Original Article

American Journal of Men's Health
January-February 2019: 1–7
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DOI: 10.1177/1557988319831920
journals.sagepub.com/home/jmh

Preseason Dynamic Balance Performance in Healthy Elite Male Soccer Players

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Abstract

Lower limb musculoskeletal injuries in sports are linked with balance abnormalities and altered postural control. Dynamic balance screening should be performed in order to identify athletes at risk. The purpose of the study was to evaluate the preseason dynamic balance performance and side-to-side asymmetry of healthy elite male soccer players, using modified Star Excursion Balance Test (mSEBT). Seventy-three elite soccer players (23.8 ± 5.4 years) were evaluated using the mSEBT. Normalized reach distances, side-to-side asymmetries, and composite scores were determined. The composite scores were 93.33% ± 8.99% for dominant leg and 93.36% ± 9.23% for nondominant leg. No significant differences were found between dominant and nondominant limb in any direction. The mSEBT is an easy-to-use tool to measure the dynamic balance performance in elite athletes. It can be applied successfully during preseason physical examinations. Future studies are needed to establish predictive cutoff points in order to increase mSEBT use in screening soccer players for dynamic balance abnormalities and identify those at risk for noncontact lower limb injuries.

Keywords

Star Excursion Balance Test, side-to-side asymmetry, athletes, screening

Received October 27, 2018; revised January 17, 2019; accepted January 24, 2019

Dynamic balance represents the ability to perform an action while maintaining or restoring a stable position (Winter, Patla, & Frank, 1990) and plays a crucial role in many sports activities. Soccer is a sport that requires a good dynamic balance during actions such as kicking, passing, dribbling, and cutting maneuvers (Chew-Bullock et al., 2012; Pau et al., 2015; Teixeira, de Oliveira, Romano, & Correa, 2011). Correlations between single-leg balance and kicking accuracy have been found (Chew-Bullock et al., 2012). Lower limb musculoskeletal injuries are frequent in soccer players (Agel, Palmieri-Smith, Dick, Wojtys, & Marshall, 2007; Junge, Cheung, Edwards, & Dvorak, 2004; Sadigursky et al., 2017), ankle being the most affected joint (Dvorak, Junge, Derman, & Schwellnus, 2011; Wong & Hong, 2005). Deficiencies in dynamic balance and an altered postural control increase the risk of lower limb lesions (Leavey, Sandrey, & Dahmer, 2010; McGuine, Greene, Best, & Leverson, 2000; Read, Oliver, De Ste Croix, Myer, & Lloyd, 2016; Trojian & McKeag, 2006). Soccer players with dynamic balance asymmetries are more likely to sustain a lower limb injury (Gonell, Romero, & Soler, 2015), thus requiring medical treatment. This fact will cause absence from soccer training and competition and will decrease team performance. Preventing injuries is the major goal in all sports, while improving the dynamic balance reduces the risk of ankle sprains (Hübscher et al., 2010; Malliou, Gioftsidou, Pafis, Beneka, & Godolias, 2004; McGuine & Keene, 2006). Therefore, in order to identify athletes at risk for lower limb musculoskeletal injuries, dynamic balance screening should be performed.

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There are several tests that can evaluate dynamic balance in athletes, including single-leg balance tests, jumping and landing tests, and movement analysis. So for a test to be used during preseason physical examination, it has to be easily implemented, time efficient, without requiring special equipment, reliable, and specific to a certain population and pathology. One of the tests used for assessing the dynamic balance in athletes both in clinical practice and in research is the modified Star Excursion Balance Test (mSEBT). Strength, adequate range of motion, proprioception, and neuromuscular control are required in order to complete the tasks and maintain proper balance (Olmsted, Carcia, Hertel, & Shultz, 2002; Plisky, Rauh, Kaminski, & Underwood, 2006). It has been shown that mSEBT can accurately identify those with ankle instability or with risk for lower limb injuries (De Noronha, França, Haupenthal, & Nunes, 2013; Hertel, Braham, Hale, & Olmsted-Kramer, 2006; Plisky et al., 2006). It is an efficient functional test, with good reliability (Gribble, Kelly, Refshauge, & Hiller, 2013; Hertel, Miller, & Denegar, 2000; Stiffler, Sanfilippo, Brooks, & Heiderscheit, 2015; van Lieshout et al., 2016) and can be used during preseason physical examination to identify athletes with dynamic balance deficiencies.

Based on this version of SEBT, an instrumented version was developed to standardize the measurements, the Y-Balance test (Plisky et al., 2009). Despite similarities between the two tests, researchers found differences in the anterior direction performance (Coughlan, Fullam, Delahunt, Gissane, & Caulfield, 2012; Fullam, Caulfield, Coughlan, & Delahunt, 2014).

The hypothesis of the current study was that when using the mSEBT in preseason physical assessment, elite athletes with side-to-side asymmetries and a potential risk for lower limb injuries could be identified. Therefore, the aims were to evaluate the preseason dynamic balance performance in healthy elite male soccer players and to identify possible side-to-side asymmetry, as quantified by mSEBT.

Methods

Study Design

A cross-sectional design was adopted to evaluate the mSEBT performance in healthy elite soccer players. All testing was undertaken by a single investigator, in one session. The study was carried out in accordance with the Declaration of Helsinki and was approved by the institutional ethics committee ("Pius Brinzeu" Emergency County Hospital Timisoara—144/22.07.2018).

Participants

Ninety-eight male soccer players from four elite soccer teams (second division) were evaluated during preseason physical evaluations and a convenience sample was recruited for this study. To be recruited, participants had to meet the following criteria: (a) elite male soccer players between 18 and 35 years; (b) minimum score for each of the questions of the Oslo Sports Trauma Research Centre questionnaire—full participation without problems/no training reduction/no performance reduction/no symptoms in the past week (Clarsen, Rønsen, Myklebust, Flørenes, & Bahr, 2014); (c) no lower limb injury or surgery at least 6 months prior to testing; (d) no concussion in the past 12 months; and (e) no vestibular disorder. Athletes who met the inclusion criteria and agreed to participate in the study read and signed the informed consent form.

Testing Protocol

Before testing, participants' demographic characteristics were collected by the same investigator—age, height, weight, body mass index, and leg length. Leg length was measured in centimeters on each lower limb with participants lying supine, from the anterior superior iliac spine to the ipsilateral medial malleolus, with a standard tape measure. The dominant leg was considered to be the self-reported, preferred kicking leg (van Melick, Meddeler, Hoogeboom, Nijhuis-van der Sanden, & van Cingel, 2017).

The mSEBT was performed according to the protocol described by Gribble and Hertel (2003), in the morning (Gribble, Tucker, & White, 2007). The three reach directions used by the mSEBT were anterior, posteromedial, and posterolateral, named in relation with the stance leg.

The participants were instructed to maintain a single-leg stance in the center of the grid, while reaching with the non-stance leg as far as possible along each of the three directions. They had to touch lightly the line with the most distal part of the reaching leg and to return to the center of the grid, keeping both hands on their hips (Gribble, 2003; Gribble & Hertel, 2003). The stance limb was placed in the middle of the grid, aligned with the anterior–posterior directions. The maximal reach distance in each direction was recorded in centimeters. The test was performed barefoot. A trial was considered invalid if the participant moved or lifted the stance leg from the middle of the grid, removed his hands from the hips, touched heavily the ground with the reaching foot in order to maintain balance, did not touch the line with the reaching foot, or did not bring back the reaching leg to the starting position. In these cases, an additional trial was performed (Gribble & Hertel, 2003; Gribble et al., 2012).

Participants performed four practice trials (Gribble et al., 2012; Robinson & Gribble, 2008) and after a 1-min rest, performed three trials in the specified directions on

Table 1. Descriptive Statistics of the Study Sample.

	Age (years)	Weight (kg)	Height (cm)	BMI (kg/m^2)	Leg length (cm) Right leg	Leg length (cm) Left leg	Dominant leg Right, *n* (%)	Dominant leg Left, *n* (%)
Subjects (*n* = 73)	23.8 ± 5.4	74.6 ± 7.6	177.7 ± 20.2	23± 1.8	93.1 ± 4.4	93.1 ± 4.5	56 (76.7)	17 (23.3)

Note. Data are presented as mean ± *SD*. BMI = body mass index.

Table 2. Normalized and Composite mSEBT Mean Scores.

	Reach direction			
	Anterior	Posterolateral	Posteromedial	Composite
Dominant leg	80.31 ± 10.74 [77.81, 82.82]	96.22 ± 9.89 [93.91, 98.53]	103.47 ± 11.21 [100.86, 106.09]	93.33 ± 8.99 [91.23, 95.43]
Nondominant leg	80.31 ± 11.75 [77.57, 83.05]	96.29 ±10.09 [93.94, 98.65]	103.48 ± 11.45 [100.80, 106.14]	93.36 ± 9.23 [91.21, 95.52]

Note. mSEBT scores are presented as % of limb length (mean ± *SD*; 95% confidence interval). mSEBT = modified Star Excursion Balance Test.

each leg. A 5-s rest between trials was allowed. The testing order was the following: right anterior, left anterior, right posteromedial, left posteromedial, right posterolateral, and left posterolateral. The mean of these three trials was used in the study.

Data Analysis

Reach distances were normalized to the respective stance-leg length (percent limb length; Gribble & Hertel, 2003). The composite mSEBT score was calculated as the average of the normalized scores in each direction for both dominant and nondominant leg. The absolute side-to-side asymmetries were calculated as the difference between the dominant and nondominant leg, for the reach distances (cm) and normalized scores in each direction and for composite scores.

Statistical Analysis

All continuous variables were tested for normality with the Shapiro–Wilk test and for equality of variances with Levene's test. Descriptive statistics were used to describe the subjects' characteristics, the normalized reach distances (frequencies, percentages, means, and standard deviation), and side-to-side asymmetries (median and interquartile range).

Paired *t*-tests were conducted to compare the normalized reach distances in each direction and composite scores between the dominant and nondominant leg. The composite scores were compared with the cutoff values reported in previous studies (89.6 %; Butler, Lehr, Fink, Kiesel, & Plisky, 2013) using the one-sample *t*-test.

The Friedman test was used to compare the absolute side-to-side asymmetries across directions. Moreover, the absolute side-to-side asymmetries in each direction were compared with the cutoff of 4 cm reported by Plisky et al. (2006), by using the Wilcoxon signed-rank test.

The significance level was set at .05 for all tests. Statistical analysis was performed using Medcalc version 17.9.7 (MedCalc Software bvba, Ostend, Belgium) and R (R Development Core Team, 2011).

Results

From the 98 male soccer players evaluated during preseason physical evaluation, only 73 (mean age 23.8 ± 5.4 years) met the inclusion criteria and agreed to participate. Ten athletes suffered ankle sprains, seven had knee surgery in the past 6 months, and eight reported an affected performance during the past week (Oslo Sports Trauma Research Centre Questionnaire). Table 1 provides a summary of the descriptive statistics of the study sample.

The normalized and composite mSEBT scores for the dominant and nondominant leg showed normal distribution and are presented in Table 2. No significant differences were found between dominant and nondominant limb in any direction.

With regard to the comparison of the composite score with the cutoff value of 89.6%, the appropriate statistical test showed significant higher composite mSEBT mean score for dominant leg ($t_{72} = 3.55$, $p < .001$) and nondominant leg ($t_{72} = 3.48$, $p < .001$).

The absolute side-to-side asymmetries showed a nonnormal distribution and are presented in Table 3. The magnitude of asymmetries differed significantly across the three directions of mSEBT ($F_{2,144} = 5.03$, $p < .01$),

Table 3. Side-to-Side Asymmetries of Normalized Reach Distances and Composite mSEBT Score.

Side-to-side asymmetries (cm)				Side-to-side asymmetries (% limb length)			
Anterior	Posterolateral	Posteromedial	Composite	Anterior	Posterolateral	Posteromedial	Composite
1.33 (2.33)	2.67 (3.17)	2.33 (3)	1.44 (1.89)	1.50 (2.25)	2.96 (3.68)	2.46 (3.80)	1.67 (2.30)

Note. Side-to-side asymmetries are median. IQR = interquartile range; mSEBT = modified Star Excursion Balance Test.

with higher asymmetries in posteromedial and posterolateral direction than in the anterior direction.

The side-to-side asymmetries (absolute value, cm) turned out to be significantly lower than the predictive value of 4 cm for all directions (anterior: $Z = -5.74$, $p < .001$; posterolateral: $Z = -2.81$, $p < .001$; posteromedial: $Z = -3.70$, $p = .003$).

Discussion

The main aim of current study was to assess the preseason dynamic balance performance of healthy elite male soccer players and to identify possible side-to-side balance asymmetries, as quantified by mSEBT. The results regarding the mSEBT performance were not in perfect concordance with the results reported in the literature for elite athletes.

The study by Stiffler et al. (2015) assessing the SEBT performance in various sports reported that both dominant and nondominant legs had lower normalized average reach distances for anterior and posterolateral directions and composite scores for soccer players (mean age 19.7±1.3 years). The difference between findings may be due to the difference in the sample's age and the protocol; in the current study, the subject placed the stance foot in the middle of the grid, while in Stiffler's study, the stance foot was aligned at the most distal aspect of the toes for each direction.

In their study, Cug, Wikstrom, Golshaei, and Kirazci (2016), using the same protocol as Stiffler et al. (2015), identified lower values for all directions both for dominant and nondominant legs in soccer players. Daneshjoo, Mokhtar, Rahnama, and Yusof (2012) evaluated professional male soccer players (aged between 17 and 20 years) and reported an increased value of the composite score compared with our results.

The current study did not identify significant differences between dominant and nondominant leg. Similar results were found by other studies (Cug et al., 2016; Stiffler et al., 2015). The asymmetries in posteromedial and posterolateral directions were significantly higher than in the anterior direction.

The mSEBT is frequently used as a screening test in order to detect dynamic balance deficits, to identify athletes at risk for lower limb injuries (Attenborough et al., 2017; Butler et al., 2013; De Noronha, França, Haupenthal, & Nunes, 2013; Plisky et al., 2006), or to monitor the improvements after a preventive or rehabilitation program (Filipa, Byrnes, Paterno, Myer, & Hewett, 2010; Kahle & Gribble, 2009; Leavey et al., 2010; Mcleod, Armstrong, Miller, & Sauers, 2009; Sandrey & Mitzel, 2013).

Optimal cutoff points that could predict lower limb injuries in specific sports were not established. When comparing the composite score with the cutoff proposed by Butler et al. (2013) in a sample of American footballers, values significantly higher than 89.6% were identified in the sample of soccer players. The side-to-side asymmetries (absolute values, cm) in all three directions identified in the present study were significantly lower than the cutoff value of 4 cm noticed by Plisky et al. (2006) in a sample of basketball players. Using these cutoff points, none of the soccer players evaluated was at risk for lower limb injuries.

Stiffler et al. (2017) reported the anterior asymmetry to be related to lower limb injuries in elite athletes, but they could not establish a cutoff to identify athletes at risk. No significant differences between dominant and nondominant leg in anterior direction were identified in the current study.

The sample was one of convenience, based on teams' availability, and this represents a limitation. The dynamic balance performance was assessed in only one preseason physical evaluation and there are no follow-ups at the moment in order to record possible noncontact lower limb injuries. Prospective dynamic balance testing and injury tracking for at least one competition season would be recommended comprising athletes from multiple sports and levels of competition, with and without a history of lower limb injuries. The dynamic balance performance has not been compared with that of soccer players with history of injury, since the study sample included only healthy players. Further studies are necessary to prove the ability of mSEBT to identify athletes at risk of lower limb injuries and to determine a specific cutoff point for side-to-side asymmetries, mSEBT directions, or normalized composite score values, applicable in athletic population, considering age, gender, specific sports, and levels of competition. A standardized protocol is also needed in order to eliminate potential errors and differences across studies derived from administration of the test (stance-leg position, hands position, average of three trials, or maximum reach distance achieved).

Conclusion

The mSEBT is an easy-to-use measuring tool of dynamic balance performance in elite athletes and can be used during preseason physical examinations. Future studies are needed to establish predictive cutoff points for normalized reach distances, composite score, and side-to-side asymmetries in order to increase its use in screening athletes for dynamic balance abnormalities and identify those at risk for noncontact lower limb injuries.

Authors' Contributions

Conception: RRO, EA, and OS. Data acquisition: RRO and RP. Data analysis: RRO and DS. Manuscript draft: RRO, EA, and OS. Advice on editing of the manuscript: RRO, EA, RP, DS, and OS. All the authors have taken an active part in the study and take responsibility for its contents; they have read and approved the manuscript.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was partially funded by the Victor Babes University of Medicine and Pharmacy Timisoara.

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