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Validity and Reliability of the Timed 360° Turn Test in Children with Cerebral Palsy

Serebral Palsili Çocuklarda Süreli 360° Dönme Testinin Geçerliliği ve Güvenirliği

Hatice Adiguzel Tat[1], Zekiye Ipek Katirci Kirmaci[2], Cengiz Dilber[3], Suat Erel[4]

[1]Kahramanmaraş Sütçü Imam University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Kahramanmaras, Turkey
[2]Gaziantep Islamic Science and Technology University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Gaziantep, Turkey
[3]Kahramanmaraş Sütçü Imam University, Faculty of Medicine, Department of Child Health and Diseases, Kahramanmaras, Turkey
[4]Pamukkale University, School of Physical Therapy and Rehabilitation, Denizli, Turkey

Abstract

Aim: The purpose of this study was to evaluate the timed 360° turn test (360DTT) in children with cerebral palsy (CP) for validity and reliability.

Material and Method: Children with spastic CP (n=91) with lower extremity spasticity ≤ 3 according to the Modified Ashworth Scale (MAS) and Expanded and Revised Gross Motor Functional Classification System (GMFCS-E&R) Level ≤ 2 were included. 360DTT, Pediatric Berg Balance Scale (PBBS), Timed Up and Go Test (TUG), Pediatric Functional Reaching Test (PFRT) and Four Square Stepping Test (FSST) were performed. 360DTT was repeated by two different physiotherapists on consecutive days. The test-retest reliability of 360DTT was assessed using intraclass correlation coefficients (ICC).

Results: The correlation between PBBS, TUG, PFRT and FSST tests were used for validity. Inter-rater reliability of 360DTT (right) and 360DTT (left) (Inter-rater ICC=0.849-0.918, ICC=0.859-0.924) were found to be excellent. Significiant correlation was found between 360DTT (right) (1st measurement) and PBBS (r=-0.520 p≤0.001), TUG (r=0.304 p=0.003), PFRT front (r=-0.283 p=0.007) PFRT right (r=-0.295, p=0.005), PFRT left (r=-0.228 p=0.03) and FSST (r=0.381 p≤0.001). Also there was correlation between 360DTT (left) (1st measurement) and PBBS (r=-0.517 p≤0.001), PFRT front (r=-0.213 p=0.042), PFRT right (r=-0.253 p=0.016) and FSST (r=0.280, p=0.007). Significiant correlation was found between the 360DTT (right) (2nd measurement) and PBBS (r=-0.542 p≤0.001), TUG (r=0.217 p=0.039), PFRT front (r=-0.272 p=0.009) PFRT right (r=-0.304 p=0.003) and FSST (r=0.312 p=0.003) tests. There was significiant correlation between 360DTT (left) (2nd measurement), PBBS (r=-0.479 p≤0.001), and FSST (r=0.232 p=0.027).

Conclusion: 360DTT was found to be valid and reliable in children with CP.

Keywords: Validity, reliability, timed 360° turn test, cerebral palsy

Öz

Amaç: Bu çalışmada, Serebral Palsi (SP)'li bireylerde Zamanlı 360° Dönme Testi'nin (360DTT) geçerlilik ve güvenilirliğinin belirlenmesi amaçlanmıştır.

Gereç ve Yöntem: Modifiye Ashworth Skalası'na (MAS) göre alt ekstremite spastisitesi ≤ 3 düzeyindeki Genişletilmiş ve Revize Edilmiş Kaba Motor Fonksiyon Sınıflandırma Sistemi (GMFCS-E&R) ≤ 2 olan spastik SP'li (n=91) çocuklar dahil edildi. 360DTT, Pediatrik Berg Denge Skalası (PBBS), Zamanlı Kalk ve Yürü Testi (TUG), Pediatrik Fonksiyonel Uzanma Testi (PFRT) ve Dört Kare Adımlama Testi (FSST) yapıldı. 360DTT farklı günlerde iki ayrı fizyoterapist tarafından tekrarlandı. 360DTT'nin test-tekrar test güvenirliği sınıf içi korelasyon katsayıları (ICC) kullanıldı.

Bulgular: Geçerlilik için PBBS, TUG, PFRT ve FSST testleri arasındaki korelasyon kullanıldı. 360DTT (sağ) ve 360DTT (sol)'in derecelendiriciler arası güvenilirliği (interrater ICC=0.849-0.918, ICC=0.859-0.924) mükemmel bulundu. 360DTT (sağ) (1. ölçüm) ile PBBS (r=-0.520 p≤0.001), TUG (r=0.304 p=0.003), ön PFRT (r=-0.283 p=0.007) sağ PFRT (r=-0.295) (p=0.005) testleriyle, sol PFRT (r=-0.228 p=0.03) ve FSST (r=0.381 p≤0.001) arasında anlamlı korelasyon bulundu. 360DTT (sol) (1. ölçüm) ile PBBS (r=-0.517 p≤0.001), ön PFRT (r=-0.213 p=0.042), sağ PFRT (r=-0.253 p=0.016) ve FSST (r=0.280 p=0,007) arasında anlamlı korelasyon bulundu. 360DTT (sağ) (2. ölçüm) ile PBBS (r=-0,542 p≤0,001), TUG (r=0,217 p=0,039), PFRT ön (r=-0,272 p=0,009) PFRT sağ (r=-0,304 p=0,003) ve FSST (r=0,312 p=0,003) testleri arasında anlamlı korelasyon bulunurken, 360DTT (sol) (2. ölçüm) ile PBBS (r=-0,479 p≤0,001) ve FSST (r=0,232 p=0,027) testleri arasında anlamlı korelasyon bulundu.

Sonuç: 360DTT'nin SP'li çocuklarda geçerli ve güvenilir olduğu bulundu.

Anahtar Kelimeler: Geçerlilik, güvenirlik, 360 derece dönme testi, serebral palsi

Corresponding *(İletişim)*: Hatice ADIGUZELTAT, Kahramanmaras Sutcu Imam University, Faculty of Health Science, Department of Physiotherapy and Rehabilitation, Onikisubat, Kahramanmaras, Turkey
E-mail *(E-posta)*: fzthatis@gmail.com
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INTRODUCTION

Cerebral Palsy (CP) is a group of disorders with with sensorimotor problems that start in early childhood and have a lifelong impact on posture and muscle coordination.[1] Damage in the developing brain cause the problems of regulating movements, maintaining posture and balance. Motor function disorders are the core symptoms of CP, but other dysfunctions accompanied like sensory, perceptual, cognitive, communication..etc.[1,2] Children with CP display a diverse array of motor skills and difficulties. About 58% of people with CP can walk on their own, but the remaining individuals have a wide range of movement abilities. CP is often thought of as a disorder affecting both posture and mobility, as it impairs a child's gait and balance.[1,3]

Static reflexes and dynamic sensory systems work together to provide the complex skill of postural control. It comprises two fundamental components: postural balance and postural orientation.[4,5] Somatosensory problems, as well as impairment to any underlying systems, can cause postural control abnormalities in people with CP. Because of inadequate adaptive responses, extended activation durations, and co-contraction in antagonist muscles, children with CP have loss of postural control compared to healthy peers.[6,7] Functional skills, balance control, and walking ability are all hampered by poor postural control. Thus, children with CP have negative effects on their everyday activities and quality of life.[8-10] A precise and timely assessment of the underlying cause of balance disorders (vestibular, somatosensorial, visual, etc..) is crucial for developing a therapy plan, following the prognosis, thoroughly describing symptoms, and maximizing treatment efficacy.[10] Therefore, a good performance test should be simple to use, assess the issue, have a high degree of reliability and validity in the population being studied, and be adaptable to changes. It should also assess how an individual's traits relate to the environment and task performance.[11] The Pediatric Berg Balance Scale (PBBS),[12] the Pediatric Functional Reach Test (PFRT),[13] The Timed Up Go (TUG) test,[14] and the Timed Up Down Stairs (TUDS) test,[15] the Kids-Balance Evaluation Systems Test (Kids-BESTest),[16] and Fullerton Advanced Balance Scale (FAB),[17] are just a few of the several objective tests that assess balance in people with CP. Each has a number of drawbacks even though they are both trustworthy and effective tests for determining static and functional balance. The TUG and TUDS tests do not evaluate static balance; instead, they measure dynamic balance.[14,15] FRT measures the forward-reaching control.[13] Although it takes longer and requires different equipment, the Kids-BESTest has been used to differentiate between the effects of sensory integration disorder and the sensory systems on postural control in children with CP.[16] According to studies, the PBBS can identify balance abnormalities in children with varying degrees of neurological involvement, but it is insufficient for children who are functional but just slightly affected.[12] Similarly, the PBBS lacks items to evaluate damage in the multisensory systems that interpret sensory inputs during function.[4,8]

It has recently been proposed that children with CP require balance-related aids designed for those with greater functional abilities.[17,18] A quick, simple, and accurate way to assess an individual's rotation capacity is to use the Timed 360° Turn Test (360DTT).[19] It measures the time it takes for a person to turn from a standing position. This test has demonstrated strong test-retest, intraobserver, and interobserver reliability in the studies.[19] A crucial element of many clinical mobility and balance evaluations is turning ability. Turning, for instance, is a fundamental component of the TUG.[20] and BBS,[8] two of the most widely used evaluation instruments for determining balance and mobility. Nevertheless, TUG does not evaluate 180° rotation twice in particular. Of the 14 items, only timed 360° turn test is scored by BBS. The rotation's score ranges from 0 to 4, depending on whether it is standing or below 4seconds. When evaluating rotation capacity, 360DTT is a more accurate and efficient testing method than TUG and BBS. It is accessible to senior citizens who live in communities through functional partnerships.[21] For these reasons, this study aimed to examine the validity and reliability of 360DTT in children with CP.

MATERIAL AND METHOD

Participants

Children with CP between the ages of 7 and 18 who applied to Kahramanmaraş Sütçü Imam University, Faculty of Medicine, Pediatric Neurology Clinic were included in the study. Parents of the children signed written informed consent. The study was obtained from Kahramanmaras Sutcu Imam University Medical Research Ethics Committee (Date: 12.02.2022, Decision No: 2022/07). And the study performed according to the principles of the Declaration of Helsinki. The clinical trial number is NCT05213039.

Children with spastic CP were diagnosed according to SCPE criteria, children whose lower extremity spasticity was ≤2 according to Modified Ashworth Scale (MAS), The Gross Motor Function Classification System - Expanded & Revised (GMFCS-E&R) level of ≤2, Communication Function Classification System (CFCS) level ≤3 and the children who were able to follow verbal commands were included. Who had received Botox (Botulinum toxin) or surgery in the last 6 months, and had contractures in the ankle or knee joints were excluded from the study.

Measurements

The assesments were performed at the deparment of Physiotherapy and Rehabilitation. Demographic information was recorded. The tests were experienced by the children at first. All of the tests started with 360DTT. The measurements were performed by two separate physiotherapists (Physiotherapist A and B) with 10 years of experience of pediatrics. The completion times of the tests were recorded. The assesments were made in two separate sessions in seperate days. On the first day, in the first session, the first physiotherapist (A Physiotherapist) performed the 360DTT three times. Data collection procedure is shown in Figure 1. Then, the PBBS, TUG, PFRT and Four Square

Step Test (FSST) were performed. The second physiotherapist (B Physiotherapist) performed the 360DTT three times in the other session consecutive day. The average of the three recorded times was noted by two Physiotherapists. All of the children were evaluated in the same environment with their shoes on a hard surface without any orthosis.

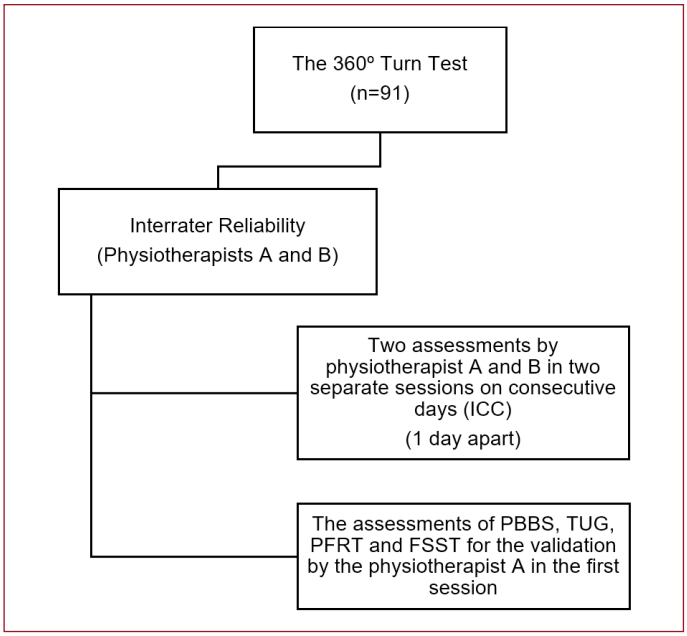

Figure 1. Data collection procedure. ICC: intraclass correlation coefficient, PBBS: Pediatric Berg Balance Scale, TUG: Timed Up and Go Test, PFRT: Pediatric Functional Reach Test, FSST: Four Square Step Test

Modified ashworth scale (MAS): It classifies resistance to passive movement in the direction of the antagonist of the spastic muscle. The bilateral hip flexors, hip adductors, knee flexors, plantar flexors were measured in supine position. The tone felt in these muscles were classified as; 0: No increase in tone- 4: The affected part is rigid.[22]

The gross motor function classification system - expanded & revised (GMFCS-E&R): Children with CP are categorized using a standard classification system for their gross motor functions. GMFCS classifies the children from level 1 to 5: Level 1 represents the best and 5 represents the worst motor function.[23]

The timed 360° turn test (360DTT): A stopwatch is used to measure the time, and a marker is used to indicate the starting point. Each participant stands comfortably at the starting point and turns 360° on each side. Timing begins with the word "start" and ends when the participant's shoulder looks forward again. Three trials on each side and the average of these trials is recorded. The average score for the timed 360DTT performance is recorded.[19]

Pediatric Berg Balance Scale (PBBS): It consists of 14 problems that get harder as you go, testing functional skills linked to daily life activities including sitting and standing on one leg. Every item is given a score on an ordinal five-point scale from 0 to 4, with a maximum score of 56. Better postural balance is indicated by a higher score. The test-retest and inter-rater reliability in children with CP is high.[8] PBBS is used in this validation study. Because this scale measures the dinamic and static balance of children which is similar to 360DTT.

Timed up and go test (TUG): It measures functional mobility, gait speed, postural control, and balance with high reliability. Children were seated in chairs appropriate to their height. A distance of 3 meters was marked. The children was asked to get up and walk to the marked area with the command, then return and sit on the chair. The stopwatch was started with the command and stopped with the child's sitting. The average of the three measures was collected after the test was conducted three times.[15] TUG measures the dinamic parameters of the balance as if 360DTT. So it is used for the validation in this study.

Pediatric functional reach test (PFRT): The test was explained to the children verbally and visually. The child was asked to stand sideways against a wall, extending their elbows without contacting the wall and bending their shoulders to a 90-degree angle. In this position, the initial measurement was taken. Then, without taking a step, they were instructed to reach forward. The youngsters' final point of reach was noted. These two lengths were separated by a reported distance expressed in meters. When the child stepped off the ground, the test was repeated.[24] PFRT was preferred for the validation of 360DTT, because it measures the balance reactions.

Four square step test (FSST): Four 90-cm-long walking sticks and a timer are required pieces of equipment for this test. The sticks are laid flat on the ground, forming a square with 4. The child stands in square on a marked area divided into 4 squares. The child steps into each square as quickly as possible in these order: forward, backward, right and left in a sequence of 2, 3, 4, 1, 4, 3, 2 and 1. One of the two FSST measurement time is been recorded in seconds (sec). Stop watch begins with the first foot touching the floor in frame 1 and ends in frame 4.[25] FSST was prefeered for the validation of 360DTT, as it is similar to use the dinamic balance reastions in standing position.

Sample Size Calculation

The sample size was calculated using the G*Power 3.1.9.7 package program. For the reliability part of the study; when the null hypothesis was intraclass correlation coefficient (ICC)=0.70, the alternative hypothesis was ICC=0.90, alpha coefficient=0.05 and power=0.95, 57 children were calculated.[34] For the validity part; When effect size=0.62, alpha coefficient=0.05 and power=0.90, 57 children were calculated.[34]

Data Analysis

IBM SPSS 24 package program (SPSS Inc., Chicago, IL, USA) was used. Descriptivites were given as mean, standard deviation (X±SD) and percentage. Intraclass correlation coefficient (ICC) was used to assess the interrater reliability of the 360DTT, and Cronbach's alpha was used for internal consistency.

Two-way mixed effects models were used on mean measurements with the agreement definition form of ICC. Concurrent validity of 360DTT; correlation with PBBS, TUG, PFRT and FSST tests was evaluated with Pearson correlation

analysis. Coefficient value is defined as if: >0.75 good reliability, between 0.51 and 0.75 moderate reliability, and <0.5 poor reliability. Pearson correlation coefficient was evaluated as unacceptable between 0-0.49, moderate between 0.50-0.69, high between 0.70-0.79 and excellent between 0.80-1.00. Significance level of p≤0.05 was evaulated.

The Standard Error Measure (SEM) was utilized to assess the variations in individual scores across multiple assessments. The MDC value was used to evaluate the data and decide whether a change observed between testing was due to chance or actual performance changes.[26] Practically, MDC values help researchers and doctors identify whether an individual's physiological gait performance genuinely varies under various circumstances, including experimental settings, aging-related changes in the body, and surgical or rehabilitation procedures.[27] The SEM was computed using formula and the 95% confidence interval's minimal detectable change (MDC) was then computed as if below.[28]:

- (1) SEM = [SD at first assessment] x sqrt (1- intra-class correlation coefficient)
- (2) MDC = [SEM] x 1.96x sqrt

RESULTS

The children's (n=91) (11.40±2.84 years) sociodemographic information is shown in **Table 1**.

Table 1. Sociodemographic information of the children in the study

	(n=91) X±SD (Min-max)
Age (year)	11.40±2.84 (7-11)
Weight (kg)	41.21±12.64 (21-72)
Height (cm)	140.98±15.26 (106-165)
Sex (n) %	
Male	37 (40.7)
Female	54 (59.3)
Clinical Type of CP (n) %	
Spastic Hemiparetic	54 (59.3)
Spastic Diparetic	37 (40.7)
Dominant side (n) %	
Right	58 (63.7)
Left	33 (36.3)
Education (n) %	
None	14 (15.4)
Primary	28 (30.8)
Secondary	41 (45.1)
High School	8 (8.8)
GMFCS Level (n)%	
Level 1	48 (52.7)
Level 2	13 (47.3)
Orthosis (n)%	
Yes	37 (40.7)
No	54 (59.3)

n:number, %: Percent, X:mean; SD: Standard Deviation; min: minimum; max: maximum; CP: Cerebral Palsy, kg: Kilogram, cm: centimeter

The averages of the 360DTT, PBBS, TUG, PFRT and FSST tests used in the study are given in **Table 2**.

Table 2. Averages of tests 360DTT, PBBS, TUG, PFRT and FSTT used in the study

	Test X±SD (min-max)
360DTT right (First Physiotherapist)	7.24± 2.74 (3.12-20.4)
360DTT left (First Physiotherapist)	6.13± 2.8 (2.84-20.01)
360DTT right (Second Physiotherapist)	6.37±2.75 (2.95-19.5)
360DTT left (Second Physiotherapist)	5.92±3.35 (2.27-30)
PBBS	49.13±7.05 (30-56)
TUG	12.75±7.69 (4.43-35.6)
PFRT (front)	17.65±7.47 (0-34)
PFRT (right)	13.93±6.18 (0-29)
PFRT (left)	15.01±6.01 (3-36)
FSST	1.87±11.71 (5.43-50.05)

360DTT: The Timed 360° Turn Test, PBBS: Pediatric Berg Balance Scale, TUG: Timed Up and Go Test, PFRT: Pediatric Functional Reach Test, FSST: Four Square Step Test

The inter-rater reliability of 360DTT (right) and 360DTT (left) was found to be excellent (Inter-rater ICC=0.849-0.918, ICC=0.859-0.924) For the right and left sides, the SEM values were 1,06 sec. and 1,27 respectively. And the MDC values were 1.44 and 1.57 sec. respectively (**Table 3**).

Significant correlation was found between the tests of 360DTT (right) (1st measurement) and PBBS (r=-0.520 p≤0.001), TUG (r=0.304 p=0.003), PFRT front (r=-0.283 p=0.007), PFRT right (r=-0.295 p=0.005), PFRT left (r=-0.228 p=0.03) and FSST (r=0.381 p≤0.001) (**Table 4**).

Significant correlation was found between the tests of 360DTT (left) (1st measurement) and PBBS (r=-0.517 p≤0.001), PFRT front (r=-0.213 p=0.042), PFRT right (r=-0.253 p=0.016) and FSST (r=0.280 p=0.007) (**Table 4**).

Significant correlation was found between PBBS (r=-0.542 p≤0.001), TUG (r=0.217 p=0.039), PFRT front (r=-0.272 p=0.009), PFRT right (r=-0.304 p=0.003) and FSST (r=0.312 p=0.003) tests of 360DTT (right) (2nd measurement). Significant correlation was found between PBBS (r=-0.479 p≤0.001) and FSST (r=0.232 p=0.027) tests of 360DTT (left) (2nd measurement) (**Table 4**).

DISCUSSION

This study revealed that 360DTT has a high test-retest reliability and a good validity for using as a performance test of the assessment of functional mobility and balance in children with CP who is at GMFCS (E&R) levels I and II. It is thought that the use of a performance test such as 360DTT, which evaluates turning skills in children with CP, may be beneficial in terms of functional skills.

Table 3. Test-retest reliability of 360DTT

n=91	Two assessments by different physiotherapists in 2 separate sessions on consecutive days	Cronbach's Alpha	ICC*	95% CI	SEM (sec)	MDC (sec)
Test-Retest Reliability	360DTT (right)	0.918	0.849-0.918	0.780-0.946	1,06	1,44
	360DTT (left)	0.924	0.859-0.924	0.794-0.950	1,27	1,57

*Two-way mixed-effect model on average measures with absolute agreement definition. CI: Confidence Interval; ICC: intraclass correlation coefficient, MDC: Minimal detectable change; SEM: standard error of measurement, sec: second

Table 4. The correlation between 360DTT and PFRT, PBBS, FSST and TUG

		PFUT (front)	PFUT (right)	PFUT (left)	PBBS	FSST	TUG
360DTT right (First Physiotherapist)	r	-0.283	-0.295	-0.228	-0.520	0.381	0.304
	p	0.007*	0.005*	0.03*	≤0.001**	≤0.001**	0.003*
360DTT left (First Physiotherapist)	r	-0.213	-0.253	-0.154	-0.517	0.280	0.162
	p	0.042*	0.016*	0.144	≤0.001**	0.007*	0.124
360DTT right (Second Physiotherapist)	r	-0.272	-0.304	-0.176	-0.542	0.312	0.217
	p	0.009*	0.003*	0.095	≤0.001**	0.003**	0.039*
360DTT left (Second Physiotherapist)	r	-0.199	-0.192	-0.116	-0.479	0.232	0.126
	p	0.058	0.068	0.276	≤0.001**	0.027*	0.234

Pearson correlation, *p<0.05, **≤0.001, 360DTT: The Timed 360° Turn Test, PFRT: Pediatric Functional Reach Test, PFUT: Pediatrik Fonksiyonel Uzanma Testi, PBBS: Pediatric Berg Balance Scale, TUG: Timed Up and Go Test, FSST: Four Square Step Test

Studies on the validity and reliability of 360DTT have been carried out in various patients except CP in recent studies.[29,30] This study was performed with CP children by the interrater assessments of two physiotherapists who have high mobility levels but also can have loss of postural control and balance problems in daily life. CP is classified in different clinical types. The functional mobility and balance disorders of children with CP varies over time according to clinical types and functional classification.[15] 360DTT is a performance test that may be utilized in the clinics to categorize these children into several functional group. Therefore, the 360DTT can be an alternative method in the clinics as an objective performance test for classifying these children's mobility and balance problems into different functional groups.

The 360DTT, which can be easily applied in clinical measurements, may be important in terms of functionality in daily life in the assessment of dynamic balance by interacting with the somatosensory system and postural control mechanisms. In this respect, we believe that determining that the 360DTT is valid and reliable in children with high mobility levels of CP will contribute to the literature.

There are many studies of the validity and reliability of 360DTT that were carried out in various disease populations like Parkinson's Disease (PD), Multiple Sclerosis (MS), Stroke, ankle sprain, adults with cognitive impairment and knee osteoarthritis.[19,29-33] In the current study the inter-rater reliability The 360DTT's ICC value was determined to be consistent with values reported in other populations.[29-33] The studies of 360DTT showed that it has a good test-retest, intrarater, and interrater reliability people with Parkinson's Disease (PwPD), MS, Stroke, ankle sprain, cognitive impairment, and knee osteoarthritis (KO).[19,29-33] 360DTT was also found to be connected with motor symptoms, dynamic balance, functional mobility, and the severity of PD.[29] ICCs range was found high for dominant side (ICC=829-0.971) and non-dominant side (ICC=0.827-0.972) with PD.[29] In the MS population ICC range was found 0.898 to 0.980 (dominant side) and 0.893 to 979 (non-dominant side).[30] Also the ICC values were excellent and similar to the current study (ICC=0.849-0.924) with the individuals of cognitive impairment (ICC=0.96–0.98), ankle sprain (ICC=0.87), and stroke ICC=0.824-0.993), and KO (ICC=0.933-0.937).[19,30-33] Consequently, it can be seen that the 360DTT intra- and inter-rater reliability (ICC) values for the children with CP were found to be consistent with other studies.[29-32] Similarly, both GMFCS (E&R) levels had outstanding ICC values. These results showed that this test can be used for postural control, dynamic mobility and balance in different populations.

The measurement error that could occur is represented by the SEM value of clinical assessment tests. The SEM values of 360DTT in children with CP were 1,06 sec. and 1,27 respectively for the right and left sides. Yildiz et. al. found the SEM value 0.101 in ankle sprain patients.[33] This value might suggest that a low SEM value can give a sense of whether any change is genuine and can also provide high confidence with other outcomes. These findings provide as baseline information for future research with children with CP.

The MDC for both the 360DTT times on the dominant and non-dominant sides in MS patients were 1.49 sec. and 1.53 sec, respectively.[30] The minimum difference that would accurately reflect the differences in finishing the 360DTT is represented by such MDC values. From a clinical perspective, the MDC may prove beneficial in upcoming CP clinical trials when assessing whether the intervention protocol has indeed improved turning ability.

The minimal difference that would indicate a real change in the patient's state of health might be shown by the MDC. Also the MDC values of 360DTT were found 1.44 and 1.57 sec. respectively in children with CP. When Soke et al. identified the intra-rater MDC values of 1.98 s for dominant side and 1.48 sec. for nondominant side in PS patients,[29] Shiu et al. revealed that MDC values were 1.22 seconds for participants turning toward the unaffected side and 0.76 seconds for subjects turning toward the damaged side in stroke patients.[19] With terms of clinical trials, the MDC may prove beneficial for assessing whether the turning ability of participants with CP has indeed changed as a result of the intervention program.

Research investigating the 360DTT's concurrent validity in evaluating dynamic balance across various populations has revealed the test's strong validity. In these research, the Berg Balance Scale (BBS), TUG, and FSST were primarily utilized for concurrent validity.[19,30-33] These tests are similar to the 360DTT in that they require functional independence, coordination, stability in postural control, and both static and dynamic balance. We used PBBS, PFRT, TUG and FSST for validation.

Correlations were detected between 360DTT (right-left) and PBBS, PFRT, FSST, and TUG in all children with CP. The examination of dynamic balance by changing the center of gravity by turning and increasing the functional mobility of the 360DTT is considered to upload more postural control mechanisms like activating balance reactions or increasing muscle activity with using somatosensory and vestibular systems.

Deficits in balance are common in children with neurological (central and peripheral), orthopedic, and/or vestibular problems. Strong evidence for the use of one or more functional balance tests in children with CP cannot be offered due to a dearth of high-quality methodological studies. Furthermore, the establishment of a criterion standard for measuring balance is necessary in children with CP.[34] The PFRT, PBBS, 3meter walk test (3mBWT), FSST and TUG tests have all undergone extensive testing and demonstrate strong reliability in children with CP.[14,24,25,34-37] But the review studies shows that there is an absence of a criteria standard to gauge balance control raises questions about validity.[34] Technical tests are difficult to apply in clinical practice, and developmental scales are not expressly developed to evaluate balance control. So 360DTT can be useful for measurement of the dynamic balance as a good and practical performance test for CP children the GMFCS (E&R) level I and II.

The 360DTT is a simple, quick, and accurate assessment method for determining a person's ability to turn after a stroke.[19] It measures how long it takes an individual to rotate from a standing position. A crucial element of many clinical mobility and balance evaluations is turning ability. Turning, for instance, is a fundamental feature of the TUG and PBBS, two of the most widely used evaluation instruments for determining balance and mobility.[12,36,38]

Despite turning 180° twice, TUG does not expressly evaluate rotation.[38] The 360° turn is the only one of the 14 tasks that the PBBS measures. It receives a score ranging from 0 to 4 based on whether it takes less than or more than 4 seconds to complete. When evaluating turning abilities, the timed 360DTT is a more accurate and efficient assessment method than the TUG and PBBS.[29] It is associated to functional dependence among elderly people who live in communities.[29,30]

Functional mobility tests typically assess the capacity to move forward and turn and are performance-based. Understanding the many mechanisms underlying postural control in children with CP is necessary for conducting effective balance measurements. We think that the 360DTT dynamic balance test will be a valuable tool for all clinicians to employ in order to objectively observe the advanced functional skills that children with CP possess.

One of our limitations was that children with varying clinical types of CP and GMFCS (E&R) III were not assessed for the 360DTT. Because of this, it is not possible to apply the results to all children with CP. However, investigations involving children with CP of all different clinical types and functional levels can compute minimal detectable change (MDC) values of 360DTT in future studies. Additional research can also be conducted to identify the cut-off value of 360DTT for assessing the risk of falls in these children. For future studies, it could be beneficial to include qualitative feedback from the physiotherapists' experiences with the 360DTT.

CONCLUSION

This study revealed that 360DTT has a good test–retest reliability in children with CP in the level of GMFCS I and II. Also 360DTT is a good performance test to evaluate functional mobility and dynamic balance in children with CP. The advantages of 360DTT are that it specifically evaluates rotations in standing position. It may be better in this regard than other functional mobility tests since it incorporates additional parameters that are difficult for current evaluations to fully capture. As a result, we believe that this test should be used often for assessing dynamic balance, functional mobility, and gait in clinical settings.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was obtained from Kahramanmaras Sutcu Imam University Medical Research Ethics Committee (Date: 12.02.2022, Decision No: 2022/07).

Informed Consent: Parents of the children signed written informed consent.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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REFERENCES

1. Rosenbaum P, Paneth N, Leviton A, et al. A report: the definition and classification of cerebral palsy April 2006. Dev Med Child Neurol Suppl 2007;109(suppl 109):8-14.
2. Cans C, Dolk H, Platt MJ, Colver A. Recommendations from the SCPE collaborative group for defining and classifying cerebral palsy. Dev Med Child Neurol 2007;49:35.
3. Franjoine MR, Darr N, Young B, McCoy SW, LaForme Fiss A. Examination of the effects of age, sex, and motor ability level on balance capabilities in children with cerebral palsy GMFCS levels I, II, III and typical development using the Pediatric Balance Scale. Dev Neurorehabil 2022;25(2):115-24.
4. Franjoine MR, Darr N, Held SL, Kott K, Young BL. The performance of children developing typically on the pediatric balance scale. Pediatr Phys Ther 2010;22(4):350-9.
5. Horak FB. Postural orientation and equilibrium: what do we need to know about neural control of balance to prevent falls? Age and ageing 2006;35(suppl_2):ii7-ii11.

6. Pierret J, Caudron S, Paysant J, Beyaert C. Impaired postural control of axial segments in children with cerebral palsy. Gait Posture 2021;86:266-72.
7. Woollacott MH, Burtner P, Jensen J, Jasiewicz J, Roncesvalles N, Sveistrup H. Development of postural responses during standing in healthy children and children with spastic diplegia. Neurosci Biobehav Rev 1998;22(4):583-9.
8. Franjoine MR, Gunther JS, Taylor MJ. Pediatric balance scale: a modified version of the berg balance scale for the school-age child with mild to moderate motor impairment. Pediatr Phys Ther 2003;15(2):114-28.
9. Prosser LA, Lee SC, VanSant AF, Barbe MF, Lauer RT. Trunk and hip muscle activation patterns are different during walking in young children with and without cerebral palsy. Phys Ther 2010;90(7):986-97.
10. Woollacott MH, Shumway-Cook A. Postural dysfunction during standing and walking in children with cerebral palsy: what are the underlying problems and what new therapies might improve balance? Neural plasticity. 2005;12(2-3):211-9.
11. Saether R, Helbostad JL, Riphagen II, Vik T. Clinical tools to assess balance in children and adults with cerebral palsy: a systematic review. Dev Med Child Neurol 2013;55(11):988-99.
12. Kembhavi G, Darrah J, Magill-Evans J, Loomis J. Using the berg balance scale to distinguish balance abilities in children with cerebral palsy. Pediatr Phys Ther 2002;14(2):92-9.
13. Norris RA, Wilder E, Norton J. The functional reach test in 3-to 5-year-old children without disabilities. Pediatr Phys Ther 2008;20(1):47-52.
14. Williams EN, Carroll SG, Reddihough DS, Phillips BA, Galea MP. Investigation of the timed 'up & go'test in children. Dev Med Child Neurol 2005;47(8):518-24.
15. Zaino CA, Marchese VG, Westcott SL. Timed up and down stairs test: preliminary reliability and validity of a new measure of functional mobility. Pediatr Phys Ther 2004;16(2):90-8.
16. Dewar R, Claus AP, Tucker K, Ware RS, Johnston LM. Reproducibility of the Kids-BESTest and the Kids-Mini-BESTest for children with cerebral palsy. Arch Phys Med Rehabil 2019;100(4):695-702.
17. Klein PJ, Fiedler RC, Rose DJ. Rasch analysis of the Fullerton Advanced Balance (FAB) scale. Physiother Can 2011;63(1):115-25.
18. Erturan S, Atalan P, Çimen YA, et al. Reliability and validity of the Turkish version of Fullerton Advanced Balance Scale in cerebral palsy. Gait Posture 2022;96:295-300.
19. Shiu CH, Ng SS, Kwong PW, Liu T-W, Tam EW, Fong SS. Timed 360 turn test for assessing people with chronic stroke. Arch Phys Med Rehabil 2016;97(4):536-44.
20. Podsiadlo D, Richardson S. The timed "Up & Go": a test of basic functional mobility for frail elderly persons. J Am Geriatr Soc 1991;39(2):142-8.
21. Gill TM, Williams CS, Tinetti ME. Assessing risk for the onset of functional dependence among older adults: the role of physical performance. J Am Geriatr Soc. 1995;43(6):603-9.
22. Bohannon RW, Smith MB. Interrater reliability of a modified Ashworth scale of muscle spasticity. Phys Ther 1987;67(2):206-7.
23. Palisano R, Rosenbaum P, Walter S, Russell D, Wood E, Galuppi B. Development and reliability of a system to classify gross motor function in children with cerebral palsy. Dev Med Child Neurol 1997;39(4):214-23.
24. Bartlett D, Birmingham T. Validity and reliability of a pediatric reach test. Pediatr Phys Ther 2003;15(2):84-92.
25. Bandong ANJ, Madriaga GO, Gorgon EJR. Reliability and validity of the Four Square Step Test in children with cerebral palsy and Down syndrome. Res Dev Disabil 2015;47:39-47.
26. Altman DG, Bland JM. Standard deviations and standard errors. Bmj 2005;331(7521):903.
27. Haley SM, Fragala-Pinkham MA. Interpreting change scores of tests and measures used in physical therapy. Phys Ther 2006;86(5):735-43.
28. Weir JP. Quantifying test-retest reliability using the intraclass correlation coefficient and the SEM. J Strength Cond Res 2005;19(1):231-40.
29. Soke F, Guclu-Gunduz A, Ozkan T, Ozkul C, Gulsen C, Kocer B. Reliability and validity of the timed 360 turn test in people with Parkinson's disease. Eur Geriatr Med 2020;11:417-26.
30. Soke F, Guclu-Gunduz A, Ozkul C, Cekim K, Irkec C, Gonenli Kocer B. Reliability and validity of the timed 360 turn test in people with multiple sclerosis. Physiother Theory Pract 2021;37(6):736-47.
31. McGough EL, Gries M, Teri L, Kelly VE. Validity of instrumented 360 turn test in older adults with cognitive impairment. Phys Occup Ther Geriatr 2020;38(2):170-84.
32. Yarar HA, Narin S, Erduran M, Gurbanov I. The test-retest reliability and concurrent validity of 360 turn test in patients with knee osteoarthritis. Somatosens Mot Res 2024;41(2):90-6.
33. Yıldız NT, Canlı M, Kocaman H, et al. Validity and Reliability of the Timed 360° Turn Test in Individuals with Ankle Sprain. Indian J Orthop 2024:1-8.
34. Verbecque E, Lobo Da Costa PH, Vereeck L, Hallemans A. Psychometric properties of functional balance tests in children: a literature review. Dev Med Child Neurol 2015;57(6):521-9.
35. Carey H, Martin K, Combs-Miller S, Heathcock JC. Reliability and responsiveness of the timed up and go test in children with cerebral palsy. Pediatr Phys Ther 2016;28(4):401-8.
36. Ko J-Y, Kim G-W. Test-retest, inter-rater, and intra-rater reliability of a pediatric balance scale in children with cerebral palsy. J. Korean phys. ther. sci 2010;22(4):43-8.
37. Celik OF, Adiguzel H, Kirmaci ZIK, Erel S, Demirguc A. Validity and reliability of the 3-meter backward walk test in children with cerebral palsy. Acta Neurol Belg 2023;123(4):1439-46.
38. Dhote SN, Khatri PA, Ganvir SS. Reliability of" Modified timed up and go" test in children with cerebral palsy. Journal of pediatric neurosciences. 2012;7(2):96-100.