ABSTRACT

Background: The Lower Quarter Y-Balance Test (YBT-LQ) is used by sports medicine professionals to measure an athlete’s dynamic balance. The YBT-LQ is used by clinicians to track recovery during clinical rehabilitation, assess an athlete's readiness to return to sport after injury, and to identify athletes potentially at-risk for a time-loss injury. Normative data for the YBT-LQ are lacking for female collegiate volleyball (VB) players. The purpose of this study was to examine preseason YBT-LQ scores and their relationships to level of competition, starter status, player position, and prior lower quadrant (i.e., low back and lower extremities) injury history.

Methods: One-hundred thirty-four female collegiate VB players (mean age = 19.3 ± 1.1 years) representing athletes from three levels of competition (D II = 32, D III = 77, NAIA = 25) participated in this study. Athletes reported their prior injury history and performed the YBT-LQ testing protocol.

Results: NAIA and D III athletes demonstrated significantly greater reach measures on the YBT-LQ than D II athletes in several directions. Starters demonstrated significantly greater reach measures in five out of eight reach directions. Liberos/defensive specialists/setters demonstrated significantly greater posterolateral and composite reach measures bilaterally. There was no difference in reach measures based on prior history of lower quadrant (low back and lower extremities) injury.

Conclusion: This study provides normative data for YBT-LQ in female collegiate volleyball players. The data presented in this report may be used by coaches and rehabilitation professionals when evaluating dynamic balance in healthy volleyball players and by clinicians to compare an injured athlete’s recovery to norms.

Level of Evidence: 3b

Keywords: balance, college, functional test, Movement System, volleyball, Y-Balance Test-Lower Quarter
INTRODUCTION
The Lower Quarter Y-Balance Test (YBT-LQ) is used by sports medicine professionals to measure an athlete's dynamic balance. The YBT-LQ is a relatively new test inspired by the star excursion balance test. The YBT-LQ is used by clinicians to track recovery during clinical rehabilitation, assess an athlete's readiness to return to sport after injury, and to identify athletes potentially at-risk for a time-loss injury.

Assessing a patient's balance, as measured by the YBT-LQ, during clinical rehabilitation may help clinicians identify side-to-side asymmetries and/or general deficits when compared to normative data. It is important to note that several studies have reported normative data for the YBT-LQ in various athletic and military populations. YBT-LQ scores may differ between athletes based on sport participation, gender, or competition level; therefore a clinician should compare their patient’s scores with those from a homogeneous sample.

Only two studies have reported normative data for collegiate VB players with each study marked by limitations. Hudson et al collected YBT-LQ measures in a population of National Collegiate Athletic Association (NCAA) Division I (D I) female collegiate VB players. The authors reported YBT-LQ composite scores (a score that sums each reach distance normalized to limb length); however, they did not report individual reach measures. Stiffler et al also collected measures using the shape of the “Y” (using the star excursion balance test and not the YBT test) from a population of D I female VB players reporting individual reach measures; however, the data represented measures from only 22 athletes and they did not use the YBT-LQ device. There is also paucity in the literature regarding individual and composite YBT-LQ scores for female collegiate VB players from other divisions. In addition there is paucity regarding YBT-LQ scores for collegiate VB players based on player position, starter status, level of competition, and prior injury history. To address the aforementioned gaps in the literature additional studies are warranted.

The purpose of this study was to examine preseason YBT-LQ scores and their relationships to level of competition, starter status, player position, and prior lower quadrant (i.e., low back and lower extremities) injury history in female collegiate VB players. There were five hypothesis explored in this study. 1) NCAA D II and NAIA would have significantly greater YBT-LQ reach measures than NCAA D III VB players. 2): Starters would have significantly greater YBT-LQ reach measures than their non-starter counterparts. 3): VB athletes who play positions that require more vertical jumps (e.g., outside hitter, middle blocker, opposite hitter) would have significantly shorter YBT-LQ reach measures than their counterparts (e.g., setters, libero, defensive specialist). 4): D II and NAIA VB players would have significantly greater YBT-LQ scores, per position, than their D III counterparts. 5): VB athletes with prior history of time-loss lower quadrants (LQ = lower extremity and low back region) injury or prior history of time-loss lateral ankle sprain injury would have significantly shorter reach measures than those with no prior history of injury.

METHODS
Participants
Recruitment of VB players occurred in a two-step process. First, an investigator from each region contacted the team's head coach via either phone or email to recruit team participation. Next, if the head coach agreed to allow his/her team to be tested then an investigator from each region recruited team members, via email, to be tested at the investigators’ labs. The data for this study was collected over a a three-year period with testing occurring at two locations: George Fox University and Azusa Pacific University. The majority of athletes were tested in the George Fox University lab (n = 118). Investigators from each institution reviewed the standardized testing protocol prior to data collection. One hundred and thirty-four female collegiate volleyball players, representing athletes from NCAA D II, NCAA D III, and NAIA teams, were tested over a three-year period. Informed consent was obtained from each subject prior to testing. The Institutional Review Boards of George Fox University and Azusa Pacific University approved this study.

Procedures
Collection of YBT-LQ measures occurred at the start of preseason as part of a larger study investigating the relationship between performance measures
and time-loss injury. Specific to this study each athlete performed a dynamic warm-up prior to testing, reported demographic information and prior injury history to the lower quadrant region (i.e., low back and lower extremities), and completed the YBT-LQ protocol.

Dynamic Warm-Up
Each athlete performed a five-minute dynamic warm-up prior to testing. Subjects performed the following movements at their own pace: forward walking, backward walking, heel walking, tip toe walking, marching, and hip flexion with opposite arm reach. Demographic information collected from each athlete included age, year in school, and age starting sport. Athletes also reported prior sport related injury history including injury location, diagnosis, and the date the injury occurred (month/year).

Y-Balance Test – Lower Quarter Protocol
The YBT-LQ protocol consisted of two steps: 1) test instruction and 2) test performance. Prior to performing the YBT-LQ each subject was provided test performance instruction and completed six warm-up trials per lower extremity (LE).1 When performing the test an athlete would stand barefoot on the weightbearing platform with toes positioned behind the red indicator line. Next, the athlete would reach their non-weightbearing LE into one of the three components of the “Y” [anterior (ANT); posteromedial (PM); posterolateral (PL)] to slide the reach indicator (aka the moveable platforms). The anterior reach trials were performed first with the athlete performing three on the right (i.e., right LE weightbearing) followed by performing three reach trials on the left (i.e., left LE weightbearing).1,26 After successfully completing three trials, per LE, in the ANT direction three trials per LE (right followed by left) were performed in the PM direction followed by the PL direction.1,26

A reach trial would be repeated by the athlete if she demonstrated any of the following common technique errors: loss of balance, maintaining one’s balance by using the non-weightbearing limb, failing to slide the reach indicator under control (e.g. flicking it or kicking it forward), or moving the reach indicator forward by applying contact to the indicator outside of the red target region.1,26 A successful trial was measured and recorded by the investigator.

YBT-LQ reach distance is normalized to the athlete’s limb length. Limb length measurements were collected by the investigator after the athlete completed testing. The limb length measurements were obtained bilaterally with the athlete in supine measuring the distance from the anterior superior iliac spine to the distal aspect of the medial malleolus.1,2 The following formula was used to calculate normalized reach distance measurements: \( \frac{\text{reach distance}}{\text{limb length}} \times 100 \) [note: right limb measurements were used to normalize right sided reach distances and left limb measurements were used to normalize reach distances on the left].1,2 The composite reach score was calculated using this formula: \( \frac{\left[\text{mean ANT} + \text{mean PM} + \text{mean PL}\right]}{\text{limb length x 3}} \times 100 \).1,2 The intrarater reliability (0.85 – 0.91) and the interrater reliability (0.99 – 1.00) for the YBT-LQ have been previously reported.1

Statistical Analyses
Mean (± SD) scores were calculated for demographic variables and individual YBT-LQ reach measures. Independent t-tests were used to compare reach distance measures per starter status and per prior history of injury. Analysis of variance (ANOVA) was performed to compare demographic measures per level of competition and to compare YBT-LQ measures per level of competition, per player movement categorization (e.g., grouping based on vertical movements versus horizontal or lateral movements), and per player position. Statistical analyses was performed using SPSS 24.0 (Chicago, IL) for all calculations.

RESULTS
The mean age was 19.3 (± 1.1) years with NAIA athletes significantly older than D III players (Table 1). The mean number of years in school was 2.2 (± 1.1) years; the NAIA population of athletes had been in school significantly more years than D II or D III athletes. The mean age starting for this sport was 11.7 (± 2.1) years.

Individual and composite reach measures per level of competition and for the entire population are presented in Table 2. Several significant differences in reach distance, per level of competition, were found. NAIA athletes had significantly greater
There are six primary positions in volleyball: setter (S), defensive specialist (DS), libero (L), outside hitter (OH), middle blocker (MB), and opposite side hitter [OPP (aka right side hitter)]. Player positions were identified from team statistics. Some players were identified as having two player positions. The following frequencies per position were: L only = 1; DS only = 13; L/DS specialist = 10; setter S = 27; OH = 43; OPP = 8; MB = 21; MB/OPP = 11.

Normalized reach measures per player movement categorization are presented in Table 3. Two player position groups were formed for the purpose of this research, based on movement categorization (e.g., grouping based on vertical movements versus horizontal or lateral movements): Group 1 consisted of (R) posteromedial, (R) posterolateral, (L) anterior, (L) posteromedial, and (L) posterolateral reach distances than D II athletes. Division III athletes had significantly greater (R) posterolateral and (L) posteromedial reach distances than D II athletes.

Table 2 also presents YBT-LQ measures per starter status. A review of team statistics identified 52 athletes as starters (note: two athletes who were starters did not participate in testing). Analysis of YBT-LQ measures between starters/non-starters was performed for the entire population; comparisons per level of competition were not performed due to sample sizes. There were several reach directions where starters had significantly greater YBT-LQ measures than their non-starter counterparts (Table 2). Starters had significantly greater reach measures in the following directions: (R) anterior, (R) posteromedial, (L) anterior, (L) posteromedial, and (L) posterolateral.

There are six primary positions in volleyball: setter (S), defensive specialist (DS), libero (L), outside hitter (OH), middle blocker (MB), and opposite side hitter [OPP (aka right side hitter)]. Player positions were identified from team statistics. Some players were identified as having two player positions. The following frequencies per position were: L only = 1; DS only = 13; L/DS specialist = 10; setter S = 27; OH = 43; OPP = 8; MB = 21; MB/OPP = 11. Normalized reach measures per player movement categorization are presented in Table 3. Two player position groups were formed for the purpose of this research, based on movement categorization (e.g., grouping based on vertical movements versus horizontal or lateral movements): Group 1 consisted of (R) posteromedial, (R) posterolateral, (L) anterior, (L) posteromedial, and (L) posterolateral.
The data presented in this study may be of benefit to clinicians who use this test to evaluate patient status during rehabilitation.

There were five hypothesis explored in this study. It was hypothesized (H1) that D II and NAIA VB players would have greater reach measures than D III athletes. This was hypothesized because D II and NAIA schools can offer scholarships; therefore they may be able to recruit athletes who score better on physical performance tests. However, there were several reach directions where NAIA athletes had significantly greater measures than D II athletes. In addition, D III athletes had some greater reach measures than D II athletes. It could be speculated that differences in YBT-LQ performance in this study may be related to the significant differences in age between NAIA/ D III athletes and D II athletes. However, a prior study of high school, collegiate, and professional level baseball players reported that high school athletes (i.e., younger athletes) had significantly greater anterior reach measures. Therefore, it may reflect differences in training programs between schools. A future study would be warranted to compare training programs and YBT-LQ performance.

There were no significant differences in YBT-LQ reach measures based on prior history of injury (Table 5). In addition to the data presented in Table 5 a comparison between athletes with or without prior history of anterior cruciate ligament reconstruction (ACLR) was also performed. There were a total of eight athletes with prior history of ACLR (right = 4; left = 4). There were no differences in reach measures between groups based on ACLR history or based on involved limb.

**DISCUSSION**

This study presents the largest set of YBT-LQ data for female collegiate VB players and the first to present test measures for D II, D III, and NAIA levels of competition. The data presented in this study may be of benefit to clinicians who use this test to evaluate patient status during rehabilitation.

There were five hypothesis explored in this study. It was hypothesized (H1) that D II and NAIA VB players would have greater reach measures than D III athletes. This was hypothesized because D II and NAIA schools can offer scholarships; therefore they may be able to recruit athletes who score better on physical performance tests. However, there were several reach directions where NAIA athletes had significantly greater measures than D II athletes. In addition, D III athletes had some greater reach measures than D II athletes. It could be speculated that differences in YBT-LQ performance in this study may be related to the significant differences in age between NAIA/ D III athletes and D II athletes. However, a prior study of high school, collegiate, and professional level baseball players reported that high school athletes (i.e., younger athletes) had significantly greater anterior reach measures. Therefore, it may reflect differences in training programs between schools. A future study would be warranted to compare training programs and YBT-LQ performance.

It was hypothesized (H2) that starters would have greater reach measures than non-starters. In five out of eight measures starters had significantly greater scores than non-starters. This finding confirms our hypothesis that athletes who earn more playing time

---

**Table 3. Normalized Reach Distance (Mean ± SD) per Player Movement Categorization.**

| Normalized Reach Direction | Total Population (n = 134) | L/DS/S (n = 53) | OH/MB/Opp (n = 81) | p-value |
|---------------------------|---------------------------|----------------|-------------------|--------|
| Right Lower Extremity     |                           |                |                   |        |
| Anterior                  | 66.1 (6.6)                | 67.1 (6.5)     | 65.5 (6.6)        | 0.172  |
| Posteroomedial            | 106.0 (10.6)              | 108.0 (10.7)   | 104.8 (10.5)      | 0.089  |
| Posterolateral            | 102.3 (11.0)              | 106.1 (10.7)   | 99.8 (10.6)       | 0.001  |
| Composite                 | 99.6 (13.0)               | 106.9 (12.8)   | 94.8 (10.8)       | 0.000  |
| Left Lower Extremity      |                           |                |                   |        |
| Anterior                  | 66.1 (6.4)                | 66.3 (6.4)     | 65.9 (6.5)        | 0.720  |
| Posteroomedial            | 107.3 (9.6)               | 109.0 (9.5)    | 106.1 (9.6)       | 0.093  |
| Posterolateral            | 102.4 (10.5)              | 105.8 (9.1)    | 100.1 (10.8)      | 0.002  |
| Composite                 | 100.1 (12.1)              | 107.0 (11.4)   | 95.6 (10.4)       | 0.000  |

L = libero; DS = defensive specialist; S = setter; OH = outside hitter; MB = middle blocker; OPP = opposite (aka right side hitter)
It was hypothesized (H3) that athletes who play positions that require more vertical jumps would have significantly lower YBT-LQ measures than athletes who play positions that require more horizontal and lateral movements. OH, MB, and OPP are VB player (i.e., starter) would have statistically better reach scores. It is currently unknown if dynamic balance, as measured by the YBT-LQ, is correlated with sport performance. This finding of greater reach distance measures in VB starters warrants further investigation.

It was hypothesized (H3) that athletes who play positions that require more vertical jumps would have significantly lower YBT-LQ measures than athletes who play positions that require more horizontal and lateral movements. OH, MB, and OPP are VB player (i.e., starter) would have statistically better reach scores. It is currently unknown if dynamic balance, as measured by the YBT-LQ, is correlated with sport performance. This finding of greater reach distance measures in VB starters warrants further investigation.

| Normalized Reach Direction and Level of Competition | Libero / Defensive Specialist | Setter | Outside Hitter | MB and Opposite |
|---------------------------------------------------|-------------------------------|--------|----------------|-----------------|
| Right Lower Extremity                            |                               |        |                |                 |
| Anterior                                          |                               |        |                |                 |
| Division II (6)                                   | 61.2 (4.1)†                   | 63.0 (5.4) | 66.1 (7.1) | 66.0 (5.3) |
| Division III (5)                                  | 70.1 (9.6)                    | 67.0 (6.1) | 65.7 (7.1) | 65.2 (6.3) |
| OIA (11)                                          | 69.7 (5.6)                    | 64.6 (8.5) | 68.0 (7.0) | 75.5           |
| Totals (22)                                       | 67.5 (7.2)                    | 65.7 (6.4) | 66.3 (7.0) | 65.6 (6.2) |
| p-value                                           | 0.036†                        | 0.415  | 0.729          | 0.261          |
| Posterior Medial                                   |                               |        |                |                 |
| Division II (6)                                   | 102.6 (9.0)                   | 98.0 (7.9) | 104.6 (8.2) | 98.8 (7.3) |
| Division III (5)                                  | 112.9 (15.1)                  | 107.0 (10.4) | 106.7 (9.9) | 104.7 (12.1) |
| NAIA (11)                                         | 113.5 (10.0)                  | 110.6 (7.4) | 108.6 (8.9) | 108.5          |
| Totals (22)                                       | 110.4 (11.6)                  | 105.7 (10.1) | 105.5 (9.2) | 103.5 (11.3) |
| p-value                                           | 0.153                         | 0.082  | 0.646          | 0.360          |
| Posterior Lateral                                  |                               |        |                |                 |
| Division II (6)                                   | 91.8 (6.9)‡                    | 100.1 (8.9) | 98.8 (10.1) | 94.1 (9.8) |
| Division III (5)                                  | 109.5 (13.7)                  | 104.9 (10.8) | 101.6 (11.3) | 104.0 (10.8) |
| NAIA (11)                                         | 109.2 (10.0)                  | 105.7 (9.5) | 99.9 (11.2) | 98.7           |
| Totals (22)                                       | 104.5 (12.6)                  | 104.0 (10.0) | 100.6 (10.8) | 101.8 (11.1) |
| p-value                                           | 0.008‡                        | 0.580  | 0.761          | 0.056          |
| Composite                                          |                               |        |                |                 |
| Division II (6)                                   | 98.8 (5.7)                    | 96.7 (7.8) | 97.1 (10.8) | 89.8 (6.8) |
| Division III (5)                                  | 115.5 (24.3)                  | 104.2 (12.5) | 98.8 (11.3) | 100.1 (15.1) |
| NAIA (11)                                         | 101.6 (12.8)                  | 101.3 (11.3) | 96.0 (9.7) | 92.4           |
| Totals (22)                                       | 104.0 (15.5)                  | 102.0 (11.4) | 97.9 (10.7) | 97.6 (14.3) |
| p-value                                           | 0.158                         | 0.400  | 0.801          | 0.106          |
| Left Lower Extremity                               |                               |        |                |                 |
| Anterior                                          |                               |        |                |                 |
| Division II (6)                                   | 61.2 (8.2)                    | 63.5 (3.8) | 65.4 (7.7) | 67.0 (5.4) |
| Division III (5)                                  | 72.6 (7.2)                    | 65.6 (6.4) | 65.4 (6.9) | 64.8 (5.3) |
| NAIA (11)                                         | 68.9 (7.1)                    | 67.3 (4.3) | 69.5 (5.0) | 76.3           |
| Totals (22)                                       | 67.6 (8.3)                    | 65.4 (5.6) | 66.2 (6.9) | 65.6 (5.5) |
| p-value                                           | 0.049                         | 0.493  | 0.317          | 0.081          |
| Posterior Medial                                   |                               |        |                |                 |
| Division II (6)                                   | 102.0 (8.1)†                   | 100.8 (9.1) | 105.8 (9.1) | 101.3 (7.8) |
| Division III (5)                                  | 118.4 (9.5)                  | 109.4 (8.4) | 107.5 (9.0) | 105.1 (9.4) |
| NAIA (11)                                         | 114.6 (8.6)                  | 112.8 (12.4) | 107.9 (8.3) | 105.6          |
| Totals (22)                                       | 112.1 (10.5)                  | 108.3 (9.9) | 107.1 (8.8) | 104.3 (9.0) |
| p-value                                           | 0.011†                        | 0.094  | 0.839          | 0.541          |
| Posterior Lateral                                  |                               |        |                |                 |
| Division II (6)                                   | 96.5 (6.7)‡                    | 98.7 (8.8) | 99.1 (10.1) | 96.9 (12.2) |
| Division III (5)                                  | 108.5 (15.2)                  | 105.0 (8.6) | 101.7 (10.9) | 101.9 (10.1) |
| NAIA (11)                                         | 111.0 (10.3)‡                 | 106.6 (8.6) | 100.8 (9.0) | 102.3          |
| Totals (22)                                       | 106.5 (12.1)                  | 103.9 (8.8) | 100.8 (10.2) | 100.8 (10.5) |
| p-value                                           | 0.046‡                        | 0.252  | 0.783          | 0.452          |
| Composite                                          |                               |        |                |                 |
| Division II (6)                                   | 100.5 (6.2)                    | 96.8 (6.4) | 97.4 (10.6) | 91.0 (14.3) |
| Division III (5)                                  | 118.0 (20.6)                  | 104.8 (10.8) | 99.3 (10.8) | 99.2 (13.4) |
| NAIA (11)                                         | 103.0 (12.7)                  | 103.9 (12.3) | 96.8 (8.1) | 92.9           |
| Totals (22)                                       | 105.7 (14.6)                  | 102.9 (10.4) | 98.3 (10.1) | 97.3 (12.6) |
| p-value                                           | 0.093                         | 0.400  | 0.796          | 0.215          |

†Difference between NAIA and D II; p-value = 0.05 post-hoc
‡Difference between NAIA and D II; p-value = 0.01 post-hoc
§Difference between D III and D II; p-value = 0.031 post-hoc
¶Difference between D III and D II; p-value = 0.017 post-hoc
†Difference between NAIA and D II; p-value = 0.03 post-hoc
‡Difference between NAIA and D II; p-value = 0.047 post-hoc
positions that frequently require vertical jumps (e.g., hitting, blocking). Prior research has suggested that there is no correlation between jump performance and balance.\cite{29,30} In contrast to the aforementioned “jumping” positions, S, DS, and L are player positions that require horizontal and lateral movements (e.g., laterally lunging to dig the ball) and therefore may require greater levels of dynamic balance. In this study there were four reach measures that were significantly greater in the L/DS/S group including both posterolateral reach measures.

It was hypothesized (H4) that D II and NAIA VB athletes would have greater scores per player position than D III athletes. Similar to the findings associated with H1 there were some instances where NAIA and D III athletes had greater reach measures, per the combined L/DS group, than D II athletes. The difference in reach measures between D II and NAIA/D III athletes may reflect differences in training programs between volleyball teams. In most cases, there were no significant differences in reach measures per level of competition. This was likely due to some smaller player position subgroups and therefore requires future investigation.

It was hypothesized (H5) that VB athletes with a prior history of injury would have significantly lower YBT-LQ measures than those without prior injury history. There are numerous examples in the literature identifying residual deficits in patients post-ACLR or post-ankle sprain despite having been discharged from clinical rehabilitation.\cite{31,38} There were no differences in reach measures based on injury history in this study. This finding may be the result of one or more of the following reasons: 1) formerly injured athletes may have been adequately rehabilitated and/or 2) the YBT-LQ is not an effective test for identifying deficits in “healthy” athletes who had prior history of injury.

There are several strengths to this study. First, this study measured a large sample (n = 134) and included VB athletes from several levels of collegiate competition. Second, this study provides normative data for VB players based on level of competition, starter status, and player position. This normative data may be useful to rehabilitation professionals when tracking a patient’s progress during therapy and to guide decision making as to whether an athlete is able to return to sport. There are a few limitations to this study. First, although athletes were recruited from several collegiate competition levels, there were no D I athletes assessed in this study. As previously mentioned there are two studies that have reported some YBT-LQ data for the D I population.\cite{14,25} While a statistical comparison between the D I YBT-LQ measures in Hudson et al\cite{14} and Stiffler et al\cite{25} and the scores in the current study cannot

| Characteristic | Right Anterior Reach | Right Posteromedial Reach | Right Posterolateral Reach | Right Composite Score | Left Anterior Reach | Left Posteromedial Reach | Left Posterolateral Reach | Left Composite Score |
|----------------|---------------------|--------------------------|---------------------------|----------------------|---------------------|-------------------------|-------------------------|----------------------|
| **Prior History of Lower Quadrant Injury** | | | | | | | | |
| Yes (n = 96) | 65.6 (6.4) | 106.5 (10.5) | 101.7 (11.3) | 98.9 (12.8) | 65.7 (6.5) | 107.3 (9.3) | 101.7 (10.7) | 99.4 (11.6) |
| No (n = 38) | 67.5 (7.1) | 105.0 (11.1) | 103.7 (10.5) | 101.5 (13.5) | 67.0 (6.4) | 107.1 (10.4) | 104.0 (10.0) | 102.1 (13.2) |
| p-value | 0.130 | 0.483 | 0.367 | 0.302 | 0.283 | 0.875 | 0.263 | 0.245 |
| **Prior History of Lateral Ankle Sprain** | | | | | | | | |
| Yes (n = 47) | 64.9 (6.4) | 105.5 (10.6) | 100.5 (11.6) | 97.5 (11.9) | 65.8 (6.1) | 106.4 (9.2) | 101.4 (11.1) | 98.6 (10.9) |
| No (n = 87) | 66.8 (6.7) | 106.4 (10.7) | 103.2 (10.7) | 100.8 (13.5) | 66.2 (6.7) | 107.7 (9.9) | 102.9 (10.2) | 101.0 (12.7) |
| p-value | 0.122 | 0.647 | 0.182 | 0.164 | 0.680 | 0.461 | 0.440 | 0.268 |
| **Prior History of Lateral Ankle Sprain in Previous 12 months** | | | | | | | | |
| Yes (n = 12) | 66.5 (5.0) | 104.2 (11.5) | 94.1 (13.3) | 94.0 (10.3) | 67.5 (5.5) | 104.3 (8.2) | 97.9 (12.4) | 95.8 (8.3) |
| No (n = 122) | 66.1 (6.8) | 106.2 (10.6) | 103.1 (10.5) | 100.2 (13.1) | 65.9 (6.5) | 107.6 (9.7) | 102.8 (10.2) | 100.6 (12.4) |
| p-value | 0.818 | 0.524 | 0.007 | 0.116 | 0.426 | 0.266 | 0.119 | 0.192 |
be made it is interesting to note similarities and differences in composite scores between groups. Hudson et al\textsuperscript{14} reported composite scores, based on dominant/non-dominant limb and player position ranging between approximately 92 to 95 percent of limb length. In the current study composite scores were 106.9 (± 12.8) on the right and 107.0 (± 11.4) on the left with variations based on level of competition and player position. One must be cautious though when comparing the results from this study with those in Stiffler et al\textsuperscript{25} Stiffler et al\textsuperscript{25} had subjects reach into each direction of the “Y”; however, they did not use the YBT-LQ device (essentially the subjects performed the star excursion balance test in the anterior, posteromedial, and posterolateral directions).\textsuperscript{25} One might assume that performance on the YBT-LQ would be similar to performance on the SEBT; however, subjects reach further into the anterior direction during the star excursion balance test than when performing the YBT-LQ.\textsuperscript{40,41}

CONCLUSIONS
The results of the current study provide normative YBT-LQ data for DII, DIII, and NAIA female collegiate volleyball players. This study found that NAIA and DIII athletes had several reach measures that were significantly greater than their DII counterparts. Also, starters had significantly greater reach scores than nonstarters. There were also significant differences in reach scores based on player positions. The descriptive data presented in this study may help coaches and sports medicine professionals when assessing a female volleyball player’s dynamic balance and when evaluating and tracking balance during a course of rehabilitation.

REFERENCES
1. Plisky PJ, Gorman PP, Butler RJ, et al. The reliability of an instrumented device for measuring components of the star excursion balance test. \textit{N Am J Sports Phys Ther.} 2009; 4: 92-99.
2. Plisky PJ, Rauh MJ, Kaminski TW, et al. Star excursion balance test as a predictor of lower extremity injury in high school basketball players. \textit{J Orthop Sports Phys Ther.} 2006; 36: 911-919.
3. Boyle MJ, Butler RJ, Queen RM. Functional movement competency and dynamic balance after anterior cruciate ligament reconstruction in adolescent patients. \textit{J Pediatr Orthop.} 2016; 36: 36-41.
4. Garrison JC, Bothwell JM, Wolf G, et al. Y balance test anterior reach symmetry at three months is related to single leg functional performance at time of return to sports following anterior cruciate ligament reconstruction. \textit{Int J Sports Phys Ther.} 2015; 10: 602-611.
5. Gonell AC, Romero JA, Soler LM. Relationship between the Y balance test scores and soft tissue injury incidence in a soccer team. \textit{Int J Sports Phys Ther.} 2015; 10: 955-966.
6. Hall EA, Docherty CL, Simon J, et al. Strength-training protocols to improve deficits in participants with chronic ankle instability: a randomized controlled trial. \textit{J Athl Train.} 2015; 50: 36-44.
7. Hallagin C, Garrison JC, Creed K, et al. The relationship between pre-operative and twelve-week post-operative Y-balance and quadriceps strength in athletes with an anterior cruciate ligament tear. \textit{Int J Sports Phys Ther.} 2017; 12: 986-993.
8. Hartley EM, Hoch MC, Boling MC. Y-balance test performance and BMI are associated with ankle sprain injury in collegiate male athletes. \textit{J Sci Med Sport.} 2018; 21: 676-680.
9. Kline PW, Johnson DL, Ireland ML, Noehren B. Clinical predictors of knee mechanics at return to sport after acl reconstruction. \textit{Med Sci Sports Exerc.} 2016; 48: 790-795.
10. Kim K, Jeon K. Development of an efficient rehabilitation exercise program for functional recovery in chronic ankle instability. \textit{J Phys Ther Sci.} 2016; 28: 1443-1447.
11. Smith CA, Chimera NJ, Warren M. Association of y balance test reach asymmetry and injury in division I athletes. \textit{Med Sci Sports Exerc.} 2015; 47: 136-141.
12. Stiffler MR, Bell DR, Sanfilippo JL, et al. Star excursion balance test anterior asymmetry is associated with injury status in division I collegiate athletes. \textit{J Orthop Sports Phys Ther.} 2017; 47: 339-346.
13. Mayer SW, Queen RM, Taylor D, et al. Functional testing differences in anterior cruciate ligament reconstruction patients release versus not released to return to sport. \textit{Am J Sports Med.} 2015; 43: 1648-1655.
14. Hudson C, Garrison JC, Pollard K. Y-balance normative data for female collegiate volleyball players. \textit{Phys Ther Sport.} 2016; 22: 61-65.
15. Alnahdi AH, Alderaa AA, Aldali AZ, Alsobyel H. Reference values for the Y balance test and the lower extremity functional scale in young healthy adults. \textit{J Phys Ther Sci.} 2015; 27(12): 3917-3921.
16. Bullock GS, Arnold TW, Plisky PJ, Butler RJ. Basketball players' dynamic performance across competition levels. \textit{J Strength Cond Res.} 2018; 32: 3528-3533.
17. Butler RJ, Queen RM, Beckman B, Kiesel KB, Plisky PJ. Comparison of dynamic balance in adolescent
male soccer players from Rwanda and the United States. Int J Sports Phys Ther. 2013; 8: 749-755.
18. Butler RJ, Bullock G, Arnold T, et al. Competition-level differences on the lower quarter Y-balance test in baseball players. J Athl Train. 2016; 51: 997-1002.
19. Chimera NJ, Smith CA, Warren M. Injury history, sex, and performance on the functional movement screen and Y balance test. J Athl Train. 2015; 50: 475-485.
20. Culiver A, Garrison JC, Creed KM, et al. Correlation among Y balance test-lower quarter composite scores, hip musculoskeletal characteristics, and pitching kinematics in NCAA division I baseball pitchers. J Sport Rehabil. 2018; epub.
21. Kenny SJ, Palacios-Derflingher L, Shi Q, et al. Association between previous injury and risk factors for future injury in preprofessional ballet and contemporary dancers. Clin J Sport Med. 2017; epub ahead of print.
22. Slater LV, Vriner M, Schuyten K, et al. Sex differences in Y-balance performance in elite figure skaters. J Strength Cond Res. 2018; epub ahead of print.
23. Teyhen DS, Riebel MA, McArthur DR, et al. Normative data and the influence of age and gender on power, balance, flexibility, and functional movement in healthy service members. Mil Med. 2014; 179: 413-420.
24. Gorman PP, Butler RJ, Rauh MJ, et al. Differences in dynamic balance scores in one sport versus multiple sport high school athletes. Int J Sports Phys Ther. 2012; 7: 148-153.
25. Stiffler MR, Sanfilippo JL, Brooks MA, Heiderscheit BC. Star excursion balance test performance varies by sport in healthy division I collegiate athletes. J Orthop Sports Phys Ther. 2015; 45: 772-780.
26. Butler RJ, Lehr ME, Fink ML, et al. Dynamic balance performance and noncontact lower extremity injury in college football players: an initial study. Sports Health. 2013; 5: 417-422.
27. Barnes JL, Schilling BK, Falvo MJ, et al. Relationship of jumping and agility performance in female volleyball athletes. J Strength Cond Res. 2007; 21: 1192-1196.
28. Schaal M, Randsell LB, Simonson SR, et al. Physiologic performance test differences in female volleyball athletes by competition level and player position. J Strength Cond Res. 2013; 27: 1841-1850.
29. Muehlbauer T, Gollhofer A, Granacher U. Associations between measures of balance and lower-extremity muscle strength/power in healthy individuals across the lifespan: a systematic review and meta-analysis. Sports Med. 2015; 45: 1671-1692.
30. Muehlbauer T, Gollhofer A, Granacher U. Association of balance, strength, and power measures in young adults. J Strength Cond Res. 2013; 27: 582-589.
31. Brumitt J, Englis A. Functional performance test differences in female NAIA athletes with prior history of anterior cruciate ligament reconstruction. Athletic Training & Sports Health Care. 2016; 8: 216-221.
32. Ardern CL, Taylor NF, Feller JA, et al. Sports participation 2 years after anterior cruciate ligament reconstruction in athletes who had not returned to sport at 1 year: a prospective follow-up of physical function and psychological factors in 122 athletes. Am J Sports Med. 2015; 43: 848-856.
33. Ardern CL, Taylor NF, Feller JA, Webster KE. Fifty-five per cent return to competitive sport following anterior cruciate ligament reconstruction surgery: an updated systematic review and meta-analysis including aspects of physical functioning and contextual factors. Br J Sports Med. 2014; 48: 1543-1552.
34. Ithurburn MP, Altenburger AR, Thomas S, et al. Young athletes after acl reconstruction with quadriiceps strength asymmetry at the time of return-to-sport demonstrate decreased knee function 1 year later. Knee Surg Sports Traumatol Arthrosc. 2018; 26: 426-433.
35. Ithurburn MP, Paterno MV, Ford KR, et al. Young athletes after anterior cruciate ligament reconstruction with single-leg landing asymmetries at the time of return to sport demonstrate decreased knee function 2 years later. Am J Sports Med. 2017; 45: 2604-2613.
36. Cho BK, Park JK, Choi SM, et al. The peroneal strength deficits in patients with chronic ankle instability compared to ankle sprain copers and normal individuals. Foot Ankle Surg. 2018; 39: 105-112.
37. Olmsted LC, Carcia CR, Hertel J, Schultz SJ. Efficacy of the star excursion balance tests in detecting reach deficits in subjects with chronic ankle instability. J Athl Train. 2002; 37: 501-506.
38. McKeon PO, Hertel J. Systematic review of postural control and lateral ankle instability, part I: can deficits be detected with instrumented testing. J Athl Train. 2008; 43: 293-304.
39. Homes A, Delahunt E. Treatment of common deficits associated with chronic ankle instability. Sports Med. 2009; 39: 207-224.
40. Coughlan GF, Fullam K, Delahunt E, Gissane C, Caulfield BM. A comparison between performance on selected directions of the star excursion balance test and the Y balance test. J Athl Train. 2012; 47: 366-371.
41. Fullam K, Caulfield B, Coughlan GF, Delahunt E. Kinematic analysis of selected reach directions of the star excursion balance test compared with the Y-balance test. J Sport Rehabil. 2014; 23: 27-35.