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Original Article

The validity and reliability of the Turkish version of the functional mobility scale in patients with cerebral palsy

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ABSTRACT

Objectives: The aim of this study was to investigate the validity and reliability of the Turkish version of the Functional Mobility Scale (FMS) in patients with cerebral palsy.

Patients and methods: The validity and reliability study was conducted with 100 cerebral palsy patients (66 males, 34 females; mean age: 6.4±2.7 years; range, 2 to 18 years) between July 2015 and July 2018. The translation of the FMS was performed according to international standards. For test-retest reliability, 54 patients were reevaluated one week after the initial test with the Turkish version of the FMS, and Cohen's weighted kappa values were analyzed. The validity of the scale was assessed by correlating the FMS with the Gross Motor Function Classification System and the Gillette Functional Assessment Questionnaire Walking Scale. Twenty patients were evaluated by two researchers for interobserver reliability.

Results: The kappa coefficients for test-retest reliability were 0.90 for FMS 5 m, 0.92 for FMS 50 m, and 0.91 for FMS 500 m. An evaluation of the validity revealed a significant correlation between FMS and the Gross Motor Function Classification System for all distances ($r=-0.95$, $r=-0.96$, and $r=-0.92$ for 5, 50, and 500 m, respectively; $p<0.001$), as well as the Gillette Functional Assessment Questionnaire Walking Scale ($r=-0.95$, $r=-0.94$, and $r=-0.91$ for 5, 50, and 500 meters, respectively; $p<0.001$). The kappa coefficients related to interobserver reliability were 0.73 for 5 m, 0.69 for FMS 50 m, and 0.81 for FMS 500 m.

Conclusion: The Turkish version of the FMS can be considered a valid and reliable instrument for the assessment of cerebral palsy patients.

Keywords: Cerebral palsy, functional mobility scale, validity and reliability.

Movement, posture, and motor functioning impairments are the hallmarks of cerebral palsy (CP), a chronic but nonprogressive clinical condition. Cerebral palsy develops in childhood as a nonprogressive disability resulting from injury to the immature or developing central nervous system secondary to any reason in the perinatal, natal, or postnatal period.[1,2] Children with CP frequently experience mobility restrictions, which can range from the ability to navigate the community on foot to complete reliance on the caregiver.[3]

Functional mobility, which is defined as how a person moves within an environment to achieve daily engagement with family and society, is another important component of physical function. This large spectrum of functional mobility abilities is a result of the wide range of movement and posture abnormalities that are part of CP. It has been discovered that this mobility variability affects social involvement and functional independence.[4] The neuromotor dysfunction and limitations of activity complicate their active participation in society, while the frequently observed sensorial, cognitive, auditory, visual, perceptual, and behavioral disorders impair their quality of life.[5-7]

Reliable and valid measuring methodologies are required to evaluate the extent to which these functional deficiencies impact the lives of children with CP, as well as to monitor changes over time and following interventions. The International

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Classification of Functioning Disability and Health[8] and the World Health Organization are both changing their views on activity and participation, emphasizing limitations on participation and limitations in activities rather than being handicapped or having a disability.[9] The Gross Motor Function Classification System (GMFCS), created by Palisano et al.,[10] is the most widely used functional classification system that has been created for the examination of patients with CP. The GMFCS is a five-level method for categorizing gross motor function that evaluates sitting, transfers, and mobility tasks. It can be challenging to utilize the GMFCS alone to categorize children who use various mobility devices at various times and across various distances, as well as to evaluate any improvements following therapeutic interventions.[11] The Functional Mobility Scale (FMS) is used in conjunction with the GMFCS by clinicians treating children with CP to help address some of these issues, hence expanding each of the GMFCS functional mobility status levels.[12]

The FMS, a 6-level scale for identifying the help needed for walking, was created in 2004 for the assessment of changes in the capacity of children with CP to walk, particularly after orthopedic surgical treatments.[13] The FMS assesses functional mobility in children using various mobility methods encountered in daily life (for example, walking without support, walking with support, and use of a wheelchair) and determines the level of improvement or deterioration in mobility as they grow up or after the interventions (for example, orthopedic surgery and botulinum toxin injections). Similar to the GMFCS, the FMS assesses the need for assistive equipment and mobility aids, with assessments ranging from the need for a wheelchair to independent mobilization. The FMS evaluates mobilization separately within different daily environments associated with three different distances, in home (5 m), at school (50 m), and in society (500 m), distinguishing it from other evaluation tools.[13]

The FMS form is filled out based on the responses of the parent or child during an interview, although it can also be completed by the parents. No equipment or formal education is required as the evaluation is based completely on the verbal responses of the parent or child rather than direct visualization.[14,15]

The FMS is commonly utilized in clinical practice and in trials to determine alterations in the motor performance of children with CP, although it can be applied to other neurologic conditions, such as spina bifida, in clinical practice.[16] Despite this widespread use of FMS, a Turkish version of FMS has not been developed to date. The present study aimed to translate the FMS into Turkish and assess its validity and reliability for use in clinical practice.

PATIENTS AND METHODS

The validity and reliability study was conducted with 100 cerebral palsy patients (66 males, 34 females; mean age: 6.4±2.7 years; range, 2 to 18 years) who applied to the CP outpatient clinic of the department of physical medicine and rehabilitation of the Dokuz Eylül University Faculty of Medicine between July 2015 and July 2018. The patients who had undergone orthopedic surgery within the preceding six months or who had received botulinum toxin injections within the last three months were excluded from the study. The age and sex of the participants, the type of CP, parental education levels, any accompanying cognitive disorders, speech disorders, visual impairments or history of seizure, the participation of the child in a physical therapy program, surgical history, the devices used, and history of botulinum toxin injections were questioned and recorded.

Adaptation

Prior to the development of a Turkish version of the FMS and a subsequent reliability and validity study, Harvey et al.,[14] who developed the original FMS, was contacted, and the required approval was obtained. The FMS was translated into Turkish using a forward-backward translation approach, according to international guidelines.[17] The scale was first translated into Turkish by the two physical therapy and rehabilitation specialists who were involved in the study, and the Turkish translation was then retranslated into English by an English linguist. The Turkish form was produced after a reevaluation of the grammar of the Turkish and English translations. The preliminary Turkish version of the form was then used for the evaluation of 20 patients with the diagnosis of CP, and the final version of the form was determined after identifying any aspects of the form that could be open to misunderstanding. During the adaptation there was no need for any changes specific to the Turkish population compared to the original form, thus no changes were made. The Turkish version of the FMS used for this study is available as a supplement (Supplement 1).

Measurements

The functional evaluation of the patients was assessed using the FMS, GMFCS, and the Gillette

Functional Assessment Questionnaire. The FMS is a categorical scaling system for the assessment of walking performance using assistive mobility devices across three fixed distances of 5, 50, and 500 m, representing the typical distances that children travel at home, at school, and in society. Performance is rated on a 6-level scale, in which 6 corresponds to walking independently over all surfaces and 5 to walking independently over flat surfaces. Patients requiring the use of a manual (with or without the aid of another person) or electric wheelchairs and that can take steps only if aided by another person are graded 1, while those requiring the use of a walker, two crutches, one crutch, or two walking sticks are graded 4. Finally, those who can "move by crawling" and those who can "travel no distance" are graded (C) and (N), respectively. The evaluation is made during an interview with the family and requires no observation of the child. The mobility of the child is graded, taking into account their need for mobility devices, such as crutches, walkers, or wheelchairs, across three different distances. The grading of movement should be made with any regularly used orthoses in place. The FMS measures the degree of performance of the respondent, and it is important to grade what the child can do at the time of assessment rather than what the child will be able to do or was able to do in the past.[13,18]

The GMFCS is a standard and valid 5-level scale applied in clinical practice and is categorized by age to define the gross motor function performance and the degree of motor disability in children with CP. The basic criterion is the acceptance of differences between the levels in daily life as significant. Since motor abilities vary with age, the level of function at predetermined age ranges has been defined for each motor level: <2 years, 2-4 years, 4-6 years, 6-12 years, and 12-18 years. The FMS performs differentiations based on functional mobility and the need for mobility aids (walkers, crutches, and walking sticks) and wheelchairs. Children with less severe motor dysfunction are graded GMFCS 1 and 2, while those with more severe motor dysfunction are graded GMFCS 3-5.[10,19] The validity and reliability study of the Turkish version of the GMFCS was carried out in 2012 by El et al.[20]

The Gillette Functional Assessment Questionnaire is a survey tool developed in 2000 for the evaluation of the walking function of patients on a scale of 1 to 10 using any necessary mobility devices. In the application of the scale, the parent is asked to select the item that best explains the walking capacity of the child.[21] The validity and reliability study of the Turkish version was performed by Günel et al.[22] in 2010.

Validity and reliability

The reliability of the FMS was examined using the test-retest reliability method, for which 54 patients were reevaluated using the Turkish version of the FMS, and Cohen's weighted kappa values were analyzed for the two measurements. For the validity analysis, the correlation of the FMS scores with the GMFCS and Gillette Functional Assessment Questionnaire scores was evaluated to determine the external validity of the FMS. Furthermore, after 20 patients were evaluated by two researchers, interobserver reliability was assessed based on Cohen's weighted kappa values. The reliability of the FMS was examined using the weighted kappa coefficient of the agreement, with values specified as follows: poor agreement, <0; slight agreement, 0.0-0.2; fair agreement, 0.21-0.4; moderate agreement, 0.41-060; substantial agreement, 0.61-0.80; almost perfect agreement, 0.81-1.0.[23]

Statistical analysis

The sample size calculation was performed using the G*Power version 3.1 software (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany). Building upon a previous study,[24] the correlation bivariate normal model (r^2=0.7) was employed to determine a correlation coefficient of r=0.83 for a single group, with a worst-case margin of error of 5% and a target power of 95% at a confidence interval of 95%. Accordingly, a total of 92 participants were planned to be included in the study.

Data were analyzed using IBM SPSS version 25.0 software (IBM Corp., Armonk, NY, USA). Descriptive statistics included means, standard deviations, frequencies, and ratios. Pearson's chi-square test was used for the correlation of categorical variables, and the normality assumption for the quantitative data was tested with the Shapiro-Wilk test. Cohen's weighted kappa value was calculated for the evaluation of the test-retest reliability of the categorical variables, and the construct validity was evaluated through the calculation of Spearman's correlation coefficients between nonparametric variables. Spearman's correlation coefficients of <0.20, 0.21-0.40, 0.41-0.60, 0.61-0.80, and >0.81 correspond to poor, moderate, intermediate, high,

and very high correlations. A p-value <0.05 was considered statistically significant.

RESULTS

Of the sample, 32 (32%) patients had spastic unilateral CP, and 68 (68%) were spastic bilateral. The patients' demographic and clinical characteristics are summarized in Table 1. Most patients were assessed as GMFCS level 2 (28%), followed by level 4 (24%) and level 1 (22%). The patients evaluated by the Gillette Functional Assessment Questionnaire were levels 9 (29%), 3 (17%), 1 (11%), and 8 (11%). Using FMS over 5 m, 16 patients were assessed as level 1, 29 patients as level 2, and 32 patients as level 6. Over 50 m, 22 patients were assessed as level 1, 24 patients as level 2, 29 patients as level 5, and 19 patients as level 6. Finally, over 500 m, 43 patients were assessed

TABLE 1
Demographic and clinical characteristics of the patients

Characteristics	n	%	Mean±SD
Age (year)			6.4±2.7
Sex			
Male	66	66	
Female	34	34	
Time of awareness of complaints			
Newborn	25	25	
0–6 months	25	25	
6–12 months	17	17	
12–24 months	33	33	
Type of cerebral palsy			
Spastic unilateral	32	32	
Spastic bilateral	68	68	
Cognitive disorder			
Present	32	32	
None	68	68	
History of seizure			
Present	17	17	
None	83	83	
Speech disorder			
Present	39	39	
None	61	61	
Vision disorder			
Present	50	50	
None	50	50	
History of participation in physical therapy program			
Present	98	98	
None	2	2	
History of orthopedic surgery			
Present	28	28	
None	72	72	
Area treated surgically			
Soft tissue	27	96.4	
Bone	1	3.4	
History of previous botulinum toxin injection			
Present	64	64	
None	36	36	
History of use of assistive device			
Present	67	67	
None	33	33	

SD: Standard deviation.

as level 1, 35 patients as level 5, and 13 patients as level 6 (Table 2).

The test-retest results for reliability showed almost perfect agreement, with kappa values for the FMS 5 m, 50 m, and 500 m recorded in the 0.81-1.00 range in the reliability evaluation (Table 3). The interobserver reliability evaluation revealed almost perfect agreement, with kappa values for the FMS 5 m and 50 m recorded in the range of 0.61-0.80, thus showing substantial agreement. The kappa value for FMS 500 m was in the 0.81-1.00 range (Table 4).

When the correlation between the GMFCS and FMS values was analyzed for a validity analysis of FMS, a statistically significant ($p<0.05$) and a very highly powerful ($r=-0.959$) negative correlation was found between the GMFCS and FMS values; a statistically significant ($p<0.05$) and very highly powerful ($r=-0.965$) negative correlation between the GMFCS and FMS 50 m evaluations. A statistically significant ($p<0.05$) and a very highly powerful ($r=-0.926$) negative correlation was found between the GMFCS and FMS 500 m.

When the correlation between the FMS and Gillette Functional Assessment Questionnaire was evaluated for a validity analysis of the FMS, a statistically significant ($p<0.05$) and very highly powerful ($r=0.951$) positive correlation was found between the Gillette Functional Assessment Questionnaire and FMS 5 m. A statistically significant ($p<0.05$) and a very highly powerful ($r=0.946$) positive correlation was found between the Gillette Functional Assessment Questionnaire and FMS 50 m, and a statistically significant ($p<0.05$) and very highly powerful ($r=0.915$) positive correlation was found between the Gillette Functional Assessment Questionnaire and FMS 500 m (Table 5).

TABLE 2
Results of FMS, GMFCS, and Gillette Functional Assessment Questionnaire

	n	%
GMFCS		
I	22	22
II	28	28
III	10	10
IV	24	24
V	16	16
Gillette Functional Assessment Questionnaire		
1	11	11
2	8	8
3	17	17
4	7	7
5	3	3
6	4	4
7	6	6
8	11	11
9	29	29
10	4	4
Functional Mobility Scale		
1	16	16
2	29	29
3	2	2
4	4	4
5	17	17
6	32	32
FMS 50 meters		
1	22	22
2	24	24
3	1	1
4	5	5
5	29	29
6	19	19
FMS 500 meters		
1	43	43
2	4	4
3	1	1
4	4	4
5	35	35
6	13	13

FMS: Functional Mobility Scale; GMFCS: Gross Motor Function Classification System.

TABLE 3
Evaluation of FMS test-retest results (weighted kappa values, n=54)

	Weighted kappa values
FMS 5 meters	0.90*
FMS 50 meters	0.92*
FMS 500 meters	0.91*

FMS: Functional Mobility Scale; * Weighted kappa <0=poor agreement, 0.0-0.2=slight agreement, 0.21-0.4=fair agreement, 0.41-060=moderate agreement, 0.61-0.80=substantial agreement and 0.81-1.0=almost perfect agreement.

TABLE 4
Evaluation of FMS interobserver reliability (n=20)

	Weighted kappa values
FMS 5 meters	0.73*
FMS 50 meters	0.69*
FMS 500 meters	0.81*

FMS: Functional Mobility Scale; * Weighted kappa <0=poor agreement, 0.0-0.2=slight agreement, 0.21-0.4=fair agreement, 0.41-060=moderate agreement, 0.61-0.80=substantial agreement and 0.81-1.0=almost perfect agreement.

TABLE 5
Correlation of FMS values with GMFCS and Gillette Functional Assessment Questionnaire

Assessment Scales	FMS 5 meters	FMS 50 meters	FMS 500 meters
GMFCS			
r	−0.959	−0.965	−0.926
p	<0.001*	<0.001*	<0.001*
Gillette Functional Assessment Questionnaire			
r	0.951	0.946	0.915
p	<0.001*	<0.001*	<0.001*

FMS: Functional Mobility Scale; GMFCS: Gross Motor Function Classification System; r: Spearman correlation coefficient.

DISCUSSION

The present study demonstrates the reliability and validity of the Turkish version of FMS for the assessment of children with CP. Test-retest reliability of the Turkish version of FMS was almost perfect for all the distances and the presence of a significant correlation between the Turkish version of the FMS and the other applied scales indicates the external validity of the scale. Interobserver reliability was an almost perfect agreement level over 500 m and a substantial agreement level over 5 and 50 m.

These findings are consistent with studies evaluating the validity and reliability of the FMS in children with CP and also in patients with spina bifida.[13,19,24-26] The original FMS[13] was initially developed as a tool for the evaluation of mobility in children with CP, and the developers have established their own interrater reliability[19] and demonstrated good validity in patients with CP.[13,18,27,28]

In consistent with the present study, in the validity and reliability study of the Brazilian Portuguese version of FMS in patients diagnosed with spina bifida, the weighted kappa coefficients for test-retest reliability were 0.90 for FMS 5 m, 1.00 for FMS 50 m, and 1.00 for FMS 500 m.[25] Test-retest reliability analysis was performed on a smaller number of patients (14 parents) compared to the present study. In addition, unlike the present study, interrater reliability of the FMS was not reported in the study of the Brazilian Portuguese version of FMS.

For the Greek version of the FMS, the weighted kappa coefficients for test-retest reliability for patients diagnosed with CP were 0.98 for FMS 5 m, 0.99 for FMS 50 m, and 1.00 for FMS 500 m.[26] Similar to the Greek version of the FMS, the present study revealed almost perfect test-retest reliability for the 5 m, 50 m, and 500 m distances, with weighted kappa coefficients for test-retest reliability of 0.90, 0.92, and 0.91 for FMS 5 m, FMS 50 m, and FMS 500 m, respectively. In contrast, the weighted kappa coefficients for the validity and reliability of the Japanese version of FMS, performed by Himuro et al.,[24] were 0.72 for FMS 5 m, 0.87 for FMS 50 m, and 0.76 for FMS 500 m. Since only ambulatory patients with GMFCS levels 1 to 3 were included in Himuro et al.'s study and the sample size was small, it is possible that cultural variations account for the significant discrepancy between their results and those reported in the current study (24 parents).

The external construct validity of the Turkish version of FMS was evaluated in the present study through an analysis of the correlation between the GMFCS, Gillette Functional Assessment Questionnaire, and the Turkish version of the FMS. The validity and reliability of GMFCS and Gillette Functional Assessment Questionnaire have been established in the Turkish population in earlier studies.[20,22] The reason for selecting these two tests relates to their simplicity over other functional evaluation scales, and the consideration of the GMFCS as the optimum tool for the classification of motor function in children with CP. In addition, similar to the FMS, the Gillette Functional Assessment Questionnaire is based on the responses of the family of the patient and requires no observation of the patient. A statistically significant and very highly powerful correlation was identified between the FMS and GMFCS values, which concurs with the results of the previous studies evaluating the construct validity of the FMS in patients with CP.[23,24] A negative correlation is associated with the inverse scoring of the levels in the scales. A significant and highly powerful negative correlation was detected between the GMFCS and FMS findings in a study of FMS applied to a Japanese population,[24] while similar to the present study, in a validity and reliability study of the Greek version of FMS, a

statistically significant and very highly powerful correlation was identified between the FMS and the GMFCS.[26]

In the correlation analysis of the FMS and Gillette Functional Assessment Questionnaire to test the construct validity of the Turkish version of FMS, a statistically significant and highly powerful positive correlation was found between the GMFCS and the FMS over all three distances. In a prior study, it was found that both the FMS and the Gillette Functional Assessment Questionnaire showed a change in the children's and adolescents' walking performance due to motor disorders.[29] An increase of one level in FMS and a two-level improvement in Gillette Functional Assessment Questionnaire scores are considered clinically significant changes. The highly significant correlation identified between the Turkish version of FMS and the Gillette Functional Assessment Questionnaire supports the construct validity of the scale.

In the present study, 20 patients were evaluated by two different researchers for the assessment of interobserver reliability. This measurement characteristic is important for FMS since although a scaling system may be easy to apply, variations may occur in the applications of different raters.

The validity of the Turkish version of the FMS can be considered important as patients undergo continuous evaluations by multidisciplinary healthcare teams. The weighted kappa coefficients of the scale were found to be 0.73, 0.69, and 0.81 for FMS 5 m, FMS 50 m, and FMS 500 m, respectively, in the present study, while Harvey et al.[18] reported weighted kappa coefficients for FMS 5 m, FMS 50 m, and FMS 500 m of 0.87, 0.92, and 0.86, respectively, in their study evaluating the interrater reliability of FMS. The higher values reported by Harvey et al.[18] may be associated with the larger patient sample and inclusion of a larger number of raters than in the present study. In the study by Ammann-Reiffer et al.,[30] weighted kappa coefficients of 0.74, 0.82, and 0.87 were reported for FMS 5 m, FMS 50 m, and FMS 500 m, respectively, for the interrater reliability of FMS of patients with neuromuscular disorders.

This study has some limitations. First, the children were recruited from a single center, which prevents the generalization of the results to other regions of Turkey. Another potential limitation is that the two raters were clinic physiatrists with good knowledge of the FMS. This may have affected the results of the interrater reliability analysis. Further studies involving clinicians from different disciplines, such as physiotherapists, orthopedists, and pediatric neurologists, as raters should be carried out for the evaluation of the interrater reliability of the Turkish version of the FMS.

In conclusion, the FMS can be considered to have sufficient reliability and validity for use in Turkish children with CP. Since FMS is an evaluation tool that has been proven appropriate for the assessment of functionality in children with both CP and other neuromuscular disorders, this present study can be considered to contribute to the range of tools available for the functional evaluation of patients diagnosed with CP in Turkish society.

Ethics Committee Approval: The study protocol was approved by the Dokuz Eylul University Non-Interventional Research Ethics Committee (date: 27.07.2017, no: 2017/19-37). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from the parents and/or legal guardians of the patients.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Idea/concept, critical review: Ö.E., E.Ş.; Design: N.E.G., Ö.E., E.Ş.; Control/supervision: E.Ş.; Data collection and/or processing: G.K., A.K.; Analysis and/or interpretation: Ö.E.; Literature review: G.K.; Writing the article: N.E.G.

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SUPPLEMENT 1

FONKSİYONEL MOBİLİTE SKALASI

Rating **6**

Tüm yüzeylerde bağımsız
Düzgün olmayan yüzeyler, kaldırım kenarlar ya da kalabalık ortamları da içeren tüm yüzeylerde herhangi bir yürüme yardımcısı kullanmaz ya da bir kişi yardımına ihtiyaç duymaz

Rating **3**

Koltuk değneği kullanır
Bir kişinin yardımını almadan koltuk değneği kullanarak mobilize olur.

Rating **5**

Düzgün yüzeylerde bağımsız
Herhangi bir yürüme yardımcısı kullanmaz ya da bir başka kişinin yardımına ihtiyaç duymaz. Merdiven için tırabzanlara tutunma ihtiyacı olur.

Rating **2**

Yürüteç kullanır
Bir kişinin yardımını almadan yürüteç kullanarak mobilize olur.

Rating **4**

Baston kullanır (1 ya da 2)
Bir kişinin yardımını almadan 1 ya da 2 baston kullanarak mobilize olur.

Rating **1**

Tekerlekli sandalye
Transferler için ayakta durabilir, bir başka kişinin yardımı ile adımlama yapabilir.

C: Emekleme: Çocuk evde mobilite için emekler (5m).
N (UD): Uygulanamaz. Çocuk mesafeyi hiçbir şekilde tamamlayamaz.

5 metre: Çocuk merdiven için tırabzanlara ihtiyaç duyarsa 5 olarak derecelenir eğer ihtiyaç duymuyorsa 6 olarak derecelenir.
50 metre: Çocuk düzensiz yüzeyleri, basamakları içeren tüm ortamlarda ve özellikle okulda yürüyebiliyorsa 6 olarak derecelenir ve bu yüzeylerde yardıma ihtiyaç duyuyor, düzgün yüzeylerde bağımsız yürüyebiliyorsa 5 olarak derecelenir.
500 metre: Çocuk pürüzlü zeminler, kaldırım kenarları ve basamakları içeren tüm yüzeylerde ve toplumda kalabalık ortamlarda bağımsız olarak yürüyorsa 6 olarak derecelenir ve çocuk sadece düzgün yüzeylerde uzun mesafe yürüyebiliyor ancak kalabalıkta yardıma ihtiyaç duyuyorsa 5 olarak derecelenir.