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Correlation between clinical measurement scales on gross motor function in children with spastic cerebral palsy

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Abstract

Background Children with cerebral palsy (CP) may have different gross motor impairments which in sequence affecting their life occupations. The purpose of the study is to investigate the correlation between Gross Motor Function Measurement-66 (GMFM-66), the test of Bruininks-Oseretsky Motor Proficiency (BOTMP), and the Peabody Developmental Motor Scale–Second Edition (PDMS-2) in young children with CP.

Methods A correlational study was applied on 50 children aged from 4 to 6 years (30 girls, 20 boys) with spastic CP.

Results The Pearson correlation coefficient between the GMFM scale and PDMS-2 motor quotients, and its subscales (stationary, locomotion, and object control) and also between GMFM and BOTMP gross motor quotients and its subscales (strength, agility, and body coordination) were statistically significant. Spearman's coefficients between the grade of the Gross Motor Classification System (GMFCS) and the PDMS-2 Gross Motor Composite, BOTS-2, and its subscale results were also statistically significant.

Conclusion The three measurement scales, GMFM- 66, BOTS-2, and PDMS-2, are significantly related. Therefore, GMFCS is useful in predicting movement performance in children with CP and correlated with predictive guidance in treatment development.

Trial registration ClinicalTrials.gov Identifier: NCT06124352.

Keywords Clinical measurement scales, Gross motor function, Spastic cerebral palsy

Background

Cerebral palsy (CP) is a non-progressive but long-term disorder characterized by weakened posture and movement due to neurological and physical disabilities leading to restrictions of activity [1]. Cortical damage causes several types of motor impairment and neurologic impairments, such as spasticity. These influences interact to increase muscle tone and resistance to passive movements of the lower limbs [2]. Therefore, an increase of muscle tone results in excessive energy loss during activities of daily living [3].

Children with CP had experience various impairments, and their participation in life situations may vary due to changes in level of activity [4]. Reduced selective movement control due to abnormal movement coordination interferes with isolated joint measurements that affect functional patterns such as walking and manipulation [5]. Reduced muscle action is often associated with muscle weakness, hypertonia, and muscle shortening [6].

Evaluating and applying an early and consistent rehabilitation approach to children with neurological impairments requires a multidisciplinary approach that involves different specialists including pediatricians, pediatric neurologists, professional therapists, and pediatric

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physical therapists. Evaluation of children with disabilities is essential to validate the judgment, monitor the progress, and evaluate the mechanical function and related difficulties affecting motor performance [7, 8].

There is not enough information in this area about mobility problems affecting child's contribution in everyday life. While gross motor function is usually measured in CP children, accurately observing and measuring movement skills are challenging for therapists [9]. Various measurement implements for assessing motor skill functioning in young children are presented. Many of these tools target a defined set of conditions and have specific content [10, 11].

To date, assessment tools for measuring the impact of physiotherapy in CP children in clinics that are GMFM, PDMS-2, BOTMP, and the Functional Independence Measurement Scale (Wee FIM) have been widely used. Uncontrolled movements that appeared in young children with CP due to loss or inability to control their balance considered the most significant factor in defining movement impairment [12, 13].

Measurement kits are used for CP patients to quantify efficient functioning as a standard expressive evaluation, choose management areas, and assess consequences [14]. Progressing concern in the research extents to advance and usage highly reliable, valid, and consistent implements as effective measures, and their correlation with each other is considered significant for evidence-based research. The principal aim of this cross-sectional study is to find the relationship between the clinical measurement scales for gross motor function in young CP children [15].

Methods

Participants

In this single-group cross-sectional study design, 50 participants with diplegic CP from the ages of 4 and 6 years evaluated in a physical therapy outpatient clinic and receiving a physiotherapy program for at minimum 6 months were included. Four out of 54 children were unwilling to complete the required assessments and eliminated from the final analysis due to their incomplete data.

Inclusive criteria of participants concerned to children with spastic CP with the capability to keep a standing position alone for at minimum five seconds, and the grade of hypertonicity in the lower extremity varied from grade 1 to grade 2 on the modified Ashworth scale with the capability to collaborate and follow directives. Participants were ignored if they had a serious neurological condition (epilepsy), orthopedic complications, leg operations, treatment with botulinum toxin in the lower extremity in the last 6 months before the study, and if suffered from advanced intellectual disability.

Outcome measures

Before managing the study, consent formulae that defined purposefulness and detailed procedure of the study were offered to the contributors and their parents. The Faculty of Physical Therapy Research Ethical Committee provided approval number REC\012\004460 for this cross-sectional study, before starting the study. The study was started in May and completed in August 2023. Assessment grades were given by one pediatric physical therapist who had an experience in pediatric rehabilitation.

First, GMFM-66 was performed for participants established on self-independent motion, with importance on allocations, and motion. The emphasis is to detect the grade that greatest reveals the current skills and disabilities of the child regarding motor functions. The new Gross Motor Ability Estimator (GMAE) scoring method for test–retest reliability data showed a high level of stability of the GMFM-66 over time (ICC = 0.9932) that did not differ since the original GMFM 88-item test–retest reliability [16, 17].

The points of GMFM-66 were assessed by scoring done through a four-criteria regular scale (0, does not initiate; 1, initiates 10% of activity; 2, partially completes 10% to 100% of activity; 3, completes activity). The points of measure are observed, assessed, and classified into 5 extents: (a) lying and rolling (17 items); (b) sitting (20 items); (c) crawling and kneeling (14 items); (d) standing (13 items); and (e) walking, running, and jumping (24 items). The entire grade is gained through the percentage scores through the 5 domains that were computed using the GMAE package that examines the level scale of the GMFM-66 [18].

The GMFCS categorizes the motor functions of children into 5 levels that classify a child's motion ability: as level I is walking without constraints; level II is walking without limits but with limitations walking outside; level III is walking with assistive movement equipment, but with restrictions walking outside and in the external environments; level IV is self-motion with restrictions; and level V is independent -motion that is severely limited, in spite of the use of assistive devices [19].

The BOT-2 scale is used to evaluate motor function and skill development. It is expended to classify children with movement control limitation. The scale is appropriate for those who aged from 4 to 21 years. The interrater reliability ranges from 0.92 to 0.99 and constructs validity ($r = 0.78$; 0.56–0.86) [20].

The BOT-2 test comprises of subtests that gradually increase in difficulty. The BOT-2 short form includes fourteen items from the BOTMP complete form. The

test's reliability and validity have been evaluated with a coefficient of 0.78 [21].

The scoring system for assessing gross motor skills varies for each individual variable, fluctuating from a two to a thirteen-item scale. Raw scores can be converted into percentile ranks for two composites: a body coordination composite (including bilateral coordination and balance) and a strength and agility composite (including running speed, agility, and strength). The time required to assess an individual using the short form varies between 15 and 20 min for both composites [22, 23].

The PDMS-2 is a consistent test that evaluates a child's movement skills. It is norm-referenced and consists of three composites: fine motor (FM), gross motor (GM), and total movement composites (TM). GM composite incorporates 151 points from four sub-tests: reflexes, stationary, locomotion, and object manipulation. A 3-point scale scored for each item, with 2 being the highest score. Definite criterion for grade of 2 is given when achieving score successfully, 1 is given when the action is developing but not fully met, and 0 is given when the child cannot achieve the point. The highest raw scores of the sub-tests range from 16 to 198. The test–retest reliability of PDMS-2 was found to be $r=0.85$ [24, 25].

The PDMS-2 GM composite (stationary; 7 items, locomotion; 12 items, and object manipulation; 5 items) was administered affording to the child's age included in the study through snapshot evaluation representing gross motor function. Depending on the outcomes from the raw scores for every subscale of the PDMS-2, the average scores and developmental age equivalents on the subscale should be attained from the standards of PDMS-2's manual [26].

The total evaluation time for three measurement scales persisted approximately 90 min. If the children were uninterested or unmotivated, the assessments were accomplished during the following session. For this study, a correlation between these 3 categories of clinical measures scales was analyzed in diplegic patients.

Sample size calculations

Using exact, correlation to bivariate normal model with effect size = 0.35, power = 80%, $\alpha=0.05$, and with G*Power statistical software (version 3.1.9.7, Germany) were used for estimating the sample size and showed that the required sample is 49 children [27]. Fifty-four children were enrolled for possible dropouts, so the total number of children enrolled in the study is equal to 50.

Data analysis

The study involved calculating the mean and standard deviation of children's characteristics, as well as the frequency distribution of GMFCS. Correlation coefficients were used to investigate the association among clinical measurement scales. Pearson product-moment correlation coefficient (r) was analyzed for variables on the ratio scale (GMFM with PDMS-2 gross motor composite and BOT-2 motor quotient), while Spearman rank correlation (r_s) was used for variables on an ordinal scale (GMFCS with GMFM, PDMS gross motor composite, and BOTS motor quotient). Correlations were considered significant with p value of less than 0.05. The statistical analysis was carried out by IBM SPSS, version 25, in Chicago, IL, USA.

Table 1 Descriptive statistics for participant's variables

	Mean (SD)	Minimum value	Maximum value
Age	5.11 (0.59)	4	6
Weight (kg)	29.24 (1.12)	28	31
Height (cm)	110.52 (1.04)	109	112

Table 2 Frequency distribution of GMFCS and gender for participants

	Frequency	Percent (%)
GMFCS		
Level I	35	70%
Level II	10	20%
Level III	5	10%
Gender		
Boys	20	40%
Girls	30	60%

Results

In this study, 50 children diagnosed with diplegic CP which were selected according to sample size calculation. The average age was 5.11 ± 0.59, weight was 29.24 ± 1.12, and height was 110.52 ± 1.04 representing similar baseline characteristics between the participants which are displayed in Table 1. GMFCS frequency distribution (level I (70%), level II (20%), and level III (10%)), and gender (boys (40%) and girls (60%)) are calculated and shown in Table 2.

Table 3 summarizes the significant Pearson (r) positive correlation coefficients between GMFM and the BOT-2 gross motor quotient with its subscales (strength and agility and body coordination subscales) with $r=0.821$, 0.884, and 0.883 respectively, with p value < 0.01. Also, significant Pearson (r) positive correlation coefficients between GMFM with PDMS-2 gross motor composite and its subscales (stationary, locomotion, and object

Table 3 Correlation between GMFM, PDMS-2, and BOT-2 variables

	PDMS gross motor quotient	Stationary subscale of PDMS	Locomotion subscale of PDMS	Object control subscale of PDMS	BOT gross motor quotient	Strength and agility subscale of BOT	Body coordination subscale of BOT	GMFM-66
GMFM-66	$r=0.843$ $p=0.0001$	$r=0.793$ $p=0.0001$	$r=0.791$ $p=0.0001$	$r=0.873$ $p=0.0001$	$r=0.821$ $p=0.0001$	$r=0.884$ $p=0.0001$	$r=0.883$ $p=0.0001$	
Body coordination subscale of BOT	$r=0.697$ $p=0.0001$	$r=0.746$ $p=0.0001$	$r=0.610$ $p=0.001$	$r=0.847$ $p=0.0001$	$r=0.782$ $p=0.0001$	$r=0.802$ $p=0.0001$		
Strength and agility subscale of BOT	$r=0.724$ $p=0.0001$	$r=0.777$ $p=0.0001$	$r=0.811$ $p=0.0001$	$r=0.83$ $p=0.0001$	$r=0.755$ $p=0.0001$			
BOT gross motor quotient	$r=0.626$ $p=0.001$	$r=0.854$ $p=0.0001$	$r=0.723$ $p=0.0001$	$r=0.799$ $p=0.0001$				
Stationary subscale of PDMS	$r=0.654$ $p=0.0001$							
Locomotion subscale of PDMS	$r=0.650$ $p=0.0001$	$r=0.644$ $p=0.001$						
Object control subscale of PDMS	$r=0.775$ $p=0.0001$	$r=0.788$ $p=0.0001$	$r=0.783$ $p=0.0001$					
GMFCS	$r_s=$—**0.754** $\boldsymbol{p=0.0001}$				$r_s=$—**0.759** $\boldsymbol{p=0.0001}$	$r_s=$—**0.794** $\boldsymbol{p=0.0001}$	$r_s=$**-775** $\boldsymbol{p=0.0001}$	$r_s=$**-0.934** $\boldsymbol{p=0.0001}$

r Pearson correlation coefficient, r_s Spearman correlation coefficient table

control) were $r=0.843$, 0.793, 0.791, and 0.873 respectively, with a p value < 0.01. Significant Spearman (r_s) negative correlation coefficients between GMFCS and PDMS-2 gross motor composite, BOT-2 gross motor quotient, and GMFM were $r=$—0.754,—0.759, and—0.934 respectively, with a p value < 0.01.

Discussion

Apparently, this is the primary study that explores the relation among PDMS-2, BOTS, GMFM, and GMFCS for children with spastic diplegic. We believe that this study can serve as an introduction to pediatricians and pediatric physical therapists on the advancements made in CP's movement skills. It is important to make the relevance of using these instruments clear to health professionals and explain how they can improve the capability to maintain movement skill for CP children.

The purpose of correlations for evaluating CP children is to aid in interaction among professionals, identify similar clusters of children for experimental research studies, develop rating scales to measure progress or regression over time, and ultimately, to equivalent specific children with treatment more effectively.

The GMFM and BOT-2 assessments are extensively used in both experimental and research settings. Validation of the three systems is already previously established. Using a combination of these tools could provide a practical and straightforward way to define the movement skill levels for children with CP.

Several studies have shown that PDMS-2 is dependable for experts that emphasizes on the achievement or progress of motion skills in CP children. Sensitivity to change alone is not enough for a scale to be considered meaningful or relevant to decision-makers. Therefore, the sensitivity for each scale would also be considered. It has been found that the PDMS-2 test has acceptable responsiveness for children with CP, as revealed by studies [28].

Our study designed to explore the correlation amongst the GMFM, BOT-2, PDMS-2, and GMFCS on 50 children with CP. The results of our analysis showed a strong correlation between the clinical scales. Specifically, the GMFM had the highest correlation scores with the BOT-2 and the object control subtest of the PDMS-2. Additionally, we found a significant correlation between the GMFM and the GMFCS. These findings suggest that motor function is more effective in tasks involving object manipulation and locomotion.

When selecting a movement assessment tool for educational research purposes, it is significant to study various factors. The purposefulness of the evaluation should be considered, including whether it is for overall motor competence gross motor skill, or assess the incidence of movement dysfunction. Additionally, the age specificity and relevance of the test, as well as the simplicity of the

instructions and demonstrations, should be considered. It is also the principle to select a test that is easy for examiners and observers to administer and to ensure that there is cultural resemblance between the standard and the test group. Finally, the percentage of tested items should be considered to ensure that the test time is appropriate [29].

A child's skill to handgrip objects and develop classification systems is influenced by their motivation and cognitive ability. If a child lacks motivation, does not understand a task, or consistently seeks help from adults, their classification and functional status should be based on their definite functioning, though they have the potential for advanced competence [30].

It has been reported that numerous motor assessments for disabled children do not supply discrete standards for gender, despite strong gender variances in gross and fine motor functions. Additionally, there can be significant divergences concerning children of the similar age interval, particularly when analyzing total test scores. It is essential for scale users to be responsive for little relationship amongst diverse motion tests. Unfortunately, there are no certain age norms for the achievement of fundamental movement skills. Assessment of motor function is complex and suggests the multifactorial nature of movement, including the potential occurrence of sex or social alterations, as well as the great difference in children of the similar age. To ensure accuracy in the judgment process, it is recommended to use more than one assessment tool [31].

Assessment tools such as BOT-2 and PDMS-2 are more suitable for lesser groups of children due to their complexity. However, they are time-consuming. PDMS-2 provides independent scoring for motor skills, which enables evaluation of relative differences in performance from birth to 6 years of age. In agreement with another study, BOTMP and its second edition are convenient for evaluating variations in motor function [32].

The limitation of the study

Based on our research, we recommend that future studies in this field should prioritize investigating IQ levels and co-morbid circumstances. Subsequent research should focus on emphasizing these correlations on the other clinical types of CP as this study applied on only spastic diplegic children. Additionally, gender and cultural differences should be considered as restraints of this study that need to be adopted.

Conclusion

From our findings, we conclude that all the scales used in our study are effective, concise, and complementary in assessing the motor function that is crucial for daily living activities.

Hence, the application of GMFM, GMFCS, BOT-2, and PDMS-2 in both practical and research domains will offer a hassle-free, pragmatic, and uncomplicated evaluation of functional condition of CP children, as the main aim of the study was to test the variances and correlation concerning gross motor function measures in children with CP.

Most of the instruments used in studies aim to detect deficits in the development of movement skills. However, these tools are less commonly used to assess the variation in motor skill development among children with atypical development such as CP.

Consequences revealed strong association within measurements obtained from clinical scales, which suggests that one of these scales which is GMFM scale had higher correlation scores between measuring variables than other scales, so it could be utilized effectively to achieve the desired outcome of motor assessment for children with diplegic CP.

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Authors' contributions
SR designed the study, collected and analyzed the data, contributed to the writing of the initial draft, and revised the manuscript draught. AE conceptualized the study, provided direction guidance, and contributed to the writing and critical review of the manuscript. All named authors approved the final manuscript as submitted.

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Availability of data and materials
All the data presented in the main manuscript.

Declarations

Ethics approval and consent to participate
The faculty of Physical Therapy Research Ethical Committee provided approval number REC\012\004460 for this cross-sectional study, before starting the study.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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References

1. Ostensjø S, Carlberg EB, Vøllestad NK (2004) Motor impairments in young children with cerebral palsy: relationship to gross motor function and everyday activities. Dev Med Child Neurol 46:580–589. https://doi.org/10.1017/S0012162204000994

2. Voorman JM, Dallmeijer AJ, Knol DL et al (2007) Prospective longitudinal study of gross motor function in children with cerebral palsy. Arch Phys Med Rehabil 88:871–876. https://doi.org/10.1016/j.apmr.2007.04.002
3. Sanger TD, Chen D, Delgado MR et al (2006) Taskforce on childhood motor disorders: definition and classification of negative motor signs in childhood. Pediatrics 118:2159–2167. https://doi.org/10.1542/peds.2005-3016
4. Fowler EG, Staudt LA, Greenberg MB et al (2009) Selective Control Assessment of the Lower Extremity (SCALE): development, validation, and interrater reliability of a clinical tool for patients with cerebral palsy. Dev Med Child Neurol 51:607–614. https://doi.org/10.1111/j.1469-8749.2008.03186.x
5. Tedroff K, Knutson LM, Soderberg GL (2006) Synergistic muscle activation during maximum voluntary contractions in children with and without spas- tic cerebral palsy. Dev Med Child Neurol 48:789–796. https://doi.org/10.1017/S0012162206001721
6. Pavão SL, Barbosa KA, Sato TO et al (2014) Functional balance and gross motor function in children with cerebral palsy. Res Dev Disabil 35:2278–2283. https://doi.org/10.1016/j.ridd.2014.05.024
7. Leemrijse C, Meijer OG, Vermeer A et al (1999) Detecting individual change in children with mild to moderate impairment: the standard error of measurement of the Movement ABC. Clin Rehab 13:420–429. https://doi.org/10.1191/026921599467549188
8. Palisano RJ, Rosenbaum PL, Walter S et al (1997) Development and reliability of a system to classify gross motor function in children with cerebral palsy. Dev Med Child Neurol 39:214–223. https://doi.org/10.1111/j.1469-8749.1997.tb07414.x
9. Kroes M, Vissers YLJ, Sleijpen FAM et al (2004) Reliability and validity of a qualitative and quantitative motor test for 5- to 6-year-old children. Eur J Paediatr Neurol 8:135–143. https://doi.org/10.1016/j.ejpn.2004.01.007
10. Haywood KM, Getchell N (2005) Life span motor development, 4th edn. Human Kinetics, Champaign
11. Ottenbacher KJ, Msall ME, Lyon N et al (2000) The WeeFIM instrument: its utility in detecting change in children with developmental disabilities. Arch Phys Med Rehabil 81:1317–1326. https://doi.org/10.1053/apmr.2000.9387
12. Russell DJ, Rosenbaum PL, Cadman DT et al (1989) The gross motor function measure: a means to evaluate the effects of physical therapy. Dev Med Child Neurol 31:341–352. https://doi.org/10.1111/j.1469-8749.1989.tb04003.x
13. Dumas HM, Haley SM, Fragala MA, Steva BJ (2001) Self-care recovery of children with brain injury: descriptive analysis using the Pediatric Evaluation of Disability Inventory (PEDI) functional classification levels. Phys Occup Ther Pediatr 21:7–27. PMID: 12029856
14. Netelenbos, J.B. Motorische ontwikkeling van kinderen, (2001a) handboek 1, introductie. Boom, Amsterdam. https://hdl.handle.net/1871.1/35662af8-8fd9-4a3b-8bee-691e36ad07a9.
15. Netelenbos, J.B. Motorische ontwikkeling van kinderen, (2001b) handboek 2, theorie. Boom, Amsterdam.
16. Bjornson KF, Graubert C, McLaughlin JF et al (1998) Test-retest reliability of the gross motor function measure in children with cerebral palsy. Phys Occup Ther Pediatr 18(2):51–61. PMID: 17091035
17. Nordmark E, Ha"gglund G, Jarnlo GB (1997) Reliability of the gross motor function measure in cerebral palsy. Scand J Rehabil Med 29:25–28. PMID: 9084102
18. Bjornson KF, Graubert C, McLaughlin JF et al (1994) Inter-rater reliability of the gross motor function measure. Dev Med Child Neurol. 80:873–885. https://doi.org/10.1093/ptj/80.9.873
19. Morris C, Galuppi BE (2004) Rosenbaum PL Reliability of family report for the gross motor function classification system. Dev Med Child Neurol 46:455–460. https://doi.org/10.1017/s0012162204000751
20. Bruininks RH, Bruininks BD (2005) Test of motor proficiency, 2nd edn. Manual.: AGS Publishing, Circle Pines
21. Bruininks RH (1978) Bruininks Oseretsky test of motor proficiency. American Guidance Service, Circle pines-Minnesota
22. Duger T, Bumin G, Uyanik M et al (1999) The assessment of Bruininks-Oseretsky test of motor proficiency in children. Ped Rehab 3(3):125–131. https://doi.org/10.1080/136384999289531
23. Hassan MM (2001) Validity and reliability for the Bruininks-Oseretsky-test of motor proficiency-short form as applied in the United Arab Emirates culture. Percept Mot Skills 92:157–166. https://doi.org/10.2466/PMS.92.1.157-166
24. Folio, M.R. and Fewell, R.R. Peabody developmental motor scales and activity cards. DLM teacher's resources, (1983) Allen- Texas. url={https://api.semanticscholar.org/CorpusID:41588889}
25. Darrah J, Magill-Evans J, Volden J et al (2007) Scores of typically developing children on the peabody developmental motor scales: infancy to preschool. Physic Occu Ther Pediatr 27(3):5–19. PMID: 17613453
26. Folio MR, Fewell RR (2000) Peabody developmental motor scales. Examiners manual. Pro-ED. Inc, Austin-Texas
27. Cohen J (1988) Statistical power analysis for the behavioral sciences, 2nd edn. Lawrence Erlbaum. Associates, Publishers, New Jersey
28. Tripathi R, Joshua AM, Kotian MS et al (2008) Normal motor development of Indian children on Peabody Developmental Motor Scales-2 (PDMS-2). Ped Phys Ther 20(2):167–172. https://doi.org/10.1097/PEP.0b013e3181710340
29. Wang HH, Liao HF, Hsieh CL (2006) Reliability, sensitivity to change and responsiveness of Peabody developmental motor scales-second edition for children with cerebral palsy. Phys Ther 86(10):1351–1359. https://doi.org/10.2522/ptj.20050259
30. Yoon D, Scott K, Hill M (2006) Review of three tests of motor proficiency in children. Percept Mot Skills 102:543–551. https://doi.org/10.2466/pms.102.2.543-551
31. Morris C, Bartlett D (2004) Gross motor function classification system: impact and utility. Dev Med Child Neurol 46:60–65. https://doi.org/10.1017/s0012162204000118
32. Oeffinger DJ, Tylkowski CM, Rayens MK et al (2004) Gross motor function classification system and outcome tools for assessing ambulatory cerebral palsy: a multicenter study. Dev Med Child Neurol 46:311–319. https://doi.org/10.1017/s0012162204000519

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