

ORIGINAL SCIENTIFIC PAPER

Association of Laboratory and Field Balance Test

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Abstract

Balance can be defined as keeping the center of gravity of the body within the surface of the support and has crucial role in sport. However, there are insufficient knowledge regarding balance field testing. The main aim of this study was to determine association between Biodex laboratory balance test and Y balance field test. The participants in this study were 12 students (6 males, 6 females) of Faculty of Kinesiology in Split, Croatia. The set of variables included anthropometric measures (body height, body weight, body mass index), two laboratory balance tests conducted on Biodex (Postural stability test, Limits of stability test) and field balance test (Y balance test). The correlations between observed variables were calculated by Pearson's product moment correlation. No significant correlations were found between Y balance test and both Postural stability test ($r=-0.06$ and 0.02 respectively for left and right leg) and Limits of stability test ($r=-0.06$ and 0.02). The results of this study indicate that Y balance test is not a precise measure of balance ability in well-trained individuals. Authors hypothesize that Y balance test performance is greatly influenced by lower extremity strength and mobility. There is an obvious need for the construction and validation of new field tests to assess the level of balance in amateur and professional athletes.

Keywords: *dynamic balance, Y balance test, limits of stability, postural stability, Biodex*

Introduction

When performing daily physical activities, from the simplest such as walking to extremely complex motor skills, a person constantly goes out and returns to a state of balance. As ability, balance is defined differently within different professions, since it has a different meaning in practice. In biomechanics, balance is defined as the ability to maintain individual's center of gravity within base of support, with minimal postural sway. As such we view it from the angle of sporting performance (Hrysomallis, 2007; Ndayisenga, 2019; Shumway-Cook, Anson, & Haller, 1988). Researchers have found that good balance plays a crucial role in many physical activities and directly contributes to the success of sports performance (Ghram, Damak, & Costa, 2017). In addition to allowing other motor abilities and skills to be optimally utilized, adequate balance has the effect of reducing the risk of injury (Ghram et al., 2020).

The general classification of balance is on: static and dynamic. Static balance represents the ability of sustaining the body position within its base of support (Goldie, Bach, & Evans, 1989; Olmsted, Carcia, Hertel, & Shultz, 2002).

Dynamic balance, which is much more common in sport activities, involves maintaining a balanced position when performing dynamic movements (Bressel, Yonker, Kras, & Heath, 2007; Winter, Patla, & Frank, 1990). Both manifestations of balance are dependent on sensorimotor information collected through the somatosensory, visual and vestibular system and motor responses to these information (Amiri-Khorasani & Gulick, 2015; Grigg, 1994; Palmieri et al., 2003).

Testing the state of balance depends on the goals within the particular profession. In general, all tests in sports science, including those related to balance, can be divided into laboratory and field. Most commonly used laboratory balance test is the Biodex Balance System SDTM (Biodex medical Systems, NY, USA). Among other standardized tests, the Limits of Stability Test (LST) and the Postural Stability Test (PST) are most popular Biodex tests for balance monitoring (Cachupe, Shifflett, Kahanov, & Wughalter, 2001). PST is used to assess static balance. During PST performance, the subject stands with one or two legs on an unstable platform, and his task is to minimize the movement of the platform with timely and precise muscle contraction (Aydoğ,



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Aydoğ, Cakci, & Doral, 2006). LST assess dynamic balance. During test performance subject controls his body's center of gravity and manipulates/moves the platform in a desired direction (Glave, Didier, Weatherwax, Browning, & Fiaud, 2016).

On the other hand, field tests are much simpler and cheaper to use, and the Star Excursion Balance Test (SEBT) and the Y Balance test (YBT) are mostly used in balance testing (Gribble, Hertel, & Plisky, 2012; Plisky et al., 2009). YBT is derived from SEBT and is used to assess the asymmetries of lower limb movements and the level of balance. It is assessed through single-leg standing with movements in the anterior (ANT), posteromedial (PM) and posterolateral (PL) direction (Smith, Chimera, & Warren, 2015). Previous researches have repeatedly confirmed the reliability and validity of both PST and LST on the Biodex System and YBT (Arnold & Schmitz, 1998; Cachupe et al., 2001; Gribble et al., 2012; Plisky et al., 2009).

In the review study of Sibley, Beauchamp, Van Ooteghem, Straus and Jaglal (2015), authors indicated that both LST and YBT assessed underlying motor systems, functional stability limits, and anticipatory postural control (Sibley, Beauchamp, Van Ooteghem, Straus, & Jaglal, 2015). Since there is a lack of research that compared outcomes of laboratory and field tests, aim of this study was to investigate association of Biodex platform and YBT test in context of measuring same or similar aspects of balance. We hypothesize that results will be positively correlated, specifically between LST and YBT as both tests supposed to measure dynamic balance capacity.

Methods

Participants in this study were 12 students (6 male and 6 female, 21 years old on average) of third-year undergraduate study of Kinesiology. All participants are active athletes and in the time of testing were clinically healthy and without any locomotor injuries. The testing was held during the Strength and conditioning of athlete's course and was part of the courses' exam. This cause an additional motivating factor for subjects' test performance.

Variables included in this study were (i) anthropometric measures - body height (BH), body weight (BW) and body mass index (BMI), (ii) laboratory balance tests including Limits of Stability Test (LST) and the Postural Stability Test (PST) and (iii) field balance test Y balance test (YBT).

In the PST, participants needed to maintain static balance position for 30 seconds while standing on two feet in the center of the platform. Before the test the position of the subjects' feet is recorded. The result on the test shows a deviation from the center. Smaller results values are and presented with Balance index (BI). In the LST, participants had to move the body to bring the cursor on the screen to the blinking targets and return the cursor to the center as soon as possible with as less deflection possible. This was repeated randomly with 9 targets position in circle around the center target. LST BI is calculated with Biodex software. Higher BI indicates better dynamic stability result.

YBT was assessed with a YBT kit (Perform Better, FMS). Before testing participants conducted five minutes warm up and were allowed to have one trial attempt on each leg in each of the three directions before official testing. Participant task was to stand on one leg in the center of the platform and reach three times with the free leg in the anterior, posteromedial and posterolateral direction. While reaching, participants were forbidden to kick indicator. Farthest point reached by the foot at the proximal edge of the indicator was noted as the result. If the participant lost his balance during the test, raised the heel of the foot in the center, leaned on the moving foot or moved indicator improperly, the trial was annulled and had to be repeated (Kokinda et al., 2018). Normalization of results is calculated by the ratio of average results (absolute distance) of each movement and leg length of the subject. The total result on the test is the sum of all three absolute distances divided by three times leg length and multiplied with 100. All tests were measured three times and the best score was taken as final.

Statistical analyses included the calculation of descriptive statistical parameters (arithmetic means and standard deviations, minimum and maximum measurement values and the Kolmogorov-Smirnov test for testing normality of distribution) and correlation analysis (Pearson's product-moment) to determine the relationship between the observed variables. For all analyses, Statistica 13.0 (TIBCO Software Inc, USA) was used, and a p-level of 95% was applied.

Results

In Table 1 descriptive statistic parameters are shown.

Table 2 represents association between YBT and LST and

Table 1. Descriptive parameters

Variable	Mean±St.Dev.	Minimum	Maximum
body height	179.50±6.053	168.00	186.00
body weight	75.83±12.209	60.00	96.00
body mass index	23.44±2.817	20.05	29.00
PST – Postural stability test	1.47±0.543	0.80	2.50
LST – Limits of stability	19.33±9.326	5.00	38.00
YBT (L) – Y balance test left leg	98.22±8.251	76.00	106.10
YBT (D) – Y balance test right leg	100.35±7.734	80.00	107.70

PST on Biodex. Results show no statistically significant correlation between YBT and LST ($r=-0.06$ and $r=0.02$ for left and

right leg respectively) and PST ($r=-0.02$ and $r=0.05$ for left and right leg respectively).

Table 2. Correlation matrix (Pearson's product-moment correlation)

Variables	YBT (L) – Y balance test left leg	YBT (D) – Y balance test right leg
PST-Postural stability test	-0.06	0.02
LST-Limits of stability	-0.02	0.05

Discussion

This study aimed to evaluate the association of the YBT with the LST and PST on the Biodex Balance System. Regarding to this, main finding is that there are no significant correlations between Biodex tests and YTB. Lack of correlations implies that: (i) the conducted test protocols measure different aspects of balance, or (ii) other factor could influence results (e.g. flexibility, strength, stability).

As previously mentioned, YBT is used to estimate dynamic balance as well as LST on Biodex, while PST is a measure of static balance. If a somewhat smaller association of PST and YTB could be expected to some extent, it was assumed that the two tests that measured dynamic balance would have a significant association. These results are most likely conditioned by different factors that influenced the assessment of balance in each test and nature of particular test. In particular, in PST the participant stands still and resists platform movements in anteroposterior and mediolateral directions simultaneously (Almeida, Monteiro, Marizeiro, Maia, & de Paula Lima, 2017). In LST, the participant needs to move center of pressure as a representation of body center of mass. On the other side, YBT is much more dynamic and includes maintaining center of mass over base of support through performing a dynamic movement with the other leg (Glave et al., 2016).

Also, in both tests on Biodex, movements in the hip and knee joints are limited, and the movement takes place almost exclusively in the ankle of the standing leg, while in YBT hip and knee flexion is one of the more important parameters that affect performance (Kang et al., 2015; Robinson & Gribble, 2008). Researches confirmed that YBT requires lower limb strength, stability, range of motion, and coordination while in tests on Biodex that dimension of motor space will be less pronounced (Coughlan, Fullam, Delahunt, Gissane, & Caulfield, 2012; Plisky, Rauh, Kaminski, & Underwood,

2006). It is obvious, that mobility and strength of the lower extremities will play a major role in the performance of YBT. Especially in well-trained individuals as is was the case in our study. Although there are no many studies that have dealt with this issue, the results of this study are in accordance with some previous researches (Almeida et al., 2017; Glave et al., 2016). In a study conducted on 40 recreational individuals, no statistically significant correlation was found between YBT and PST (Almeida et al., 2017). Moreover, a study of 31 students from a university in Texas found a negative association between the Star Excursion Balance Test (SEBT) and the LST test at Biodex (Glave et al., 2016). These findings suggest that YTB and LST and PST on Biodex measure different aspects of balance and therefore comparison and consistency of the results is limited.

Conclusion

This was one of the first studies exploring associations between laboratory and field balance tests. Main limitation of this study is relatively small sample of participants and fact that both males and females were included. However, given that such a practice was also in other researches related to balance, the authors believe that this was methodologically appropriate couldn't produce suppressors' effect.

The results of this study confirm the conclusions of previous studies that say that there is no "gold standard" in the field of balance diagnostics and that different tests should be used for different subtypes of balance. Also, in assessment selection, gender and characteristics and level of training status should be taken into consideration. This study induced an issue in exploring athletes' balance capacities, specifically in specific conditions. Clearly, future studies should be focused on construction and validation sport (activity)-specific field balance tests.

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Conflict of interest

The authors declare that there are no conflicts of interest.

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