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Introduction:

Nearly three to five million sports related injuries occur each year, most often in the lower extremity (Powden, Dodds and Gabriel, 2019). Dynamic postural control closely mimics the physical demands of athletics and poor dynamic postural control is a strong predictor of lower extremity injury (Gribble and Hertel, 2012). The Star Excursion Balance test (SEBT) and the modified SEBT have been frequently cited in literature as a reliable tool for measuring dynamic postural control and balance of the lower extremity (Powden et. al, 2019).

The SEBT assesses an athlete's balance, coordination, strength and flexibility; poor performance on the test has been shown to predict lower extremity injury in athletics (Stiffler, Sanfilippo, Brooks, Heiderscheit 2015). Sport demands and sport specific exercises may also require a difference in proprioception of the lower extremity by challenging sensorimotor systems that may not be the same between each sport/gender (Bressel, Yonker, Kras, Health, 2007). Evidence suggests that superior balance of the lower extremity is linked to repetitive training experiences, such as those in athletics. Balance being defined as, static: maintaining a base of support with no or minimal movement, and dynamic: consisting of the ability to move or perform a task while maintaining a stable base of support (Bressel et. al, 2007). Bressel et. al, found a difference in SEBT reach distances between different sports, with basketball exhibiting inferior reach distances compared to soccer and gymnastics. Basketball athletes are less likely to regularly practice static muscle contractions and single leg balancing movements like those seen in soccer and gymnastics, contributing to the balance differences observed (Bressel et. al, 2007).

It's been established that the demands of a particular sport can impact dynamic postural control of an athlete. Soccer and lacrosse both require single leg movements, with athletes rarely

standing with their weight distributed bilaterally. Since both sports involve similar training experiences, the next step is to determine what other factors may influence their balance. Excluding athletes with lower extremity injury, vestibular or vision problems, and concussion symptoms continues to narrow down the variables, allowing us to look solely at differences related to gender.

Literature Review:

The link between sex and SEBT reach distances have been inconsistent in previous studies. One study found that women exhibited superior reach distances in all directions, while another found that men reached 5% further than women. Yet another study found that there were no significant differences between genders (Stiffler et. al 2015, Gribble and Hertel 2012). The inconsistent findings lead to a gap in the body of knowledge. It has been well established that the SEBT is an accurate and reliable test of balance and that inadequate balance is a predictor of lower extremity injury, however the influence of gender on balance still needs to be determined.

Athletes that participate in dynamic, lower extremity sports, are at increased risk of sustaining lower body injuries. So, being able to identify other factors contributing to the athlete's level of risk will allow us to address the issue and prevent future injury. There are multiple factors other than muscular stability that go into injury susceptibility. The modified SEBT addresses the neuromuscular characteristics and can be seen as an effective way to single out at-risk athletes (Plisky, Rauh, Kraminski, Underwood, 2006). The ultimate purpose of this study is to determine the difference in dynamic balance between female and male collegiate athletes; focusing on Ohio Northern University men's and women's soccer and lacrosse teams.

Chronic ankle stability (CAI) is a common occurrence following lateral ankle sprains. It is estimated that approximately 40% of individuals suffering from a lateral ankle sprain will develop some type of long standing ankle dysfunction (Hertel, Braham, Hale, Olmsted-Kramer, 2006). In addition, it has been established that 3-5 million sports related injuries occur each year, primarily lower extremity. Due to such prevalence, it is imperative that we develop screening tools to reduce injury rate. Dynamic balance is essential for physical activity, so the ability to identify deficits in balance could be a useful predictor of injury and a baseline for prevention exercises (Powden, Dodds, Gabriel, 2019).

Performance on the SEBT has been compared bilaterally, as asymmetry between reach distances can be a predictor of lower extremity injury. In a study conducted by Zazulak BT, it was identified that a difference of more than 4 cm between reach distances increased the likelihood of injury in high school basketball players (Stiffler, Sanfilippo, Brooks, Heidersheit, 2015). Furthermore, a study led by Robert Butler looked into dynamic balance using SEBT and revealed a cut-off point of 89.6% the receiver operator curve. With this, all athletes in the study that sustained a non-contact lower leg injury while playing football were identified as high risk and another 15 were deemed high risk but were not injured (Butler, Lehr, Fink, Kiesel, Plisky, 2013).

The modified SEBT was used in this study. The SEBT has been used in the assessment of dynamic balance in 44 academic journals since 1980 (Gribble et. al 2012) and has been found to have high inter-rater and intra-rater reliability (Pousden, Teralyn, Gabriel 2019). Gribble and Hertal 2003 discussed the importance of normalizing SEBT reach distances for the participant's leg length. Because males typically have a longer leg length than females, it is important to

adjust for this by normalizing the data. The SEBT reach distance can be normalized by taking the reach distance and dividing by the leg length, then multiplying this number by 100. This number represents the percentage of leg length and will allow for comparison of athletes with various leg lengths. This method has been used in various studies and has shown reliable and comparable data (Bressel, Yonker, Kras, Health 2007, Halabchi, Abbasian, Mirashi, Shahi, Mansournia 2019, Plisky et. al 2006, Pousden et. al 2019, Stiffler, Sanfilippo, Brooks, Heiderscheit 2015).

This study seeks to determine the difference in dynamic balance between male and female athletes participating in Division III collegiate lacrosse and soccer. Dynamic balance is a predictor of lower extremity injury (Plisky, Rauh, Kaminski, Underwood 2006, Gribble, Hertal, Plisky 2012) and has shown sensitivity in screening for functional deficits related to lower extremity injuries such as CAI, quadricep strength deficits post ACL reconstruction and patellofemoral pain syndrome (PFPS) (Gribble & Hertal 2003).

Participants will be between the ages of 18 and 23 and will be free of lower leg injury, vestibular problems, visual problems or concussion within the last 12 weeks (Bressel et. al 2007). Participants will use their dominant leg for the testing protocol and will have their leg length measured from anterior superior iliac spine (ASIS) to medial malleolus. We will be using the modified SEBT, similar to that used by Plisky in 2006. Participants will stand with their dominant foot in the center of the grid and be asked to reach with the free limb as far as possible in the anterior, posteromedial and posterolateral directions (Plisky et. al, 2006). The average distance of three trials will be used and normalized based on the leg length previously recorded. The average normalized reach distances will be compared to assess the difference in reach distances between male and female athletes.

The relationship between gender and SEBT reach distance is one that has not been heavily studied. Other research conducted on the topic produced conflicting evidence. One study looking at 8 NCAA DI programs found that women's teams and hockey exhibited significantly greater reach distances in the anterior direction (Stiffler et. al 2015). While, a 2006 study found that female basketball players had a lower composite SEBT reach distance score (Plisky et. al 2006). One study conducted by Gribble on the effects of gender and fatigue on dynamic postural control found that women performed better than men on the modified SEBT in all three directions. (Gribble, Robinson, Hertal, Denegar 2009). Another study found that after normalizing the excursion distances for leg length, there was no significant difference between genders (Gribble and Hertal et. al 2003). After reviewing the literature, there is no current consensus on the connection between gender and balance.

Inconclusive data relating to gender in sport and relationship to dynamic balance creates the need to expand the body of knowledge. Looking at the population of division III collegiate soccer and lacrosse players will give us a better understanding of gender's effects on dynamic balance in an athletic population. It is predicted that the results will reveal a difference between gender in the population observed.

Methods:

Upon arrival all athletes will be asked to fill out a paper with demographic information such as name, age, gender, sport played dominant foot and their prior history of injury. Dominant foot will be determined by which leg the participant would use to kick a ball. Athletes will be excluded if they have experienced a lower leg injury, vestibular problems, visual problems or a concussion within the last 12 weeks. The length of the dominant leg will be measured with the

subject a supine position from the anterior superior iliac spine to the medial malleolus. This length will be recorded on their paper and will be used later when normalizing their results for comparison.

All subjects will be asked to complete a modified star excursion balance test. This test evaluates dynamic stability and balance in the anterior, posteromedial and posterolateral directions. The test will be performed using a grid formed by 3 lines with tape. During the test the subject will stand with their dominant leg in the center of the grid, with their big toe at the starting line. While maintaining the single leg stance, the subject will be asked to reach with the free leg in the anterior, posteromedial and posterolateral directions. Subjects will be instructed to keep their hands on their hips and make a light touch on the ground with the most distal part of the reaching leg, returning to a double leg stance without allowing this to affect overall balance. Subjects will be shown an instructional video on how to complete the test and will then be allowed a practice trial in each direction.

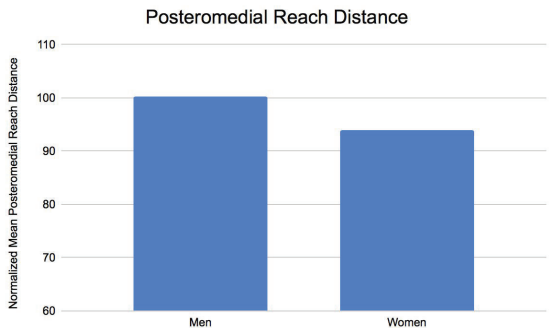
For the testing trials, the maximum reach distance will be marked by erasable ink and measured using a tape measure. After completion of each trial, participants will be given 15 seconds of rest before beginning the next trial. Participants will perform 3 test trials, the greatest of which will be used in our analysis. The trial will be discarded and repeated if the subject failed to maintain a one-legged stance, lifted or moved the standing leg from the grid, touched down with the reach foot, or failed to return the reach foot to the starting position.

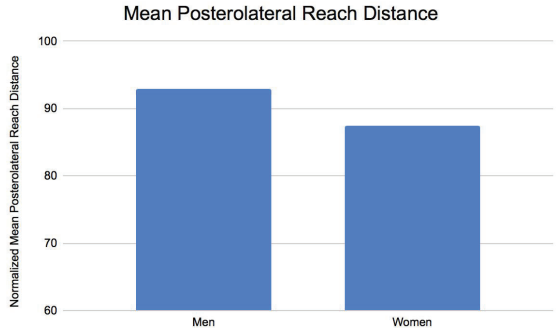
The greatest reach distance for each subject will be used and normalized based on leg leg length for the data analysis. The results will be normalized to get the percentage of leg length by

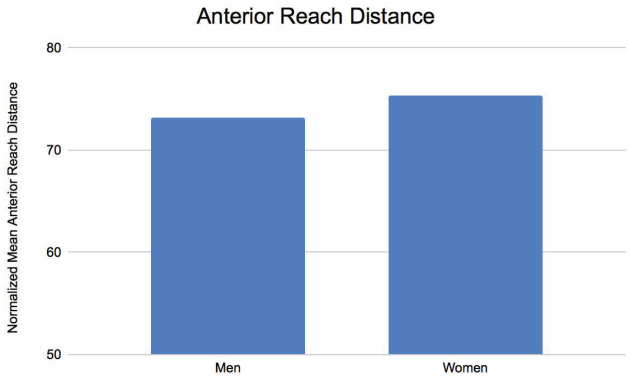
taking the (excursion distance/leg length x 100). The percentage of leg length based on gender can then be compared during our data analysis.

Results:

Male participants demonstrated a significantly greater posteromedial reach than female participants (male: 100.2 (± 10.6), female: 94.0 (±9.03), p=0.03). No significant differences were found in the anterior and posterolateral direction. Anterior: (male: 73.14 (± 6.08), female: 75.4 (± 7.6), p=0.26). Posterolateral: (male: 92.99 (± 11.05), female: 87.48 (± 9.08), p=0.067).







Discussion:

The principal finding of our study was that males demonstrated a significantly greater posteromedial reach distances on the modified SEBT than females. While previous investigators

have found conflicting results on the dynamic balance differences between male and females, our study demonstrates that in the posteromedial direction there appears to be a difference.

While there were no significant differences in the anterior and posterolateral direction, the posterolateral direction showed males exhibiting a greater reach distance than females with a p value of 0.067. With our significance level set at 0.05, this data is not significant for our study. However these findings suggest that with a greater sample population, this value may be significant and warrants further investigation on the difference between male and female dynamic balance in the posterolateral direction.

As previously discussed dynamic balance is a strong predictor of lower extremity injury. Superior dynamic balance strongly correlates to decreased lower extremity injury in an athletic population. Our data suggests that collegiate female soccer and lacrosse players may benefit from prophylactic posteromedial dynamic balance training, as they exhibit inferior balance in this direction. Future studies should investigate how balance training affects the dynamic balance of this population in the posteromedial direction.

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