



## Motor Function Measurement in Children: Gross Motor Function Measure (GMFM)

**Ja Young Choi, MD, PhD**

*Department of Physical and Rehabilitation Medicine, Chungnam National University College of Medicine, Daejeon, Korea*

The assessment and management of motor function in children, particularly those with cerebral palsy (CP) and other motor disorders, are crucial components of pediatric rehabilitation. The Gross Motor Function Measure (GMFM) and the Gross Motor Function Classification System (GMFCS) are key tools that offer structured and reliable methods to assess and classify motor abilities, guiding therapeutic decisions and tracking progress over time. The GMFM is a standardized observational measure to evaluate and monitor changes in gross motor function, especially in children with CP [1]. It is based on typical developmental stages, with items designed to be completed by typically developing children by age 5.

### GMFM-88 and GMFM-66

There are two versions of GMFM: the original 88-item measure (GMFM-88) and the 66-item measure (GMFM-66) (Table 1). The GMFM-88 consists of five dimensions: (A) lying and rolling; (B) sitting; (C) crawling and kneeling; (D) standing; (E) walking, running, and jumping. Raw and percent scores are calculated for each of the five dimensions as well as a total score. The GMFM-88 uses an ordinal scale, which can reduce sensitivity at extreme score ranges. To overcome this, the GMFM-66 was developed using Rasch analysis, converting ordinal data into an interval scale, arranging items by difficulty and ensuring equal scoring intervals. This improves the accuracy and sensitivity of assessing motor function changes over time. The interrater and intrarater reliability of the GMFM-88 total score, assessed with the intraclass correlation coefficient (ICC), are both 0.99, while the interrater and intrarater reliability of the GMFM-66 are 0.98 and 0.99, respectively [1,2]. Validity was confirmed by a correlation of 0.82 between GMFM-88 scale changes and the clinical judgments of blinded assessors [1]. Both versions of the GMFM are reliable, valid, and responsive to change in children with CP.

### Administration and best practice for GMFM

Children are rated on each item using a 4-point scale with specific descriptors: 0=does not initiate; 1=initiates but completes less than 10%; 2=partially completes (10% to less than 100%); and 3=fully completes the task. The GMFM-66 score can be obtained using the Gross Motor Ability Estimator (GMAE) scoring program [1]. During the assessment, all items the child can attempt must be tested. If an item is not attempted, it is scored as 0 in GMFM-88, whereas in GMFM-66, it is marked as not tested (NT) and the expected score can be estimated using the GMAE

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### Correspondence:

Ja Young Choi  
Department of Physical and  
Rehabilitation Medicine, Chungnam  
National University College of Medicine,  
266 Munhwa-ro, Jung-gu, Daejeon  
35015, Korea.  
Tel: +82-42-338-2460  
Fax: +82-42-338-2461  
E-mail: jaychoi3399@gmail.com

**Table 1.** Comparison between GMFM-88 and GMFM-66

Feature	GMFM-88	GMFM-66
Total items	88 items, 5 dimensions	66 items
Time to administer (min)	45–60	All 66 items: 30–45 IS, B&C: 20–30
Scoring system	Dimensional score (%) Total score (%)	Score (0–100) with 95% CI
Scale property	Ordinal scale	Interval scale
Not tested item	Scored 0 point	Marked NT; GMAE software can estimate the expected scores
Target population	Children with CP and wide range of motor disorders	Children with CP
Use of software	Scoring typically done manually or through the GMFM App+	GMAE-2 or GMAE-3 through the GMFM App+
Use of assistive devices	Allowed during the assessment	Not allowed during the assessment

GMFM, Gross Motor Function Measure; IS, GMFM-66-Item Sets; B&C, GMFM-66-Basal & Ceiling; CI, confidence interval; NT, not tested; GMAE, Gross Motor Ability Estimator; CP, cerebral palsy.

program. Each item can be tried up to three times, with the best performance recorded. Demonstrations are permitted, but physical assistance is not, as the GMFM is an observational tool. If a child becomes uncooperative, alternative methods like role play or toys can help. While no specific certification is required to use the GMFM, training has been shown to significantly improve scoring consistency and accuracy [3]. The GMFM user's manual was first published in 2002, and the most recent third edition was published in 2021 [1]. The Korean version has been translated as the K-GMFM, demonstrating construct validity and inter-rater reliability [4].

### Target population

The GMFM, originally validated for children with CP aged 5 months to 16 years, has also been found valid and reliable for children with Down syndrome [5,6], acquired brain injuries [7], and osteogenesis imperfecta [8], Fukuyama congenital muscular dystrophy [9], and spinal muscular atrophy [10]. Additionally, a version adapted for children with acute lymphoblastic leukemia (GMFM-ALL) has demonstrated strong validity and reliability [11]. However, before using GMFM with other populations, it is crucial to establish its reliability and validity for those specific groups.

### GMFCS and GMFM

The GMFCS is a classification system for children with CP, categorizing their functional mobility and need for assistive devices into five levels, from minimal (Level I) to severe impairment (Level V) [12]. Based on GMFM-66, five distinct motor development curves of GMFCS were created to stratify typical motor

function according to age. GMFCS provides a broader, predictive measure of motor function over time, emphasizing daily performance. While GMFM is an evaluative measure, GMFCS is a classification tool not designed to measure changes, and should not be used as an outcome measure.

### Which GMFM version to choose?

The choice of which GMFM version to use depends on the purpose of the assessment and the population. Since GMFM-66 excludes 22 items from GMFM-88 dimensions A, B, and C, GMFM-88 is recommended for very young children or functioning at GMFCS Level V. Additionally, GMFM-66 does not permit the use of orthoses, shoes, or mobility aids, so GMFM-88 should be used if these are required. GMFM-88 is also better suited for assessing children with motor impairments from conditions other than CP, such as Down syndrome and acquired brain injuries. The items of the GMFM-66 were weighted according to difficulty and were validated specifically for children with CP, and may not be appropriate for other conditions. Therefore, it is not recommended for use with non-CP children. For a briefer method of GMFM-66 scoring, either item set (GMFM-66-IS) or the basal & ceiling approach (GMFM-66-B&C) can be used [13]. For children with CP and cerebral visual impairment (CVI), the adapted version known as GMFM-88-CVI is recommended [14].

### Applications in clinical practice and research

One of the key strengths of the GMFM is its sensitivity to changes in motor function over time. It is widely used to evaluate the impact of various interventions, such as rehabilitation

programs, medications, orthoses, and orthopedic or neurosurgical procedures, on gross motor function. The GMFM also helps set short-term goals and plan interventions aimed at improving motor function. When used alongside the GMFM-66 reference curves, it allows for a comparison of a child's development relative to peers of the same age and GMFCS level [12]. Beyond clinical applications, the GMFM plays a critical role in research, where it is used to assess the efficacy of new treatments, compare therapeutic approaches, and explore the natural history of motor development in children with CP. The minimum clinically important difference (MCID) for the GMFM has been reported vary depending on the GMFCS level and the research [1,15-17]. One study reported MCID values of 1.58 for the GMFM-66 score and 1.29 for the GMFM-88, indicating a clinically significant improvement in gross motor function [17].

In conclusion, the GMFM is an objective measure for assessing motor function, tracking progress over time, and supporting research in children with CP and other motor disorder. While GMFM effectively measure the quantitative aspects of motor function, evaluating the quality of movement remains a challenge. Selecting the appropriate tool based on the evaluation's purpose and the characteristics of the target population is crucial.

## CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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## ORCID

Ja Young Choi, <https://orcid.org/0000-0001-9829-8922>

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