# PRE-SEASON DYNAMIC STABILIZATION MEASURES IN FIVE COLLEGIATE TEAMS

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The purpose of this study was to measure baseline dynamic stability using time to stabilization (TTS) during two landing tasks at the start of pre-season training in a group of college athletes. Seventy-one male and female athletes representing men's soccer (n=22), women's soccer (n=13), women's volleyball (n=12), men's basketball (n=12), and women's basketball (n=11) performed single-leg forward jump and lateral drop landing tasks on each leg onto a force plate. GRF data were used to calculate TTS in the anteroposterior (A/P) and mediolateral (M/L) directions. Data were assessed descriptively using SPSS for differences between sports. Results showed that men's basketball players had higher TTS values for 6 of 8 measures while women's volleyball players had lower TTS values for 6 of 8 measures.

**KEY WORDS:** stabilization, jump landing, time to stabilization

**INTRODUCTION:** Athletic injuries to the ankle and knee are most prevalent in sports such as volleyball, soccer and basketball where cutting and jumping are inherent requirements of the sport. Landing, in particular, has been associated with 63% of all reported volleyball injuries, and 58% of all injuries in female basketball players. Impaired neuromuscular control may play a role in these injury rates as successful and safe landing from a jump requires strength, balance and stability. Commonly used clinical tests of neuromuscular control include the Rhomberg (single-leg static stance with eyes open and closed), Star Excursion Balance Test (single-leg stance while contra-lateral limb moves), and Bass Test of Dynamic Balance (single-leg hopping). None of these tests addresses the fully functional nature of landing from a jump. Time to stabilization (TTS) is a relatively recent measure of neuromuscular control that quantifies the body's ability to transition from a dynamic state to a static state (Ross & Guskiewicz, 2003) using components of the ground reaction force (GRF). It is the time needed to reduce the variation of a given GRF component to the range of variation of the corresponding GRF component in a stabilized position. The range of variation in a stabilized position can be determined from a 5-s window at the end of a data collection period (i.e. 20 s) (Ross, Guskiewicz, & Yu, 2002). Thus far, it has been used primarily in comparing dynamic stability in individuals with and without functionally unstable ankles after jump landing tasks (Brown, Ross, Mynark & Guskiewicz, 2004; Ross, Guskiewicz, & Yu, 2002) Ross and Guskiewicz (2003) proposed that TTS be used as a preseason baseline screening tool to provide more information on dynamic stability. TTS might aid in identifying postural-stability deficits in physically active individuals that would provide clinicians the means for developing rehabilitation protocols aimed at those who show deficits. Additionally, this measure could serve as a baseline measurement and thus, be used in return-to-play decision making.

Ogawa and colleagues (2006) measured TTS in persons with functional ankle instability (FAI) using the aforementioned method and found TTS measures in the anteroposterior (A/P) direction during a lateral jump to be approximately 1s. TTS in the A/P direction increased to 3 to 3.5s for the forward jump. Conversely, TTS values in the mediolateral (M/L) direction, were 3.4 to 4.0s when landing from the lateral direction, and less than 1s to 1.5s for the forward jump. These numbers were higher (longer stabilization times) than those found in Wikstrom and colleague's study (2004) that involved healthy participants. Unfortunately, this latter study only included the forward jump. Brown et al (2004) also found that participants (those with and without FAI) demonstrate longer TTS in the A/P plane than M/L plane during forward jump landing.

At this time, no norms exist, and thus, no criteria for what TTS is considered adequate. As part of establishing baseline data, at least for a single university, the purpose of this study was to assess baseline dynamic stability using TTS during two landing tasks at the start of pre-season training in a group of college athletes.

**METHODS**: Seventy-one collegiate, healthy, male and female athletes from men's basketball (n=12, 94±13.37 kg, 1.92±0.8 m), men's soccer (n=22, 74.87±8.48 kg, 1.81±0.7 m), women's volleyball (n=12, 70.46±9.55 kg, 1.78±0.8 m), women's basketball (n=11, 68.38 kg±7.72, 1.73±0.7 m) and women's soccer (n=13, 59.14±6.62 kg, 1.68±0.7 m) were invited to participate in this study. Data collection occurred over 3 sessions in August, 2005, with women's volleyball and men's and women's soccer testing one day prior to their first official, organized practice for the season; men's and women's basketball were tested the second week of the academic semester, but 6 weeks prior to an official, organized practice. Athletes were invited to participate in the study if they had been medically cleared by the licensed physicians associated with Barry University. This data collection was approved by the university's institutional review board.

Two single-leg landing tasks were selected to assess dynamic stability: (a) forward jump landing (FDL), and (b) lateral drop landing (LDL). These tasks were chosen as they are more functionally related to the movement requirements in sports such as volleyball, basketball, and soccer, and would challenge stabilization when landing from two different directions. Only one other known study has assessed TTS from a lateral direction (Ogawa, et al., 2006).

*FDL*

Participants performed forward drop landings onto each leg from a 40 cm (16 in) high jumping platform that was positioned to the back of an AMTI force plate (Advanced Medical Technology, Inc., Watertown, MA) sampling at a rate of 600 Hz (gain 4000). They landed in the center of a force plate on the testing limb, and were instructed to "stick the landing as quickly as possible." Hands were held constant at the hips.

*LDL*

Participants performed single-legged lateral drop landings onto each leg from a 40 cm (16 in) high jumping platform that was positioned to the side of the force plate. They landed in the center of the force plate on the testing limb, and were instructed to "stick the landing as quickly as possible." Hands were held constant at the hips.

If a participant lost balance or touched the ground with the other foot for either of the landing tasks, trials were repeated until they were successful.

*TTS*

GRF data were smoothed and calculated using the Peak Motus software (ver. 8.2, ViconPeak, Centennial, CO). GRF data for A/P and M/L directions were then imported into a spreadsheet that computed TTS in the A/P and M/L directions using sequential estimation (Colby, Hintermeister, Torry, & Steadman, 1999). This technique uses an algorithm to calculate a cumulative average of the GRF component data points in a series by successively adding one point at a time. The cumulative average was then compared with the overall series mean. When the sequential average remained within 0.±.25 standard deviations (SDs) of the overall series mean, a participant was considered stable. The series consisted of all raw data points within the first 10 s from initial contact with the force plate. Data were then analyzed descriptively for each team using SPSS, ver. 12.0.

**RESULTS:**

Tables 1 and 2 depict the mean TTS values for the right and left legs during both landing tasks in the A/P and M/L directions.

Table 1. Mean TTS (ms) for Right Leg FDL and LDL Tasks by Sport

| | ♂ Soccer (n=22) | ♀ Soccer (n=13) | ♀ Volleyball (n=12) | ♂ Basketball (n=12) | ♀ Basketball (n=11) |
|---|---|---|---|---|---|
| **FDL** | | | | | |
| A/P | 2242.06± 623.79 | 2290.16± 512.01 | 2442.82±529.93 | 2566.81± 220.50 | 2471.24± 229.03 |
| M/L | 1071.91± 612.87 | 1502.17± 638.67 | 1273.08±455.21 | 1944.39± 692.29 | 1522.39± 787.65 |
| **LDL** | | | | | |
| A/P | 882.72±518.85 | 910.28± 689.23 | 690.11± 277.82 | 843.43± 351.66 | 1240.02± 882.89 |
| M/L | 2826.57±309.58 | 2794.21± 459.42 | 2847.66± 567.05 | 3027.24± 147.29 | 2778.39± 670.74 |

Table 2. Mean TTS (ms) for Left Leg FDL and LDL Tasks by Sport

| | ♂ Soccer (n=22) | ♀ Soccer (n=13) | ♀ Volleyball (n=12) | ♂ Basketball (n=12) | ♀ Basketball (n=11) |
|---|---|---|---|---|---|
| **FDL** | | | | | |
| A/P | 2500.34± 193.04 | 2532.00± 422.67 | 2466.94± 394.37 | 2722.70± 180.85 | 2670.61± 197.79 |
| M/L | 1559.32± 541.78 | 1791.05± 604.27 | 1472.49± 809.49 | 1817.25± 460.64 | 1785.00± 608.14 |
| **LDL** | | | | | |
| A/P | 1188.67± 812.02 | 2181.98± 978.09 | 894.75± 660.65 | 1085.02± 899.83 | 1142.70± 826.26 |
| M/L | 2416.39± 1058.27 | 2197.18± 1207.90 | 1959.75± 1182.11 | 3104.62± 066.61 | 2487.51± 769.12 |

**DISCUSSION AND CONCLUSIONS:** Neuromuscular control is necessary for performing safe and successful landing tasks in sport. TTS is a relatively novel measure of neuromuscular control, or dynamic stability. Thus far, impairments in dynamic stability have been noted in individuals with functional ankle instability and knee ligament injuries using TTS as a measure. Ross & Guskiewicz (2003) have suggested the use of TTS as a clinical tool to identify deficits during pre-season screening of athletes, and to serve as a baseline for return to play decision making. Thus, this study sought to measure TTS in a group of university athletes during pre-season in order to gain baseline data, and is the first known study to examine dynamic stability across sports. Results showed that the participants in men's basketball had longer stabilization times in 6 of the 8 measures. These values are similar to those found in participants with FAI (Brown et al., 2004) and larger than those found in healthies (Wickstrom, Powers, & Tillman, 2004). Women's volleyball had smaller stabilization times in 6 of the 8 measures. Men's and women's soccer were fairly similar to one another in all measures, and women's basketball had values close to men's basketball. It is possible that the nature of the sport demands between the two sports influenced the measures. In basketball, players perform dynamic skills (running, cutting, landing) the entire length of the court. Upon landing from a rebound, they quickly jump again to shoot, or cut and run (dribble) out of the key or to the other end of the court. Although, often required during some plyometric drills stopping and "sticking" a landing is an unfamiliar task in a game situation. Volleyball players have a smaller and more defined area to cover. Landing from a block or spike does not involve running to the other side of the court, although returning for another block is possible. Additionally, the timing of the tests may have influenced the results. Both groups of soccer players and the volleyball players were tested just one day prior to an organized, official practice. It would be expected that they would show up to pre-season training having just completed an off-season program that might have included landing drills. Both groups of basketball players were tested 6 wks prior to their first organized, official practice. It is possible that they did now show up with the same specificity of jump training at this time. It is not known how long dynamic stability takes to develop or diminish using TTS.

The tendencies for stabilization time to be longer in the A/P versus M/L direction in the FDL, and shorter in the LJL were demonstrated in our results. Since the body was propelled in the A/P direction during the FDL, it was expected that stabilization times would be larger in the A/P versus M/L directions as the participant attempts to control the forward motion. Likewise, when the body lands from a lateral direction, stabilization in the M/L direction would take longer as the participant attempts to control the lateral motion.

This descriptive study was the first known to examine TTS across sport. Results showed that men's basketball players have longer TTS values than women's basketball, volleyball, and men's and women's soccer players. While these values were higher than those reported for other healthies, we cannot conclude that these values are necessarily a clinical concern. We also found that women's volleyball players had the smallest TTS values in 6 of 8 measures. Sport specific demands and time of testing may have influenced the differences.

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