



Reliability and validity of lower limb functional strength tests in children with bilateral cerebral palsy



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1. Introduction

Lower limb functional strength tests (FSTs) are clinically applicable evaluations of dynamic muscle strength [1]. Although they have been often applied in functional children and adults with cerebral palsy (CP) [1–4], their reliability and validity have only been tested in CP patients with rather high functional capacity.

2. Research Question

What are the reliability and validity of lower limbs FSTs in children with CP, GMFCS levels II and III?

3. Methods

Twenty-four children with bilateral CP (11.4 ± 2.5 yrs, GMFCS II/III:13/11) were recruited. Commonly described FSTs were adapted with upper limb support to the children's abilities where needed to ensure quality of execution. FSTs were repeated within one week to define the reliability. Total averaged scores were created separately for endurance strength and explosiveness. Composite lower limb isometric strength scores for the dominant and non-dominant limb were obtained from hand-held dynamometer assessments in a custom-designed chair [5]. Gait capacity (GC) was evaluated by Timed Up and Go (TUG) and 1-minute walking test (1MWT) and a composite score for selective motor control (SMC) combining multiple lower limb joint measures [6]. Associations of FST with isometric strength, GC and SMC were evaluated by means of Spearman's rank correlation coefficient to determine convergent validity. Known group validity was examined by comparing scores between GMFCS levels with the Mann Whitney U test ($p < 0.01$).

4. Results

FSTs' reliability ranged from good to excellent for all tests (Table 1A). There were no significant associations of FSTs with composite lower limb isometric strength scores. Both total FST endurance and explosive associated moderately with SMC ($r = 0.48/p = 0.017$ and $r = 0.64/p = 0.019$ respectively) and GC (TUG: $r = -0.65/p < 0.001$ and $r = -0.59/p = 0.035$, 1MWT: $r = 0.50/p = 0.013$ and $r = 0.63/p = 0.020$ respectively). Only averaged FST endurance showed a tendency to discriminate between GMFCS II and III ($p = 0.047$) (Table 1B).

5. Discussion

Strength endurance tests were feasible for most children, whether or not with upper limb support, but explosive strength tests were not feasible for children GMFCS level III. The reliability indices were similar to values obtained in more functional children [1–3], but previously reported moderate associations with isometric strength could not be confirmed by this investigation [2]. Functional and isometric tests evaluate different strength modalities. It is likely that upper limb support further confounded their relationship. The upper limb support may have influenced the scores to such extent that the endurance tests could not distinguish between two known groups. Yet, the ability to perform the explosive tests distinguished them almost perfectly. Nevertheless, associations with lower limb SMC and GC confirm part of its convergent validity. The associations with SMC represent the potential importance of inter- and intramuscular coordination during function, whilst the associations with GC indicate the importance of functional strength in mobility [7]. Concluding, FSTs are reliable and partially valid, but attention is required to changes in upper limb sup-

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Table 1
Reliability (A) and known-group validity (B) of functional strength tests.

		A. Reliability			B. Known-group validity				
		N	ICC (95% CI)	SEM	GMFCS II	GMFCS III	Mann Whitney U		
Functional strength test					N	Median (IQR)	N	Median (IQR)	P-value
Endurance	Sit to stand (n)	24	0.91 (0.81-0.96)	1.7	13	11.3 (7.2-12.8)	11	6.3 (5.7-13.7)	0.207
	Lateral step up dominant (n)	23	0.92 (0.83-0.97)	3.1	13	13.7 (10.0-20.7)	10	12.8 (6.4-15.0)	0.343
	Lateral step up non-dominant (n)	20	0.92 (0.80-0.97)	3.5	12	14.2 (10.4-20.1)	8	13.9 (9.5-16.2)	0.792
	Bilateral heel raise (n)	16	0.88 (0.70-0.96)	2.2	13	19.0 (13.1-23.1)	3	12.5 (11.7-12.5)	0.704
	Total averaged FST endurance (n)	24	0.97 (0.92-0.99)	2.2	13	14.9 (9.7-18.9)	11	10.5 (6.3-3.8)	0.047
Explosive	High jump (cm)	13	0.96 (0.88-0.99)	0.6	12	8.8 (6.4-10.2)	1	4.4 -	/
	Long jump (cm)	12	0.93 (0.73-0.98)	4.7	11	54 (40-67)	1	24.8 -	/
	Total averaged FST explosive (cm)	13	0.95 (0.83-0.99)	2.4	12	30.7 (18.6-38.3)	1	14.6 -	/

95% CI: 95% confidence interval, ICC: Intra-class correlation coefficient, IQR: inter-quartile range, N: number of participants, n: number of repetitions, SEM: standard error of measurement

port when evaluating intervention effects.

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