Y-Balance Test Performance After a Competitive Field Hockey Season: A Pretest–Posttest Study

Matthew C. Hoch, Lauren A. Welsch, Emily M. Hartley, Cameron J. Powden, and Johanna M. Hoch

Context: The Y-Balance Test (YBT) is a dynamic balance assessment used as a preseason musculoskeletal screen to determine injury risk. While the YBT has demonstrated excellent test-retest reliability, it is unknown if YBT performance changes following participation in a competitive athletic season. Objective: Determine if a competitive athletic season affects YBT performance in female field hockey players. Design: Pretest-posttest. Setting: Laboratory. Participants: 20 NCAA Division I women’s field hockey players (age = 19.55 ± 1.30 y; height = 165.10 ± 5.277 cm; mass = 62.62 ± 4.64 kg) from a single team volunteered. Participants had to be free from injury throughout the entire study and participate in all athletic activities. Interventions: Participants completed data collection sessions before (preseason) and following (postseason) the athletic season. Between data collections, participants competed in the fall competitive field hockey season, which was ~3 months in duration. During data collection, participants completed the YBT bilaterally. Main Outcome Measures: The independent variable was time (preseason, postseason) and the dependent variables were normalized reach distances (anterior, posteromedial, posterolateral, composite) and between-limb symmetry for each reach direction. Differences between preseason and postseason were examined using paired t tests (P ≤ .05) as well as Bland-Altman limits of agreement. Results: 4 players sustained a lower extremity injury during the season and were excluded from analysis. There were no significant differences between preseason and postseason reach distances for any reach directions on either limb (P ≥ .31) or in the between-limb symmetries (P ≥ .52). The limits of agreement analyses determined there was a low mean bias across measurements (±1.67%); however, the 95% confidence intervals indicated there was high variability within the posterior reach directions over time (±4.75 to ±14.83%). Conclusion: No changes in YBT performance were identified following a competitive field hockey season in Division I female athletes. However, the variability within the posterior reach directions over time may contribute to the limited use of these directions for injury risk stratification.

Keywords: dynamic postural control, lower extremity injury, injury prevention, reliability

The Y-Balance Test (YBT) has been used to assess dynamic postural control through a series of maximal lower extremity reach tasks while maintaining single limb stance.1 Shorter reach distances and greater between-limb asymmetries on the YBT are indicative of postural control deficits and increased injury risk.2,3 The YBT and the noninstrumented version known as the Star Excursion Balance Test (SEBT) have been successfully implemented as a screening mechanism to identify athletes at greater risk for lower extremity musculoskeletal injuries. Decreased reach distances on anterior reach direction and increased anterior reach asymmetry have predicted ankle sprain injuries in female high school basketball players.4 Similarly, decreased normalized composite reach distances,2 decreased normalized anterior reach distances,5 and increased anterior reach asymmetry were predictors of lower extremity injury in collegiate athletes.3 Additionally, decreased normalized posteromedial reach was identified in cricket pace bowlers who sustained lower extremity injuries,5 while decreased normalized posterolateral reach predicted ankle sprain injuries in physically active university students.6 Therefore, evidence supports incorporating the YBT into screening efforts to identify athletes who may be more susceptible to lower extremity injury.

While the YBT has demonstrated excellent interrater and intrarater reliability,1,7 little is known about changes in test performance that may occur after training, such as participation in a competitive sport season. The SEBT has demonstrated good-to-excellent between-session reliability when assessed over 1-week intervals;8 however, this has not been assessed within the YBT. It is important to understand the effects of time and physical activity on YBT performance as musculoskeletal injury risk screenings are often performed annually at the beginning of a competitive sport season and not reevaluated until the...
start of the following season. Intensive participation in sport along with routine strength and conditioning may have either deleterious or beneficial effects on dynamic postural control. If changes in performance do occur in conjunction with normal participation in sport there may be opportunities to increase the diagnostic capability of this assessment to accurately stratify injury risk if repeated assessments are warranted. Therefore, the purpose of this study was to determine the effects of a competitive athletic season on YBT performance in healthy collegiate field hockey athletes.

Methods

Twenty NCAA Division I women’s field hockey players (age = 19.55 ± 1.30 y; height = 165.10 ± 5.277 cm; mass = 62.62 ± 4.64 kg) from a single team volunteered to participate in this pretest-posttest study. To be included, participants had to be free from injury at the time of enrollment. Participants also had to remain active on the team roster and participate in all athletic activities. All participants provided written informed consent in compliance with the University’s Institutional Review Board.

All participants completed a baseline data collection session within 1 week of starting the athletic season (preseason). Subjects completed a follow-up data collection session 2 weeks after cessation of the athletic season (postseason). Between data collection sessions, all participants participated in the Fall competitive field hockey season, which was approximately 3 months in duration. During each data collection session, all participants completed the anterior, posteromedial, and posterolateral directions of the YBT (Perform Better; Warwick, RI) barefoot on each limb. The order of limb testing was counterbalanced across sessions. Participants were positioned in the center of the YBT instrument and instructed to keep their hands on their hips and reach as far as possible by pushing a board in each reach direction. Four practice trials were followed by 3 test trials for each direction.9 Test trials were repeated if any of the following errors occurred: removing hands from hips, failing to return to the starting position, lifting the heel of the stance limb, touching down with the nonstance limb, applying too much weight to the push board, or slinging the push board forward.1 Limb length was measured from the ASIS to the distal end of the medial malleolus (cm). All assessments were conducted by 3 licensed Athletic Trainers with 5–7 years of experience using the YBT/SEBT in research and clinical practice. All assessors completed a training session with the primary investigator and used the same standard operating procedures and script to administer the test during both sessions.

Reach distances were measured in centimeters, averaged for each direction, and normalized to leg length (%). Composite reach distances for each limb were calculated by summing the average normalized reach distances for each direction and dividing by 3. Between-limb asymmetry was calculated by subtracting the normalized reach distance of the left limb from the normalized reach distance of the right limb for each reach direction and composite, respectively. These procedures for administering the YBT have previously exhibited good intrarater (ICC = 0.85–0.91) and interrater (ICC = 0.99–1.00) reliability.1

The independent variable was time (preseason, postseason) and the dependent variables were YBT reach distances for each limb and between-limb asymmetries for all reach directions (anterior, posteromedial, posterolateral, composite). Differences between preseason and postseason reach distances and between-limb asymmetries were examined using paired t tests after determining all variables were normally distributed based on the Shapiro-Wilk test. Alpha was set at $P \leq .05$ for all analyses.

Bland-Altman plots for limits of agreement were created to qualitatively examine systematic changes in reach distance as well as consistency between preseason and postseason measurements.10 All plots were created by plotting the difference between sessions over the average of both sessions for each YBT variable. For all plots, the limits of agreement were assessed by calculating the mean bias between sessions with 95% confidence intervals (CI; SD ± 1.96). Variables with a mean bias of approximately 0 indicated the participants did not systematically achieve greater reach distances at preseason or postseason. Variables with a mean bias > 0 indicated reach distances were greater in preseason while mean bias values <0 indicated that reach distances were greater in preseason. Smaller 95% CI were also desirable as this would indicate participants had consistent reach distances across time. All statistical analyses were completed with SigmaPlot (Version 13, Systat Software Inc, San Jose, CA).

Results

Four players sustained a lower extremity injury during the season and were not included in the statistical analysis. In the remaining 16 athletes, there were no significant differences between preseason and postseason reach distances for any reach directions or composite scores in either limb ($P \geq .31$). Similarly, there were no significant differences between preseason and postseason between-limb asymmetry ($P \geq .52$). The limits of agreement for individual reach distances and composite scores ranged from -0.77 ± 10.88% to 1.67 ± 13.95% (Figure 1). The limits of agreement for the between-limb symmetry ranged from -0.56 ± 7.05% to 0.72 ± 14.84% (Figure 2). The Bland-Altman analyses indicated that mild biases occurred in both preseason and postseason across variables however a systematic increase or decrease in test performance was not observed. In addition, the 95% CI were ≥ 10% for many measures which indicated test performance lacked consistency; particularly the posterior reach directions. Descriptive statistics, $P$-values, mean bias, and 95% limits of agreement for each variable are presented in Table 1.
Figure 1 — Bland-Altman plots for normalized anterior, posteromedial, and posterior lateral reach directions for the left and right limbs. All plots are presented as the difference of postseason minus preseason over the average of both measurements.
Figure 2 — Bland-Altman plots for normalized composite reach values for the left and right limbs as well as the between-limb symmetry of the anterior, posteromedial, and posterolateral reach directions. All plots are presented as the difference of postseason minus preseason over the average of both measurements.
Discussion

No statistically significant changes in YBT reach distances or between-limb symmetry were identified following a competitive field hockey season in healthy Division I female athletes. This was supported by low mean bias values which indicated that systematic changes in reach distances were not observed over the course of the season. The lack of systematic change in YBT reach distances over the course of a competitive season supports the use of the YBT as a preseason screening measure that may not warrant periodic reassessment over the course of an athletic season when used in clinical practice for injury risk stratification.

The limits of agreement analyses provided additional insights into YBT measures over the course of the athletic season. Although the mean bias between the repeated measures was relatively low, the 95% CI around several measures was large (≥10%). This indicates that although the group means did not significantly change over time, there were relatively large, nonsystematic individual changes over time. The posteromedial and posterolateral reach directions as well as the between-limb symmetry values for these directions exhibited the greatest variability across sessions. For example, the 95% CI for posterolateral direction of the right limb was nearly ±14%. It is not clear from this study if the changes in reach distance are the result of measurement error or other factors which may influence performance. Potentially, the posterior directions are more novel of tasks with more possible strategies for completion that results in performance variability. The anterior reach direction and composites exhibited the most consistency across sessions. Based on qualitative assessment of the Bland-Altman plots, it does not appear that participants with lesser or greater averages of the preseason and postseason measurements exhibited greater variability across time.

Thus far, a majority of the investigations which have used the YBT or SEBT to prospectively examine lower extremity injury risk have found the anterior direction or composite to have the greatest diagnostic capabilities.2–4,11 The variability within the posterior reach directions over time may contribute to the limited use of these directions for injury risk stratification as these performance fluctuations could limit accurate assessment of function. The lower nonsystematic variability over time in the anterior and composite reach distances may provide a potential explanation for these previous findings.

There are limitations to this study. A single team of Division I field hockey athletes were included. Future studies should consider expanding upon this study by including a more diverse group of participants from different men’s and women’s sports, levels of participation, and ages. In addition, this study conducted measurements at preseason and postseason. Systematic fluctuations in YBT performance may occur at other points in an athletic season which were not captured in this study. In addition, we collected the reach directions in the same order for all participants in both sessions. Future studies should randomize this aspect of testing to reduce the possibilities of an order effect. Finally, approximately 3 months passed between measurements in this study based on the start and end of the athletic season. The consistency of YBT performance across a longer period such as preseason to preseason is unknown. Continued research to fill in these knowledge gaps will enhance the utility and feasibility of using the YBT as an injury risk assessment for physically active populations.
Conclusion

Systematic changes in YBT performance were not identified following participation in a competitive collegiate field hockey season. However, relatively large nonsystematic changes were observed in the posteromedial and posterolateral directions when examined in individual participants. These findings should be considered when attempting to use the YBT as an injury risk assessment in clinical practice and future research.

References