Original Article

Intra-Rater Reliability of Star Excursion Balance Test

Numra Shafiq[1]*, Sidrah Shabbir[2], Muhammad Mahmood Alam[3], Muhammad Waseem Akhtar[4], Muhammad Burhan[5], Adiya Masora[6]

[1]Akhtar Saeed College of Rehabilitation Sciences Pakistan.
[2]Assistant Professor, Physical Therapy, Akhtar Saeed College of Rehabilitation Sciences Pakistan.
[3]Principal, Physical Therapy, Akhtar Saeed College of Rehabilitation Sciences Pakistan.
[4]Head of Department, Physical Therapy, Akhtar Saeed College of Rehabilitation Sciences Pakistan.
[5]Demonstrator, Physical Therapy, Akhtar Saeed College of Rehabilitation Sciences Pakistan.
[6]Physical Therapist, Akhtar Saeed College of Rehabilitation Sciences Pakistan.
*Corresponding Author: Numra Shafiq; Email: numrashafiq332@gmail.com
Conflict of Interest: None.

ABSTRACT

Background: Balance is crucial for maintaining the center of gravity over the base of support, relying on three main subsystems: somatosensory, vestibular, and visual, managed by the central nervous system. The Star Excursion Balance Test (SEBT), developed by Gray, assesses dynamic balance by standing on one leg and reaching with the other in various directions. It is recommended for screening sports participation and post-rehabilitation, with studies indicating improved performance through training.

Objective: This study aimed to evaluate the intra-rater reliability of the SEBT in young, healthy adults.

Methods: A cross-sectional study was conducted with 47 young, healthy adults, selected based on inclusion and exclusion criteria. Each participant completed the SEBT after providing written consent. The mean of six attempts was recorded for each direction. Data were analyzed using IBM SPSS Statistics 23.0, with significance set at $p < 0.05$. The intra-class correlation coefficient (ICC) was calculated to determine reliability.

Results: The ICC for the dominant limb in all directions ranged from 0.75 to 0.9, indicating good agreement. Specifically, the ICC values were 0.81 for anteromedial reach, 0.86 for medial reach, 0.79 for posteromedial reach, 0.91 for posterior reach, 0.91 for posterolateral reach, 0.77 for lateral reach, 0.88 for anterolateral reach, and 0.75 for anterior reach ($p = 0.00$ for all). For the non-dominant limb, ICC values ranged from 0.81 to 0.9, with specific values of 0.91 for anteromedial reach, 0.91 for medial reach, 0.87 for posteromedial reach, 0.81 for posterior reach, 0.83 for posterolateral reach, 0.94 for lateral reach, 0.88 for anterolateral reach, and 0.90 for anterior reach ($p = 0.00$ for all).

Conclusion: The SEBT demonstrated good intra-rater test-retest reliability for assessing dynamic balance in young, healthy adults. The test can be reliably used to evaluate balance and postural stability in both clinical and sports settings.

Keywords: Star Excursion Balance Test, SEBT, dynamic balance, intra-rater reliability, postural stability.

INTRODUCTION

The central nervous system (CNS) plays a pivotal role in the perception and execution of musculoskeletal control and movement, which is achieved through the integration of three primary subsystems: vestibular, somatosensory, and visual. The sense of balance, its performance, and measurement are directly influenced by these subsystems. The Star Excursion Balance Test (SEBT), developed by Gray, is a valid and reliable outcome measure of dynamic balance (1). The SEBT requires subjects to maintain a single-leg stance on one leg while extending the contralateral leg in various directions, thus testing their range of motion. Researchers have advocated the use of SEBT for ensuring dynamic functional balance post-rehabilitation and as a screening tool for sports participation. Additionally, studies have shown that SEBT performance improves with training (2).

Sports participation demands adequate balance and coordination, making the assessment of balance and postural stability crucial for determining the extent of injury or functional performance capabilities (3). Clinicians frequently employ postural-control tests to predict injury risk, identify primary impairments caused by injuries, and evaluate the extent of improvement following treatment. Active postural control is now recognized in both clinical and research contexts as a valid function evaluation tool. The distance a subject can reach while maintaining their base of support is more indicative of dynamic postural control than the degree of control itself (4).

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Shafiq N., et al. (2024). 4(2): DOI: https://doi.org/10.61919/jhrr.v4i2.1126

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The SEBT comprises a series of lower limb reaching tasks in eight directions, evaluating the subject's postural control, muscular power, range of motion (ROM), and proprioceptive abilities. A subject's perceived functional performance increases with the distance they can reach with one leg while maintaining balance on the other. Good balance, muscular strength, and coordination on the stance leg are essential for the ability to extend reach with the opposite leg (5). Despite its utility, the test's full administration, requiring 48 reaches to complete (three reaches in each of the eight directions, bilaterally), presents practical limitations. To address these constraints, Hertel et al. identified that the anterior, posterolateral, and posteromedial reach directions provide sufficient information, allowing for a more feasible administration of the test (6).

The SEBT is highly reliable for evaluating dynamic balance in athletes and healthy individuals. This reliability is critical for diagnostic purposes and for distinguishing balance performance among individuals (7, 8). Researchers have developed scientific scoring standards to meet the requirements of other functional activities, including the tuck jump evaluation, single-leg squats, and lateral step-downs, with degrees of reliability suitable for medical application. The SEBT has been acknowledged as a valuable tool for predicting lower limb impairments and assessing athletes prior to sports participation (9).

The aim of this study was to gather, critically appraise, and synthesize published information on the SEBT's intra-rater reliability and its effectiveness in measuring dynamic balance in healthy individuals. This study also aimed to determine the rate and pattern of movement (10).), the validity and reliability of clinical diagnostic testing are paramount (11). The reliability of the SEBT is supported by multiple studies, including those by which demonstrate that the test's reliability ranges from good to excellent (12-18). This reliability is essential for the SEBT's application in clinical and sports settings, providing a robust method for assessing dynamic balance.

In summary, the SEBT has demonstrated high intra-rater test-retest reliability and low levels of measurement error, making it a trustworthy tool for assessing balance and coordination. The test's reliability, confirmed by various studies, underscores its value in both clinical and research contexts for evaluating dynamic balance and predicting lower limb impairments.

MATERIAL AND METHOD

A cross-sectional study was conducted at Akhtar Saeed Medical and Dental College, Lahore, from July 2022 to January 2023, involving individuals aged between 18 and 30 years. Both male and female participants were included in the study. The Ethics Review Committee of Akhtar Saeed College of Rehabilitation Sciences in Lahore approved the study, ensuring adherence to the principles outlined in the Declaration of Helsinki. Participants provided informed consent before any data collection commenced.

A total sample size of 47 participants was determined using the formula , accounting for statistical power and precision requirements. The participants were selected through non-probability convenience sampling based on predefined inclusion and exclusion criteria. The Star Excursion Balance Test (SEBT) was administered to all participants to assess their dynamic balance. Each subject performed the SEBT while standing on one leg and reaching with the contralateral leg in various directions. The mean of six attempts was recorded for each participant.

Data collection involved recording demographic information, limb length, and performance scores on the SEBT. The measurements were conducted by trained assessors to ensure consistency and accuracy. The data were entered into a secure database, with double-checking to avoid entry errors. SPSS version 25.0 was utilized for data analysis. Descriptive statistics, including means and standard deviations, were calculated for continuous variables, while frequencies and percentages were determined for categorical variables. The intra-class correlation coefficient (ICC) was employed to assess the reliability of the SEBT, with values ranging from 0.75 to 0.9 indicating good agreement for both dominant and non-dominant limbs.

The significance level was set at 0.05 for all statistical tests. The ICC for the dominant limb in all directions ranged from 0.75 to 0.9, reflecting good agreement. Similarly, the ICC for the non-dominant limb in all directions ranged from 0.81 to 0.9, also indicating good agreement. These results were interpreted to confirm the SEBT as a reliable method for assessing dynamic balance.

Ethical considerations were paramount throughout the study, ensuring that all procedures conformed to ethical standards for research involving human subjects. Participants were assured of their right to withdraw from the study at any time without any consequences. All data were anonymized to maintain confidentiality and privacy. The results of this study contribute to the understanding of the reliability of the SEBT and its application in clinical and research settings

RESULTS

The study included 50 participants with an average age of 22.84 ± 2.860 years. The sample comprised 14 males (28%) and 36 females (72%). The detailed demographic characteristics are presented in Table 1.

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JHRR

Table 1 Limb Length and Age of Participants

Variable	Minimum	Maximum	Mean	Standard Deviation
Limb Length (cm)	80.00	96.50	87.73	4.99
Age of Participants	19	35	22.84	2.86

Table 2 Gender of Participants

Gender	Frequency	Percent
Male	14	28.0
Female	36	72.0

The intra-class correlation coefficient (ICC) for the dominant limb in all directions ranged from 0.75 to 0.9, indicating a good level of agreement. The detailed ICC values for the dominant limb are shown in Table 3.

Table 3 Intra-Class Correlation Coefficient of Dominant Limb in All Directions

Direction	Intra-class Correlation Coefficient	95% Confidence Interval	Sig.
Anteromedial Reach	0.81	0.73 - 0.87	0.00
Medial Reach	0.86	0.79 - 0.91	0.00
Posteromedial Reach	0.79	0.72 - 0.87	0.00
Posterior Reach	0.91	0.87 - 0.94	0.00
Posterolateral Reach	0.91	0.87 - 0.94	0.00
Lateral Reach	0.77	0.69 - 0.85	0.00
Anterolateral Reach	0.88	0.83 - 0.92	0.00
Anterior Reach	0.75	0.64 - 0.84	0.00

Similarly, the ICC for the non-dominant limb in all directions ranged from 0.81 to 0.9, also indicating a good level of agreement. The detailed ICC values for the non-dominant limb are shown in Table 4.

Table 4 Intra-Class Correlation Coefficient of Non-Dominant Limb in All Directions

Direction	Intra-class Correlation Coefficient	95% Confidence Interval	Sig.
Anteromedial Reach	0.91	0.89 - 0.96	0.00
Medial Reach	0.91	0.86 - 0.94	0.00
Posteromedial Reach	0.87	0.80 - 0.92	0.00
Posterior Reach	0.81	0.71 - 0.88	0.00
Posterolateral Reach	0.83	0.74 - 0.99	0.00
Lateral Reach	0.94	0.91 - 0.96	0.00
Anterolateral Reach	0.88	0.82 - 0.93	0.00
Anterior Reach	0.90	0.85 - 0.94	0.00

These results indicate that the SEBT is a reliable method for assessing dynamic balance in young, healthy adults. The good agreement in ICC values for both the dominant and non-dominant limbs across all directions confirms the test's reliability for clinical and research applications.

The study's findings are consistent with previous research, highlighting the SEBT's utility in evaluating balance and postural control. The high intra-rater reliability observed in this study supports the SEBT as a valuable tool for dynamic balance assessment, essential for both rehabilitation and sports participation screening.

DISCUSSION

The findings of this study demonstrated that the Star Excursion Balance Test (SEBT) possesses high intra-rater reliability, which aligns with previous research that highlighted the test's robustness in assessing dynamic balance (19) The intra-class correlation coefficients (ICCs) for both the dominant and non-dominant limbs in various directions indicated good to excellent reliability, reaffirming the SEBT's utility in clinical and research settings. First established the SEBT as a reliable measure of dynamic balance, reporting ICC values comparable to those found in this study. Reported high reliability of the SEBT, further validating its application across different populations and settings. These consistent findings across studies suggest that the SEBT is a robust tool for evaluating postural control, essential for both injury prevention and rehabilitation in athletic and general populations (18).

One of the strengths of this study was the thorough methodology, including the use of a well-defined sample and rigorous statistical analysis. The sample size of 47 participants was adequate for ensuring the reliability of the findings, and the use of SPSS version 25.0 allowed for precise data analysis. Additionally, the study adhered to ethical standards, ensuring participant safety and data integrity (20)

However, there were some limitations. The use of a non-probability convenience sampling technique may have introduced selection bias, limiting the generalizability of the findings to a broader population. Moreover, the study's cross-sectional design precluded the assessment of changes in balance over time or the long-term effects of interventions on SEBT performance. Future studies could address these limitations by employing longitudinal designs and randomized sampling techniques to enhance the generalizability and robustness of the findings (17).

The study also highlighted the practical application of the SEBT in clinical settings. Given the test's high reliability, it can be effectively used by clinicians to assess balance deficits and monitor progress in rehabilitation programs. The ease of administration and the non-invasive nature of the SEBT make it a suitable tool for routine assessments. Incorporating the SEBT into regular screening protocols for athletes could help identify individuals at risk of balance-related injuries, allowing for timely interventions. The test's ability to detect subtle balance deficits makes it valuable for both pre-participation screenings and post-injury evaluations. Furthermore, the SEBT's applicability to various populations, including those with chronic ankle instability and post-ACL reconstruction (16)

Despite its strengths, the SEBT requires careful administration to ensure consistency and accuracy. Training for assessors is essential to minimize variability and enhance the reliability of measurements. The study also suggests the need for standardized protocols to ensure uniformity in test administration across different settings.

In conclusion, this study confirmed the SEBT as a reliable and practical tool for assessing dynamic balance in young, healthy adults. The findings support its use in both clinical and research contexts, providing a valuable measure for evaluating postural control and informing rehabilitation strategies. Future research should focus on expanding the generalizability of these findings and exploring the longitudinal effects of balance training on SEBT performance. Incorporating the SEBT into routine clinical practice can enhance the assessment and management of balance-related issues, ultimately improving patient outcomes (1).

CONCLUSION

This study supports that the Star Excursion Balance Test (SEBT) is a reliable tool for assessing dynamic balance and postural stability. This study confirms the good intra-rater test-retest reliability of the SEBT in young, healthy adults, with ICC values indicating strong agreement across all directions. These findings validate the SEBT as a dependable method for evaluating balance, making it suitable for use in both clinical and sports settings to monitor and enhance balance performance.

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