

ORIGINAL ARTICLE

Validity and Reliability of the Indonesian Version Gross Motor Function Measure to Measure Gross Motor Function in Cerebral Palsy Children

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ABSTRACTS

Objectives: Cerebral palsy (CP) is the most physical disabling disease in children. Gross motor capacity in CP usually measured and evaluated by Gross Motor Function Measure (GMFM), a standardized observational instrument to evaluate gross motor function. Studies showed GMFM reliable, valid, and responsive to change of CP gross motor function. This research aims to examine validity and reliability of GMFM translated into Indonesian.

Methods: Cross sectional study with consecutive sampling of CP children aged 2-15 years came to pediatric rehabilitation clinic at RSCM Medical Rehabilitation Department or YPAC Jakarta. Subjects classified by age, type, anatomical distribution, and severity. Gross motor function evaluated with 88 GMFM items translated into Indonesian. Inter-rater evaluated gross motor function through video records. Criterion validity tested by correlation coefficient, construct validity tested by comparing GMFM item with dimension total scores and GMFM total score with corrected Spearman correlation. Inter-rater reliability tested by unpaired T-test, internal consistency by alpha Cronbach.

Results: Thirty one CP children with mean age 7 years 11 months, mean GMFM score 58.40 (SD=49.09). No significant difference of all GMFM dimensions; almost all GMFM items obtained from inter-rater evaluation. Good internal consistency (*alpha Cronbach* 0.884) and good criterion validity of all dimensions; inter-item and total correlations good to strong ($r=0.523-0.859$).

Conclusion: GMFM Indonesian has good to strong criterion validity. Construct validity of all dimensions was quite good. Internal consistency was good. No significant difference between inter-raters showed GMFM inter-rater reliability good enough.

Keywords: Cerebral palsy, gross motor function, gross motor function measure, validity, reliability.

INTRODUCTION

The prevalence of Cerebral Palsy (CP) in the United States in 2002 is about 3.6 per 1,000 children of school age,¹ whereas in 2007 the prevalence of CP in Sweden is from 2.4 to 3 per 1000 children aged 4-11 years, except

for cases of CP postnatal.² Data from medical record in the Department of Physical Medicine and Rehabilitation at Cipto Mangunkusumo hospital (RSCM),³ found 303 new and old cases of CP or 23.76% of all outpatients of Paediatric Rehabilitation clinic of the Medical Rehabilitation Department throughout the year 2010.

Bax *et al.* 2005^{4,5} defines CP as a group of disorders of movement and posture developments, leading to activity limitations, due to non-progressive disorder of the brain of fetus or the developing baby. Motor disorders are often accompanied by disturbances of sensation, perception, cognition, communication, behavior, and epilepsy or

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secondary musculoskeletal problems.

Etiology of CP is multiple,⁶ with its risk factors can be divided into 3 periods of the prenatal, perinatal and postnatal.² A modified neurological classification system classifies CP in three categories, i.e. CP with pyramidal signs or spastic CP, CP with extrapyramidal signs (dyskinetic and ataxic CP), and mixed type. Spastic CP is classified according to topography or distribution of the affected body part, which are monoplegic, diplegic, hemiplegic, triplegic, and quadriplegic.⁷ Palisano *et al.*^{8,9} classifies the degree of CP according to their functional motor skills with the objective functional scale of Gross Motor Function Classification System (GMFCS). There are 5 categories level of function, which are GMFCS level I to V for four age groups: before 2 years, 2-4 years, 4-6 years, 6-12 years.⁹⁻¹⁰

According to the International Classification of Functioning, Disability and Health (ICF-WHO 2001),¹¹ the function of a human being can be classified, measured, and influenced in various dimensions, including the body structures and the body functions, as well as their activities and participation. Environmental factors, health and personal factors can also influence the children in running their functions.

CP affects the neurological development and the function of children in different levels, which will also influence the degree of impairments, activities and participation of the children. Assessment of activities of CP children in the form of gross motor capacity is generally examined and evaluated with the Gross Motor Function Measure or GMFM developed by Russell *et al.*, 2002. GMFM is a standardized observational instrument designed to evaluate changes in gross motor function in CP children. GMFM was developed by the Gross Motor Measures Group and used both in clinics and researches. GMFM is designed to assess how a child is able to do his/her physical activity, and not to measure how well these activities can be performed.¹²

There are two versions of GMFM, the original version of GMFM-88 and the latest version GMFM-66, which has fewer items yet assumed to be unidimensional. These items cover the spectrum of activities ranging from the position of lying, rolling, sitting, crawling, standing, to walking, running and jumping skills. Whole

items can be achieved by a 5-year-old boy with typical development of motor skills. These items represent five separately dimensions of motor functions. Items in prone and supine are combined to represent the dimension of Lying & Rolling; items in 4-point and kneeling are combined to represent Crawling & Kneeling dimension; items in Sitting and Standing are examined separately, whereas the items of walking, running, and climbing up the stairs represent the dimension of Walking Running & Jumping. Assessment of each GMFM item is done by using a 4-point ordinal scale that is consistent.

A value of 0 is given when the child is not able to start (a task that is being tested), a value of 1 is given when the child is able to start (<10% of task), a value of 2 is given when children complete some tasks (between 10% to <100%), while the value of 3 is given when the child has completed all the tasks (in accordance with the description of each criteria). When the test cannot be performed in children, it is marked as NT (not tested) on the scoring sheet.¹²

The examination of GMFM-88 takes about 45-60 minutes for someone who knows the measuring instrument. This is influenced by the skills of examiner, the child's ability level, and the level of cooperation of each child. GMFM is examined in a comfortable environment for children and an environment which is wide enough to accommodate all the necessary equipment so that children can be examined well and the GMFM measurement can be as accurate as possible. After examination of each item, GMFM scores in every dimension is summed, as well as the total score. The percentage for each dimension and the percentage of GMFM total score are calculated. GMFM-66 has less items, so time needed to do the examination will be shorter, but for calculations, the GMFM-66 required a computer program that is the Gross Motor Ability Estimator (GMAE). With GMAE, score of each item can be calculated and the conversion of ordinal scale into interval scale can be conducted.¹²

Various studies on the validity and reliability of the GMFM has been done in foreign countries and the results are very good, where the GMFM has proved a quite reliable, valid, and responsive to changes in gross motor function in children with CP.¹² GMFM has been

translated into various languages, and several validity and reliability of the GMFM translation have been conducted. This study aimed to test the validity and reliability of the GMFM translated into Indonesian, which has never been done before.

METHODS

The design of this study is cross sectional, with consecutive sampling method. The study populations were CP children who came to the rehabilitation clinic of the Physical Medicine and Rehabilitation Department of RSCM or those children who came to the Yayasan Pembinaan Anak Cacat (YPAC) Jakarta.

Subjects were between 2 to 15 years old, male or female, whose parents have allowed them to be included in the study and have filled out informed consent forms. Subjects were excluded if suffering from active epilepsy, hydrocephalus, visual disturbances, hearing loss, severe mental retardation, or other neuromuscular and musculoskeletal diseases; and when the subject experienced a fairly severe illness on the day of the test which will affect his/her gross motor function or if the child was not cooperative in the examination.

Subjects were classified according to age, sex, type of CP, anatomical distribution,

and the degree of CP. In every subject, gross motor function was assessed through the examination of GMFM's 88-items. Each step was documented with a video camera in order to be re-assessed by the inter-rater.

Criterion validity was tested with the value of correlation coefficient, while the construction validity was tested by comparing the value of each GMFM dimension with the GMFM total score by using corrected Spearman's correlation test. Validity test was also performed for each GMFM dimension. Inter-rater reliability test was done by using unpaired t-test, whereas the internal consistency was tested with the value of Cronbach alpha.

RESULTS

This study included 31 children with CP, consisted of 19 males and 12 females. The mean age of respondents was 7 years and 11 months, ranged between 2 years and 7 months to 15 years and 8 months. Most of the CP (58.1%) were caused by perinatal factors. Most of them are spastic CP (80.65%), while spastic diplegic was the most common anatomical distribution of CP (45.2%). A number of 41.9% subjects were at the GMFCS level IV. Details about the characteristics of study sample can be seen in Table 1 and Table 2 below.

Table 1. Characteristics of study samples

	Variable	N	%
<i>Sex</i>	Male	19	61.3
	Female	12	38.7
<i>Etiology</i>	Prenatal	9	29.0
	Perinatal	18	58.1
	Postnatal	4	12.9
<i>Type</i>	Spastic	25	80.65
	Dyskinetic	5	16.13
	Mixed	1	3.2
<i>Anatomical Distribution</i>	Monoplegic	0	0
	Diplegic	14	45.2
	Hemiplegic	3	9.7
	Triplegic	0	0
	Quadriplegic	8	25.8
<i>GMFCS Level</i>	1	1	3.2
	2	5	16.1
	3	10	32.3
	4	13	41.9
	5	2	6.5

Table 2. Study sample characteristics of age, body height, body weight, and head circumference

	Min	Max	Mean	Std. Deviation	Skew-ness	Std. Error	Kurtosis	Std. Error
Age (year)	2.64	15.68	7.93	3.49	0.40	0.42	-0.80	0.82
Body weight (kg)	10.5	49.00	22.18	10.13	1.41	0.42	1.51	0.82
Body height (cm)	76	151.00	113.29	17.05	0.19	0.42	0.12	0.82
Head circumference (cm)	45	53.00	48.82	1.85	0.13	0.42	0.11	0.82

Table 3 describes the mean value of gross motor skills assessed by the GMFM-88. The mean GMFM of study subjects was 58.40 ± 49.09 . Mean value of % GMFM on each dimension and mean value of % total GMFM in children with GMFCS level I CP was greater than the level II, as did the mean value of %

GMFM in CP GMFCS level II was greater than the level III, GMFCS level III was greater than the level IV, and so forth. This is in accordance with Palisano,¹⁷ Rosenbaum,¹⁸ and Hanna *et al.*¹⁹ that the GMFM score is inversely correlated to the degree of CP, as being assessed by the GMFCS.

Table 3. Mean Value of Gross Motor Function of CP Children Measured by GMFM-88

	Dimension A (%)	Dimension B (%)	Dimension C (%)	Dimension D (%)	Dimension E (%)	Total (%)
GMFCS I	100	100	97.62	76.92	81.94	91.3
GMFCS II	93.33	91.33	77.14	49.15	48.89	71.968
GMFCS III	94.12	91.5	60.48	26.92	19.86	59.04
GMFCS IV	92.16	68.21	39.01	3.75	1.91	41.008
GMFCS V	82.36	57.5	3.57	0	0	28.69
<i>Standard Deviation</i>	4.113	11.731	13.054	10.454	18.051	49.086

The inter-rater reliability of the test has found no significant differences from the assessments of five GMFM dimensions and all GMFM items, except in items number 18 on the GMFM B dimension ($p=0.039$). Item 18 was the item in which a child is expected to pull himself up from supine position into a sitting position with adequate head control, while the examiner holds the child's hands. The difference of inter-raters' rating is probably caused by the different media assessment, in which the researcher conducted the assessment via direct observation, while the inter-rater used a media of video camera to observe the gross motor function in those children. According to Russell *et al.*,²⁰ an assessment through a video camera will greatly depend on the quality of

the image, which is strongly influenced by the ability and experience of the video makers, as well as the lighting, the camera angles, and the movement of the test itself. In this study, the images were taken by the researcher, with the help of a tripod.

The internal consistency of GMFM Indonesian version is good, with Cronbach alpha value of 0.884. Table 4 has shown that the validity of all criterias in GMFM (A, B, C, D and E dimensions) are good; with the power of correlation values among inter-items with the total are good into the strong ($r=0.523$ to 0.859). When one dimension is removed (i.e. dimension A), the value of the total consistency will be better (Cronbach alpha 0.897).

**Table 4. Criterion Validity Test of Each Criteria and Reliability Test of Total GMFM
(Item-Total Statistics)**

Criteria (Dimension)	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
A	170.6526	8229.326	0.523	0.389	0.897
B	183.4690	6515.224	0.688	0.619	0.847
C	211.5642	4665.736	0.807	0.685	0.821
D	241.9974	5065.348	0.859	0.928	0.796
E	245.3323	5462.431	0.801	0.915	0.814

Total Cronbach Alpha =0.884

Table 5 shows the results of the analysis of construction validity on the criterion of the dimension A. There are several items with not too good validity, which are items number 1, 3, 4, 5, 7, and 9 (item-total correlation coefficients

below 0.4). Some items cannot be analyzed because the results were consistent in all 31 respondents either items number 8, 10 and 11. Yet overall, the reliability of this dimension is good, with Cronbach alpha 0.764.

**Table 5. Validity Test of Each GMFM Item and Reliability Test of Total GMFM of Dimension A
(Item-Total Statistics)**

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Cronbach's Alpha if Item Deleted
V1	35.55	15.523	0.311	0.764
V2	35.39	15.178	0.432	0.755
V3	35.35	15.903	0.191	0.773
V4	35.81	16.361	0.074	0.782
V5	35.84	16.340	0.024	0.795
V6	35.35	15.237	0.448	0.755
V7	35.39	16.178	0.084	0.785
V9	35.29	15.680	0.389	0.761
V12	35.74	12.265	0.702	0.717
V13	35.61	13.045	0.650	0.727
V14	35.35	15.037	0.358	0.760
V15	35.42	13.918	0.526	0.743
V16	35.42	13.518	0.617	0.733
V17	35.42	13.585	0.602	0.735

Total Cronbach Alpha =0.764

Construction validity analysis of GMFM dimension B in table 6 found some items with not too good validity (item-total correlation coefficients below 0.4) which are the items number 18 and 22. Some items cannot be

analyzed because the results are consistent in 31 respondents, which are items number 21 and 23. Nevertheless, the overall reliability of GMFM in this dimension is very good with Cronbach's alpha 0.919.

Table 6. Validity Test of Each GMFM Item and Reliability Test of Total GMFM of Dimension B

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
V18	39.48	136.391	0.083	0.927
V19	40.55	117.256	0.618	0.921
V20	40.29	117.013	0.648	0.920
V22	39.39	137.112	0.006	0.927
V24	39.42	133.118	0.473	0.924
V25	40.03	125.499	0.589	0.920
V26	39.52	130.058	0.461	0.923
V27	39.48	130.658	0.482	0.923
V28	39.77	121.714	0.750	0.917
V29	39.74	122.131	0.768	0.917
V30	40.03	118.966	0.778	0.916
V31	40.39	113.112	0.741	0.917
V32	40.52	113.325	0.710	0.918
V33	40.58	120.652	0.714	0.917
V34	39.68	124.159	0.703	0.918
V35	40.16	116.940	0.658	0.919
V36	40.39	116.978	0.872	0.913
V37	40.61	117.112	0.750	0.916

Total Cronbach Alpha =0.919

Construction validity analysis on GMFM dimensions C and D found that the validity of all GMFM items in both dimensions are good. The overall reliability of GMFM in this

dimension are very good with the reliability test for dimension C (table 7, Cronbach's alpha 0.937) and dimension D (table 8, Cronbach's alpha 0.963).

Table 7. Validity Test of Each GMFM Item and Reliability Test of Total GMFM of Dimension C

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
V38	19.39	156.112	0.431	0.939
V39	19.35	147.237	0.747	0.930
V40	19.87	147.449	0.816	0.928
V41	19.65	145.837	0.753	0.930
V42	19.71	143.813	0.725	0.930
V43	19.68	141.092	0.838	0.927
V44	20.00	142.133	0.808	0.928
V45	20.52	143.858	0.747	0.930
V46	20.48	145.191	0.659	0.933
V47	20.58	148.118	0.581	0.935
V48	19.94	144.529	0.804	0.928
V49	21.16	156.540	0.618	0.934
V50	21.06	154.796	0.576	0.935
V51	20.84	150.540	0.624	0.933

Total Cronbach Alpha =0.937

Table 8. Validity Test of Each GMFM Item and Reliability Test of Total GMFM of Dimension D

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
V52	6.74	90.998	0.731	0.954
V53	7.19	87.228	0.879	0.950
V54	7.42	88.185	0.847	0.951
V55	7.45	89.989	0.795	0.952
V56	7.68	89.292	0.889	0.949
V57	8.16	104.006	0.742	0.957
V58	8.16	104.473	0.529	0.959
V59	7.42	88.385	0.837	0.951
V60	7.81	92.828	0.874	0.950
V61	7.94	96.729	0.807	0.953
V62	7.84	93.740	0.900	0.950
V63	7.94	97.396	0.759	0.953
V64	7.74	91.665	0.813	0.951

Total Cronbach Alpha =0.963

Construction validity of GMFM dimension E in table 9 finds that the validity of all items on the dimension E are good; all are more than 0.4. Only at 1 item, which is in item 82 the correlation values <0.4. The overall reliability of this dimension is very good with Cronbach's alpha 0.972. Standard

errors of measurement (SEM) of the Indonesian version for GMFM dimension A is 2; dimension B is 3.34; dimension C is 3.28; dimension D is 2.01; dimension of E is 3.03, and for the total GMFM is 16.72. All these values are between 10 to 12% of the average results of all research subjects.

Table 9. Validity Test of Each GMFM Item and Reliability Test of Total GMFM of Dimension E

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
V65	11.74	288.531	0.762	0.963
V66	11.71	288.680	0.739	0.963
V67	11.35	294.237	0.600	0.965
V68	11.84	288.940	0.740	0.963
V69	12.32	288.959	0.865	0.962
V70	12.32	288.959	0.865	0.962
V71	12.39	292.378	0.839	0.962
V72	12.32	288.959	0.865	0.962
V73	12.42	295.518	0.827	0.962
V74	12.77	316.781	0.736	0.964
V75	12.55	297.656	0.831	0.962
V76	12.58	299.785	0.838	0.962
V77	12.55	298.923	0.824	0.962
V79	12.13	285.449	0.856	0.962
V80	12.71	310.946	0.870	0.963
V81	12.68	307.959	0.892	0.963
V82	12.87	323.583	0.342	0.966
V83	12.74	312.198	0.645	0.964
V84	12.06	291.329	0.817	0.962
V85	12.16	296.740	0.788	0.962
V86	12.81	316.961	0.617	0.965
V87	12.81	316.961	0.617	0.965
V88	12.81	316.895	0.450	0.965

Total Cronbach Alpha =0.97

CONCLUSIONS

GMFM Indonesian version has a criterion validity good to strong with the inter-item with total correlations ($r=0.523$ to 0.859). In general, all dimensions of GMFM Indonesian version has quite good construct validity. From inter-rater analysis of GMFM Indonesian version, we did not find any significant differences between the two examiners, means that the GMFM Indonesian version is reliable enough to be examined by different examiners. GMFM Indonesian version has good internal consistency with Cronbach's alpha of 0.884 . Conclusively, GMFM can be used as an instrument for measuring gross motor functions in CP patients, but sufficient training to obtain the real gross motor ability of children with CP is needed.

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