



# Reliability and Validity of the Turkish Version of the Mini-BESTest Balance Scale in Patients with Stroke

## *Mini-BESTest Denge Ölçeğinin Türkçe Versiyonunun İnmeli Hastalarda Geçerlilik ve Güvenilirliği*

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### Abstract

**Objective:** To determine the validity and reliability of the Turkish version of the Mini-BESTest balance scale (Mini-BESTest-Turk) and provide a culturally adapted version for use in Turkish patients with stroke.

**Materials and Methods:** A convenience sample of 84 Turkish patients with chronic stroke (28 female, 56 male; mean age: 59.52±14.04 years) was recruited. Researchers administered the scale, for the inter-rater reliability and twice within 7 days for the test-retest reliability. Mini-BESTest reliability study was performed by calculating internal consistency. The reliability of Mini-BESTest-Turk and its subsections was evaluated using Cronbach's alpha coefficient. Item-total correlation and test-retest reliability were calculated. For structural validity, factor analysis was performed. The construct validity of Mini-BESTest-Turk and Berg Balance scale (BBS) was assessed using Spearman correlation analyses. The minimum detectable change (MDC) at 95% confidence intervals (MDC 95%) was established.

**Results:** The Mini-BESTest-Turk demonstrated test-retest [intraclass correlation coefficient: 0.994, 95% confidence intervals: (0.981-0.998); p<0.001]. In the correlation for validation study, correlations between Mini-BESTest-Turk and BBS scores (r=0.925, p<0.001) were very strongly positive. MDC95 was 2.01 points.

**Conclusion:** The reliability study showed that the Mini-BESTest-Turk had excellent internal consistency. The Turkish version of the Mini-BESTest scale (Mini-BESTest-Turk) seems to be a reliable and valid measure in patients with stroke. We believe that it may be useful in the follow-up of patients with stroke and clinical research. The ability to identify clinically significant changes was determined.

**Keywords:** Mini-BESTest, reliability, validation, stroke, balance

### Öz

**Amaç:** Mini BESTest (Mini-BESTest-Türk) denge ölçeğinin Türk toplumundaki inmeli hastalarda kullanımı için kültürel adaptasyon çalışmasını sağlamak ve geçerlilik-güvenilirliğini belirlemektir.

**Gereç ve Yöntem:** Çalışmaya yaş ortalaması 59,52±14,04 yıl olan 84 hasta (28 kadın, 56 erkek) alındı. Araştırmacılar ölçeği, iç güvenilirlik ve test-tekrar test güvenilirliği için 7 gün içinde iki kez uyguladılar. Mini-BESTest güvenilirlik çalışması iç tutarlılığın hesaplanması ile yapıldı. Mini-BESTest-Türk ve alt bölümlerinin güvenilirliği Cronbach'ın alfa katsayısı kullanılarak değerlendirildi. Madde-toplam korelasyonu ve test-tekrar test güvenilirliği hesaplandı. Yapısal geçerlilik için faktör analizi uygulandı. Mini-BESTest-Türk ve Berg Denge ölçeğinin (BDÖ) yapı geçerliliği Spearman korelasyon analizleri kullanılarak değerlendirildi. %95 güven aralığında (MDC %95) saptanabilir asgari değişim olarak belirlenmiştir.

**Bulgular:** Mini-BESTest-Türk, güvenilirlik (sınıf içi korelasyon katsayısı: 0,994, %95, güven aralığı: 0,981-0,998 ve p<0,001) gösterdi. Yapı geçerliliği için korelasyonda, Mini-BESTest-Türk ile BDÖ arasında, çok kuvvetli pozitif yönde (r=0,925, p<0,001) korelasyon bulundu. MDC95 2.01 puandı.

**Sonuç:** Güvenilirlik çalışması, Mini-BESTest-Türk ölçeğinin mükemmel iç tutarlılığa sahip olduğunu göstermiştir. Mini-BESTest denge ölçeğinin (Mini-BESTest-Türk) Türkçe versiyonu inme hastalarında güvenilir ve geçerli bir ölçek olarak görünmektedir; bu nedenle inmeli hastaların takibinde ve klinik çalışmalarda kullanımının yararlı olabileceğine inanıyoruz. Klinik olarak anlamlı değişiklikleri belirleme yeteneği olduğu belirlendi.

**Anahtar Kelimeler:** Mini-BESTest, güvenilirlik, geçerlilik, inme, denge

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## Introduction

Balance is defined as the ability to maintain the body's position over its base of support within stability limits (1). In the literature, balance reactions, posture, postural reactions, and postural control terms are used to define balance. It is the integration of sensory information of the body position in relation to the surroundings and the ability to create appropriate motor responses to control the body movement. It is an important functional ability to safely maintain dynamic posture during daily living activities: it is necessary to ensure stability while moving from one position to another and to thereby to function independently within the community (2).

Postural and balance changes are common in hemiparesis caused by cerebrovascular events (1,2,3,4,5,6,7). Stroke, as defined as a clinical syndrome, is one of the leading causes of death and disability worldwide (8,9). The World Health Organization reported that the incidence of stroke varies between 200 to 100,000 among countries (10).

Patients with post-stroke may have tonus, strength, coordination, and balance disorders. Muscle weakness, disorders in motor planning, deep sensory impairment, changes in spatial perception, and disturbances in vestibular mechanisms may affect body balance. Patients typically have an increase in postural oscillations. Shifts to the unaffected extremity and asymmetric load distributions are observed in the body center of gravity with increased postural responses (10). One of the most important post-stroke problems is the deterioration of postural control in sitting and standing balance. Studies have examined the risk factors of falling in patients with stroke and the general population and identified falling history and balance disorder as risk factors (11).

In addition, the ratio of dependency in daily living activities (e.g. dressing, bathing, going out) that result from physical or cognitive deficiencies has been reported as only 20% to 30% even after 1 year following the stroke (12,13,14,15,16). Post-stroke balance, motor, cognitive, sensory, and emotional disorders hinder patients' social participation and limit their skills in some or all of the basic and assistive activities of daily life, education, work, and leisure (8,13,14).

Scales have been developed to evaluate posture and balance in the field of rehabilitation. The Tinetti Balance and Gait scale (12), the Berg Balance scale (BBS), the One Leg Stance test, the Functional Reach test (FRT), the Timed Up and Go test (TUGT) (17), the Activity-specific Balance Confidence scale (ABC) (18), the Four Square Step test (19), the balance section of the Fugl-Meyer Assessment scale, the Brunel Balance Assessment, and the Performance Oriented Mobility Assessment scale (20) are examples of the most widely used scales for a comprehensive evaluation of body balance and posture.

However, they are not without their limitations. The evaluation tools used presently can determine a balance disorder but cannot explain its causes. These scales, being single-task assessments, are unable to provide information on which postural control subsystem is dysfunctional. Also, they have a limited role in directing treatment (17). The main disadvantage of other popular balance scales is that they do not include important aspects of dynamic balance control such as the capability to react to postural perturbations, to stand on a compliant or inclined surface, or to walk while performing a cognitive task (21,22). All these features

of balance control are known to be important in assessing balance disorders of patients and reflect balance challenges during activities of daily living. Therefore, there is a need for a comprehensive balance assessment tool that can be administered in a short period.

Balance in patients with stroke is important to determine the most effective treatment methods, as well as which activities might be safe or unsafe for the patients. As the balance in patients with stroke is an ever-changing dynamic process, quantitative measurement methods are required to select appropriate treatment methods and record accompanying changes (23).

In the literature, the Mini-Balance Evaluation Systems Test (Mini-BESTest) was used in patients with chronic stroke, and its reliability was shown (24,25). This scale helps in the detailed evaluation of postural control and balance, prediction of prognosis, and in the evaluation of development in patients with stroke in the acute and chronic period. The Mini-BESTest can determine a balance disorder and can explain its causes. The scale is also considered as one of the most comprehensive balance assessment scales for identifying postural control systems underlying poor functional balance (26,27). The scale is easy to use because of its short evaluation time and non-requirement for equipment (9,21). It has come to be one of the international balance assessment tools most preferred for use in evaluating patients with stroke with balance disorder thanks to its excellent reliability (17,21,28,29) and validity (17,19,20,30). The scale has been translated into German, Greek, Italian, Japanese, Norwegian, Persian, and Portuguese. Therefore, the Mini-BESTest must be formally adapted to Turkish to take advantage of its features in the Turkish clinical setting. The aim of this study was to translate and make the Turkish adaptation of the Mini-BESTest scale for Turkish patients with stroke (Mini-BESTest-Turk) and evaluate its reliability and validity.

## Materials and Methods

### Translation and Cross-cultural Adaptation

#### Mini-BESTest Balance Scale Translation and Adaptation

The validity study was initiated with language equivalence and cultural adaptation. The Mini-BESTest score table and the accompanying instructions were translated based on Guillemín's translation guidelines (31).

The Mini-BESTest, which was originally written in English, was first translated to Turkish independently by four PhD physiotherapists from Ankara University Faculty of Health Sciences Department of Ergotherapy having a good command of English and experience of 14 to 30 years. These translations were compared by PhD physiotherapists, and for each item, the expression that was considered to be the best representation of that item was determined. At this stage, the cross-cultural adaptation was also performed. In the second stage, this joint version was back-translated to English by a fifth independent person whose native language is English and who has a good command of Turkish. In the third stage, original form and translation form comparisons were made. A satisfactory compliance with the original scale was achieved by consensus of the translator and expert physiotherapists. Upon observing that it was not different from the original scale, the Turkish version of the Mini-BESTest balance scale was created.

## Study Design and Setting

The study was approved by the Non-invasive Clinical Research Ethics Committee at Ankara University (decision no: 04-217-18, date 26 February 2018). Eighty-four individuals with hemiplegia were diagnosed and recruited at the Ankara University outpatient Occupational Therapy clinic. One hundred patients with chronic stroke were evaluated. Twelve patients with aphasia, one patient with ankylosing spondylitis, one patient with visual impairment, and two patients aged over 83 years were excluded from the study.

The participants were informed about the study purpose and methods before being included in the study. The study was conducted in accordance with the Declaration of Helsinki. A signed informed volunteer consent form was obtained from all 84 patients who participated in the study.

## Participants

### Inclusion Criteria

Patients diagnosed as having stroke due to a vascular lesion on clinical evaluation and computed tomography and/or magnetic resonance imaging of the brain, patients with hemiplegia who could accept to participate voluntarily, and patients with stroke who had survived the three-month were included. Participants were included according to the following criteria: age 28 to 83 years; ability to understand the aims of the study; able to express opinions; demonstrated coherent speech and spatiotemporal orientation.

### Exclusion Criteria

Patients with a history of surgery in the last 6 months, bilateral stroke, known mental illness (major depression, schizophrenia, psychosis), malignancy, and those whose native language was not

Turkish, patients who could not communicate, and those who did not want to participate in the study were excluded.

## Data Collection

The participants were evaluated by two researchers. The BBS and Mini-BESTest balance scale were administered by the researchers (Figure 1).

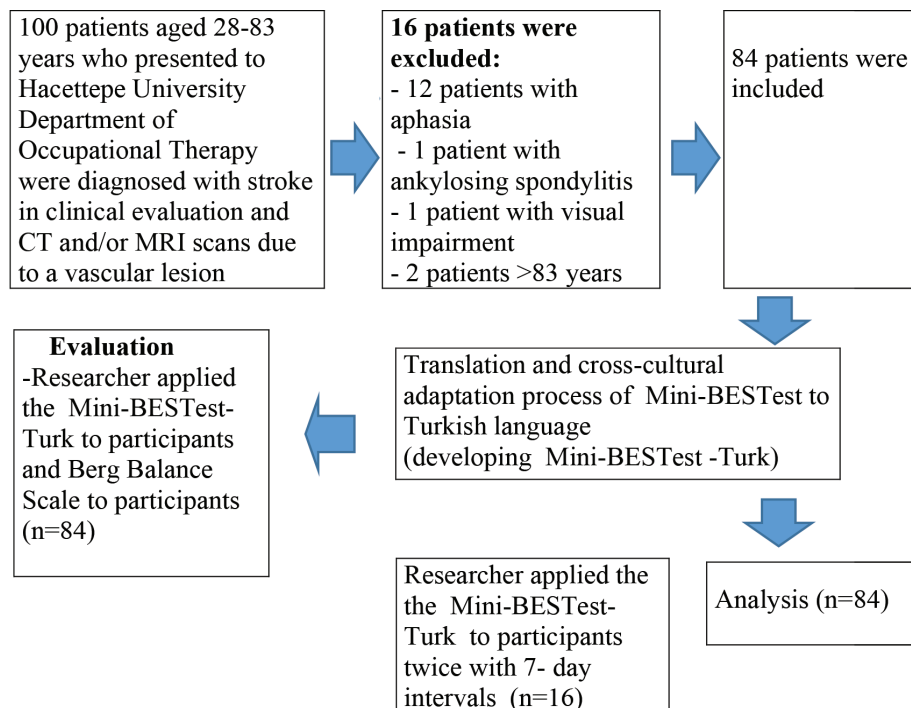
## Assessment Scales

### Data Collection Tools Used in This Study

The Turkish version of Mini-BESTest-Turk Balance Scale and the BBS.

### Mini-BESTest Balance Scale

This scale sets well defined and established clinical evaluation criteria for patients with balance deficits resulting from neurologic disorders (32). All these aspects of balance control are important in reflecting balance difficulties in daily life activities in patients with different disorders. The main focus of the Mini-BESTest emphasizes dynamic balance. The scale is used to evaluate the risk of imbalance and falling. Provides dynamic evaluation of balance and can be conducted in 10-15 minutes. The Mini-BESTest scale consists of 14 tasks-elements of the original BESTest, which represent four systems of balance control; anticipatory postural adjustments, compensatory postural adjustments, sensory orientation, and gait stability. Some of the tasks include sit to stand, standing on toes, single-leg stance, compensatory reactions forwards, backwards and sideways, tasks with the eyes closed, on a foam surface, on an inclined surface, and tasks involving gait with a change of speed, head rotations, walking over obstacles and timing (33,34). Each item is scored on a three-point ordinal



**Figure 1.** Flow diagram of participants

MRI: Magnetic resonance imaging, CT: Computed tomography

scale (0-2), yielding to a total maximum score of 28 points. Better balance performance is indicated with higher scores. A score of 2 indicates the highest level of function and 0 the lowest level of function (33). If a subject requires physical assistance to perform a function, the item is scored 0 (33). The Mini-BESTest scale is advantageous in that it is extensive comprehensive balance scale, sensitive to assessing changes in patients.

### Comparative Instrument for Validity Testing

#### Berg Balance Scale

The BBS was developed to measure balance performance. It is used to evaluate balance disorders and the risk of falling and provides a static and dynamic evaluation of balance. It evaluates the following functions: sitting to standing, standing unsupported, sitting unsupported, standing to sitting, transfers, standing with eyes closed, standing with feet together, reaching forward with an outstretched arm, retrieving an object from the floor, turning to look behind, turning 360 degrees, placing an alternate foot on a stool, standing with one foot in front, and standing on one foot.

This 14-item scale has a maximum score of 56 points. Each item is scored on a 5-level ordinal scale (0-4) where 0 indicates the lowest level of function and 4 the highest level of function. The scale total score is interpreted as follows: 0-20, high fall risk and balance disorder; 21-40, medium fall risk and existence of an acceptable balance; and 41-56, low fall risk and presence of good balance. Between 10 and 20 minutes are required to complete the scale (23). The scale was adapted to Turkish by Büyükcavcı et al. (2).

#### Other Data Collection

Patients' data, including demographic information such as age, sex, education level, marital status, and use of alcohol and cigarettes, as well as clinical information such as etiology (thromboembolic/hemorrhagic), duration of disease (time from the onset of the disease to hospital admission in days), stroke-affected body part (right/left), and chronic disease were recorded during their first evaluation. Initially, we would like to thank Dr. Horak for giving us permission to adapt and use the Mini-BESTest into Turkish.

#### Statistical Analyses

The data were analyzed using the Mplus 4 trial version and SPSS 11.5 for Windows software packages. Descriptive statistics are shown as arithmetic means and standard deviation (mean  $\pm$  SD), median, minimum, maximum values or number of observations or percentage (%). The results were evaluated at the level of significance  $p < 0.05$ , and 95% confidence intervals (CI).

For criterion validity, the relationship between Mini-BESTest total score and Berg total score was evaluated using Spearman's correlation test. Factor structure of the scale was determined using confirmatory factor analysis (CFA). Interobserver compliance was assessed using the intraclass correlation coefficient (ICC).

Factor analysis was performed for structural validity. Also, CFI, TLI and RMSEA compliance indices were used for CFA. The reliability of Mini-BESTest-Turk was evaluated using Cronbach's alpha coefficient. The ICC was used to investigate the correlation between the initial and retest results. In item

analysis, the compatibility between test-retest for each item was examined using weighted kappa. Spearman's correlation test was used to evaluate the relationship between items and the total score.

## Results

### Participants

The mean age of the 84 participants was  $59.52 \pm 14.04$  (minimum 28, maximum 83) years; 28 were female (33.3%) and 56 were male (66.6%). The mean duration of stroke was  $3.54 \pm 10.4$  (minimum 3, maximum 90) months. The affected side was the right side in 52 patients (61.9%) and left side in 32 patients (38.1%). The Mini-BESTest-Turk mean total score was  $9.21 \pm 8.74$ , where the minimum and maximum values were 0 and 28, respectively. Other characteristics are shown in Table 1. item analysis.

### Reliability

#### Internal Consistency

The reliability of the scale, which was validated using CFA, was evaluated using Cronbach's alpha coefficient. Cronbach's alpha value was found as 0.967 for all items. From this, it can be seen that the reliability of all items was high.

#### Test-retest

Test-retest agreement coefficients for individual Mini-BESTest-Turk items presented by kappa values ranging from 0.77 for item 9 (incline-eyes closed) (toes up) to 1.00 for item 3 (stand on one leg), 5 (compensatory stepping correction-backward), 6 (compensatory stepping correction-lateral), 8 (eyes closed, foam surface (feet together), 11 (walk with head turns-horizontal), 12 (walk with pivot turns) and 13 (step over obstacles). Test-retest agreement coefficients for individual Mini-BESTest-Turk items

Table 1. Item statistics

	Mean	SD	Variance	n
Mini-BESTest-1	0.98	0.82	0.67	84
Mini-BESTest-2	0.38	0.69	0.48	84
Mini-BESTest-3	0.36	0.67	0.45	84
Mini-BESTest-4	0.75	0.83	0.70	84
Mini-BESTest-5	0.71	0.84	0.71	84
Mini-BESTest-6	0.71	0.84	0.71	84
Mini-BESTest-7	1.17	0.94	0.89	84
Mini-BESTest-8	0.94	0.87	0.75	84
Mini-BESTest-9	0.65	0.78	0.61	84
Mini-BESTest-10	0.74	0.85	0.73	84
Mini-BESTest-11	0.68	0.76	0.58	84
Mini-BESTest-12	0.61	0.73	0.53	84
Mini-BESTest-13	0.51	0.70	0.49	84
Mini-BESTest-14	0.64	0.80	0.64	84
Total	9.81	9.36	87.58	84

Mini-BESTest-Turk item statistics, SD: Standard deviation

presented moderate to almost perfect agreement with weighted kappa values ranging from 0.77 for item 9 to 1.00 for items 3, 5, 6, 8, 11, 12, and 13 (Table 2).

The item-total correlations were statistically significant for all items with item 3 presenting the lowest correlation with the total score of Mini-BESTest-Turk (Tables 2, 3).

**Psychometric Analysis with Structural Equation Modeling**

**Construct Validity**

**Exploratory Factor Analysis**

The validity of Mini-BESTest-Turk was evaluated using construct validity. Table 4 presents the factor loadings of the items. Factor loads for other items ranged from 0.623 to 0.993 (Table 4). In this context, the lowest factor load was calculated for item 3, standing on one leg (0.623) and item 7, stance (feet

together); eyes open, standing on foam surface (0.688). The CFA is presented in Table 4.

**Confirmatory Factor Analysis**

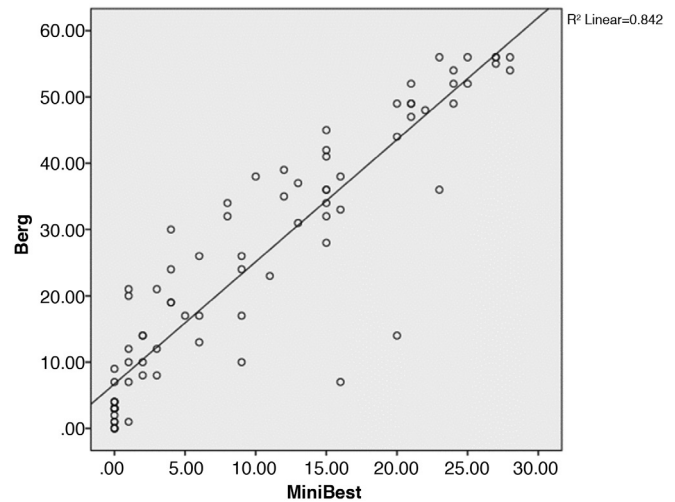
CFA was performed to confirm the factor structure of the Mini-BESTest-Turk. As a result of the single factor CFA using 84 patients' responses, it was determined that all items were loaded on a single factor with factor loads greater than 0.60. There was a strong correlation between the Mini-BESTest-Turk and the Berg, which was statistically significant ( $r=0.925$ ,  $n=84$ ,  $p<0.001$ ) (Figure 2). The path diagram of CFA is presented in Figure 2. Among the goodness of fit statistics, TLI value was found as 0.888 and the CFI value was found as 0.913. The RMSEA value was 0.150.

**Ability to Detect Changes**

The minimum detectable change (MDC) 95% was computed according to formula:  $MDC\ 95\%: 1.96 * \text{scanning electron microscopy (SEM)} * \sqrt{2}$ . The SEM of the Mini-BESTest-Turk total score was calculated according to formula  $SEM: SD \sqrt{(1-ICC)}$ , where ICC was the coefficient of the test-retest reliability and SD the standard deviation of the Mini-BESTest-Turk total score (17,23,28). A MDC 95% of 2.01 points on the scale was yielded.

Mini-BESTest-Turk item	Single items agreement intra-rater reliability (weighted kappa) n=16	Item/total n=84
1	0.906*	0.831*
2	0.717*	0.692*
3	1.000*	0.669*
4	0.903*	0.882*
5	1.000*	0.884*
6	1.000*	0.888*
7	0.892*	0.841*
8	1.000*	0.835*
9	0.771*	0.811*
10	0.904*	0.883*
11	1.000*	0.877*
12	1.000*	0.844*
13	1.000*	0.811*
14	0.893*	0.798*

\* $p<0.001$ , Mini-BESTest-Turk: Mini-balance evaluation systems test, statistically significant at  $p\leq 0.05$  (kappa for item scores or ICC for total scores), ICC: Intraclass correlation coefficient



**Figure 2.** Scatterplot showing the relationship between the Mini-BESTest and Berg

	Intraclass correlation coefficient			F-test with true value 0			
	Intraclass correlation	95% confidence interval		Value	Df 1	Df 2	Sig
		Lower bound	Upper bound				
Single measures	0.994 <sup>a</sup>	0.981	0.998	365.986	15	15	<0.001
Average measures	0.997 <sup>c</sup>	0.990	0.999	365.986	15	15	<0.001

Two-way mixed-effects model where people effects are random and measures effect is fixed, <sup>a</sup>Type estimator is the same where the interaction effect is present or not, <sup>b</sup>Type A interclass a correlation coefficient using an absolute agreement definition, <sup>c</sup>This estimate is computed assuming the interaction effect is absent because it cannot be estimated otherwise

Items	Factor loadings
Mini-BESTest-1	0.709
Mini-BESTest-2	0.699
Mini-BESTest-3	<b>0.623</b>
Mini-BESTest-4	0.948
Mini-BESTest-5	0.981
Mini-BESTest-6	0.993
Mini-BESTest-7	<b>0.688</b>
Mini-BESTest-8	0.748
Mini-BESTest-9	0.750
Mini-BESTest-10	0.884
Mini-BESTest-11	0.859
Mini-BESTest-12	0.785
Mini-BESTest-13	0.787
Mini-BESTest-14	0.712

Note: Mini-BESTest-Turk = Bold text indicated the lowest factor loading of the items for each factor

## Discussion

This study was designed to show that the Mini-BESTest-Turk balance scale was a valid and reliable measurement tool for subjects with stroke.

Although device-assisted measurements can be made in clinical practice, balance in patients with stroke is measured using functional scales (35). Accurate assessment of balance in patients with stroke is important to determine the most effective treatment methods, and also as well as which activities might be safe or unsafe for patients. As the balance in patients with stroke is an ever-changing dynamic process, quantitative measurement methods are required to select appropriate treatment methods and record accompanying changes (23).

Both the test-retest and reliability of the Mini-BESTest-Turk in the results of our study are also consistent with previous studies. In the literature, the Mini-BESTest was used in patients with chronic stroke, and its reliability was shown (24,25). In other words, this scale helps in the detailed evaluation of postural control and balance, prediction of prognosis, and in the evaluation of development in patients with stroke in the acute and chronic period. In our study, Mini-BESTest was translated into Turkish and named Mini-BESTest-Turk, and the reliability and validity study of Mini-BESTest -Turk was performed.

A 2010 study of adults with balance disorders examined the performance of Mini-BESTest in 115 patients with various neurological diagnoses and severity. The authors found the scale ICC (0.86) and concluded that the Mini-BESTest was a clinically dynamic balanced scale with excellent psychometric properties (21).

In the literature, Mini-BESTest was used in patients with chronic stroke, and its reliability was shown. The study found an excellent concurrent validity between the Mini-BESTest and the BBS and adequate correlation between the Mini-BESTest and the ABC scale (18).

Another study in 2013 examined the Mini-BESTest using patients with stroke and found the Cronbach's alpha higher than 0.80. That study also found a high correlation between the Mini-BESTest and the BBS. The Mini-BESTest was found to have an adequate correlation with the functional access test, a high correlation with one-leg standing on the paretic side test, an adequate correlation with one-leg standing on the non-paretic side, and a high correlation with the TUGT. Compared with other scales such as the TUGT and one-leg standing used in this study to evaluate balance function, the Mini-BESTest was concluded to be useful to identify specific postural control problems and to guide treatment (17).

Another study of patients with stroke in 2014 had results similar to the present study with a 95% CI. In general, these results are measurements taken by different raters and therefore emphasize the validity, consistency, and repeatability of the scale under the same conditions in different time periods (36). A study of patients with stroke in 2016 found that the Mini-BESTest has been widely used in both clinical applications and research. The study results supported the scale's reliability and validity (29).

A study (2018) of 21 patients with stroke found a very high correlation of the Mini-BESTest with the BBS, the TUGT, and the Greek Falls Efficacy scale FES-I, but a moderate correlation with the FRT (23). Our study found a positive correlation between the Mini-BESTest-Turk and the BBS in the same direction. Although the results are similar, our study had a larger sample size and thus an increased statistical power. For the scores of the subscales of Mini-BESTest-Turk and the total score, the measurements were found to be perfectly consistent with each other. In addition, the very high Cronbach's alpha values indicate the reliability of the scale and the structural validity (29). According to the Cronbach's alpha coefficient of Mini-BESTest-Turk, the scale is quite reliable. The original Mini-BESTest has interrater and intrarater agreements of  $r=0.98$  and  $r=0.86$ , respectively, which are comparable with Mini-BESTest-Turk (34). The original mini-BESTest for dynamic balance offers a unique, clinical rating scale for dynamic balance that has excellent psychometric characteristics. The potential interest of the mini-BESTest in clinical settings is high.

Another reliability analysis of a scale is the test-retest method. The similarity of the measurement results performed at different times shows the consistency of a test or scale. The correlation coefficient of the values obtained from the two measurements is the reliability coefficient of the scale (36). A study in 2013 compared the reliability and validity of Mini-BESTest and BBS in hemiplegic and other patients with balance disorders and found the total-scoring test-retest reliability as high for the Mini-BESTest scale, significantly higher than that for the BBS. Although similar results were obtained on both scales, the Mini-BESTest was found to have a slightly higher level of reliability and greater accuracy in the classification of individual patients with significant improvement in balance function (28). The test-retest reliability for both subsections and Mini-BESTest-Turk total scores indicate that the scale is quite reliable.

The principal components analysis showed that the two-dimensional structure consisting of 14 items could explain 60% of the total variations in the posture assessment. The factor loadings of the items range between 0.623 and 0.993 according to the

principal components analysis. Researchers consider that item factor loads should be 0.50 and above. Factor loads of more than 0.50 are interpreted as “very meaningful” by some researchers. According to the results in this study, the factor loadings of the items were quite high. All items were loaded to the relevant factor through factor loads of 0.60 or higher. This result shows that the scale items are entirely above the boundary value (0.50) and highly correlated with each other.

The content validity of a scale indicates how appropriate the total scale is. The content validity of a scale is evaluated with a standard scale, which was previously developed in the same field. The correlation coefficient between these two scales is calculated (26,36). To evaluate the validity of the Mini-BESTest-Turk scale, the total scores and sub-section scores of the scale were compared with BBS scores. Pearson’s correlation was used for comparison. In our validity study, a high correlation was found between the Mini-BESTest and the BBS in patients with stroke ( $r=0.925$ ,  $p<0.001$ ). Similarly, a study strong correlations between the original Mini-BEST-Turk and the BBS were found (17,28,23).

Our study also acknowledges that other clinical balance scales, including the Mini-BESTest-Turk and the BBS, are available for patients with stroke, but we have chosen the most widely used balance assessment tool in stroke rehabilitation. A MDC of 2.01 points is of great clinical use because it could help to identify any real change in the balance ability of individuals with chronic stroke following a rehabilitation program. One important feature of a clinical tool is its ability to detect real changes in the patients’ status. Studies reported results regarding the MDC for measurements: 4.25 points in the study of Lampropoulou et al. (23) and 4.4 points in the study of Dahl and Jørgensen (36). A MDC 95% CI of 2.01 points was found in our study, which is not far from the other changes reported.

Our study results are compatible with other literature results regarding the Mini-BESTest validity and reliability. These comparable results indicate the concurrent validity of Mini-BESTest in Turkish individuals with stroke. An important feature of a clinical tool is its ability to detect actual changes in patients’ health conditions and to differentiate patients based on their level of functionality. The minor differences in the results of published studies may have arisen from differences in study methods and different characteristics in the clinical populations used.

### Study Limitations

Although power analysis helps us to determine the minimum sample size required to identify key results, a larger sample size will further increase the statistical power of the study. In addition, further studies are needed to show the scale’s in other disease groups.

### Conclusion

The Turkish version of the Mini-BESTest balance scale, a body balance assessment scale, was shown to be a valid and reliable scale that could be used in patients with stroke. The scale may be useful in following the changes in balance ability after a rehabilitation program in individuals who have had a stroke.

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### Ethic

**Ethics Committee Approval:** Non-invasive Clinical Research Ethics Committee at Ankara University (decision no: 04-217-18, date 26 February 2018).

**Informed Consent:** A signed informed volunteer consent form was obtained from all 84 patients who participated in the study.

**Peer-review:** Externally peer-reviewed.

### Authorship Contributions

**Concept:** A.G., G.E., **Design:** A.G., G.E., **Data Collection or Processing:** A.G., F.D.Ç., **Analysis or Interpretation:** A.G., İ.K., **Literature Search:** A.G., F.D.Ç., **Writing:** A.G.

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