present study shows that there might be a stage in childhood (10 to 12 years of age) in which past motor experiences is crucial as a basis for reaching more specific and complex stages. Thus, sport coaches will be able to conduct sports practice prior to this phase with the aim of positively projecting them for later phases.

Some strengths of the present study should be highlighted, such as the fact of suggesting an approach different from that of current studies that debate systematized sports participation of children. Emphasis was placed on GMC as a significant condition for the progression of motor development, but not on the differences between elite and sub-elite athletes or in sport-specific performance measures. However, this study also has limitations since the children who practiced only one sport were not assessed. This would allow us to better identify the aspect of the minimum number of sports compared to the higher extremes, such as 3 or 4 sports. In addition, information about class methods was not considered, which would enable the researchers to reflect whether the activities carried out were global or specific to the sport modality.

Conclusions

In conclusion, GMC and the number of sports practiced were not associated with younger children, aged 6 to 9 years. This suggests that there does seem to be either a latent or hidden association at this stage. The positive relationship seen between GMC and the number of sports for the sample aged 10 to 12 years strengthens this premise, which shows that the relationship between them becomes apparent with advancing age. The latent effect observed implies the idea that only with adequate levels of GMC the child is prepared to acquire a set of motor skills so that the existence of an association between their GMC and sports participation is seen in the future. Thus, the importance of sports participation throughout childhood is evident. In this sense, the role of the Physical Education professional becomes essential to conduct motor experiences in an organized manner, with the aim of enhancing children's motor development and making them to participate in sporting activities throughout their lives, regardless of whether the outcome of sports practice is high performance, health or recreational activity.

References

1. Kiphard EJ. Insuficiências de movimiento y de coordinación en la edad de la escuela primaria. Buenos Aires, Kapeluscz. 1976;
2. 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 [Internet]. 2012;15(3):220–5. DOI: 10.1016/j.jsams.2011.09.006.
3. Rudd J, Butson ML, Barnett L, Farrow D, Berry J, Borkoles E, et al. A holistic measurement model of movement competency in children. J Sports Sci [Internet]. 2015;1–9. DOI:10.1080/02640414.2015.1061202.
4. Fransen J, Pion J, Vandendriessche J, Vandorpe B, Vaeyens R, Lenoir M, et al. Differences in physical fitness and gross motor coordination in boys aged 6-12 years specializing in one versus sampling more than one sport. J Sports Sci. 2012;30(4):379–86. DOI:10.1080/02640414.2011.642808.
5. Fransen J, Deprez D, Pion J, Tallir IB, D'Hondt E, Vaeyens R, et al. Changes in physical fitness and sports participation among children with different levels of motor competence: a 2-year longitudinal study. Pediatr Exerc Sci. 2014 Feb;26(1):11–21. DOI:10.1123/pes.2013-0005.
6. Opstoel K, Pion J, Elferink-Gemser M, Hartman E, Willemse B, Philippaerts R, et al. Anthropometric characteristics, physical fitness and motor coordination of 9 to 11 year old children participating in a wide range of sports. PLoS One. 2015;10(5):1–16. DOI: 10.1371/journal.pone.0126282.
7. Côte J, Lidor R, Hackfort D. ISSP position stand: To sample or to specialize? Seven postulates about youth sport activities that lead to continued participation and elite performance. Int J Sport Exerc Psychol. 2009;7(1):7–17. DOI:10.1080/1612197X.2009.9671889.
8. Schilling VF, Kiphard EJ. Körperkoordinationstest für Kinder KTK: manual Von Fridhelm Schilling. Weinhein: Beltz Test. 1974;
9. Moreira JPA, Lopes MC, Miranda-Júnior MV, Valentini NC, Lage GM, Albuquerque MR. Körperkoordinationstest Für Kinder (KTK) for Brazilian Children and Adolescents: Factor Analysis, Invariance and Factor Score. Front Psychol. 2019;10(November):1–11. DOI:10.3389/fpsyg.2019.02524.
10. Field A. Correlação. In: Descobrindo a estatística usando o SPSS. Porto Alegre: Artmed, 2009. p. 125–55.
11. Rudd JR, Barnett LM, Farrow D, Berry J, Borkoles E, Polman R. Effectiveness of a 16 week gymnastics curriculum at developing movement competence in children. J Sci Med Sport. 2017;20(2):164–9. DOI: 10.1016/j.jsams.2016.06.013.
12. Jaakkola T, Watt A, Kalaja S. Differences in the motor coordination abilities among adolescent gymnasts, swimmers, and ice hockey players. Hum Mov. 2017;18(1):44–49. DOI:10.1515/humo-2017-0006.
13. Söğüt M. Gross motor coordination in junior tennis players. J Sports Sci [Internet]. 2016;34(22):2149–52. DOI: 10.1080/02640414.2016.1211311.
14. Gallahue DL, Ozmun JC, Goodway JD. Compreendendo o desenvolvimento motor: bebes, crianças e adolescentes. Nova Iorque: AMGH Editora Ltda.,2013. p.1–487.
15. Drenowatz C, Greier K. Cross-sectional and longitudinal association of sports participation, media consumption and motor competence in youth. Scand J Med Sci Sports [Internet]. 2019;29(6):854–61. DOI: 10.1111/sms.13400.
16. Côté J, Vierimaa M. The developmental model of sport participation: 15 years after its first conceptualization. Sci Sports [Internet]. 2014;29:S63–9. DOI: 10.1016/j.scispo.2014.08.133.
17. Lopes VP et al. Motor coordination as predictor of physical activity in childhood. Scand J Med Sci Sports. 2011; v. 21(n. 5):663–9. DOI: 10.1111/j.1600-0838.2009.01027.x.
18. Seefeldt V. Developmental motor patterns: implications for elementary school physical education. In: Psychology of motor behavior and sport. In: Nadeau CH, Halliwell WR, Newell M, Roberts C, editors. Psychology of motor behavior and sport. Champaign: Human Kinetics; 1980. p. 314–23.
19. Vasconcellos MJE de. Pensamento sistêmico: o novo paradigma da ciência. Campinas, São Paulo: Papirus Editora, 2013. p. 269.

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