Trapthi Kamath
Lecturer, RV College of
Physiotherapy, Bangalore, India

Sandesh TS
Associate Professor, Alva's
College of Physiotherapy,
Moodabidri, Kannada, India

The test retest reliability and concurrent validity of functional reach test in 5 to 15 years old children with Down's syndrome - A cross sectional study

Trapthi Kamath and Sandesh TS

Abstract
Background and objective: The functional reach test and Time up and go test are most common dynamic balance tests used in patient with Down's syndrome. To estimate test-retest reliability, inter-rater reliability and validation of a method for measuring balance functional reach test in children with Down's syndrome, A cross-sectional study conducted in Alva's special school, Chethana special school and Mangalore special school with outcome measures of Functional reach test, inter rater reliability, test retest reliability and concurrent validity to timed up and go test. Ethical clearance was obtained and 50 Down's syndrome children (5-15years) were selected with who fulfils the inclusion criteria. The subjects were asked to perform three trials of functional reach and time up and go test and average of three trials was used for data analysis and their height, weight, Waist Circumference, Body mass index were measured. For estimating test-retest reliability, functional reach test was done by principal investigator once and inter-rater reliability was assessed by principal investigator and second investigator with an interval of 5 days. Time up and go test was used as the criterion dynamic balance, locomotion and coordination measure to validate functional reach. The data was tabulated and analysed statistically.
Result: 50 children with Down's syndrome took part in the reliability study. The test- retest reliability of functional reach test is ICC (1, 1) 0.851 (p=0.002). According shrout and fleiss criteria in estimating reliability, there is moderate reliability between them. Similarly inter-rater reliability of time up and go test with ICC (2, 1) =0.72(p=0.002). Conclusion: Functional reach test is valid and reliable measure in estimating dynamic balance in children with Down's syndrome.

Keywords: Down's Syndrome, functional reach, time up and go test, inter-rater reliability, test-retest reliability, validity

Introduction
The WHO reports show an estimation of Down's syndrome incidences are between 1 in 1000 and 1 in 1100 live births worldwide. Every year almost 3000-5000 children have this chromosome disorder inborn [1]. children with Down's syndrome have complications such as gross motor, developmental delay, problems in cognitive development, body balance, and functional balance with fine motor skills such as coordination [2, 3]. It is observed that they have hypotonia, increased reaction time in performing voluntary activities, muscle weakness due to inadequate co-contraction and improper sensory integration. Research worldwide has proved that people having this syndrome are not able to maintain their center of gravity within base of support, and have impaired balance as compared to their counterparts [3, 4].

Child might be mentally handicap and specific problems in the motor development such as balance or trunk rotation, abnormal movement pattern. Problems with fine motor skills such as coordination, manipulation etc. might be seen. They have poor strength and less stamina. They have problems in executing complex motor task. Problems in eye-hand coordination, dexterity and reaction speed are also seen. Many of researchers have been proven that the individual with ds has difficulty in the maintaining their line of gravity (LOG) within the base of support (BOS). Thus children with ds have difficulty in maintaining balance [5].

Individuals with Down's syndrome have a significant delay in motor skills and balance development; these problems are present during childhood and adulthood [6]. Slow movements, different gait patterns and an inability to respond rapidly to changes in the environment are

Correspondence
Trapthi Kamath MPT
Lecturer, RV College of
Physiotherapy, Bangalore, India

easily noticed even by casual observers. Good stability supports more complicated movements, encourages us to explore new situations, and ultimately leads to optimal motor control, based on growing experience and skill in using a variety of motor synergies. In contrast, poor stability increases the risk of falling and puts constraints on physical activity, which results in very limited motor experience in subjects with down's syndrome. Individuals with Down's syndrome having lower balance when compared to general population.[7]Good balance is necessary to maintain an independent life style for individuals with Down's syndrome, hence functional reach test is good to determine balance Down's syndrome with individual [8].

A common characteristic among individuals with Down's syndrome is that they have some degree of mental retardation [9]. The most cited weakness in individuals with mental retardation is a lack of dynamic balance [10]. Dynamic balance is necessary to move from one position to another, and to move freely in the community, whereas static balance is the ability to maintain a bodily position [8, 11]. Some characteristics of Down's syndrome that affect balance include hypotonia, strength deficits and a small cerebellum and brain stem [12]. Having good balance helps maintain an independent lifestyle in individuals with down's syndrome. Training programs designed for individuals with down's syndrome include creative dancing, movement exploration, jumping, treadmill walking, and ball exercises [6, 7].

Physical therapists use various tests to examine static and dynamic components of balance for children, at different ages, with and without disabilities. Some of these tests are designed specifically to evaluate balance and other tests evaluate more generalized gross motor functions that include balance components. The functional reach test was developed by Duncan et al. [13] to measure dynamic balance in adults. The functional reach test defines the maximal distance an individual is able to reach forward beyond arm's length in a standing position without loss of balance, taking a step, or touching the wall.

Donohoe et al. [14] reported results for 116 children of 5 to 15 years of age without disabilities for a reliability study and a descriptive study. Two experienced paediatric physical therapists collected the data. There were five age groups, in increments of 2 years, and the group sizes varied from 10 per group (13–15 years old) to 36 per group (7–8 years old). The investigators reported that all subjects were able to successfully perform the functional reach. Niznik et al. [15] reported functional reach scores from a sample of 32 children with lower extremity spasticity. Subjects included children aged 5 to 18 years, and an age-matched group without disabilities. The purposes of the study were to determine if the functional reach test was reliable within this population.

Podsiadlo and Richardson et al. [16] (1991) concluded that a time up and go test time of less than 20 seconds indicated that the individual was independent for basic transfers, and a time up and go test time of more than 30 seconds indicated that the individual tend to be more dependent. They reported that the time up and go test also had content validity because "it evaluates a well-recognized series of manoeuvres used in daily life." The time up and go test is a mobility test that assesses balance and gait in a functional activity used in everyday life. The time up and go test, "standardizes most of the basic mobility manoeuvres, yet is quick and practical". This study investigated the clinical usefulness of the time up and go test in a population of frail elderly, and determined the time up and go test had good reliability and validity as a measure of balance, gait speed, and function.

Person's ability to maintain balance is estimated by the simple test functional reach test. Functional reach test has been studied extensively in adults and found to be highly reliable in children with typical development, the functional reach test also has been considered a tool to measure balance [17]. Children with Down's syndrome show worse balance compared to their peers [4]. hence, it has been difficult to establish the reliability of various postural control tests in children with Down's syndrome [18].

Materials and methods: A cross-sectional study including 50 subjects with down's syndrome were referred from Alva's special school, Chethana special school and Mangalore special school with a duration of 6 months.

Materials used: Wooden chair, Stop watch, Measuring tape, Weighing machine, Pencil.

Inclusion criteria: 5-15 years, Cooperative children, Children with functional vision and hearing, Absence of seizures, No medication, Impedance in ambulation, Children who obey verbal commands.

Exclusion criteria: History of fracture and musculoskeletal deformities within 6 months, History of severe cardiovascular respiratory disorders.

Outcome measure: Functional reach test, inter rater reliability, test retest reliability and concurrent validity to time up and go test.

The sample was recruited from the recognized special school. University research committee and institutional ethics committee approved the study protocol (ACP/OP/) the 50 subjects who will fulfil the inclusion criteria will be selected for the cross sectional study by convenience sampling based on inclusion criteria first all the subjects will be assessed with a detailed neurological assessment form and consent form has taken from the parents and also anthropometric measurements waist circumference, height, weight, body mass index as taken. We have assessed 50 subjects for the eligibility of functional reach test and time up and go test.

Functional reach test

- Instructed to stand next to the wall without touching.
- Arm position was closer to the wall at 90° shoulder flexion with a closed fist
- Location of the 3 rd. metacarpal head was recorded.
- Instructed, "reach as far as you can move forward without taking a step"
- However, it has only been done in the standing position with children, [19] and requires participants to be able to stand barefoot in a static position for at least two minutes before testing
- The dominant hand was determined by asking the subject that hand he/she uses when writing, eating or throwing the ball [19, 20].
- Difference between the start and end position of 3rd. metacarpal head was noted.
- Trial was considered successful if the functional reach test was performed without the child stepping, touching the wall, or receiving assistance from the investigator.
- Average of the difference between 1st and 2nd measures for each of the three successful functional reach trials were noted.
- Brief rest periods of approximately 5 to 10 seconds were allowed between the trials.

Time up and go test
The time up and go test consists of rising from a chair positioned 3m from a wall, walking 3m, turning around, returning to the chair, and sitting down again. The test was performed according to the modifications for children described in the study by Williams *et al*. [21] for each time up and go test evaluation, three measures are recommended and the final result is average of 3 obtained [16]. The verbal command included instructions about velocity such as: 'walk as fast as possible'. This adaptation was proposed because time up and go test results are less variable when instructions are given regarding velocity [22]. The modifications for the use of the time up and go test in patients instructions may be repeated during the test and counting time must begin when the child gets up from the chair, and stop when the child sit in the chair [21]. Time up and go test evaluations were performed by the principal investigator, with more than 3 years of experience in physiotherapy, and the individuals were evaluated wearing comfortable clothes.

Statistical analysis
- Normality of collected data will be established by shapiro-wilk test
- All data were performed in SPSS® 20.0 IBM®.
- Intra rater and inter rater reliability by ICC
- To find out the association between functional reach test and time up and go test, the spearman rank correlation test.

The data were analysed by using statistical package for social sciences, version -20(SPSS® 20.0 IBM®). To gain sufficient power for the data analysis we obtained sample of 50 children with Down's syndrome with 0.05 alpha level and 80% power to detect minimum reliability coefficient of 0.75. The normality of the collected data was established using shapiro-wilk test and it was found to be that the data doesn't follows

normal distribution. Hence, we use non-parametric test. Descriptive statistics are reported as mean (95%ci) and range. Test-retest and inter-rater reliability were established using intra-class correlation coefficient (ICC). For test re test reliability, an ICC 1, 1 (1-way random effect model) was used and for interrater analysis, an ICC 2, 1 (2-way random effect model) was used in accordance with shrout and fleiss. According to them ICC interpretation <0.4- poor, 0.4 to <0.75- moderate, 0.75 to <0.9- good, ≥0.9- excellent. The limits of agreement (LOA) were established as described by bland and Altman plots were used to display the level of agreement between repeated measures. The bland to find out the association between functional reach test and time up and go test, the spearman rank correlation test was used [23, 24, 25].

Results and Discussion
50 children with Down's syndrome took part in the reliability study. None of them complains of pain or discomfort during the test. Demographics of the children recruited are displayed in table 1. The 33 boys and 17 girls were matched in their age height and weight and this matching improves the quality of the study.

The ICC value of the repeated measures by the same investigator is displayed in the scatter plot figure 3. The test-retest reliability of functional reach is ICC (1, 1) 0.851 (p=0.002). According shrout and fleiss criteria in estimating reliability, there is moderate reliability between them. Similarly figure 2 displays inter-rater reliability of time up and go test with ICC (2, 1) =0.72(p=0.002).

The bland-Altman limits of agreement (LOA) plots are included in figure 2 and 3. The LOA between repeated measurement fall well within 2SD. In both the above figures, there is one outliers. Thus the agreement between measurements was satisfied.

Table 1: The demographic characteristics of subjects recruited and their characteristics were expressed as mean± S.D, standard error of mean and range

Demographic Data	Mean ± S.D	Standard error of mean	Range
Age	11.78±3.39	0.41	21.07
Height(cms)	1.41±1.88	2.66	70
Weight(kgs)	36.96±1.26	1.79	49
BMI	17.86±3.33	0.47	16.83
WC(inches)	25.78±3.91	0.55	18

Table 2: Demographic characteristics of functional reach and time up and go recruited and their characteristics were expressed as mean± SD standard error of mean and range

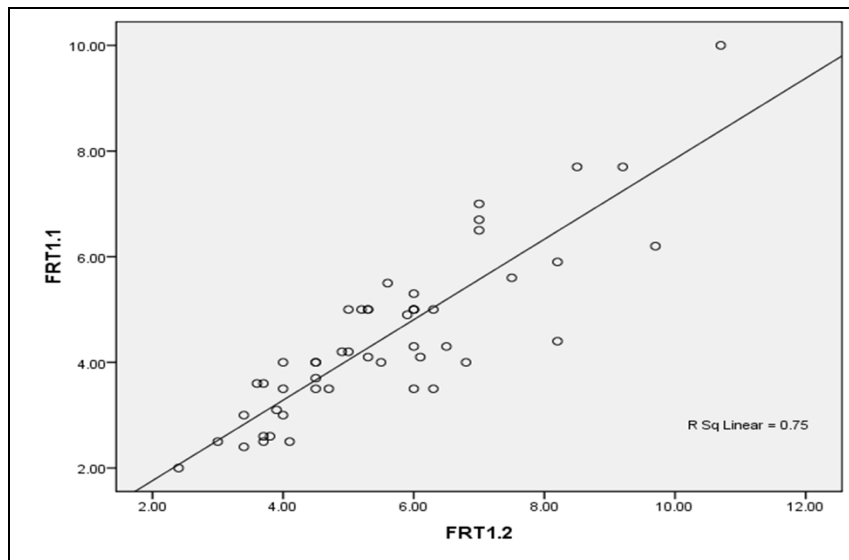| Demographic Data	Mean± S.D	Standard error of mean	Range
functional reach1 avg	5.47±1.64	0.23	7.77
functional reach2avg	5.35±1.49	0.21	7.94
Tug1avg	12.33±3.24	0.46	20.45
Tug2avg	10.90±3.39	0.48	21.07

Fig 1: Correlation scatter block displaying Inter-rater reliability of functional reach. There is good degree of agreement between functional reach done by first and second investigator.
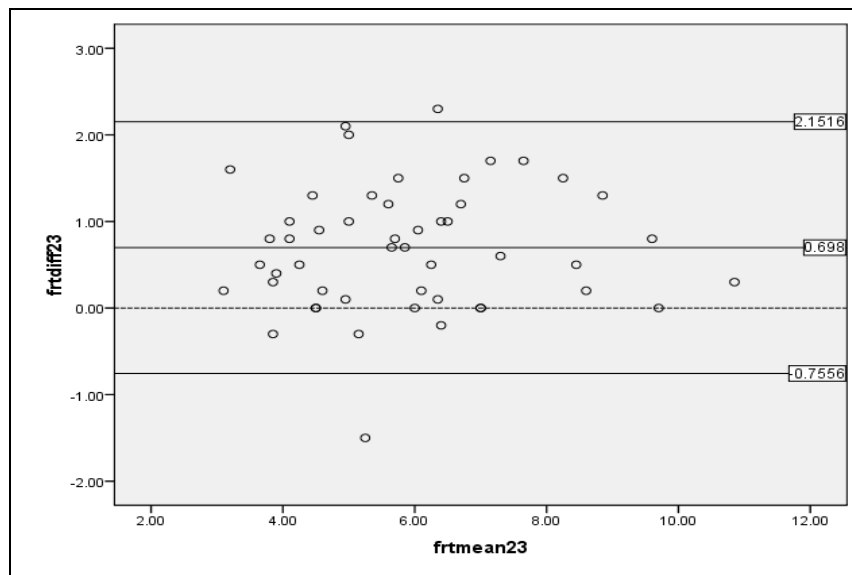

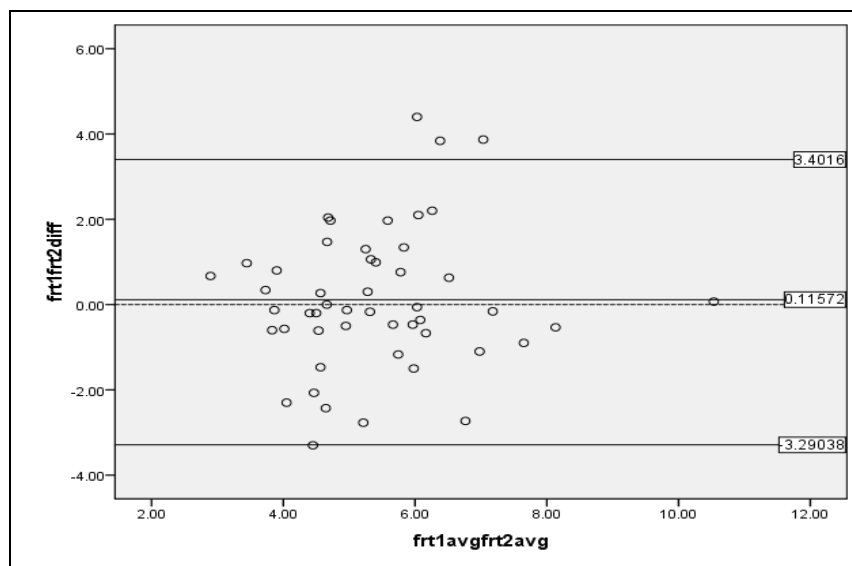**Fig 2:** The Bland- Altman graph shows LOA of repeated measurements by the same investigator

Fig 3: The Bland- Altman graph shows LOA of repeated measurements by the principal investigator and second investigator
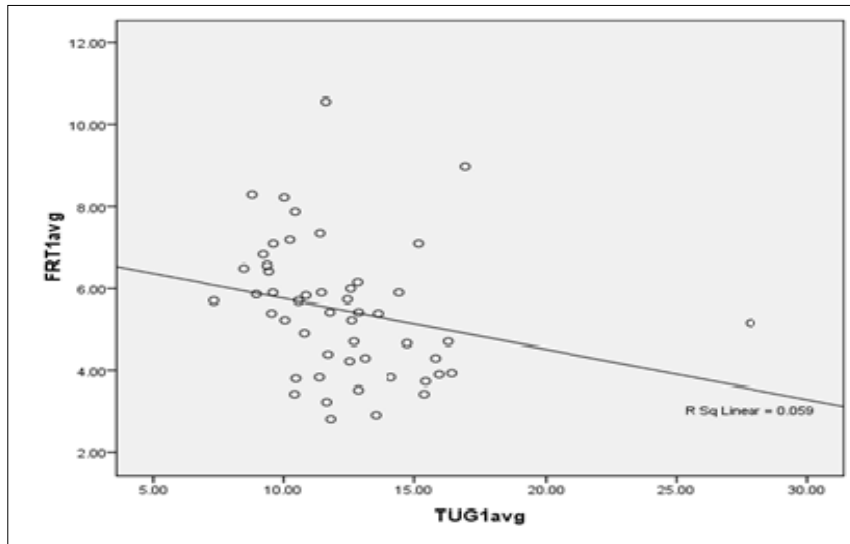
Fig 4: Correlation Scatter block between time up and go and functional reach. According Shrout and Fleiss JL criteria there is moderate degree of inverse association between time up and go and functional reach with Spearman's ρ -0.419(0.002)

Fig 5: Time up and go test

Fig 6: Functional reach test

Functional reach test is a convenient and feasible method to evaluate the dynamic balance, locomotion and co-ordination in children with Down's syndrome. From the data collected, for test-retest reliability obtained was ICC (1, 1) 0.851 (p=0.002) with functional reach principal investigator performed functional reach test once on the subjects. Similarly, for inter rater reliability was ICC (2, 1) =0.72(p=0.002). N=50, with functional reach, principal investigator and 2nd investigator on subjects, interval of 5 days.

Out of the total of 50 subjects who participated in this study, 33 were boys and 17 were girls. The participants were in comfortable clothing and performed the test barefoot. Comfortable homely environment for all the participants had made the test successful. Functional reach test has good validity with standard criterion measures. It identifies the maximum distance a subject can reach forward without moving his/her feet. It is the most convenient method, easy to

perform, it does not require large clinical setup and it can be easily demonstrated to the subject.

According to norris *et al.* [26] the normal value of functional reach test in the age group 3 to 5 years ranged between 5.2 to 22.7 cm and it was in the range of 19.7 to 32.2cm for the normal children in age group 6 to 12 from the report of abhijeet *et al.* [27] for the children's with TBI, the functional reach range between 13.3 and 31.4 cm from the analysis done by katz-leurer *et al* [29]. But in our study the normal value of functional reach test by the principal investigator for the children with down's syndrome ranges from 2.90 to 10.47 inches (5.47±1.64) while that by the second investigator was (5.35±1.49) this is almost in line with the values of other study. We have taken the age group from 5 to 15 years as by this the CNS of the children will have attained maturity. So, the disparity in balance due to the immaturity of CNS is prevented.

Tyson *et al.* [28] reported that the correlation of functional reach test with the comparator test, r=0.32-0.74 (p=≤0.05). But in TBI, Katz *et al.* [29] reported the correlation of functional reach test was r=0.71-0.92 (p=≤0.05).

The inter rater reliability for functional reach test was found to be ICC (2, 1) =0.72. And its significance was found to be moderate to good (p=0.002). The "get up and go" test (GUG), later changed to the "timed up and go" by Podsiadlo and Richardson [16] (1991), has been determined to be a valid and reliable assessment of functional ability in the hail elderly adult population (Matthias, Nayak, and Isaacs, 1986).

Podsiadlo and Richardson's [16] (1991) study investigated the clinical usefulness of the time up and go test in a population of frail elderly, and determined the time up and go test had good reliability and validity as a measure of balance, gait speed, and function (mobility). The study consisted of 60 frail elderly subjects and 10 normal elderly subjects used for the control group. The subjects were given a practice trial of the time up and go test and then performed 3 trials. Inter-rater reliability was tested on 22 subjects who performed the time up and go test for 3 different testers. The scores/times were analysed with the interclass correlation coefficient (ICC) and determined to be 0.99. Intra-rater reliability was tested on 20 subjects who performed the time up and go test for the same tester on two consecutive days. The scores/times were analysed with the ICC and determined to be 0.99.

Thompson and medley [30] (1995) determined the time up and go test, inter-rater and intra-rater reliability in their study by having the eight testers practice timing on classmates. The scores were analysed with the ICC and ranged in value from 0.81 - 0.99. The time up and go test test is a practical tool to evaluate functional mobility and balance, these refere nce values may help in the evaluation of specific groups, such as individuals with Down's syndrome.

In our study, we found out the concurrent validity for time up and go test which is a quick, easy, and objective measure of functional mobility, the test was performed in a homely environment on the children with down' syndrome who underwent functional reach test earlier to get optimum results. The time up and go test was performed by the principal investigator and its concurrent validity to functional reach test in children with down's syndrome was found to be ρ -0.419 (p=0.002) using spearman's correlation coefficient which is statistically stated as moderate to good.

Therefore, functional reach test is found to be a valid and reliable measure in estimating dynamic balance, functional mobility and coordination in children with Down's syndrome.

Conclusions
Functional reach test is valid and reliable measure in estimating dynamic balance, locomotion and coordination in children with Down's syndrome.

References
1. WHO. Genes and human diseases, genes and chromosomal diseases, down syndrome; c2013. Available from: http://www.who.int/genomics public/genticdiseases/en/index1.html. [last updated on 2013, 05. last cited on 2013 jun 23]
2. Carvalho rl, vasconcelos da. Motor behavior in down syndrome: atypical sensorimotor control. In: dey s. Prenatal diagnosis and screening for down syndrome. Croatia: intech Rijeka. 2001; 3:33-39.
3. Malak r, kotwicka m, krawczyk☐wasielewska a, mojs e, samborski w. motor skills, cognitive development and balance functions of childrenwith down syndrome. Ann agric environ med. 2013; 20:803☐6.
4. Villarroya ma, gonzalez☐aguero a, moros☐garcia t, de la flormarín m, moreno la, casajús ja. Static standing balance inadolescents with down syndrome. Res dev disabil. 2012; 33:1294☐300
5. Cynthia norkin c, pamela lavingie k. joint structure and function, a comprehensive analysis ivth edition, published by f.a. Davis company, philadelphia. 17.
6. Wang wY, chang jJ. Effects of jumping skill training on walking balance for children with mental retardation and down's syndrome. Kaohsiung journal of medical sciences. 1997; 13(8):487-495.
7. Tsimaras vK, fotiadou eG. Effect of training on the muscle strength and dynamic balance ability of adults with down syndrome. Journal of strength and Conditioning research. 2004; 18(2):343-347.
8. Carmeli e, bar-chad s, lotan m, merrick j, coleman r. Five clinical. Tests to assess balance following ball exercises and treadmill training in adult persons with intellectual disability. Journal of gerontology series a: biologicalsciences and medical sciences, 2003; 58(8):767-772.
9. hayes a, batshaw mL. Down syndrome. Pediatric clinics of north America, 1993; 40(3):523-535.
10. Boswell b. Comparison of two methods of improving dynamic balance of Mentally retarded children. Perceptual and motor skills, 1991; 73(3-1):759-764.
11. Berg kO, maki bE, williams jI, holliday pJ, wood-dauphinee sL. Clinical and laboratory measures of postural balance in an elderly Population. Archives of physical medicine and rehabilitation, 1992; 73(11):1073-1080.
12. Angelopoulou n, tsimaras v, christoulas k, kokaridas d, mandroukas k. Isokinetic knee muscle strength of individuals with mental retardation, a Comparative study. Perceptual and motor skills, 1999; 88(3-1):849-855.
13. Duncan PW, Weiner DK, Chandler J, Studenski S. Functional reach: a new clinical measure of balance. Journal of Gerontology. 1990; 45(6):M192-M197.

14. Donohoe b, turner d, worrell t. The use of functional reach as a measurement of balance in boys and girls without disabilities ages 5 to 15 years. Pediatr phys ther. 1994; 6:189-193.
15. Niznik t, turner d, worrell t. Functional reach as a measurement of balance for children with lower extremity spasticity. Phys occup ther pediatr. 1995; 15:1-15.
16. Podsiadlo d, richardson s. The timed up and go: a test of basic Functional mobility for frail elderly persons. Journal of the American geriatric society. 1991; 39:142-148.
17. volkman kg, stergiou n, stuberg w, blanke d, stoner j. Methods to improve the reliability of the functional reach test in children and adolescents with typical development. Pediatr phys ther. 2007;19(1):20-7.
18. wolff dr, rose j, jones vk, bloch da, oehlert jw, gamble jg. Postural balance measurements for children an adolescents. J orthop res. 1998; 16(2):271-5.
19. Gessell A, Lig F, Ames LB. The child from 5 to 10. London: HarnishHamilton; 1973, 53.
20. Lewis m. Clinical aspect of child development. 2nd ed. Philadelphia: lea and febiger; 1982, 236.
21. Williams en, carroll sg, reddihough ds, phillips ba,galea mp. Investigation of the timed 'up & go' test in children. Dev med child neurol. 2005; 47:518-24.
22. Bergmann jh, alexiou c, smith ic. Procedural differences directly affect timed up and go times. J am geriatr soc. 2009; 57:2168-9.
23. Walter sd, eliasziw m, donner a. Sample size and optimal designs for reliability studies stat med. 1998; 15:17(1):101-10.
24. Shrout pe, fleiss jl. Interclass correlation; uses in assessing rater reliability. Psy chol bull. 1979; 86(2):420-428.
25. Bland jm, altman dg. Statical methods for assessing agreement between two method of clinical measuremal. Lancet. 1986; 8;1(8476):307-10.
26. Norris RA, Wilder E, Norton J. Functional reach test in 3- to 5- year-old children without disabilities. Pediatr Phys Ther. 2008; 20(1):47-52
27. Abhijeet A, Deshmukh Sailaksmi G, Jaya ST. Normal Values of Functional Reach and Lateral Reach Tests in Indian School Children. Pediatr Phys Ther. 2011; 23(1):23-30
28. Tyson SF, Desouza LH. Topic Reliability and validity of functional balance tests post stroke. Clin Rehabil. 2004; 18(8):916-23.
29. Katz⍰Leurer M, Rotem H, Lewitus H, Keren O, Meyer S. Functional balance tests for children with traumatic brain injury: Within⍰session reliability. Pediatr Phys Ther. 2008; 20:254⍰8.
30. Thompson, m., and a. Medley. Performance of community dwelling Elderly on the timed up and go test. Physical and occupational therapy in geriatrics. 1995; 13(f31):17-30.