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Original Article

Assessment of the Concurrent Validity and Reliability of the Persian Version of the Pediatric Balance Scale in Schoolchildren with Down Syndrome

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Abstract

Background: Individuals with Down Syndrome face numerous challenges related to movement and balance. The present study evaluated the reliability and concurrent validity of the Persian version of the Pediatric Balance Scale in schoolchildren.
Methods: In this cross-sectional correlational study, 37 students (23 girls and 14 boys) with Down Syndrome aged 7 to 15 were recruited through convenience sampling technique. The participants were selected from special education schools in the spring of 2024. Initially, the procedure for performing the tests was taught to the children. Then, at a two-week interval (one session per week for a child), the tests were administered by two independent examiners. The Timed Up and Go, Pediatric Balance Scale, and Standing Stork Test were used to assess balance. The statistical tests used in this study were the intra-class correlation coefficient and Pearson's correlation coefficient, at a 95% confidence level.
Results: Pearson's correlation test revealed a substantial correlation between Pediatric Balance Scale and Standing Stork Test ($r=0.585$, $P<0.001$), and an inverse correlation between Pediatric Balance Scale and the Timed Up and Go test ($r=-0.606$, $P<0.001$). These correlation coefficients indicated a moderate to strong relationship between these tests and Pediatric Balance Scale. Based on the intra-class correlation coefficients obtained, the within-evaluator (ICC=1.000) and between-evaluator (ICC=0.973) agreements were high and reliable.
Conclusions: Pediatric Balance Scale appears to have excellent reliability and appropriate concurrent validity for assessing balance in schoolchildren with Down Syndrome. Therefore, it is recommended that this balance scale be used to evaluate balance in these individuals.

Keywords: Validity, Down Syndrome, Reproducibility, Postural Balance, Child

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1. Introduction

Down Syndrome (DS) is characterized by a combination of genetic disorders and intellectual disability (1). This syndrome is created by an excess expression of chromosome twenty-one, where instead of two chromosomes, three chromosomes are present, leading to complications such as intellectual, cardiac, respiratory, and motor problems (2). Individuals with DS differ from usual people, possessing specific physiological and anatomical characteristics, and also exhibit significant delays in both motor and cognitive development (3). These problems lead to slower walking speeds, shorter step lengths and widths, and altered sway in anterior, medial, and posterior directions. These children rely on various compensatory mechanisms to maintain balance in static and dynamic conditions. These include widening step width, increasing internal and external center-of-mass frequency, reducing anterior and posterior sway, posterior trunk tilt, and trunk rigidity (4). Pathophysiological-neurological causes for the motor inefficiencies in individuals with DS are still not fully understood. However, weak cerebellar function, delayed myelination, and issues with proprioception and the vestibular system have been identified as potential internal causes (5).

Research on postural sway in individuals with DS revealed that they all have postural control dysfunction, leading to balance problems (1). Reduced balance and postural control, diminished

strength, and raised predisposition to cardiovascular diseases are common challenges faced by these children. These disorders can result in activity limitations and delays in motor development, setting these children apart from their peers in participation in games and recreational activities. It is shown that physiotherapy interventions and exercise programs improve disorders and alleviate activity limitations in individuals with DS. For instance, these programs improve strength, balance, coordination, and cardiovascular fitness (6). Other studies reported that infants with DS start walking earlier than other infants, and educational protocols such as treadmill training and various games help improve their motor development. Despite these results, selecting the most suitable exercises for these individuals is particularly important (7). Therefore, therapists should carefully assess balance in school-aged children with DS to determine whether the child can perform daily activities independently and safely (8). In a previous study, the reliability of the Berg Balance Scale (BBS) was investigated among individuals aged 4 to 13 years, and based on the results, the reliability of this test was not fully determined due to the extensive time required for its administration (9). Consequently, this test is challenging for children, and PBS, a modified form of BBS, was introduced (7). Notably, PBS does not require complex and extensive equipment and can be easily administered. PBS consists of 14 items to assess a child's skill to sustain and alter posture when their support base is reduced. These items evaluate the child's ability to perform daily and basic activities independently and safely, which is essential for children with DS (7).

PBS has been translated and assessed in various countries. This test has also been used to measure equilibrium in individuals with specific disabilities, such as cerebral palsy and its types, visual impairments, and attention deficit hyperactivity disorder (ADHD), in different countries (10-16). It should be noted that the original PBS was developed in English, so when any instrument or questionnaire is translated into another language, the validity and reliability of the translated form should be re-evaluated (10, 11). However, based on the literature search, its validity and reliability have not yet been evaluated in children with DS.

Findings suggested that PBS is a suitable means for assessing balance in individuals with spastic cerebral palsy, demonstrating appropriate content and face validity (12). Studies on PBS balance scale items in children with ADHD showed that these individuals exhibit significant balance impairments compared with typically developing peers. This test is a suitable assessment criterion for this group (13). PBS was recently introduced and discussed in the literature; however, its reliability and item reliability in school children with DS have not been examined, nor has its reliability been compared with other balance tests. Furthermore, the correlation between PBS results and those from other tests like the Standing Stork (SST) and Timed Up and Go (TUG) has not been explored based on the literature search. Therefore, this study aimed to investigate the reliability and validity of PBS in individuals with DS.

2. Methods

2.1. Design

This cross-sectional correlational study applied a repeated measures design, including both inter-rater and intra-rater reliability.

2.2. Selection and Description of Participants

In this study, the convenience sampling method was used, and 37 children with DS (23 girls and 14 boys) aged 7 to 15 years from special education schools for children with intellectual disabilities in Tehran, Iran ("Shahid Aslani" girls' school and "Ershad" boys' school) were conveniencly selected.

2.3. Sample Size Determination

To estimate the sample size using PASS 2024 software, we considered $\alpha=0.05$, $\beta=0.20$, and the requirement that each examiner measured all items three times. Based on a previous study (8), which reported interrater reliability values ranging from itraclas correlation coefficient (ICC)=0.88 (minimum) to ICC=0.995 (maximum), a total of 24 participants were required. In this study, to increase the power of the test, 37 participants were selected.

2.4. Data Collection and Measurements

Two examiners conducted this study proficiently in the various PBS items and were capable of coordinating and managing the conditions of the

tests. In addition to their academic qualifications in related fields, both examiners had at least three years of experience working with children with disabilities. Before conducting the tests, proper warm-up and stretching exercises were performed to prevent injury. Subsequently, PBS, Standing Stork, and TUG tests were randomly selected, and all tests were administered to each participant. However, PBS items were executed strictly, systematically, and sequentially based on the test instructions. The test administration was designed to allow for a balanced schedule, with one examiner administering the test during the initial week and the next examiner taking over the following week. This approach was intended to assess intra- and inter-rater reliability. The SST and TUG tests were administered on the same day, repeated three times, and the average scores were recorded.

The entire PBS test procedure took approximately 15 minutes per child. A one-week interval between test administrations was maintained to avoid any learning effects influencing the results. This method was consistent with another study (14). This study employed the Persian version of PBS, previously used with children with cerebral palsy (8). PBS items were comprised of sitting to standing, standing to sitting, transfers, standing unsupported, sitting unsupported, standing unsupported with eyes closed, standing unsupported with both feet together, standing unsupported with one foot in front of the other, standing on one foot, turning 360 degrees, turning to both the left and right to view behind, retrieving object from floor, alternately moving one foot on a stool, and standing while extending arms forward. Each child could score from 0 (minimal ability) to 4 (maximum ability) on each item, with a total probable score of fifty-six. A score closer to 56 showed better balance and better performance. This scale assesses dynamic and static balance, with 8 and 6 items related to dynamic and static balance, respectively (6). The first assessor administered the PBS test during the first week, and the second assessor during the second week. Each examiner administered all items of the test three times. All measurements from both examiners were used to examine the reliability of the test results. However, to examine the correlations, all scores of the three repetitions of the first examiner were used.

The TUG test assessed balance, functional ability, and walking speed in children. According to previous research, this test exhibits strong reliability (ICC=0.99) and is valid for predicting fall risk in participants with disabilities (15). Another study also confirmed the high reliability of this test and indicated that the TUG test is a practical means recommended for drawing rapid conclusions. Based on prior findings, the intra-rater reliability of the TUG test was found to be 0.91, while the inter-rater reliability was 0.96 (16). The procedure for this test involves the child sitting on a designated chair wearing their regular shoes. Without using their hands, the child stands up, walks 3 meters along a pre-determined line, and then returns to the chair. At this moment, the examiner stops the time using a stopwatch. This step is repeated three times, and the best performance is recorded (15). The recording criteria for the TUG test are as follows: a time of 10 seconds or less indicates normal mobility, a duration between 11 and 20 seconds is considered within the normal range for patients and elderly individuals with disabilities or weakness, a time over 20 seconds indicates that the individual requires assistance, and a time above 30 seconds suggests that the individual is at risk of falling (16).

SST was used to assess static balance. According to previous study, this test has a high reliability score (0.90). For SST, the child stands on their support leg with bare feet, bends the other leg, and places it next to the standing leg. The child is then asked to place their hands on the same hip. The time from the start of the test until the individual loses balance is measured (17). After explaining the procedure, the individual was allowed to practice and perform the test three times. In the end, the average of the results was calculated. The method for calculating the SST score is as follows: if the individual can maintain their balance for more than 50 seconds, their balance is considered excellent. A time between 40 and 50 seconds indicates good balance, 25 to 39 seconds reflects moderate balance, 10 to 24 seconds indicates normal balance, and under 10 seconds suggests poor balance (18). Finally, the SST and TUG test results were compared with the PBS test results.

2.5. Procedure

The diagnosis of DS in these participants was based on documentation and medical diagnosis in their medical records available at the schools. The children's legal guardians completed a written informed consent form after being provided

with the objectives of the study. Consent for participation was also obtained from the children themselves. The inclusion criteria were: children aged 7 to 15 years, both girls and boys, a Body mass index (BMI) between 18 and 27, diagnosed with DS and without a history of atlantoaxial instability, and able to walk independently. The exclusion criteria were having heart problems, seizures, and/or orthopedic surgeries on the lower limbs or lumbopelvic area, a history of using assistive devices for visual or hearing impairments, medical conditions that limited physical activity, or using medications affecting balance. Following this, a personal information form was completed for each child, including age, height, weight, medications, other disabilities, and any specific considerations for working with the child.

2.6. Data Analysis

After data collection, descriptive statistics were used to analyze the data using SPSS version 24. Given the normal distribution of data, Pearson's correlation test was applied to investigate the correlation between different balance tests. The R coefficient values were used to interpret the correlation value between variables. In this way, the values of the R coefficient were interpreted as follows: 0.0-0.3: insubstantial or insignificant, 0.3-0.5: moderate, 0.5-0.7: strong, 0.7-0.9: very strong, and 0.9-1.0: nearly perfect statistical relationship (19). To assess the reliability between PBS test items across three measurements and the reliability within the examiner, the intraclass correlation coefficient (ICC) was used. This study was set to have a significance level of 0.05. Using this formula: $SEM=SD \times \sqrt{(1 - ICC)}$, where SD represents the standard deviation of all six measures, the Standard Error of Measurement (SEM) values were examined.

3. Results

In this study, participants were selected based on inclusion and exclusion criteria. In this study, 37 students with DS participated, ranging in age from 7 to 15 years. None of the participants were excluded from the study. Descriptive statistics of the participants were measured before the tests, and the findings are presented in Table 1:

Based on the Pearson correlation test results, it was observed that there was a significant correlation between the PBS balance scale and SST ($r=0.585$, $P<0.001$), and TUG scores ($r=0.585$, $P<0.001$), and the correlation coefficient (r) indicated that there was a strong statistical relationship (Table 2).

The intraclass correlation coefficient (ICC) test was used to examine the reliability of balance tests. Table 3 shows that the reliability and overall scores of all PBS test items have excellent intra-examiner repeatability. The repeatability is also higher compared with the Stork and TUG balance tests. Moreover, as seen in Table 4, the inter-examiner reliability rate was again excellent in all items, and the PBS test repeatability rate is still better than other balance tests.

4. Discussion

This study examined the reliability and concurrent validity of the Persian version of PBS in children with DS. This study findings indicated a significant correlation between the PBS test scores and SST, and between PBS and TUG tests.

Table 1: Demographic chareteristics of the participants

Variables	No.	Mean	SD
Age (year)	37	11.84	2.70
Weight (kg)	37	46.84	17.16
Height (cm)	37	142.35	10.30

SD: Standard Deviation

Table 2: The correlation between scores of Pediatric Balance Scale and Standing Stork Test

Variables		PBS means	PBS SD	SST means	SST SD	P value	Correlation coefficient (r)
PBS Balance Scale	SST	44.19	4.23	0.89	0.77	<0.001*	0.59
	TUG	44.19	4.23	13.40	5.00	<0.001	-0.61

PBS: Pediatric Balance Scale; SST: Standing Stork Test; SD: Standard deviation; TUG: Timed- Up and Go; E1: Examiner 1; E2: Examiner 2
* Significant correlations were observed.

Table 3: The Intraclass Correlation Coefficient to examine the Intra-Evaluator Reliability

Variables		First Evaluator					Second Evaluator				
		ICC	Mean	SD	CI95%		ICC	Mean	SD	CI95%	
					Upper Bound	Lower Bound				Upper Bound	Lower Bound
PBS	Item 1	1.00	3.92	0/3	1.00	1.00	1.00	3.95	0.20	1.00	1.00
	Item 2	1.00	3.65	0.50	1.00	1.00	0.98	3.81	0.40	0.99	0.97
	Item 3	0.99	3.32	0.60	0.99	0.99	1.00	3.54	0.70	1.00	1.00
	Item 4	0.99	3.81	0.50	0.99	0.98	0.79	3.97	0.30	0.88	0.63
	Item 5	1.00	3.86	0.60	1.00	1.00	1.00	3.95	0.30	1.00	1.00
	Item 6	0.93	3.86	0.30	0.96	0.87	1.00	3.97	0.20	1.00	1.00
	Item 7	1.00	3.84	0.40	1.00	1.00	0.88	3.95	0.20	0.94	0.80
	Item 8	0.84	0.38	0.50	0.91	0.72	0.90	0.35	0.80	0.95	0.83
	Item 9	0.98	1.35	0.90	0.99	0.98	0.97	1.41	1.00	0.99	0.95
	Item 10	0.98	3.27	0.07	1.00	1.00	0.99	3.35	1.00	0.99	0.98
	Item 11	0.99	3.49	0.80	0.99	0.98	0.16	3.51	0.70	0.54	-0.45
	Item 12	0.97	3.68	0.50	0.98	0.95	0.95	3.84	0.40	0.97	0.92
	Item 13	0.99	3.62	1.00	0.99	0.99	0.99	3.65	1.00	0.99	0.99
	Item 14	1.00	2.43	0.80	1.00	1.00	0.99	2.54	1.00	0.99	0.99
	Total PBS	0.99	44.19	12.68	0.99	0.99	0.99	44.8	13.33	0.99	0.99
TUG	TUG	0.98	13.08	5.00	0.99	0.97	0.97	13.63	5.00	0.99	0.96
	Total TUG	0.98	39.64	14.57	0.99	0.97	0.97	40.52	15.16	0.99	0.96
SST	SST	0.84	0.78	0.60	0.91	0.73	0.92	1.17	1.00	0.96	0.86
	Total Stork	0.85	2.63	2.40	0.92	0.73	0.92	3.44	2.75	0.96	0.86

PBS: Pediatric Balance Scale; SST: Standing Stork Test; SD: Standard Deviation; TUG: Timed- Up and Go; ICC: Intra-class Correlation Coefficient; CI: Confidence Interval

Table 4: The Intraclass Correlation Coefficient for Intra-Evaluator and Inter-Evaluator Correlation

Variables		ICC	Mean	SD	CI95%		SEM
					Upper Bound	Lower Bound	
PBS	Item 1	0.977	22.60	1.44	0.987	0.963	0.08
	Item 2	0.943	22.40	1.80	0.968	0.907	0.43
	Item 3	0.953	20.57	3.60	0.973	0.923	0.78
	Item 4	0.900	23.27	1.99	0.943	0.840	0.63
	Item 5	0.965	23.43	2.63	0.980	0.944	0.49
	Item 6	0.854	23.51	1.32	0.916	0.767	0.50
	Item 7	0.906	23.27	1.89	0.946	0.850	0.58
	Item 8	0.890	1.97	3.08	0.937	0.824	1.02
	Item 9	0.974	8.08	5.53	0.985	0.958	0.89
	Item 10	0.970	21.81	5.82	0.994	0.984	1.01
	Item 11	0.376	22.12	8.34	0.642	0.004	6.59
	Item 12	0.895	22.62	2.06	0.940	0.832	0.67
	Item 13	0.990	21.81	5.81	0.994	0.984	0.58
	Item 14	0.955	14.90	4.90	0.974	0.928	1.04
	Total PBS	0.853	88.90	8.10	0.924	0.716	3.11
TUG	TUG	0.975	80.15	28.58	0.985	0.960	4.52
	Total TUG	0.900	26.88	9.66	0.948	0.805	3.05
SST	SST	0.875	6.07	4.51	0.929	0.801	1.59
	Total SST	0.676	2.07	1.49	0.832	0.376	0.85

PBS: Pediatric Balance Scale; SST: Standing Stork Test; SD: Standard deviation; TUG: Timed- Up and Go; ICC: Intra-class Correlation Coefficient; CI: Confidence Interval

Also, ICC indicates a high agreement between the two evaluators. Evidence on using PBS in children aged 4 to 13 years, particularly across different types of disabilities, remains limited. The PBS test is designed as a tool for assessing balance in children, and the results of the present study indicated that it has high concurrent validity for assessing balance in children with DS. Existing evidence

also confirmed that the PBS test can effectively assess children's motor and balance abilities (8). This concurrent validity and reliability of the test in Iran were examined and confirmed previously (8). Another study assessed the PBS balance scale in children with intellectual disabilities. The study showed that, after performing and repeating the PBS test, students with intellectual disabilities demonstrated improved static and dynamic balance performance (20). This study also mentioned that performing this test was easier for adolescents than younger children, although no discrepancy was discovered in functional balance between them (20). The results of the present study were consistent with these findings (20). Another study showed that PBS test scores are directly related to age and improve with age. Particularly for children over 5 years old, this test became easier to perform. Moreover, gender comparisons in this study showed that girls scored higher on average across different age groups (21).

This study investigated the correlation between SST results and PBS. SST is recognized as a valid and easy-to-administer test because it requires minimal time and equipment and can be performed anywhere (22). However, noteably this test was not specifically designed for individuals with disabilities and presents challenges and limitations for this group. Additionally, this test measures only one aspect of motor ability, namely static balance, and does not provide a comprehensive picture of an individual's physical status (23, 24).

Other research findings showed a strong correlation between the TUG balance and PBS tests. The TUG test is designed to evaluate functional movements and balance in children. The TUG test evaluates balance and fall risk in the future, functioning as a predictive tool. This test does not require complex equipment and is easy to perform. Therefore, the TUG test is considered a rapid and efficient means for equiblirium assessment due to its simplicity and ease of implementation in various settings (25). However, this test may only evaluate one aspect of balance, and additional tests may be required for a more comprehensive assessment. Our study showed a strong correlation between the scores of PBS and TUG tests and aligned with another study demonstrating that the TUG test was valid and reliable for assessing equilibrium (26). The TUG test is a sufficiently valid means for assessing individuals with DS (27). Still, due to its unidimensional nature in assessing motor balance, it cannot be compared with the dynamic items of the PBS balance scale.

Another aim of this study was to investigate the reliability of PBS test data. Intraclass correlation coefficient (ICC) indicates a high agreement between the two evaluators and demonstrates high reliability. Although the reliability of the PBS balance test has not been investigated in children with DS, the findings of the present study were in line with a previous study that examined this issue in other disabilities (28). In this line, the Turkish version of PBS, tested on children with cerebral palsy, has been recognized as a valid tool for assessing balance, and the inter-rater reliability in this study was found to be trustworthy. Evidence indicated that this balance scale has strengths that can be used in clinics for evaluating children's balance, consistent with our findings (28).

Additionally, according to a study conducted on children with spastic cerebral palsy in Korea, PBS has been introduced as a tool for evaluating balance in everyday conditions. This study examined intra-rater, inter-rater, and test-retest reliability, with a reliability coefficient of 0.90 reported for the balance scale in children. Furthermore, this version has been recognized as a reliable tool with excellent inter-rater and test-retest reliability; the results of this study aligned with this previous finding (29). Thus, it can be concluded that the PBS test is a valid and reliable means for assessing balance in children with disabilities, particularly DS, and can be effectively used in clinical and educational settings.

The results of the present study indicated that the Persian version of PBS is a valid and reliable tool for assessing balance in children with DS. Due to its ability to simultaneously assess static and dynamic balance, this scale can be used as a practical tool in clinics and educational centers to examine these children's motor and balance abilities. Given balance and movement problems in children with DS, this scale can help therapists design and implement rehabilitation programs and balance exercises more accurately. Also, this tool can play an effective role in evaluating the progress of treatment and improving the motor function of children. Therefore, using PBS and other balance tests such as TUG and SST tests can help provide a more comprehensive picture of balance status in these children and ultimately improve their quality of life and functional independence.

4.1. Limitations

Although this study showed that the PBS balance test can be used in children with DS, some limitations should be considered when generalizing the data from this study. One limitation of the present study was the age range of the participants, and the results may not be generalizable to other age groups. The minimum clinically important differences for the PBS test have not been determined. Therefore, this should be considered when using this test as a dependent variable in intervention studies. Finally, this study included participants who could walk independently, and the findings may not apply to other individuals who require assistive devices for walking.

5. Conclusions

The results of the present study indicated that PBS can be used to assess and measure the balance of children with DS. The results showed that the PBS balance scale is valid, reliable, and suitable for evaluating functional balance in children with DS. This scale assesses various aspects of balance and includes items that examine balance in various body parts. Additionally, based on the findings, SST and TUG tests cannot comprehensively assess all dimensions of balance, and therefore, they should not be used alone. For a complete evaluation, using SST and TUG tests alongside more comprehensive tests is recommended.

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Authors' Contribution

Maedeh Shahbaz-Borujeni: Contributed to the conception and design of the work, acquisition, analysis, and interpretation of data; drafted the work and reviewed it critically for important intellectual content. Rahman Sheikhhoseini: Contributed to the conception and design of the work, acquisition, analysis, and interpretation of data; drafted the work and reviewed it critically for important intellectual content. Fariba Mohammadi: Contributed to the conception and design of the work, acquisition, analysis, and interpretation of data; reviewed the work critically for important intellectual content. Hashem Piri: Contributed to the conception and design of the work; reviewed the work critically for important intellectual content. All authors have read and approved the final manuscript and agree to be accountable for all aspects of the work, such as the questions related to the accuracy or integrity of any part of the work.

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Ethical Approval

The Ethics Committee of Allameh Tabatab'i University, Tehran, Iran approved the present study with the code of IR.ATU.REC.1403.038. Also, written informed consent was obtained from the participants.

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