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Review articles

Application of Motor Development Scale: an integrative review

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ABSTRACT

Objective: to know, understand, and analyze studies that employed the Motor Development Scale as a method for motor evaluation.

Methods: the study included the databases Scielo, Pubmed, Lilacs, Science Direct, Web of Science, Scopus and Cochrane to identify the studies, using the following keywords: child; motor skills; motor skills disorders. The methodological quality of cross-sectional studies was analyzed by the Loney scale, cohort and case-control studies were assessed by the Newcastle-Ottawa scale, and clinical trials by the Physiotherapy Evidence Database.

Results: twenty studies met the inclusion criteria. There was predominance of cross-sectional studies, which had as main outcome the analysis of motor development of schoolchildren, children with obesity and overweight, premature, with Attention Deficit Hyperactivity Disorder, learning disabilities and Down syndrome. The studies presented objective criteria to measure the outcome and for interpretation and applicability of adequate results, although they did not reach the minimum score established by the assessment scales.

Conclusion: the Motor Development Scale is being used in Brazil in several contexts, presenting clear and statistically consistent results, although the methodologies of studies do not fully meet the standards of methodological quality.

Keywords: Child; Motor Skills; Motor Skills Disorders

INTRODUCTION

The utilization of standardized scales and instruments to assess the motor development in childhood are common in the clinical practice and scientific research[1]. These instruments have allowed for professionals the early detection and understanding of the mechanisms and disorders of psychomotor development in children, besides aiding as a diagnostic screening tool for the planning of preventive or rehabilitative interventions based on scientific evidences in childhood[2].

The Motor Development Scale (MDS) is a valid instrument in Brazil and is currently one of the most comprehensive scales for motor evaluation in children, including the main domains of psychomotricity: fine motricity, global motricity, balance, body scheme, spatial organization, temporal organization and laterality[3]. The instrument may be applied to populations of children aged 2 to 11 years, allowing quantitative comparison of the motor age and chronological age.

In special education, the scale may be used to evaluate children with school learning difficulties, attention deficit-hyperactivity disorder (ADHD), anxiety, lack of motivation, neurological, mental and sensorial disorders, delayed neuropsychomotor development and disorders in speech, writing and calculation[3,4].

Studies have also been found in different populations in the health area, including children with typical[5-7] and atypical motor development, congenital heart disease[8], Williams syndrome[9], autism[10] and children with Down syndrome[11]. These authors observed delayed motor development in these children by comparing the chronological and motor ages.

Within this context, and considering the importance of using the scale to act in evidence-based practices, this study aimed to respond the following guiding question: in which contexts has the MDS been used?

Therefore, the study aimed to perform an integrative review, to know, understand and analyze the studies that employed the Motor Development Scale as a tool for motor evaluation.

METHODS

This review followed the steps for integrative review proposed by Mendes, Silveira and Galvão[12].

The study used the databases *Scielo, Pubmed, Lilacs, Science Direct, Web of Science, Scopus* and *Cochrane,* by direct search using the keywords selected for the study and available in the Health Sciences Descriptors (DeCS) and the Medical Subject Headings (MeSH): *"Children"*, *"Motor Skills"*, *"Motor Skills Disorders"*. Using these descriptors, the following combinations were used with the aid of Boolean indicators AND and OR for search in the databases: *("Child* OR *"Motor Skills") AND ("Child" OR Motor Skills Disorders").*

The following inclusion criteria were considered: a) utilization of the Motor Development Scale; b) cross-sectional, case-control, cohort, randomized clinical trial or nearly experimental study; c) Publications from 2008 to March 2018; d) journals scored as B1 or higher according to the Qualis classification in the field of Physical Education, and with minimum impact factor of 0.08; e) studies published in Portuguese, English and Spanish languages.

Two investigators independently performed the search on the databases. The combinations of keywords were inserted, and the studies were recorded on a spreadsheet. Duplicated studies and those that did not meet the inclusion criteria were excluded. Following, the selected references were read in full text. The information was organized according to the following criteria: authors, year of publication, country of origin, age, population, objective, study design and main outcomes.

The criteria of methodological quality of cross-sectional studies were analyzed by the Loney scale[13]; longitudinal studies were assessed by the *Newcastle Ottawa quality assessment scale cohort studies (NOS)*[14], and the methodological quality of clinical trials was analyzed by the Physiotherapy Evidence Database scale (PEDro, 2011)[15]. The scoring of studies was performed by two independent examiners. In case of discordance, the studies were re-evaluated in combination until consensus was reached as to the final score.

Table 1 presents the analysis of methodological quality of cross-sectional studies by the *Loney* scale[13]. The items without scores in all studies refer to the lack of sample calculation (item 3) and blinding of examiners (item 5), which precluded the studies from reaching the methodological quality score advocated by the instrument (seven points).

Table 1. Methodological quality of cross-sectional studies (Loney)

References	Are the study methods valid?						What is the interpretation of results?	What is the applicability of results?	Total score
	1	2	3	4	5	6	7	8	
Fonseca, Beltrame, Tkac[16] (2008)	1	1	0	1	0	1	1	1	6
Rocha, Rocha, Bertolasce[17] (2010)	1	1	0	1	0	1	1	1	6
Rosa Neto, Santos, Xavier, Amaro[18] (2010)	1	1	0	1	0	1	1	1	6
Rosa Neto, Santos, Weiss, Amaro[19] (2010)	1	1	0	1	0	1	1	1	6
Medina e Marques[20] (2010)	1	1	0	1	0	1	1	1	6
Goulardins, Marques, Casella[21] (2011)	1	1	0	1	0	1	1	1	6
Okuda et al.[22], (2011)	1	1	0	1	0	1	1	1	6
Camargos et al.[23], (2011)	1	1	0	1	0	1	1	1	6
Goulardins et al.[24], (2012)	1	1	0	1	0	1	1	1	6
Rosa Neto et al.[25], (2013)	1	1	0	1	0	1	1	1	6
Santos, Neto, Pimenta[26] (2013)	1	1	0	1	0	1	1	1	6
Torquato et al.[27], (2013)	1	1	0	1	0	1	1	1	6
Bucco-Santos e González[28] (2013)	1	1	0	1	0	1	1	1	6
Silva; Dounis[29] (2014)	1	1	0	1	0	1	1	1	6
Santos et al.[30], (2015)	1	1	0	1	0	1	1	1	6
Rosa Neto et al.[31], (2015)	1	1	0	1	0	1	1	1	6
Silva et al.[32], (2016)	1	1	0	1	0	1	1	1	6

Legend: 1- Are the study design and sampling appropriate to respond the study question? **2**- Is the sample adequate? **3**- Is the sample size adequate? **4**- Are adequate and standardized objective criteria used to assess the motor development? **5**- Was the MDS applied in an unbiased manner? **6**- Was the response rate adequate? **7**- Were the results of MDS presented in detail? **8**- Are the participants and context described in detail and can they be generalized for other situations?

Table 2 presents the methodological quality of nearly experimental studies, assessed by PEDro[15]. The studies had no scores in items related to the random distribution of groups (item 2), lack of subject blinding (item 5), therapists (item 6) and examiners (item 7). Therefore, the studies did not reach the methodological quality score advocated by the instrument (seven points).

Table 2. Methodological quality of nearly experimental studies (PEDro)

	Physiotherapy Evidence Database **(PEDro)**										
Studies	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total Score**
Fernani et al.[33], (2013)	1	0	0	1	0	0	0	1	1	1	5
Silva et al.[34], (2017)	1	0	0	1	0	0	0	1	1	1	5

Legend: 1- Specified eligibility criteria; **2**- Subjects randomly distributed into groups; **3**- Blind allocation of subjects; **4**- Groups were similar concerning the most important indicators of prognosis; **5**- Blinded individuals; **6**- Blinded therapists; **7**- Blinded examiners; **8**- Measurements of at least one key outcome were obtained in more than 85% of individuals initially distributed between groups; **9**- All subjects whose results were measured either received the treatment or the control condition according to the allocation or, when was not the case, data were analyzed for at least one of the key outcomes by "intention to treat"; **10**- The results of statistical comparisons between groups were described for at least one key outcome.

Table 3 presents the methodological quality of the longitudinal study by the *NOS*[14], and the study did not score in items related to sample calculation (item 1 - selection), sample randomization (item 2 - selection), comparability of cohorts (items 1a and 1b – comparability) and lack of blinding of therapists and examiners (item 1 – results). Therefore, the study did not reach the methodological quality score advocated by the instrument (seven points).

Table 3. Methodological quality of longitudinal study (NOS)

Studies	NOS – items scores									
Criteria	Selection 1	Selection 2	Selection 3	Selection 4	Comparability 1a	Comparability 1b	Results 1	Results 2	Results 3	Total Score
Santos et al.[35], (2016)	0	0	1	1	0	0	0	1	1	4

Legend: selection 1: representativity of exposed cohort; **selection 2**: selection of unexposed cohort; **selection 3**: determination of exposure; **selection 4**: demonstration that the result of interest was not present at study onset; **comparability 1a** and **1b**: comparability of cohorts based on the design or analysis; **results 1**: evaluation of outcome; **results 2**: follow-up of cohorts; **results 3**: adequacy of follow-up of cohort

LITERATURE REVIEW

The electronic search retrieved 144 papers published in Portuguese, English and Spanish, among which 20 met the inclusion criteria (Figure 1).

The studies organized according to the aforementioned criteria are presented in Figure 2.

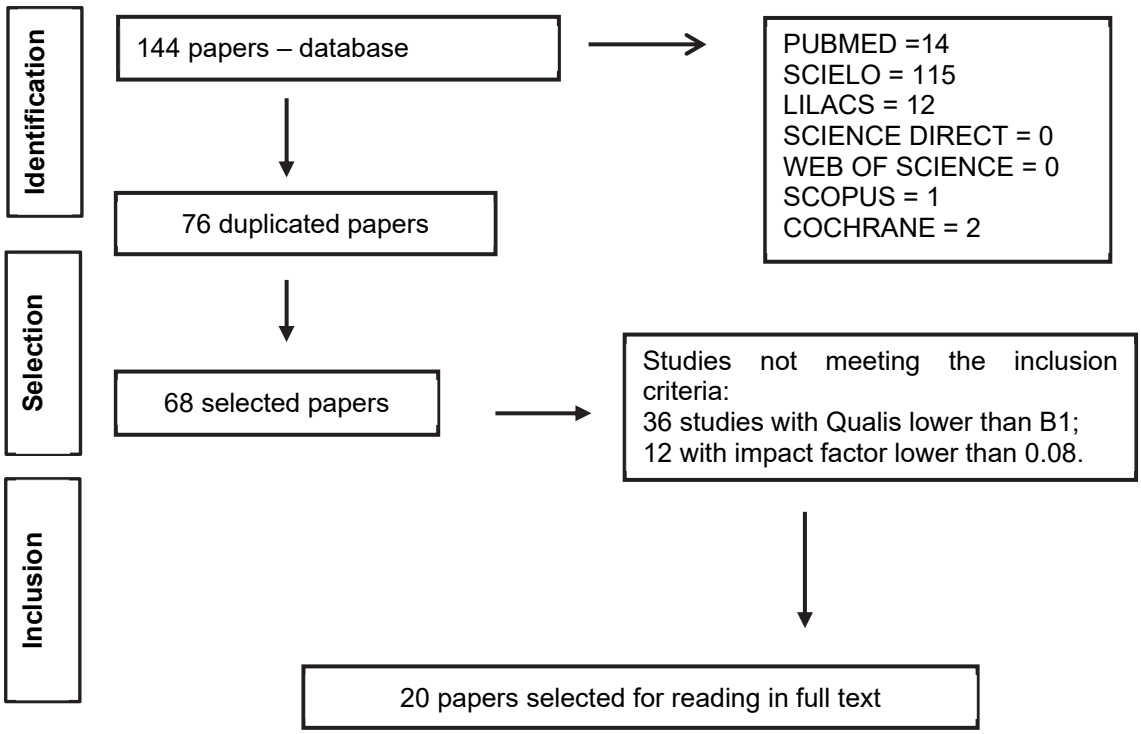

Figure 1. Flowchart of stages for references search

AUTHORS	YEAR	COUNTRY	AGE	SAMPLE	OBJECTIVE	STUDY DESIGN	OUTCOMES
Fonseca et al.[16]	2008	Brazil	6 to 9 years	40 children in fundamental school.	To analyze the motor development.	Cross-sectional	Motor quotient scored as "normal low" to "much higher" by the MDS.
Rocha et al.[17]	2010	Brazil	6 to 9 years	GI: 40 children initiating futsal. GII: 40 children practicing futsal for at least six months.	To investigate the contributions of sports initiation for the motor development.	Cross-sectional	Children with more than six months of practice presented higher means of general motor age than chronological age.
Rosa Neto et al.[18]	2010	Brazil	6 to 10 years	101 schoolchildren in fundamental school.	Analysis of reliability of MDS.	Cross-sectional	High correlation between chronological and general motor age indicated good internal consistency (0.889) and reliability of the MDS.
Rosa Neto et al.[19]	2010	Brazil	6 to 10 years	101 schoolchildren in fundamental school.	Analysis of internal consistency of fine motricity tests of the MDS.	Cross-sectional	High correlation between thin and general motor ages indicated good internal consistency (0.834) of the de tests.
Medina et al.[20]	2010	Brazil	8 to 10 years	30 children with learning difficulty.	To evaluate the motor impairment.	Cross-sectional	The motor age was lower than the chronological age in all tests analyzed.
Goulardins et al.[21]	2011	Brazil	7 to 10 years	14 children com ADHD.	To evaluate the psychomotor profile of children with ADHD.	Cross-sectional	The motor age was lower than the chronological age in all tests analyzed.
Okuda et al.[22]	2011	Brazil	6 to 11 years	GI: 11 schoolchildren with ADHD. GII: 11 schoolchildren with dyslexia.	To compare the performance of fine motor coordination in schoolchildren using the MDS.	Cross-sectional	The thin motor age was lower than the chronological age for both groups.
Camargos et a.l[23]	2011	Brazil	7 and 8 years	13 premature children. 13 children born full term.	To compare the motor development of premature to full-term children.	Cross-sectional	Premature group: lower performance in motor age and motor quotient (fine motricity) compared to full-term children.
Goulardins et al.[24]	2012	Brazil	7 to 11 years	GI: 34 children with ADHD. GII: 32 typical children.	To evaluate the motor profile of children with ADHD.	Cross-sectional	Children with ADHD achieved a mean age of -12.8 months. Children with typical motor development, mean age – 3.9 months.
Rosa Neto et al.[25]	2013	Brazil	8 to 9 years	166 schoolchildren in fundamental school.	To analyze the cross laterality of schoolchildren with application of MDS.	Cross-sectional	57.8% of children presented complete right laterality, 33.1% "cross" laterality, 7% "undefined" and 2% "left".
Santos et al.[26]	2013	Brazil	8 to 9 years	GI: children not participating in projects. GII: participants of social projects. GIII: participants of sports projects.	To evaluate and compare the motor abilities of schoolchildren.	Cross-sectional	The GIII presented motor quotient scored by the MDS as middle normal in relation to GII (low normal) and GI (low).
Torquato et al.[27]	2013	Brazil	4 to 13 years	33 children with Down syndrome.	To analyze the motor development of children with Down syndrome who practice equine therapy and conventional physiotherapy.	Cross-sectional	Equine therapy group: normal low motor quotient in balance and very low in global motricity. Physiotherapy group: middle normal motor quotient in balance and in global motricity.

AUTHORS	YEAR	COUNTRY	AGE	SAMPLE	OBJECTIVE	STUDY DESIGN	OUTCOMES
Bucco-dos Santos et al.[28]	2013	Spain	6 to 10 years	GI: 100 (normal weight). GII: 90 (overweight). GIII: 94 (obesity).	To analyze the motor profile of children with overweight/ obesity	Cross-sectional	The GIII presented negative motor age in all skills tested by the MDS compared to the chronological age.
Silva et al.[29]	2014	Brazil	9 to 11 years	43 children in fundamental school.	To delineate the motor development profile of children with low school performance.	Cross-sectional	The results demonstrated mean of 25.4 months of motor delay in relation to the chronological age (negative age).
Santos et al.[30]	2015	Brazil	7 to 10 years	Control group: 40 boys and 40 girls. Systematic practice group: 40 girls practicing ballet and 40 boys practicing futsal.	To verify the impact of sports practice in schoolchildren.	Cross-sectional	The general motor quotient was scored as higher in the systematic practice group compared to the schoolchildren group.
Rosa Neto et al.[31]	2015	Brazil	5 to 10 years	GI: 50 children with clinical diagnosis of ADHD. GII: 150 typical children.	To compare the motor development of children com ADHD and typical children.	Cross-sectional	Children with ADHD: negative motor age of almost 24 months compared to typical children.
Silva et al.[32]	2016	Brazil	3 years	GI: 10 premature children. GII: 10 children born full term.	To compare the motor development of premature and full-term children.	Cross-sectional	The group of full-term children presented significant differences in relation to the premature children in thin and gross motor skills, spatial and temporal organization.
Fernani et al.[33]	2013	Brazil	6 to 11 years	28 children with delayed motor development and learning difficulty.	To evaluate the motor development before and after application of motor intervention.	Nearly experimental	The general motor quotient was chanted from normal low to middle normal in most children.
Silva et al.[34]	2017	Brazil	8 to 10 years	CG: 27 children (physical education). EG: 27 children (psychomotor intervention).	To evaluate the effects of an intervention program in schoolchildren aged eight to 10 years from public schools.	Nearly experimental	GE: advances in fine motricity and balance in relation to the control group.
Santos et al.[35]	2016	Brazil	6 to 24 months/ 8 to 9 years	Children with delayed motor development assessed between 6 and 24 months.	To analyze the biopsychosocial profile of children with delayed motor development.	Longitudinal	The general motor quotient (GMQ) revealed delayed motor development over time. In the nursing period the children were scored as "middle normal" (GMQ=95.48) and over the years as "low" (GMQ=75.23).

Legend: GI: group I; GII: group II; GIII: group III; MDS: motor development scale; ADHD: attention deficit-hyperactivity disorder; CG: control group; EG: experimental group.

Figure 2. Studies applying the Motor Development Scale

Concerning the categorization, regarding language, 65% of studies were published in Portuguese, 30% in English and 5% in Spanish. Regarding the country of origin, all were conducted in Brazil. With regard to the journal, 90% of studies were published in national journals, and 10% in international. Among the selected studies, 85% were cross-sectional, presenting clear results concerning the objective.

Two studies in schoolchildren included validation of motor tests of the instrument and revealed high correlation between chronological age and general motor age, indicating good internal consistency of the MDS,[18,19] and the children did not present delayed motor development.

In schoolchildren participating in sports social projects, the outcomes revealed advantages in

the performance of all abilities tested by the MDS compared to children who did not participate[26]. Similar results were observed for the systematic practice of physical activity[30]. Children who participated in futsal for more than six months even presented higher motor age than the chronological age[17].

The main outcomes in this population demonstrated the importance of access to physical activity for the motor development. The scientific evidences highlight these outcomes[28,29,36], since the sports practice positively influences the child development. The investigators demonstrated that children with lower performance in locomotor skills are physically less active and motivated than children with greater motor skills[28]. The opportunity of access to physical activity, not necessarily monitored physical exercise, is a means to enhance the development and social aspects. Motor intervention programs also aided the acquisition of these abilities[3,34].

The study proposed by Fernani et al.[33] demonstrated that children with learning difficulties had improved results in body scheme, spatial and temporal organization tests. Schoolchildren submitted to a motor intervention program presented enhanced fine motricity and balance[34].

The instrument has been used mainly for children with learning difficulties[20,33,36,37] and ADHD[21,22,24,31,38], and the authors demonstrated an intrinsic correlation between motor development and learning[25,29,33]. Studies in children with attention deficit-hyperactivity disorder (ADHD)[21,22,24,31] evidenced that the motor age was lower than the chronological age in all studies, similar to investigations on children with learning difficulties[29,33] and prematurely born[23,32].

The study conducted on children with Down syndrome evidenced negative motor age[27]. However, the evidence-based practice demonstrated that the type of stimulation may influence the motor development of these children in different manners[11]. The study on children with overweight and obesity revealed significant delay in the motor development of participants, with negative impact on the obese[28].

Schoolchildren with learning difficulties and low socioeconomic level presented delayed motor development during school age compared to the nursing period[35].

Most studies found in this review were conducted on children with typical motor development, and concerning sampling, the "n" was larger in this population[16-20]. As observed, larger samples are expected in studies for situational diagnoses, such as those using this scale on schoolchildren. Conversely, smaller samples were observed for children with atypical motor development[27], even due to the difficulty of previous clinical diagnosis.

Only one study on Down syndrome was conducted on children younger than 7 years[27]. At older age ranges, emphasis is given to studies on children with typical motor development, in whom the school environment was the main focus of studies, considering the ease to achieve a larger and more homogeneous sample.

The studies revealed that the MDS is a tool that allows the identification and analysis of motor development in childhood, addressing all relevant aspects of psychomotricity.

CONCLUSION

The integrative review allowed to identify that the MDS has been used in Brazil, in different contexts. Most studies were cross-sectional, with participants above 6 years of age, and were conducted in the population of schoolchildren with typical motor development and those with atypical one. The outcomes indicated detailed scientific evidences concerning the motor development of these populations, even though the studies did not meet the standards of methodological quality advocated by the assessment instruments employed.

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