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**Original Article**

# Validity of the modified star excursion balance test (mSEBT) in martial art athletes

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**Abstract**
The study highlights that dynamic balance is a critical element in martial arts, and it is essential for every martial arts athlete to have quick and powerful movements that require precise body control. The Star Excursion Balance Test (SEBT) is a dynamic balance test that measures the ability to maintain balance while reaching in multiple directions, the normalized reach distance values of the SEBT can be used as an index of dynamic postural control and to evaluate the dynamic balance of lower limbs in 8 selective directions to determine potential risk of injury. The study aimed to validate the modified star excursion balance test (mSEBT). The modified star excursion balance test (mSEBT) in this research is a widely used tool to assess dynamic postural stability in athletes. It involves performing the range of motion in eight different directions based on time. The participants included 68 undergraduate students in the physical education, sport, and recreation study program at Universitas Islam 45, Indonesia *(age: M=20.11, SD=0.38)*. Rasch analysis was utilized to evaluate the validity and reliability of the the modified star excursion balance test (mSEBT) and correlation was to hypothesis analysis. The results confirm that the mSEBT is valid and reliable measure for both test. In conclusions, martial arts athletes must possess the ability to maintain dynamic balance for an extended period of time, and the mSEBT can be used as a measuring tool to determine the ability to maintain dynamic balance in martial arts athletes with the mSEBT Based on Longest Time (LT) test procedure.
**Keyword: The modified star excursion balance test (mSEBT), Martial arts, Dynamic balance, Rasch analysis**.

## Introduction

Physical fitness is an essential aspect of an athlete's life. It is not just about building muscles or improving endurance, but also about maintaining balance in all aspects of fitness. Balance training is often overlooked, but it plays a crucial role in an athlete's performance (Saputra et al., 2022). Balance exercises can help improve coordination, ease of movement, and stability when participating in sports. Balance training is a widely recognized form of training in various sports that aims to enhance postural control. Research suggests that the benefits of balance training can extend beyond postural control and improve other physical fitness measures, including muscle strength and jump performance (Gebel et al., 2020).

Dynamic balance is a critical element in martial arts, and it is essential for every martial arts athlete to have quick and powerful movements that require precise body control (Li & Shu, 2022). Postural stability can be affected by disturbances such as body mass index (BMI) (Handayani et al., 2022; Lubis et al., 2021), which is not ideal. The center of gravity's location is influenced by a person's height and weight, which, in turn, affects balance. Young athletes in various sports, including martial arts, require dynamic balance education to improve their balance performance (Adigüzel, 2020). Core strength training is a valid physical conditioning method for martial arts players, and it can enhance their balance (Li & Shu, 2022). Traditional martial arts can improve cardiovascular adaptability, muscle capacity, and body balance performance (Lubis et al., 2020; Lubis et al., 2021; Mustafa et al., 2022). Martial arts training has also been shown to have positive effects on balance and physiological measurements (Lubis et al., 2021). In summary, dynamic balance is crucial for martial arts athletes, and various training methods, including core strength training and dynamic balance education, can improve their balance performance.


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There are four essential elements of physical fitness: cardiorespiratory endurance, muscular strength and endurance, flexibility, and maintaining a healthful body composition (Kim et al., 2011). The Star Excursion Balance Test (SEBT) is a reliable, responsive, and clinically relevant functional assessment of lower limbs' dynamic balance (Gribble et al., 2012; Picot et al., 2021). It requires strength, flexibility, and proprioception and consists of a series of reaching tasks with the lower extremity in eight directions. It is used to predict risk of lower extremity injury and identify dynamic balance deficits (Gribble et al., 2012). The Star Excursion Balance Test (SEBT) is a reliable and valid measure of dynamic balance deficits (Gribble et al., 2012; Picot et al., 2021) and is used to assess lower extremity injury risk in athletes (Stiffler et al., 2017). It can also be used to evaluate the progress of rehabilitation and the stability of the lower extremity.

The Star Excursion Balance Test (SEBT) involves standing on one leg while reaching with the other leg in different direction. The test is performed by placing a foot on a central point and reaching as far as possible with the other foot in eight different directions. The subject must maintain balance on the stance leg while reaching with the other leg. A full circle is done for one limb if all eight directions have been covered. The SEBT is a relatively simple, but somewhat time-intensive test used to measure dynamic balance. The Star Excursion Balance Test (SEBT) is an effective measure of dynamic postural control (DPC) in young athletes with back pain. It is a reliable and valid test to predict risk of lower extremity injury and identify dynamic balance deficits. Studies have compared dynamic balance education among young athletes in different sports, such as soccer, basketball, and volleyball (N. Adigüzel, 2020). Investigations of SEBT performance differences between competition levels and sports are limited but suggest that the test can be used to assess DPC in martial arts athletes (Vitale et al., 2019).

The Star Excursion Balance Test (SEBT) is a dynamic balance test that measures the ability to maintain balance while reaching in multiple directions (Zhou et al., 2018). The test was originally developed as a rehabilitative tool but has since become a clinical tool for athletic and pathologic populations (Zhou et al., 2018).The SEBT is performed by standing on one leg and reaching with the other leg as far as possible in eight different directions (Fratti Neves et al., 2017). The normalized reach distance values of the SEBT can be used as an index of dynamic postural control and to evaluate the dynamic balance of lower limbs in 8 selective directions to determine potential risk of injury (Patel, 2018). The SEBT is a simple, reliable, and cost-effective screening test that can be used for injury identification, training, and rehabilitation (Zhou et al., 2018). The test is sensitive to age-related changes in balance and can be used to identify athletes at greater risk for lower extremity musculoskeletal injuries (Hoch et al., 2017). The SEBT can be performed on a firm or unstable surface to make the test more difficult (Amacker et al., 2015). The test is also known as the Y Balance Test, which is a modified version of the SEBT that is performed in three directions. To perform the SEBT, the participant stands on one leg and reaches with the other leg as far as possible in eight different directions. The participant performs three trials in each direction while balancing on the other leg. The reach distance is measured and normalized to the participant's leg length. The normalized reach distance values are then used to calculate the overall mean for the test. In conclusion, the Star Excursion Balance Test (SEBT) is a dynamic balance test that measures the ability to maintain balance while reaching in multiple directions. The test is used to evaluate the dynamic balance of lower limbs in 8 selective directions to determine potential risk of injury. The SEBT is a simple, reliable, and cost-effective screening test that can be used for injury identification, training, and rehabilitation. The test is sensitive to age-related changes in balance and can be used to identify athletes at greater risk for lower extremity musculoskeletal injuries. The SEBT can be performed on a firm or unstable surface to make the test more difficult.

The Modified Star Excursion Balance Test (mSEBT) is a widely used tool to assess dynamic postural stability in athletes. It involves performing the range of motion in eight different directions, and the derived limb symmetry index (LSI) scores have demonstrated potential in identifying athletes at risk of increased lower limb injury (Telford et al., 2021). The mSEBT developed can be used as a reference instrument that is suitable for measuring dynamic balance as well as the injury potential of martial arts athletes, which differentiates SEBT and the mSEBT developed is the measurement of athletes' time spent in completing the 8 dimensions of SEBT movements. This study also wants to find out whether the mSEBT developed is valid and reliable. The mSEBT in this study used two procedures, namely: (1) covering 8 directions based longest time (LT), and (2) covering 8 directions based fastest time (FT). These two forms of tests are based on the needs of dynamic balance in martial arts. However, the availability of established normative performance values within certain populations is limited. In this context, the validity of the mSEBT on martial art athletes is an important area of research.

## Method

*Participant*

The study involved 68 undergraduate students who were between 19 and 21 years old *(age: M=20.11, SD=0.38),* and were enrolled in the physical education, sport, and recreation study program at Universitas Islam 45 in Indonesia. These students also attended martial arts lectures.

*Data Analysis*

The study utilized various statistical tools to analyze the data. SPSS version 25 (IBM Corp, 2017) was used for descriptive statistics and correlation calculated (Muhamad, Memet; Hanif, Achmad Sofyan; Haqiyah, 2021).. Additionally, WINSTEPS version 5.2.5.1 software (Linacre, 2022) was used for Rasch analysis to validity and reliability mSEBT

*Developed Test Procedure*

Equipment required:

a) Adequate floor space

b) Media or diagram of the eight directions with 45° angles in each direction

c) Tape measure

d) Stopwatch


Figure 1. Media mSEBT

*Test implementation instructions*

The implementation begins with a one-leg stand (at the center point of the test diagram with the following explanation:

*Right limb standing*

Stand one foot at the center point with the right foot fulcrum, then move the left foot following the eight directions as far and as fast as possible according to the ability by countering or counterclockwise. Follow the eight directions according to the test diagram while maintaining balance. Starting from the anterior, anterolateral, lateral, posterolateral, posterior, posteromedial, medial, and anteromedial directions.

*Left limb standing*

Stand one foot at the center point with the left foot support, then move the right foot following the eight directions as far as possible according to your ability by following the clockwise direction. Follow the eight direction according to the test diagram while maintaining balance. Starting from the anterior, anteromedial, medial, posteromedial, posterior, posterolateral, lateral, and anterolateral directions.

*Scoring*

The score consists of two inseparable tests (with the right or left limb standing), recorded is the distance and time travelled, based on longest time (LT) and fastest time (FT) by the subject in each lane and then the average value is calculated. The final score is the sum of the T-Score average value of the distance and time successfully carried out by the athlete.

The test diagram for the left foot is as follows:

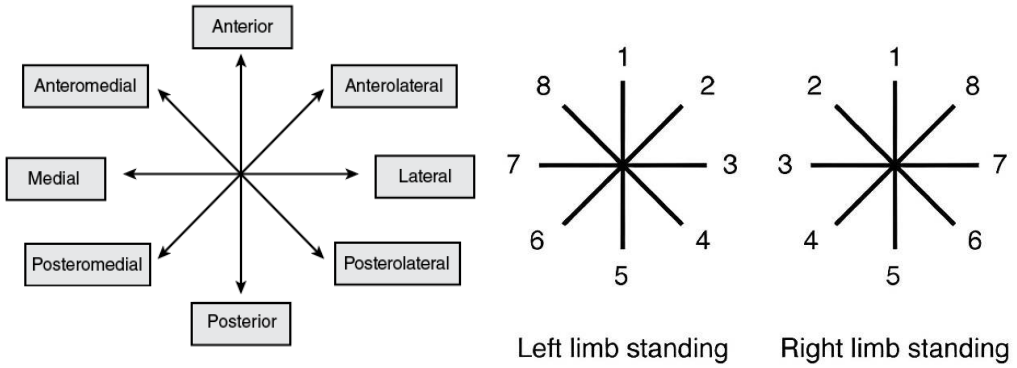


Figure 2. M-SEBT Test Direction Diagram

To maintain balance and support, participants were instructed to touch the distance indicator with their foot while performing the test. The test was performed in a counterclockwise direction by participants with the right standing leg (left reach leg) and in a clockwise direction by participants with the left standing leg (right reach leg) (Figure 1). After three successful trials in each direction, maximal reach and time were recorded. Participants were not allowed to perform a free-footed landing motion during the movement.

**Result**

Table 1 represents the characteristics of individuals who participated in the study. Descriptively, the mean value and standard deviation were greater in the mSEBT Based on the Fastest Time (FT) group (Table 2).

Table 1. Characteristics of Individuals

| Variables | Mean ± SD |
|---|---|
| Age | 20.11 ± 0.38 |
| Height | 160.31 ± 4.62 |
| Weight | 61.66 ± 8.06 |

Table 2. Descriptive Statistics

| Lower Extremity | Direction | Based on Longest Time (LT) | | | Based on the Fastest Time (FT) | | |
|---|---|---|---|---|---|---|---|
| | | Maximal Reach | | Time | Maximal Reach | | Time |
| | | Mean ± SD | Mean ± SD | Mean ± SD | Mean ± SD | Mean ± SD | Mean ± SD |
| Right | Anterior | 81.23 ± 6.74 | 82.40 ± 1.55 | 27.41 ± 1.55 | 81.56 ± 7.24 | 83.21 ± 4.30 | 13.82 ± 1.59 |
| | Anterolateral | 83.24 ± 5.77 | | | 81.59 ± 8.15 | | |
| | Lateral | 86.69 ± 3.26 | | | 87.29 ± 3.43 | | |
| | Posterolateral | 86.69 ± 4.58 | | | 88.17 ± 4.95 | | |
| | Posterior | 87.57 ± 4.07 | | | 89.26 ± 3.79 | | |
| | Posteromedial | 78.63 ± 7.99 | | | 81.22 ± 8.91 | | |
| | Medial | 74.78 ± 7.48 | | | 76.86 ± 8.74 | | |
| | Anteromedial | 80.35 ± 5.42 | | | 79.76 ± 6.40 | | |
| Left | Anterior | 83.59 ± 6.57 | 83.34 ± 1.72 | 26.97 ± 1.72 | 83.81 ± 6.42 | 84.02 ± 4.63 | 13.76 ± 1.58 |
| | Anterolateral | 78.29 ± 6.05 | | | 80.61 ± 6.96 | | |
| | Lateral | 76.00 ± 6.51 | | | 77.68 ± 8.28 | | |
| | Posterolateral | 79.79 ± 6.08 | | | 83.29 ± 6.60 | | |
| | Posterior | 88.08 ± 4.33 | | | 87.77 ± 4.25 | | |
| | Posteromedial | 87.27 ± 3.76 | | | 86.61 ± 8.24 | | |
| | Medial | 87.33 ± 6.60 | | | 87.06 ± 7.48 | | |
| | Anteromedial | 86.33 ± 5.48 | | | 85.31 ± 5.58 | | |

Table 3. The summary of Rasch parameters for mSEBT

| SEBT | The Longest Time (LT) | The Fastest Time (FT) | Total |
|---|---|---|---|
| Number of Items | 8 | 8 | 16 |
| Mean | | | |
| item outfit MNSQ | 0.73 | 1.01 | 1.01 |
| item Infit MNSQ | 0.83 | 0.98 | 0.98 |
| person outfit MNSQ | 0.73 | 1.01 | 1.01 |
| person Infit MNSQ | 0.73 | 1.01 | 1.01 |
| Item separation | 0.00 | 0.00 | 0.00 |
| Person separation | 3.24 | 2.25 | 2.25 |
| Item Reliability | 1.00 | 0.98 | 0.98 |
| Cronbach's Alpha | 0.82 | 0.78 | 0.78 |

Table 3 presents the criteria investigation for item measure and fit validity at the item level. The item measures range from -1.08 logits to 1.39 logits, and the Outfit MNSQ values range from 0.60 logits to 1.44 logits. These results demonstrate that the mSEBT is valid for all items in both tests (Fisher, 2007). The item reliability criteria are evaluated based on item reliability and Cronbach's alpha (α).

The item reliability values range from 0.98 to 1.00 for all items in the mSEBT, confirming the reliability achieved for both test. The Cronbach's alpha (α) values are 0.82 and 0.78, which exceed the minimum value of 0.6 (Taber, 2018).required for reliability. Therefore, the results confirm that the mSEBT is a reliable measure for both test.

**Table 4.** Inter-Item Correlation Matrix

| | Based on Longest Time (LT) | | Based on the Fastest Time (FT) | |
|---|---|---|---|---|
| | Reach | Time | Reach | Time |
| Reach (LT) | 1.000 | .809 | .395 | .254 |
| Time (LT) | .809 | 1.000 | .342 | .268 |
| Reach (FT) | .395 | .342 | 1.000 | .939 |
| Time (FT) | .254 | .268 | .939 | 1.000 |

The Inter-Item Correlation Matrix table. shows the relationship or correlation between items. Based on table 4. it is known that mSEBT Based on Longest Time (LT) provides the highest correlation coefficient value.

**Discussions**

The mSEBT, which stands for modified star excursion balance test, is a widely used version of the SEBT in research. It is a time-saving test that maintains consistency and reliability from the original SEBT by adding the time. The mSEBT evaluates dynamic postural stability by requiring participants to stand on one leg and reach as far as possible with the opposite leg in multiple directions. The reaching movements involved in the mSEBT do not involve a change in the base of support and are not commonly performed in daily activities or sports. The mSEBT is frequently used to assess dynamic balance and postural control. The mSEBT has been found to be a reliable and valid measure of dynamic balance in a variety of populations including martial art athletes (Table 3). The mSEBT developed can be used as a reference instrument that is suitable for measuring dynamic balance as well as the potential for injury to martial arts athletes, which is the difference between SEBT and the mSEBT developed is the measurement of athletes' travel time in completing the 8 dimensions of SEBT movements. the results of this study show that both forms of mSEBT are valid and reliable. Descriptively the mean and standard deviation showed Based on the Fastest Time (FT) is better (Table 2), but the validity, reliability and inter-item correlation matrix Based on Longest Time (LT) are higher (Table 4).

Martial arts athletes require more energy and protein than individuals with normal activity to balance their metabolic rate (Hidayah & Muniroh, 2017). Endurance is also essential for martial arts athletes (Andito et al., 2023), particularly during training and competition (Simanjuntak & Yanti, 2021). Studies have shown that martial arts training can have positive effects on balance and physiological measurements (DR et al., 2018). Additionally, core strength training has been found to be effective in improving the balance of martial arts athletes and is a valid method for their physical conditioning (Kabadayı et al., 2022; Li & Shu, 2022). Therefore, it can be inferred that martial arts athletes must possess the ability to maintain dynamic balance for an extended period of time. It is proven that mSEBT can be used as a measuring tool to determine the ability to maintain dynamic balance in martial arts athletes with the mSEBT Based on Longest Time (LT) test procedure.

**Conclusions**

The newly developed modified Star Excursion Balance Test (mSEBT) can be utilized as a reliable and valid tool to assess the dynamic balance and injury risk of martial arts athletes. The main difference between the SEBT and the mSEBT is that the latter measures the time taken by athletes to complete the 8 dimensions of SEBT movements. The study results indicate that both forms of mSEBT are valid and reliable. The descriptive statistics of mean and standard deviation showed that the Fastest Time (FT) is better. However, the validity, reliability, and inter-item correlation matrix based on Longest Time (LT) are higher

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**Conflicts of Interest**

We state that there were no conflicts of interest in this study.

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