

Determination of Biodex Balance System Cutoff Scores in Older People With Nonspecific Back Pain: A Cross-sectional Study



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ABSTRACT

Objective: The purpose of this study was to determine cutoff scores for the Biodex Balance System (BBS) and verify if they could be used to discriminate older people with nonspecific low back pain (NSLBP) with poor postural performance from those with good postural performance.

Methods: This cross-sectional study included 52 participants with NSLBP older than 65 years. One level of stability (level 5; intraclass correlation ≥ 0.70) and 2 conditions (eyes open and eyes closed) were selected for the testing procedure. Anterior-posterior stability index (APSI), medial-lateral stability index (MLSI), and overall stability index (OSI) scores were calculated. The participants were classified into 2 groups: high risk of falling and low risk of falling. Both the receiver operating characteristic and the area under the curve were used to determine the best BBS cutoff values. Binary logistic regression analysis was used to investigate the ability of BBS scores to predict risk of falling.

Results: BBS cutoff scores in the eyes-open condition (APSI = 2.60, MLSI = 1.95, OSI = 2.95) and eyes-closed condition (APSI = 3.05, MLSI = 2.17, OSI = 3.25) were found to be sensitive and specific in determining postural performance. Participants with index values lower than the cutoff scores had, respectively, 6.42, 4.20, and 3.72 times lower risk of falling in the eyes-open condition and 3.33, 5.50, and 3.00 times lower risk of falling in the eyes-closed condition. The predictive characteristics of the models for risk analysis were excellent and good to excellent.

Conclusion: Our study shows that BBS cutoff scores are sensitive and specific in distinguishing between poor and good postural performance in older people with NSLBP. (*J Manipulative Physiol Ther* 2021;44:85-94)

Key Indexing Terms: Aged; Postural Balance; Low Back Pain

INTRODUCTION

Low back pain (LBP) is an important musculoskeletal problem that causes clinical, social and economic losses.¹ It affects approximately 85% of the population and becomes a chronic condition in 23% of individuals, lasting for 3 months or more.² Although there are various forms of

LBP, the most common is nonspecific low back pain (NSLBP). In NSLBP, there are no recognizable specific underlying pathologies, such as history of spinal surgery, presence of neurologic deficits, facet joint problems, disc herniation, or sacroiliac joint dysfunction.²⁻⁴

The prevalence and incidence of NSLBP increase with age.² Various age-related physical, psychological, and mental changes (eg, comorbidities, physical inactivity, age-related changes in central pain processing, and dementia), deficiencies in back and abdominal muscle endurance, disorders of sagittal spinal mobility and sagittal postural alignment, and deterioration in lumbopelvic motor control in particular are associated with NSLBP in older people.^{2,5-9}

Dorsal proprioceptive signals, which are an important component of lumbopelvic motor control, decrease in older adults with NSLBP.¹ Lumbopelvic muscles play a major role in correctly receiving these signals. Electromyographic and ultrasonographic measurements in young asymptomatic individuals show that before shoulder flexion,

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anticipatory automatic adjustments activate lumbopelvic muscles and shorten the muscle lengths, while the diaphragm adjusts the transdiaphragmatic pressure. As a result of these postural adjustments, young asymptomatic people can demonstrate good postural control and balance performance.^{10,11} Dysfunctions in these automatic arrangements in older people with NSLBP lead to deterioration in their postural performance.^{4,11}

Although examining postural changes in various positions in older people with NSLBP has always been a topic of research, maintaining and preserving postural control during standing position has been the main focus of recent studies. According to a systematic review study, it is uncertain whether the effects of sensory manipulation on postural oscillations are altered in individual with NSLBP, and further studies are needed.¹² For instance, in cases where sensory systems with an impact on postural control (eg, visual, proprioceptive, and vestibular systems) are not manipulated, some studies report greater oscillation magnitude in individuals with NSLBP, while others report that their oscillation magnitude is similar to that of healthy individuals.¹² Sherafat et al emphasize that evaluating changes in gravity center in static positions might be a potential cause of these contradictory results.¹³ As indicated in that study, standing still on a static platform may hinder detection of small differences in postural stability and balance between individuals with and without NSLBP. In this context, evaluating older people with NSLBP under more challenging balance conditions and using a mobile platform such as the Biodex Balance System (BBS; Biodex Medical Systems, Shirley, New York) will yield more sensitive results in assessing postural stability and balance.^{13,14}

As a device used for objective evaluation of static and dynamic postural performance, the BBS allows free movements in mediolateral and anteroposterior directions.^{14,15} Validity-reliability studies of the BBS have already been conducted in various populations, including active individuals,¹⁶ inactive individuals,^{16,17} young adults,¹⁴ older people,¹⁴ and individuals with ankle sprains.¹⁸ In 2013, Sherafat et al conducted a validity-reliability study of the BBS in individuals with NSLBP.¹³ The BBS has strong to excellent correlation with other tests and scales that are frequently used in the evaluation of postural control and balance, such as the 4-square step test,¹⁹ the timed up-and-go test,¹⁹ Berg Balance Scale (BergBS),²⁰ and the single-leg stance test.²¹

Although studies emphasize the use of the BBS in older people with NSLBP, no data have been reported on the cutoff scores of this system. The determination of a cutoff score with high sensitivity and specificity is thought to be beneficial for detecting deterioration in postural performance in older people with NSLBP. Therefore, the aim of the present study was to determine BBS cutoff scores in older people with NSLBP.

METHODS

Study Design

This study was designed as a cross-sectional study. Fifty-two older people with NSLBP who were admitted to the Orthopedics and Traumatology Outpatient Clinic between December 2019 and January 2020 were included in the study if they met the inclusion criteria. These individuals were evaluated by an experienced physiotherapist (C.K.) in the laboratory for the variables within the scope of the study.

Participants

Participants were referred to the Physiotherapy and Rehabilitation Clinic by 2 orthopedic specialists (H.Ç.B., H.S.). Inclusion criteria were the presence of episodic LBP for 12 months or more, a pain score of 40 mm on the visual analog scale on the evaluation day, the ability to comprehend and follow verbal instructions, age over 65 years, and volunteering to participate in the study.^{3,4,13,22} The exclusion criteria (Fig 1) were a history of spinal surgery, severe spinal pathologies (eg, ankylosing spondylitis, lumbar spinal stenosis, spina bifida, spinal tumors, osteoporosis, cauda equina syndrome), neurologic deficits (eg, brain tumor, nerve palsies), specific causes of low back pain (eg, facet joint problem, disc herniation, sacroiliac joint dysfunction), nerve root compression, spinal deformities (eg, scoliosis, increased lordosis $>-57^\circ$, increased kyphosis $>52^\circ$), autoimmune disease (eg, rheumatoid arthritis, systemic lupus erythematosus), cancer, and dementia (Mini-Mental State Examination score ≤ 24).^{2-4,13,23,24}

The orthopedic specialists used the operational definition for diagnosis of NSLBP, which is pain that occurred at least 2 times over the past year with each episode lasting for at least 24 hours, with pain intensity greater than 2 on a visual analog scale and at least a 30-day pain-free period between the episodes. Nonspecific LBP refers to pain symptoms anywhere in the lower back between the twelfth rib and the top of the legs. It is defined as pain or discomfort localized below the costal margin and above the inferior gluteal folds, with or without leg pain. The pain sensations are not attributable to any recognizable specific pathology, such as infection, tumor, osteoporosis, fracture, radicular syndrome, or cauda equina syndrome. It further excludes organic referred pain.^{25,26}

Ethics Committee

This study was approved by the Kırşehir Ahi Evran University Medical Faculty Clinical Research Ethics Committee (24.12.2019 GO 2019-23/235). Before the study, written and verbal consent was obtained from all individuals, and the study was conducted in accordance with the Declaration of Helsinki.

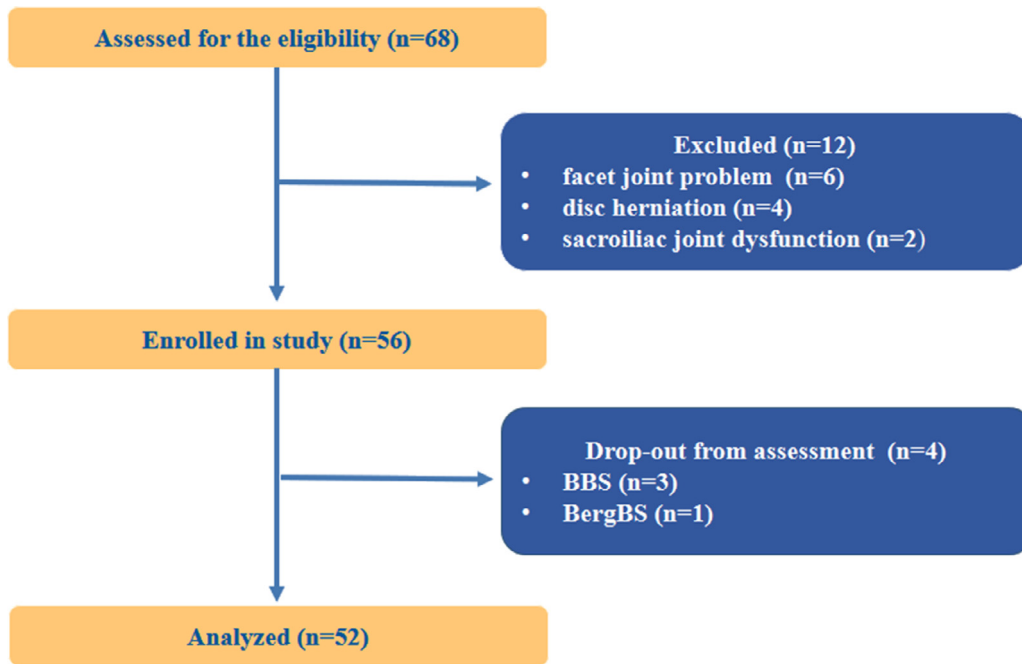


Fig 1. Flowchart of the study.

Outcome Measures

Clinical and demographical data were collected for characterization purposes.

The BBS was used to assess postural performance of the participants.¹³ The mobile platform of the BBS allows up to 20° of surface tilt in anterior-posterior and medial-lateral directions. The device is equipped with computer software (Biodex, version 3.1; Biodex Medical Systems) that produces 3 stability indices: the medial-lateral stability index (MLSI), anterior-posterior stability index (APSI), and overall stability index (OSI). These indices, representing the amount of deviation from the baseline position, are calculated as

$$APSI = \sqrt{\frac{\sum (0-Y)^2}{\text{number of samples}}}$$

$$MLSI = \sqrt{\frac{\sum (0-X)^2}{\text{number of samples}}}$$

$$OSI = \sqrt{\frac{\sum (0-Y)^2 + \sum (0-X)^2}{\text{number of samples}}}$$

In these equations, X and Y represent the degree of tilt on the anterior-posterior and medial-lateral axes, respectively. Higher scores indicate higher postural instability. The stability of the BBS platform depends on the amount of

resistance offered by the springs underneath the platform. The platform stability ranges from level 1 to level 8, with level 1 representing the greatest instability and level 8 indicating the lowest instability.

For individuals with NSLBP, BBS normative values¹² for the eyes-open condition are $APSI = 2.24 \pm 0.69$, $MLSI = 1.88 \pm 0.50$, $OSI = 2.87 \pm 0.66$; for the eyes-closed condition, $APSI = 3.35 \pm 1.09$, $MLSI = 3.17 \pm 0.80$, $OSI = 4.55 \pm 1.26$.

Based on the findings of Sherfat et al¹³ regarding intra-session and intersession reliability of the BBS in individuals with NSLBP, in the present study 1 stability level (level 5; intraclass correlation coefficient ≥ 0.70) and 2 conditions (eyes open and eyes closed) were selected as the testing procedure. All postural assessments were performed during bipedal stance for 30 seconds.

Visual information was manipulated (eyes open or closed) to change the level of difficulty. In the eyes-open condition, the participants were instructed to simply look at a paper on a wall 2 m away, and the instrument panel was covered. In the eyes-closed condition, participants wore a blindfold to eliminate visual input.¹³⁻¹⁷ In both experimental conditions, the participants were instructed to keep the platform level in balance while standing barefoot with their arms crossed in front of their chest. Participants were not permitted to touch the handrails. For each participant, foot-position coordinates remained unchanged throughout the trials.¹³

The BergBS was used as the gold-standard test to measure postural performance of the participants. The BergBS is a qualitative measure that assesses postural performance during functional activities such as reaching, bending, transferring, and standing, all of which incorporate most components of postural control: sitting and transferring safely between chairs; standing with feet apart, feet together, in a single-leg stance, and tandem Romberg position with eyes open or closed; and reaching and stooping down to pick up an object. Each item is scored along a 5-point scale ranging from 0 to 4, each grade with well-established criteria. While 0 indicates the lowest level of function, 4 represents the highest level. The total score ranges from 0 to 56. The reliability (both interrater and intrarater) and validity (concurrent and construct validity) of the BergBS in assessing postural performance in older people with NSLBP have been documented.²⁷⁻³¹ It is an effective predictor of falls within community-dwelling adults.³² A score of 45 or less is reported by many investigators to indicate a greater risk of falling in older people with NSLBP.²⁷⁻³¹

Based on their BergBS scores, the participants were categorized into 2 groups: those with a high risk of falling (BergBS score ≤ 45) and those with a low risk of falling (BergBS score > 45).

Sample Size

To the best of our knowledge, cutoff scores of the BBS in older people with NSLBP have not been investigated to date. Therefore, we could not find any study relating to analyses of receiver operating characteristic (ROC) or area under the curve (AUC) to calculate sample size.

Menezes et al examined the agreement and predictive power of 6 fall-risk assessment methods in community-dwelling older adults.³¹ Based on their findings, the minimum required sample size for a cutoff analysis was 52 participants for a probability level (α) of 0.05 and statistical power level of 80% using G*Power software (version 3.1.9.2).

Statistical Analysis

IBM SPSS Statistics for Windows software (version 20.0; IBM Corp, Armonk, New York) was used to analyze the data. The variables were investigated using visual (histograms, probability plots) and analytical methods (Kolmogorov-Smirnov and Shapiro-Wilk tests) to determine whether or not the data were normally distributed.³³ Parametric analysis was used for the normally distributed data. Values were expressed as mean \pm standard deviation, standard error of the mean, and confidence intervals for continuous variables. Values were expressed as ratios (%) for categorical variables. Both the ROC and the AUC were used to determine the best BBS cutoff score, with the most appropriate values of specificity and sensitivity, to

discriminate between participants with high and low risk of falling, followed by binary logistic regression analysis. As there was no defined cutoff value, the 20th percentile was used, and the AUC values were classified as $AUC \leq 0.5$: poor discrimination or predictive ability; $0.7 \leq AUC < 0.8$: good predictive ability; $0.8 \leq AUC < 0.9$: excellent predictive ability; and $AUC \geq 0.9$: very excellent predictive ability.³³ The Youden index—that is, the maximum sum of the sensitivity and specificity—was used to find the best cutoff score. After this procedure, the participants were classified into 2 groups: poor and good postural performance. Standard binary logistic regression analysis was used to investigate the ability of the BBS scores to predict risk of falling. Hosmer-Lemeshow goodness-of-fit analysis was used for model fit. The model was adjusted for possible confounders, such as participant sex and age. The results were expressed as adjusted odds ratios with corresponding confidence intervals. The level of significance was set at $P < .05$.

Logistic regression is the most appropriate regression analysis when the dependent variable is dichotomous (binary). Like all regression analyses, logistic regression is a predictive analysis. It is used to describe data and to explain the relationship between 1 dependent binary variable and 1 or more nominal, ordinal, interval, or ratio-level independent variables. Logistic regression may be used to predict the risk of developing a given disease.³³ As the aim of this study was to determine the ability of the BBS scores to predict risk of falling, regression analysis was sound for the dependent variable (poor and good postural performance). To test the assumption of no multicollinearity, variance inflation factors and condition indices were used. Multicollinearity was not present, and the assumption was met. To test the assumption of no autocorrelation, the Durbin-Watson test was used, and the assumption was met.

RESULTS

Fifty-two participants with a mean time since NSLBP onset of 23.12 months (standard deviation = 3.65) were included in the study. The participant characteristics are given in [Table 1](#).

Eyes-Open Condition

According to ROC analysis, the BBS cutoff scores ([Fig 2](#), [Table 2](#)) were APSI = 2.60 (AUC = 0.90), MLSI = 1.95 (AUC 0.83), and OSI = 2.95 (AUC 0.83). Sensitivity, specificity, positive predictive value, and negative predictive value are given in [Table 2](#). The predictivity of the model, based on the AUC values (0.90, 0.83, and 0.83), is excellent.

Based on these cutoff scores, the participants were classified into 2 groups: poor postural performance and good postural performance.

Table 1. Descriptive Statistics of Participants

Statistic	Minimum	Maximum	Mean	SEM	SD	95% CI
Age, y	65.00	72.00	68.09	0.30	2.18	67.48-68.70
Body mass index, kg/m ²	16.58	35.25	23.99	0.54	3.91	22.90-25.08
BergBS	39.00	50.00	45.15	0.42	3.06	44.30-46.00
Biodex Balance System/EO						
APSI	2.30	3.80	3.04	0.05	0.39	2.93-3.15
MLSI	1.70	2.70	2.13	0.03	0.22	2.06-2.19
OSI	2.70	3.90	3.28	0.04	0.35	3.18-3.38
Biodex Balance System/EC						
APSI	2.60	4.20	3.30	0.05	0.38	3.20-3.41
MLSI	1.80	3.60	2.67	0.05	0.42	2.55-2.79
OSI	3.00	5.80	3.73	0.07	0.52	3.59-3.88
Sex						
Female, n (%)	26 (50.0%)					
Male, n (%)	26 (50.0%)					
Risk of Falling (BergBS)						
≤45, n (%)	24 (46.2%)					
>45, n (%)	28 (53.8%)					

APSI, anterior-posterior stability index; BergBS, Berg Balance Scale; CI, confidence interval; EC, eyes-closed condition; EO, eyes-open condition; MLSI, medial-lateral stability index; OSI, overall stability index; SD, standard deviation, SEM, standard error of the mean.

According to the results of binary logistic regression analysis, the risk of falling in individuals with good antero-posterior postural performance (BBS APSI ≤ 2.60) was 6.42 times lower than in individuals with poor anteroposterior postural performance (BBS APSI > 2.60 ; Hosmer-Lemeshow goodness of fit > 0.05). The model was adjusted for sex and age, but no associations were found (Table 3).

The risk of falling in individuals with good mediolateral postural performance (BBS MLSI ≤ 1.95) was 4.20 times lower than in individuals with poor mediolateral postural performance (BBS MLSI > 1.95 ; Hosmer-Lemeshow goodness of fit > 0.05). The model was adjusted for sex and age, but no associations were found (Table 3).

The risk of falling in individuals with good overall postural performance (BBS OSI ≤ 2.95) was 3.72 times lower than in individuals with poor overall postural performance (BBS OSI > 2.95 ; Hosmer-Lemeshow goodness of fit > 0.05). The model was adjusted for sex and age, but no associations were found (Table 3).

Eyes-Closed Condition

According to ROC analysis, the BBS cutoff scores (Fig 2, Table 2) were APSI = 3.05 (AUC 0.84), MLSI = 2.17 (AUC = 0.69), and OSI = 3.25 (AUC = 0.72). Sensitivity, specificity, positive predictive value, and negative predictive value are given in Table 2. The predictivity of the model, based on the AUC values (0.84, 0.69, and 0.72), is good to excellent.

Based on these cutoff scores, the participants were classified into 2 groups: poor postural performance and good postural performance.

According to the results of binary logistic regression analysis, the risk of falling in individuals with good anteroposterior postural performance (BBS APSI ≤ 3.05) was 3.33 times lower than in individuals with poor anteroposterior postural performance (BBS APSI > 3.05 ; Hosmer-Lemeshow goodness of fit > 0.05). The model was adjusted for sex and age, but no associations were found (Table 3).

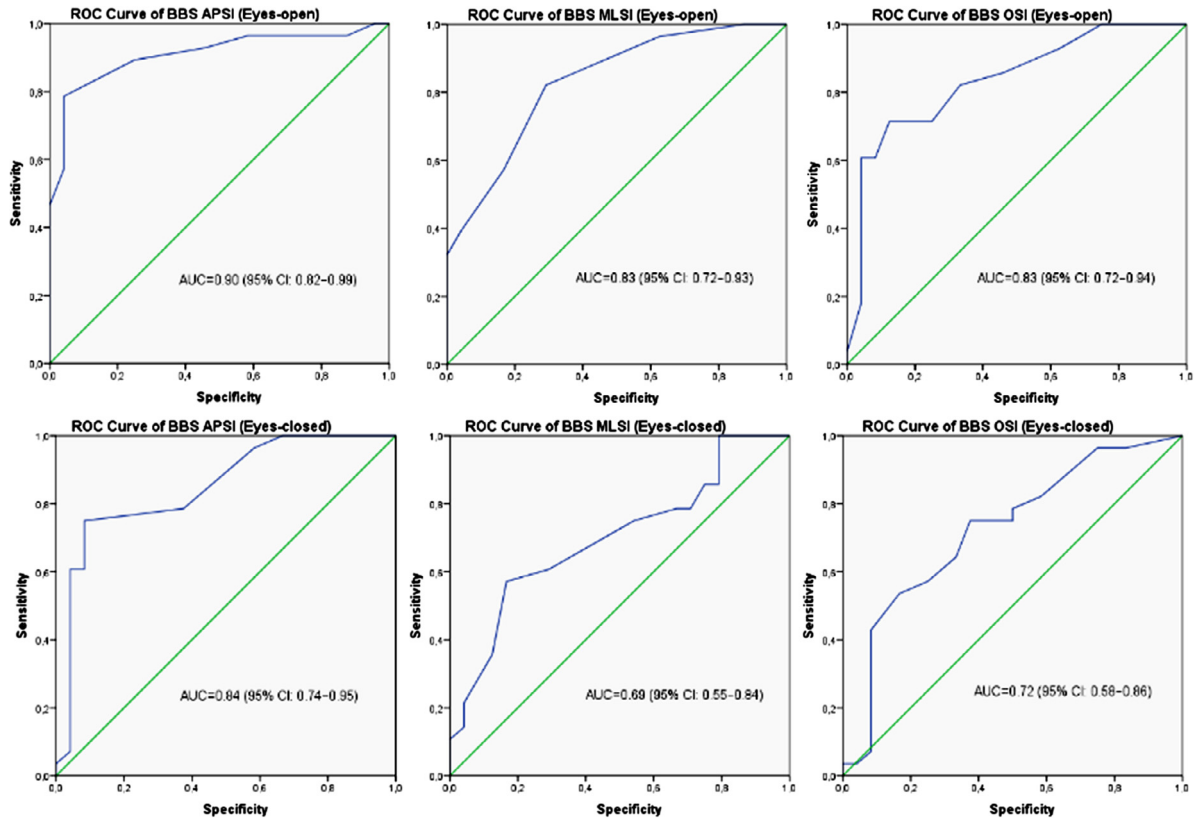


Fig 2. Receiver operating characteristic curves of 2 different conditions.

The risk of falling in individuals with good mediolateral postural performance (BBS MLSI ≤ 2.17) was 5.50 times lower than in individuals with poor mediolateral postural performance (BBS MLSI > 2.17 ; Hosmer-Lemeshow goodness of fit > 0.05). The model was adjusted for sex and age, but no associations were found (Table 3).

The risk of falling in individuals with good overall postural performance (BBS OSI ≤ 3.25) was 3.00 times lower than in individuals with poor overall postural performance (BBS OSI > 3.25 ; Hosmer-Lemeshow goodness of fit > 0.05). The model was adjusted for sex and age, but no associations were found (Table 3).

Table 2. Biodex Balance System Cutoff Scores in 2 Different Conditions

Cut-off score	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value
Eyes-open condition				
APSI = 2.60	96%	70%	61.4%	87.5%
MLSI = 1.95	96%	62%	64.3%	90.0%
OSI = 2.95	92%	62%	63.4%	81.8%
Eyes-closed condition				
APSI = 3.05	96%	58%	53.8%	46.2%
MLSI = 2.17	89%	79%	56.8%	62.5%
OSI = 3.25	89%	66%	61.0%	72.7%

APSI, anterior-posterior stability index; MLSI, medial-lateral stability index; OSI, overall stability index.

Table 3. Binary Logistic Regression Model of the Biodex Balance System in 2 Different Conditions

Conditions	Coefficient	Standard Error	P (Wald)	Odds Ratio	95% CI
Eyes-open condition					
APSI ≤ 2.60	1.86	0.40	< .001	6.42	4.26-7.95
MLSI ≤ 1.95	1.43	0.35	< .001	4.20	3.11-5.98
OSI ≤ 2.95	1.31	0.34	< .001	3.72	2.40-4.42
Eyes-closed condition					
APSI ≤ 3.05	1.20	0.32	< .001	3.33	2.64-4.78
MLSI ≤ 2.17	1.70	0.38	< .001	5.50	4.23-6.49
OSI ≤ 3.25	1.09	0.32	< .001	3.00	2.31-4.59

The dependent variable is low risk of falling.

APSI, anterior-posterior stability index; CI, confidence interval; MLSI, medial-lateral stability index; OSI, overall stability index.

DISCUSSION

To the best of our knowledge, this is the first study to determine cutoff scores of the BBS as a reliable and valid measure of postural performance in older people with NSLBP. According to the findings of our study, the BBS cutoff scores (eyes open and closed) seem to be sensitive and specific in distinguishing older people with NSLBP with poor postural performance from those with good postural performance. This is the first study to determine the cutoff scores of the BBS as a reliable and valid measure for postural performance.

Determining cutoff values involves a trade-off between sensitivity and specificity; once sensitivity—that is, the test’s ability to correctly screen an individual with the condition as positive—is increased, then specificity—which represents the test’s ability to correctly screen an individual without the condition as negative—will decrease.^{34,35} For a given measurement tool, the choice should consider its relative cost, including the possibility of false positives and false negatives. In the present study, higher sensitivity was prioritized, which led to lower rate of false negatives.

It is reported that both the incidence and the prevalence of NSLBP increase with age.³⁶⁻³⁸ According to Docking et al,³⁹ the prevalence of 1-month disabling back pain (pain that affected daily living within the past month) is 3.8% among 77- to 79-year-old people; however, this rate increases to 9.7% among those aged 90 to 100 years. Thus, timely management of NSLBP in older adults is crucial, because severe NSLBP generally leads to functional disability and poor treatment outcomes. Wong et al² highlight the research gaps in the relevant literature regarding the trajectories of NSLBP, determinants of chronic NSLBP, and effective NSLBP management strategies in older adults. It

is necessary to precisely detect NSLBP in order to minimize undertreatment of older adults. Timely and accurate assessment and treatment strategies can be generated through investigating various factors that contribute to severe or chronic NSLBP in older adults. Clinical assessment of NSLBP in older adults is mainly based on self-report or surrogate report of NSLBP or on manual physical assessments. Evaluating the effects of NSLBP on postural performance possibly requires precise methods, which include mostly challenging balance conditions. In the current study, we calculated the cutoff scores of the BBS that can be used as an objective and proper assessment tool for management of NSLBP in older adults. Because the BBS can be used as a reliable measurement of static and dynamic postural performance in clinical settings, this article would be useful as an attempt to fill the current gap in the relevant literature. We think that our results can enable clinicians to distinguish between older people with NSLBP who have poor postural performance and those with good postural performance.

Sedentary behavior may inadvertently cause reduced neuromuscular efficiency, increased skeletal-muscle atrophy, and diminished muscle strength.⁴⁰ This reduction in physical activity and the associated muscle weakening of the lower limbs might have significant negative consequences on postural control and functional performance, and could lead to back pain. It has been shown that increased physical disability affects postural control performance in older people with NSLBP.⁴¹

Most of the previous research on NSLBP mainly focuses on younger people.^{12,42-46} However, the postural control of older adults with NSLBP may be different from that of younger people. Moreover, findings from groups with widely mixed ages might not be applicable to older populations.^{47,48} Although there are several causes of

NSLBP in older adults,² weak lumbopelvic motor control is reported as an important risk factor.⁴⁹ Altered and weakened movement patterns of the transversus abdominis and lumbar multifidus muscles, deficiencies in endurance, and abnormalities in the ability to withstand perturbations are common in older people with NSLBP.⁵⁰ All these changes hinder correct anticipatory and automatic postural responses, and consequently lead to delays in adaptation to postural changes and adversely affect dynamic balance.^{2,49}

Various tests and scales, such as the 4-square step test, the timed up-and-go test, the BergBS, and the single-leg stance test, are used to evaluate postural control and balance performance in older people with NSLBP.¹⁹⁻²¹ These tests and scales might be incapable of determining the differences in oscillation changes in individuals with and without NSLBP. In this context, Sherafat et al¹³ recommend evaluating individuals with NSLBP on a mobile platform such as the BBS when they are subjected to more challenging balance conditions. They state that the BBS will yield more sensitive results in evaluating postural stability and balance in individuals with NSLBP.^{13,14} Based on the findings of Sherafat et al regarding intrasession and intersession reliability of the BBS in individuals with NSLBP, in the present study 1 stability level (level 5; intraclass correlation coefficient ≥ 0.70) and 2 conditions (eyes open and eyes closed) were selected as the testing procedure. In addition to determining BBS cutoff scores, this study provides evidence for these scores by calculating odds ratios.

The maintenance and control of postural performance, whether under static or dynamic conditions, is considered an essential requirement for daily living activities.⁵¹ Thus, postural control variables have often been used to evaluate individuals with various musculoskeletal or neuromuscular disorders.⁵¹ Previous studies report that the maintenance of postural performance is a complex function involving major sensory and motor factors.⁵²⁻⁵⁴ Assessment of postural performance—which is a complex structure—using the BBS cutoff scores would constitute a novelty for evaluations concerning risk of falling.

Although there are several studies reporting the reliability of BBS stability indices in older people,^{17,18} reliability studies of these indices in NSLBP are scarce. The results of Sherafat et al¹³ show higher test-retest reliability among participants with NSLBP than matched healthy individuals. This finding may be related to the greater heterogeneity of balance performance among participants. Although that study states that the fifth platform stability level led to more sensitive and reliable results, no study in the literature has calculated cutoff scores that could differentiate performance on this platform as good or bad. We calculated the cutoff scores for the BBS platform in older people with NSLBP and used the scores to predict the risk of falling in case of deviation from these scores. Postural performance

is commonly assessed in clinical practice, and BBS cutoff scores will enable clinicians distinguish between good and poor postural performance in their older patients with NSLBP. Detecting poor postural performance is important for clinical reasoning and decision-making in NSLBP rehabilitation.

Limitations

The age range of our participants was determined as older adults, with an average age of 68.09 ± 2.18 years. It is recommended that future studies regroup participants based on their age in intervals of years. This can help with overall availability and generalization of the results. As the study population was individuals with NSLBP, the results of the study cannot be interpreted for LBP with recognizable specific underlying pathologies. Therefore, there is a need for further studies involving participants with pathologies affecting the low back.

CONCLUSION

Our study shows that the BBS cutoff scores (eyes open and closed) seem to be sensitive and specific in distinguishing older people with NSLBP who have poor postural performance from those with good postural performance. These findings may be useful for clinicians and researchers in NSLBP rehabilitation to facilitate clinical decision-making directed to improving postural performance.

FUNDING SOURCES AND CONFLICTS OF INTEREST

No funding sources or conflicts of interest were reported for this study.

CONTRIBUTORSHIP INFORMATION

Concept development (provided idea for the research): C.K., A.Ö., H.Ç.B., İ.Ö., G.Ö., M.İ.K., H.S., İ.U.

Design (planned the methods to generate the results): C.K., A.Ö., H.Ç.B., İ.Ö.

Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): C.K., A.Ö., H.Ç.B., İ.Ö., G.Ö., H.S.

Data collection/processing (responsible for experiments, patient management, organization, or reporting data): C.K., H.Ç.B., H.S.

Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): C.K., H.Ç.B., İ.Ö., biostatistics specialist.

Literature search (performed the literature search): C.K., A.Ö., H.Ç.B., İ.Ö., G.Ö., M.İ.K., H.S., İ.U.

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Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking): C.K., A.Ö., H.Ç.B., İ.Ö., G.Ö., M.İ.K., H.S., İ.U., native speaker.

Practical Applications

- In the eyes-open condition, Biodex Balance System cutoff scores were sensitive and specific in determining postural performance.
- In the eyes-open condition, individuals with values of the three indices lower than cutoff values were found to have, respectively, 6.42, 4.20, and 3.72 times lower risk of falling.
- In the eyes-closed condition, Biodex Balance System cutoff scores were sensitive and specific for postural performance measurements of older people with nonspecific low back pain without visual input.
- In the eyes-closed condition, individuals with values of the three indices lower than cutoff values were found to have, respectively, 3.33, 5.50, and 3.00 times lower risk of falling.

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