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Review Article

MOTOR COMPETENCE OF BRAZILIAN PRESCHOOL CHILDREN ASSESSED BY THE TGMD-2: A SYSTEMATIC REVIEW

COMPETÊNCIA MOTORA DE CRIANÇAS PRÉ-ESCOLARES BRASILEIRAS AVALIADAS PELO TESTE TGMD-2: UMA REVISÃO SISTEMÁTICA

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RESUMO

O teste de desenvolvimento motor grosso (TGMD-2) é um teste discriminativo e referenciado à norma, usado para avaliar o nível de competência de crianças de 3 a 10 anos. O objetivo do presente estudo foi revisar sistematicamente os resultados de estudos brasileiros que tenham examinado o desenvolvimento motor de pré-escolares usando o teste TGMD-2, considerando as diferentes regiões do Brasil, assim como analisar os resultados relativos aos fatores associados ao desempenho no teste TGMD-2; foram revisadas as bases de dados LILACS e SCIELO usando como descritor o termo "TGMD-2", buscando estudos originais publicados de 2007 a 2018, com texto completo disponível, nos idiomas português e inglês, que avaliaram o desempenho motor em pré-escolares usando o TGMD-2; a extração de dados incluiu os itens: primeiro autor, local, periódico, objetivos, delineamento, características da amostra, resultados de desempenho no teste e fatores relacionados; também foi avaliada a qualidade dos estudos. Os dez estudos incluídos na revisão indicaram diferenças no desempenho motor nas diferentes regiões. Foram encontrados indícios de melhor desempenho motor em crianças de escola particular e que praticam atividade física sistemática e orientada por profissional de educação física.

Palavra-chave: Desempenho motor. TGMD-2. Desenvolvimento infantil.

ABSTRACT

The Test of Gross Motor Development (TGMD-2) is a discriminant, norm-referenced tool used for assessing competence level in children aged between 3 and 10 years old. The aim of the present study was to perform a systematic review of results reported in Brazilian investigations that have examined the motor development of preschoolers using the TGMD-2, considering different regions in Brazil, as well as to analyze results concerning the factors associated with development in said test; the LILACS and SciELO databases were consulted, with the term "TGMD-2" being used as descriptor for the search of original studies published from 2007 to 2018, whose full texts were available, in Portuguese and English, and which assessed motor development in preschoolers using the TGMD-2; data extraction included the following items: first author, location, journal, objectives, design, sample characteristics, test performance results, and related factors; the quality of the studies was assessed as well. The ten investigations that make up the review indicated differences in motor development by region. Evidence of better motor development was found in children from private schools and who engaged in systematic physical activity guided by a physical education professional.

Keywords: Motor development. TGMD-2. Child development.

Introduction

The test of gross motor development (TGMD-2) was proposed by Dale Ulrich, in the United States, and is a discriminant, norm-referenced tool used for assessing the competence level of children aged between 3 and 10 years old as to motor skills involving major muscle groups that produce strength to move the trunk, and the upper and lower limbs[1]. The TGMD-2 was created to assess motor development *per se*, associated with factors such as age and gender[2,3]; however, it has been increasingly employed in researches aimed at analyzing motor competence (MC) related to physical fitness[4], physical activity (PA) levels[5], cognitive parameters[6], sociocultural context[7], and others. Currently, it is validated for different countries, such as Chile[8], South Korea[9] and Brazil[10].

The core of the TGMD-2 consists of skills that involve body transport (locomotion) and skills that demand exerting/receiving force on/from objects (object control), and,

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precisely for serving to form any other motor skill throughout life, these TGMD-2 skills are referred to as fundamental. The TGMD-2 consists of a qualitative assessment on six locomotion skills (run, leap, hop, gallop, horizontal jump, and slide), and six object control skills (ball) (kick, roll, catch, strike, dribble and throw), which have their mechanical quality examined. The test is applied through verbal instruction and movement demonstration by the test conductor, followed by task familiarization and execution of the motor skill by the child[1,10]. The TGMD-2 is easy to apply and lasts on average between 15 and 30 minutes approximately; it can be used for obtaining a motor development indicator, identifying children with motor delays for their age group, planning and controlling programs to improve skills in children with delays, and assessing changes resulting from aging, experience, instruction or intervention[1].

One's capability of executing fundamental motor skills during childhood, at an age-adequate level, has been considered the main indicator of MC[11-13]. Children who properly master these skills tend to engage more in PA[14], further favoring their motor development, which can generate a virtuous behavioral cycle that raises the likelihood of them continuing to exercise, besides health benefits in the course of life[13-15]. Motor development must not be neglected or treated as secondary in child development, as it is intrinsically linked to cognitive development[16]. Childhood is a critical period for the development of motor skills, which, in their turn, at adequate levels, can play a vital role in the physical and psychological health of children[17], lowering the risks of excessive weight, obesity and chronic-degenerative diseases in the following years[12,13,18,19]. For instance, the object control skills developed in the early school years have significant impacts on PA throughout life, in addition to seeming more crucial when it comes to PA intensity, time and type in adolescence compared to locomotion skills[20].

Several studies around the world have applied the TGMD-2 to assess preschoolers' MC[21-25] in order to verify their proficiency in fundamental motor skills. Some investigations with said test in Brazil[2,26,27] have shown low motor performance when the data standardized by Ulrich[1] were used, corroborating with the results of studies that attest low motor development in children from Australia[28], Oceania[29], Israel[30] and the United Kingdom[31]. Delays in child motor development may also result from a disadvantaged sociocultural context[17]. Despite the relevance of this theme, there is no publication that provides a general and integrative view of results for studies with TGMD-2 already conducted in Brazil. Verifying the potential influence of different sociocultural contexts on the motor development of Brazilian children through a test validated for a specific population is relevant from the viewpoint of scientific knowledge advancement[32,33] and from a social viewpoint, with application to public policies on childhood that bring about benefits to individual quality of life and to the education[34,35], public health[36] and economy[37] sectors. Thus, the present study aimed to perform a systematic and integrative review of researches that have used the TGMD-2 to assess motor development in Brazilian preschoolers, as well as to verify the factors associated with their performance on the test.

Methods

The present study is characterized as a systematic and integrative review of scientific investigations that have examined MC in Brazilian preschool children assessed by the TGMD-2.

Search Strategy and Eligibility

Four digital databases were consulted: LILACS, SciELO, PubMed and ERIC, using "TGMD-2" as descriptor. Studies published in the last thirteen years (2007 to 2019), which

have employed the TGMD-2 to assess motor development in Brazilian preschoolers, were included, because this period allows capturing the most recently used articles, in Portuguese and English. Studies formatted as Monographies, Dissertations, Theses, Systematic reviews, as well as duplicated articles, were excluded.

One author (GS) conducted the search through the databases, selected the studies and removed duplicates, while two (GS and AHNR) read the articles and compiled the information. Studies whose samples contained elementary school children were not considered. Figure 1 displays a flowchart of the strategy used for selecting the studies to be included in or excluded from this systematic review, as well as the filters applied to these results, according to the model proposed by the protocol for systematic review and meta-analysis studies, PRISMA-P[38]. Data extraction counted with the following items: name of the first author, location, journal, objectives, study design, sample characteristics (size, age group and gender), results referring to performance on the TGMD-2, and associated factors (Table 1). The studies were also qualitatively assessed using the Critical Review Form – Qualitative Studies[39], which is composed of 15 items that allow detecting the risk of methodological bias of the studies (see Table 2); each item that is met is worth one point, and the quality of the study is rated high if the sum of the points is greater than or equal to 12, average when between 11 and 8, and low when below 7 points. Knowing the methodological quality of the article will allow for a more thorough analysis of its results.

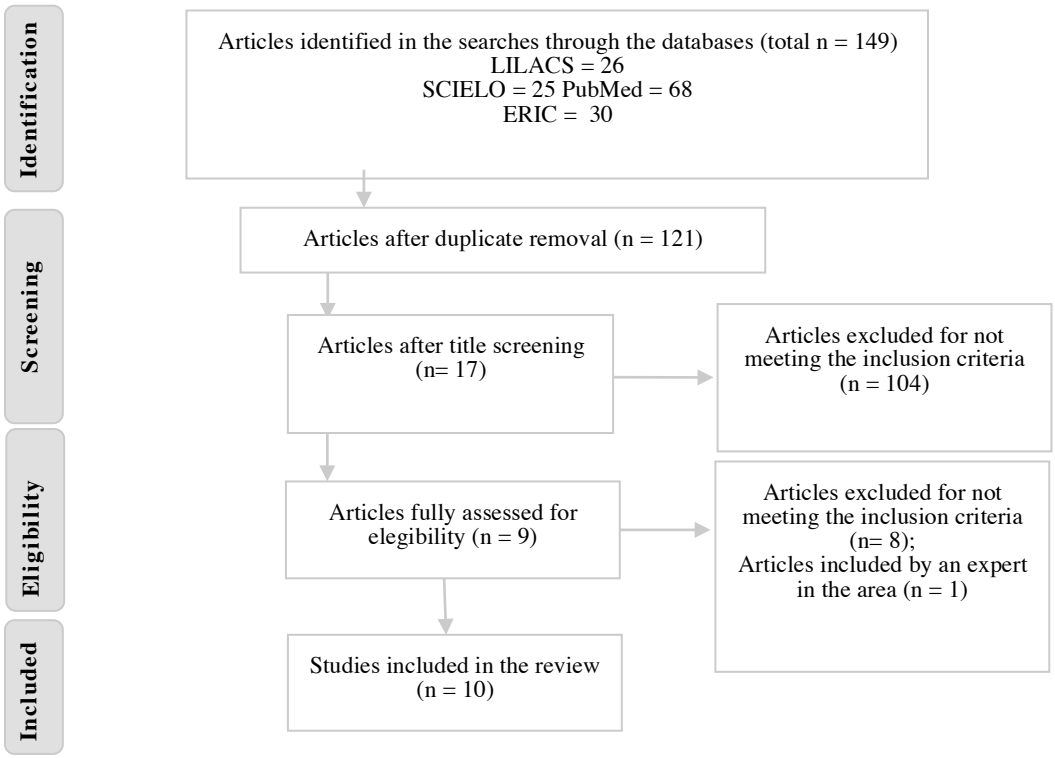

Figure 1. Flowchart displaying the steps in the process of including the studies used in the systematic review, in accordance with PRISMA-P protocol

Source: The authors

Table 1. Characteristics of studies that have investigated MC in Brazilian preschoolers using the TGMD-2

Author (year)/Location	Journal	Objectives	Sample	Results	
				Motor development	Related factors
Campos et al. [40]/ Recife – PE	Motriz	Verify the effect of preterm birth on locomotion and object control performance in early childhood kids	60 children – 20 boys / Average of 4.5 years old	Average percentiles for overall classification: preterm boys 42; preterm girls 35	Prematurity and the female gender negatively affected performance (p=0.021)
Catenassi et al. [41]/ Londrina – PR	Revista Brasileira de Medicina do Esporte	Verify the relationship between performance on gross motor skill tasks and body mass index (BMI) in boys and girls	27 children – 16 boys / Between 4 and 6 years old	Not informed	BMI did not correlate with motor development
Cattuzzo et al. [42]/ Recife - PE	Revista Brasileira de Educação Física e Esporte	Investigate levels of object control skill development in preschoolers, according to age and gender	342 children – 187 boys / Between 3 and 5 years old	Average percentiles for object control: boys 63; girls 50	Age increase positively affected performance on object control skills (p= 0.00). Boys with greater performance than girls on object control skills (p> 0.00)
Oliveira [43]/ Recife – PE	Revista Brasileira de Educação Física e Esporte	Analyze children's performance on locomotion skills by age and gender	389 children – 214 boys / Between 3 and 5 years old	Average percentiles for locomotion: boys 63; girls 63	Improved motor performance as a function of age (p≤ 0.001); Better performance for males (p= 0.002)
Nobre et al. [44]/ Várzea Alegre – CE	Pensar a Prática	Verify the correlation between opportunities for motor stimulation in the domestic environment and motor development level	12 children – 7 boys / Between 3 and 4 years old	Average percentiles for overall classification: Boys 58; Girls 58	Low correlation between stimulation opportunities in the domestic environment and motor performance (r= -0.058)
Palma [45]/ Porto Alegre – RS	Revista da Educação Física/ UEM	Assess and compare the motor development of preschoolers who practice and those who do not practice systematic PA	88 children – 40 boys / Between 4 and 6 years old	Average percentiles for overall classification: Practitioners 21; Non-practitioners 12	Groups with motor performance below the expected for their age. Practitioners of systematic PA showed a performance superior to that of non-practitioners on locomotion skills (p= 0.00) and object control skills (p= 0.01)
Queiroz,. et al. [46] / Recife–PE	Motrici-dade	Compare MC in public and private school children	292 children – 158 boys / Between 3 and 5 years old	Average percentiles for overall classification: Private school: 58 boys; 50 girls Public school; 42 boys; 42 girls	MC differences between children in different school environments Private school children presented greater MC (p< 0.01).
Ré et al. [17] / São Paulo - SP	Revista da Educação Física/ UEM	Assess MC indicators in preschoolers of low socioeconomic level and compare results between genders and age groups	257 children – Not informed / Between 3 and 6 years old	Average percentiles for overall classification: 3-4 years old: boys 45; girls 46. 5-6 years old: boys 33; girls 30	Children of low socioeconomic level presented low MC and poorer MC as a function of age for both genders. Girls showed inferior performance on object control skills (p< 0.05)

Table 1 continues...

Author (year)/Location	Journal	Objectives	Sample	Results	Author (year)/Location
Rodrigues et al. [47]/ Guarulhos – SP	Motriz	Verify the effects of different contexts on development of fundamental motor skills and on somatic growth in children	50 children – Not informed / Between 4 and 6	Average percentiles for overall classification: With Physical Education 65; Without Physical Education 50	Access to physical education classes favored locomotion skills ($p< 0.05$) and object control skills ($p= 0.07$)
Silva et al.[48]/ Campina Grande do Sul – PR	Revista Brasileira de Crescimento e Desenvolvimento Humano	Analyze the relationship between opportunities for motor stimulation in the family environment and motor development among children	72 children – 33 boys / Between 38 and 42 months old	Average percentiles for overall classification: Boys 58; Girls 50	Moderate correlations between motor performance and availability of motor skill materials: fine ($r=0.77$) and gross ($r=0.62$) in males. Moderate correlations for stimulation variety ($r=0.54$), fine motor skill materials ($r=0.64$), gross motor skill materials ($r=0.60$), and motor stimulation ($r=0.43$) in females.

Source: The authors

Results

At the first stage of the study, the search for the term "TGMD-2" on the LILACS, SciELO, PubMed and ERIC databases returned 149 articles, with filters being applied to publications from the last thirteen years, in English and Portuguese (Figure 1). During screening, 28 articles were removed for being duplicates, 104 were excluded after their titles were analyzed, and 8 articles were discarded after being fully assessed. One article was suggested by an expert in the area, so 10 articles made up this review.

All reviewed studies had a cross-sectional design, and only one was published in English[17]. As for sample size, the studies assessed between 12 and 529 children. The Brazilian regions that predominated in the investigations were the Northeast and the South, with five and three studies, respectively, whereas there were two studies in the Southwest. No studies in the North and in the Midwest were found (Table 1).

Campos, Soares and Cattuzzo[40] verified the effect of preterm birth on children's gross motor skills and found that the performance of premature ones was similar compared to that of their peers; however, the female gender, the specificity of the task and prematurity are variables that negatively affect performance on locomotion and object control skills. Cattuzzo et al.[42], comparing development levels of object control skills in children aged between 3 and 5 years old found a superior performance in boys and as a function of age. Catenassi et al.[41] aimed to verify the relationship between BMI and gross motor skills in children aged from 4 to 6 years old, and their results showed that BMI had no statistically significant correlation with motor performance. Oliveira, Oliveira and Cattuzzo[43], analyzing children's performance on locomotion skills by gender and age, found that older ones presented better motor performance, and that boys performed better than girls on the run, horizontal jump and lateral slide skills. Nobre et al.[44] sought to verify the correlation between opportunities for motor stimulation in the domestic environment and motor development level using the Affordances in the Home Environment for Motor Development (AHEMD) questionnaire, and found low correlation between them, but without negative influence on the children's motor development, with both chronological age and motor age being in balance. Silva et al.[48] analyzed the relationship between opportunities for motor stimulation in the family environment (using the AHEMD) and motor performance among children aged 38 to 42

months old, and their results indicated the existence of said relationship; in their study, girls performed better on locomotion skills, while boys were better at object control skills. Palma, Camargo and Pontes[45] reported a motor performance below expected when assessing children who engaged and did not engage in systematic PA, corroborating the findings of Ré et al.[17], who detected low MC in children of both genders. Queiroz et al.[46] compared MC in preschoolers from private and public schools. Broadly speaking, those from private schools presented greater MC, and the boys, from both school contexts, presented greater motor performance than the girls did. Rodrigues et al.[47] aimed to analyze motor performance in different contexts and found better MC in children who had classes with a physical education professional compared to those who had classes with a teacher in charge of all subjects. Six studies reported age-expected performance (percentile > 50), and four reported performance below the expected for the age (percentile < 50), evidencing a lack of consistency for motor performance in preschoolers from different regions.

Concerning the assessment of the methodological quality of the studies, the sum of points of only two[17,42] met the criterion (≥ 12 points) to have their quality considered high (low risk of methodological bias); the other ones scored 9 to 11 points and were deemed average in quality. It is worth noting that items 4 ("Have any errors that might have influenced the study results been noted?"), 6 ("Has an explanation been presented to the sample size?"), 9 ("Were the outcome measures valid?") and 15 ("Are there any implications for clinical practice, given the research results?") received the largest number of negative answers.

Table 2. Qualitative assessment of the studies that have investigated MC in Brazilian preschoolers, using the TGMD-2, following the Critical Review Form (Law et al.39)

	QUESTIONS																
STUDIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
Cattuzzo et al.[42]	1	1	1	0	1	0	1	1	1	N/A	1	1	1	1	1	1	13
Ré et al.[17]	1	1	1	0	1	0	1	0	0	N/A	1	1	1	1	1	1	13
Catenassi et al.[41]	1	1	1	0	1	0	1	1	0	N/A	1	1	1	1	0	1	11
Campos et al.[40]	1	1	1	0	1	0	1	1	0	N/A	1	1	1	1	0	0	11
Rodrigues et al.[47]	1	1	1	0	1	0	1	1	0	N/A	1	1	1	1	0	1	11
Silva et al.[48]	1	1	1	0	1	0	1	1	0	N/A	1	1	1	1	0	1	11
Oliveira[43]	1	1	1	0	1	1	0	1	0	N/A	1	1	1	1	0	0	10
Nobre et al.[44]	1	1	1	0	1	0	1	1	0	N/A	1	1	0	1	0	0	9
Palma[45]	1	1	1	0	1	0	1	1	0	N/A	1	1	1	1	0	0	9
Queiroz et al.[46]	1	1	1	0	1	0	0	1	0	N/A	1	1	1	1	0	1	9

Note: Questions: 1 - Was the objective clear?; 2 - Has a review of the literature relevant in this theme been performed?; 3 - Has the design suited the study question?; 4 - Have any errors that might have influenced the study results been noted?; 5 - Has the sample been described in detail?; 6 - Has an explanation been presented to the sample size?; 7 - Have the subjects signed the consent form? (If there is no description, assume they have not); 8 - Were the outcome measures reliable? (If there is no description, assume they were not); 9 - Were the outcome measures valid? (If there is no description, assume they were not); 10 - Has the intervention been described in detail?; 11- Have the results been reported in terms of statistical significance?; 12 - Were the analysis methods adequate?; 13 - Has the clinical importance been reported?; 14 - Were the conclusions coherent with the study methods and results?; 15 - Are there any implications for clinical practice, given the research results?; 16 - Have the authors recognized and described the study limitations?; Item scores: 0 = does not meet the criterion; 1 = meets the criterion; NA = not applicable
Source: The authors

Discussion

This research aimed to analyze, in a systematic manner, the results of Brazilian studies that have examined motor development in preschoolers, using the TGMD-2, including the analyses of results achieved on the test and associated factors. Ten studies that have assessed preschoolers by means of the TGMD-2 were found. In general, they have investigated motor

development in connection with different factors, such as preterm birth, BMI, gender, age, systematic PA, sociocultural context, and school and family environments.

The present review found diverging results as to family environment and motor development. Nobre et al.[44] reported low correlation, but with no impairments to motor development, while Silva et al.[48] found significant correlation. This difference may derive from other factors, such as motor stimulation in the school environment, a place where children spend a considerable amount of time[49], or other institutions that promote PA, such as sports schools.

The findings of Palma, Camargo and Pontes[45], Queiroz et al.[46], Ré et al.[17], and Rodrigues et al.[47] elucidate the importance of Physical Education in the preschool years. Currently, it is not routine for Physical Education professionals to work with preschool children in the Brazilian public education, but the literature already shows the implications and benefits of interventions in this age group, in order to promote the development of motor skills and facilitate the engagement of children in PA over the following years[12,50-53].

The analysis of the results showed a tendency to find differences between genders as to performance on locomotion and manipulative skills[41,43,48]. Nonetheless, broadly speaking, boys present better motor development, corroborating the results of studies with preschoolers from other countries, such as the United States[53], and suggesting a sociocultural influence at a global level. It is important that PA for preschoolers is guided and takes into account differences as to fundamental motor skills between genders.

The conceptual model proposed by Stodden et al.[13] suggests that MC in childhood has a relevant role in PA engagement throughout life, with motor differences likely resulting from different aspects (e.g., environment, presence of systematic PA, socioeconomic condition, etc.). A recent conceptual model proposed by Hulteen et al.[32] on motor skill development and its relationship with PA in the course of life argues about a possible sociocultural and geographical filter, implying that place of residence can partly determine which motor skills will be developed. It is possible to infer that sociocultural and geographical differences lead to motor differences[33], and these differences can perhaps be better evidenced in object control skills. The ball dribbling skill is typical of basketball, a popular sport in the USA[54]. Thus, one can expect that the movement culture of a location (e.g., a country, or a region) can influence the MC of those who share that context.

Sports engagement is associated with MC during early childhood in both genders, being a predictive factor for the continuity of this engagement, promoting a positive behavioral cycle for motor, physical and psychological development[46,55,56]. Nowadays, the lack of longitudinal studies to establish associations between preschoolers' MC and engagement in sports throughout life means a gap for future researches. The longitudinal study by Henrique et al.[55] investigated MC in preschoolers and found that children with better performance on locomotion skills and who started playing sports earlier in life are more inclined to play sports two years later. At later life stages, MC continues to be an important predictor for PA[57], being positively associated with moderate and moderate-intense PA, and inversely associated with sedentarism[58], overweight and obesity[14,28]. The longitudinal study by Hands[59] assessed, for five years, children with low MC and confirmed the impact of low motor development on motor skills over time and on physical fitness. Children with MC at adequate levels seem to be more involved in sports than their peers with low MC are, suggesting that those with good motor performance are more capable of dealing with sports demands[56], which can be a good tool for improving MC and physical fitness components related to health[60].

The results point to the importance of the environment in which the child is inserted, as well as the importance of Physical Education classes in the preschool years in generating a

virtuous behavioral cycle and greater engagement with PA in subsequent years, decreasing the risks of chronic-degenerative diseases, obesity and overweight.

Some limitations must be mentioned. The present study used only one descriptor to search for articles, but the specificity of the population (preschoolers) facilitated the article analysis process, lowering the risk of bias related to article exclusion. Another point worth highlighting is the relatively small number of articles found, although the main publishing bases involving the Brazilian population were used. The small number of studies in the North (0) and Midwest (0) do not allow drawing definitive conclusions about the influence of sociocultural context on different Brazilian regions, and the same can be said of the lack of longitudinal studies, preventing the establishment of causal relations. However, the present study evidences a gap to be filled by future researches.

Conclusions

The results of this systematic review show that the motor development of preschoolers from different regions and sociocultural contexts is different, and these differences could be eliminated through physical activities organized and guided by Physical Education professionals. The lack of longitudinal studies and of a representative descriptive sampling, in combination with the methodological quality of the studies found, makes it difficult to understand the factors potentially related to MC; the results of this review allow concluding that boys and girls have been showing differences as to their motor performance, assessed through the TGMD-2, with boys being superior.

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