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# Clinical Implications of Hand Position and Lower Limb Length Measurement Method on Y-Balance Test Scores and Interpretations

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***Context:*** The Lower Quarter Y-Balance Test (LQ-YBT) was developed to provide an effective and efficient screen for injury risk in sports. Earlier protocol recommendations for the LQ-YBT involved the athlete placing the hands on the hips and the clinician normalizing scores to lower limb length measured from the anterior-superior iliac spine to the lateral malleolus. The updated LQ-YBT protocol recommends the athlete's hands be free moving and the clinician measure lower limb length to the medial malleolus.

***Objective:*** To investigate the effect of hand position and lower limb length measurement method on LQ-YBT scores and their interpretation.

***Design:*** Cross-sectional study.

***Setting:*** National Sports Institute of Malaysia.

***Patients or Other Participants:*** A total of 46 volunteers, consisting of 23 men (age = 25.7 ± 4.6 years, height = 1.70 ± 0.05 m, mass = 69.3 ± 9.2 kg) and 23 women (age = 23.5 ± 2.5 years, height = 1.59 ± 0.07 m, mass = 55.7 ± 10.6 kg).

***Intervention(s):*** Participants performed the LQ-YBT with hands on hips and hands free to move on both lower limbs.

***Main Outcome Measure(s):*** In a single-legged stance, participants reached with the contralateral limb in each of the anterior, posteromedial, and posterolateral directions 3 times. Maximal reach distances in each direction were normalized to lower limb length measured from the anterior-superior iliac spine to the lateral and medial malleoli. Composite scores (average of the 3 normalized reach distances) and anterior-reach differences (in raw units) were extracted and used to identify participants at risk for injury (ie, anterior-reach difference ≥4 cm or composite score ≤94%). Data were analyzed using paired *t* tests, Fisher exact tests, and magnitude-based inferences (effect size [ES], ±90% confidence limits [CLs]).

***Results:*** Differences between hand positions in normalized anterior-reach distances were trivial ($t_{91}$ = –2.075, *P* = .041; ES = 0.12, 90% CL = ±0.10). In contrast, reach distances were greater when the hands moved freely for the normalized posteromedial ($t_{91}$ = –6.404, *P* < .001; ES = 0.42, 90% CL = ±0.11), posterolateral ($t_{91}$ = –6.052, *P* < .001; ES = 0.58, 90% CL = ±0.16), and composite ($t_{91}$ = –7.296, *P* < .001; ES = 0.47, 90% CL = ±0.11) scores. A similar proportion of the cohort was classified as at risk with the hands on the hips (35% [n = 16]) and the hands free to move (43% [n = 20]; *P* = .52). However, the participants classified as at risk with the hands on the hips were not all categorized as at risk with the hands free to move and vice versa. The lower limb length measurement method exerted trivial effects on LQ-YBT outcomes.

***Conclusions:*** Hand position exerted nontrivial effects on LQ-YBT outcomes and interpretation, whereas the lower limb length measurement method had trivial effects.

***Key Words:*** balance, injury risk, musculoskeletal system, injury prevention

**Key Points**

- Scientists and clinicians currently use different protocols when administering the Lower Quarter Y-Balance Test (LQ-YBT).
- Hand position (on the hips versus free to move) had a nontrivial effect on the LQ-YBT scores and their interpretation.
- The lower limb length measurement method (anterior-superior iliac spine to the medial or lateral malleolus) had a trivial effect on LQ-YBT outcomes.
- When using the LQ-YBT, upper limb placement needs to be clearly documented for replication purposes.
- Researchers should investigate individual responses to changes in hand position to better understand the mechanistic contribution of the upper limbs to LQ-YBT performance.

The Lower Quarter Y-Balance Test (LQ-YBT) involves maintaining single-legged balance while reaching as far as possible with the contralateral limb in 3 directions.[1] It is a simplified version of the Star Excursion Balance Test, which involves 8 reach directions.[1] The LQ-YBT has demonstrated good-to-excellent intrarater and interrater reliability[2–5]; stability over time[4]; and the ability to predict injury incidence in several athletic populations, including high school basketball players,[4] collegiate athletes,[6–8] and professional soccer players.[9] It is used not only to screen for injury risk in athletes but also to monitor rehabilitation progression and outcomes after injury or surgery,[10,11] examine the effects of training interventions in uninjured populations,[12] and assess dynamic balance across the age spectrum.[13,14]

The widespread application of the LQ-YBT has led to the development and use of a variety of protocols.[5] When the test was first used as an injury-screening tool, Plisky et al[4] illustrated participants performing the test with their hands placed on their hips (ie, the study protocol did not explicitly state the hand position, but the photograph showed an individual performing the test with hands on hips). A few years later, Plisky et al[5] illustrated participants performing the LQ-YBT with their hands free to move. Consequently, the LQ-YBT research contains data from the test being performed with both hands on the hips[3,4,11,12] and the hands free to move.[5,6,8,13] Here again, investigators[3–5,8,12,13] have not explicitly stated hand position but have provided photographs of individuals performing the LQ-YBT. Given that upper limb movement can improve performance during balance,[15] mobility,[15] and lower limb strength tests,[16] it is reasonable to assume that permitting upper limb movement during the LQ-YBT could influence outcomes and augment reach distance. Similarly, when the LQ-YBT was first used to define injury-risk cutoff scores, Plisky et al[4] normalized reach distances to lower limb length measured from the anterior-superior iliac spine (ASIS) to the lateral malleolus, but later, Plisky et al[5] recommended normalizing LQ-YBT reach scores to limb length measures taken from the ASIS to the medial malleolus. Whereas the latter method[3,5,6,14,17] is more frequently used than the former,[4,8] differences in lower limb length measurement methods could affect LQ-YBT scores and their interpretation.[18]

In the absence of age-, sex-, and population-specific injury-risk cutoff scores, the initial thresholds reported by Plisky et al[4] are often cited and used for reference.[6,7,10,19] In particular, high school basketball players who presented with an anterior-reach distance difference $\geq$4 cm or a composite-reach score $\leq$94% of lower limb length were more likely to sustain a lower limb injury.[4] In later years, Butler et al[7] determined that collegiate American football players with composite-reach scores of less than 89.6% were at greater risk of injury, whereas the anterior-reach distance difference could not predict injury incidence. Other than the population groups investigated, differences among study results might be due in part to differences in LQ-YBT protocols: Butler et al[7] used the Y-Balance Test Kit and adhered to the more recent protocol that allows the hands to move freely, measures lower limb length to the medial malleolus, and permits the stance foot to lift from the contact surface.[5]

Therefore, the purpose of this study was to investigate the effect of hand position and lower limb length measurement method on LQ-YBT scores and their interpretation using the conventional injury-risk cutoff scores. I hypothesized that participants would be able to reach farther with their hands free to move, thereby reducing the number of participants classified as being at risk for injury. I also expected longer lower limb length values when measuring from the ASIS to the lateral malleolus, which would lead to lower normalized LQ-YBT scores.

## METHODS

### Design

The cross-sectional research design with repeated measures required participants to attend 1 experimental session in the biomechanics laboratory of the National Sports Institute of Malaysia. I conducted half of the test sessions in the morning (9 AM to noon) and half in the afternoon (2 to 5 PM), thereby balancing the effect of time of day on dynamic postural control.[20] To minimize the potential influence of testing order and fatigue on LQ-YBT performance, hand position and test side were block randomized so an equal number of participants began with either their hands on their hips or their hands free to move and began with the right or left lower limb. The first lower limb length measure taken was also alternated between the lateral and medial malleoli. The independent variables of interest were hand position (on the hips or free to move) and lower limb length measurement method (lateral malleolus or medial malleolus). The dependent variables were LQ-YBT maximal reach distance in the anterior, posteromedial, and posterolateral directions normalized to lower limb length; composite-reach score normalized to lower limb length; absolute anterior-reach distance difference; lower limb length; and the proportions of the cohort identified as at risk and not at risk for injury. All participants provided written informed consent, and the study was approved by the Institutional Review Board at the National Sports Institute of Malaysia.

### Participants

A total of 46 participants (age range = 20–38 years), including 23 men (age = 25.7 $\pm$ 4.6 years, height = 1.70 $\pm$ 0.05 m, mass = 69.3 $\pm$ 9.2 kg, right-foot dominant = 20) and 23 women (age = 23.5 $\pm$ 2.5 years, height = 1.59 $\pm$ 0.07 m, mass = 55.7 $\pm$ 10.6 kg, right-foot dominant = 20), completed the study protocol. I defined *foot dominance* as the foot used to kick a ball. Inclusion criteria were good self-reported general health (ie, no known disease, infection, or illness) and no musculoskeletal injury, pathologic joint condition, or other medical condition within the 3 months before the study that could affect LQ-YBT performance. Based on the short-form International Physical Activity Questionnaire,[21] I categorized 24, 17, and 5 participants as having high, moderate, and low physical activity levels, respectively. Participants were instructed to refrain from strenuous physical activity or resistance training on the day of testing.

### Procedures

I recorded sex, age, height, body mass, foot dominance, injury history, and physical activity level. With participants standing in an upright position without shoes and with their weight evenly distributed between limbs,[6] the length of each lower limb was measured from the most inferior aspect of the ASIS to the most distal aspect of the lateral and medial malleoli. The method for measuring lower limb length (lateral malleolus or medial malleolus) was randomized and performed by a single examiner (not the author) throughout the study. Intrarater reliability of lower limb length measures was not assessed, but researchers[22] have demonstrated excellent intrarater reliability values (intraclass correlation coefficient = 0.985–0.990). Due to the novelty of the task, participants subsequently completed a 5-minute warm-up on a cycling ergometer (RevMaster, LeMond, CA) at a self-selected light intensity before the LQ-YBT. Before the experimental trials, participants were familiarized with the LQ-YBT and performed 6 practice trials on each foot in each reach direction and with each hand position to minimize any potential learning effect.[2]

The familiarization period was followed by a 2-minute rest period in quiet standing.

Metric cloth measuring tapes were affixed to the floor to reconstruct the Y-shaped reach directions. A 23-cm long, 12.5-cm wide, 15.5-cm deep cardboard box weighing 150 g was used as a reach indicator. While standing barefoot on 1 limb in the middle of the Y shape, participants reached as far as possible with their free limb 3 times in the anterior, posteromedial, and posterolateral directions sequentially, with the 2 posterior directions located 135° from the anterior direction. The 3 trials were completed with 1 limb and then the other limb in the anterior-reach direction before the posteromedial-reach direction and then the posterolateral-reach direction. Between trials, the reach foot was placed on the ground beside the stance foot. After all the trials for a given hand position were completed, participants rested for 2 minutes before performing the trials with the alternate hand position. Trials were disregarded and repeated when a participant lost balance, lifted or moved the stance foot from the floor, touched down with the reach foot, kicked the reach indicator, placed the reach foot on top of the indicator, did not return to the starting position in a controlled manner, or removed the hands from the hips during the hands-on-hips trials.[4] Throughout the study, a single examiner (not the author) recorded the reach distances from all trials. Before data collection, the examiner completed a series of training sessions with a qualified physical therapist to promote standardization of testing procedures, which included performing supervised LQ-YBT assessments a minimum of 20 times. Intrarater reliability was not assessed; however, the LQ-YBT has demonstrated good to excellent intrarater reliability values (intraclass correlation coefficient = 0.85–0.91).[5]

The greatest reach distance in each direction for each limb and hand position was retained for analysis and subsequently normalized to lower limb length. For each limb and hand position, a composite-reach score was also calculated by summing the greatest reach distances in each of the 3 directions and normalizing the value to 3 times that of the lower limb length:

$$\text{Composite-reach score (\%)} = \frac{\text{Anterior reach} + \text{posteromedial reach} + \text{posterolateral reach}}{3 \times \text{Lower limb length}} \times 100$$

Finally, the absolute difference between the right and left anterior-reach distances was calculated. The number of participants considered at risk or not at risk for injury based on their anterior-reach–distance differences ($\geq$4 cm) and composite-reach scores ($\leq$94% of lower limb length) was computed following the initial thresholds identified by Plisky et al.[4] All data were entered into Excel (version 2007; Microsoft Corp, Redmond, WA) for further analysis.

## Statistical Analysis

Means and standard deviations were computed for all variables. The effect of hand position on normalized anterior, posteromedial, posterolateral, and composite scores was investigated using paired $t$ tests, and the $\alpha$ level was set at .05. Data were analyzed for practical meaningfulness using magnitude-based inferences. Magnitudes of the standardized effect sizes (ESs) were interpreted using thresholds of <0.2 (*trivial*), 0.2 (*small*), 0.6 (*moderate*), 1.2 (*large*), and 2.0 (*very large*).[23] The uncertainty of the ES was expressed using 90% confidence limits (CLs) in a plus/minus form (ie, ES ± CL), and I qualitatively evaluated the chance that the true value of the ES was practically meaningful using the following standardized thresholds: <0.5% (*almost certainly not*), 1% to 5% (*very unlikely*), >5% to 25% (*unlikely*), >25% to 75% (*possibly*), >75% to 95% (*likely*), >95% to 99.5% (*very likely*), and >99.5% (*almost certainly*).[23]

The effect of hand position on the proportion of participants classified as at risk or not at risk for injury was also investigated using Fisher exact tests from 2 × 2 tables of frequencies and analyzed for practical meaningfulness. Differences between the 2 hand positions in the percentage of the cohort classified as at risk were interpreted using thresholds of <10% (*trivial*), 10% (*small*), 30% (*moderate*), 50% (*large*), and 70% (*very large*).[23] The same statistical procedures were used to analyze the effect of lower limb length measurement method on lower limb lengths; normalized anterior, posteromedial, posterolateral, and composite scores; and the proportions of the participants classified as at risk and not at risk for injury. Consistent with the original protocol used to establish the at-risk thresholds,[4] the lower limb length measured using the lateral malleolus and the hands-on-hips position was considered the reference condition when investigating the effects of hand position and lower limb length measurement method on LQ-YBT scores and their interpretation. Results from the alternate conditions are provided as supplemental material. All data processing and analyses were performed using Excel.

# RESULTS

## Hand Position

Hand position had a significant but likely (89.5% likelihood) trivial effect ($t_{91}$ = –2.075, $P$ = .041; ES = 0.12, 90% CL = ±0.10) on the normalized anterior-reach distance (Figure 1). In contrast, participants reached farther with the hands-free-to-move than the hands-on-hips method in the posteromedial ($t_{91}$ = –6.404, $P$ < .001; ES = 0.42, 90% CL = ±0.11), posterolateral ($t_{91}$ = –6.052, $P$ < .001; ES = 0.58, 90% CL = ±0.16), and composite ($t_{91}$ = –7.296, $P$ < .001; ES = 0.47, 90% CL = ±0.11) directions, with small and almost certain (99.9% likelihood) differences in ES measures.

Absolute anterior-reach distance with the hands on the hips (3.2 ± 2.7 cm) did not differ from the hands-free-to-move condition (3.8 ± 2.5 cm; $t_{45}$ = –1.326, $P$ = .19; ES = 0.24, 90% CL = ±0.31). Similar proportions of the cohort were identified as *at risk* and *not at risk* for injury based on the anterior-reach–distance difference when the LQ-YBT was performed with the hands on the hips (n = 16 [35%] and n = 30 [65%], respectively) compared with the hands free to move (n = 20 [43%] and n = 26 [57%], respectively). The difference between the 2 hand positions in the percentage of the cohort classified as at risk was trivial (8.7%) and not significant ($P$ = .52). However, only 7 of the 16 participants categorized as at risk with the hands on the

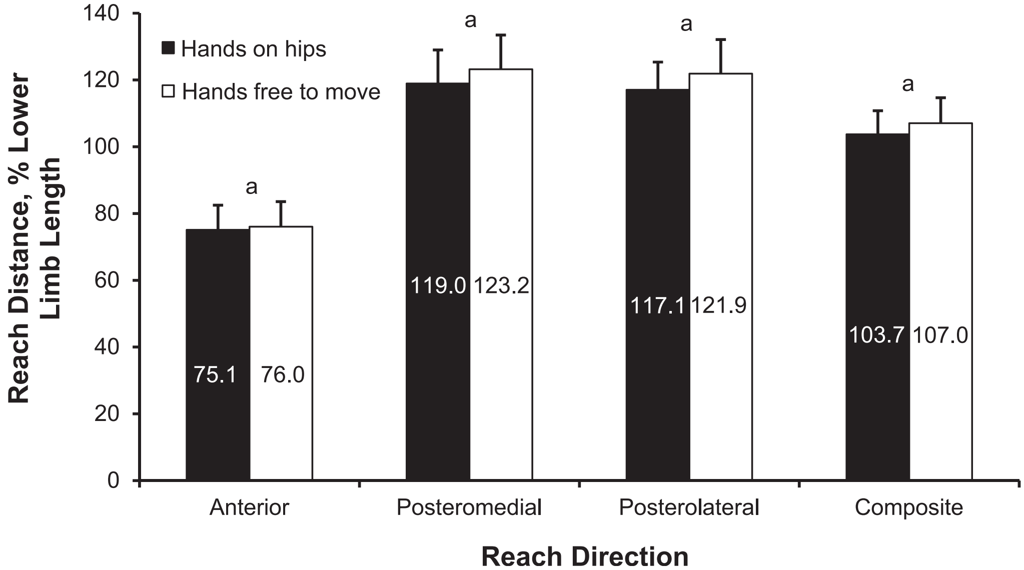


**Figure 1. The effect of hand position (on the hips versus free to move) on Lower Quarter Y-Balance Test scores normalized to lower limb length measured from the anterior-superior iliac spine to the lateral malleolus. Error bars represent standard deviations. [a] Indicates difference between conditions ($P < .05$).**

hips were also categorized at risk with the hands free to move (Figure 2A). The proportion of participants identified as at risk based on the normalized composite score was also similar between the hands-on-hips (15%) and the hands-free-to-move conditions (9%; $P = .52$), with a trivial difference in the percentage (6.5%). Again, not all participants identified as at risk with the hands on the hips were identified as at risk with the hands free to move (Figure 2B). Whereas the results for the effect of hand position are for scores normalized to lower limb lengths measured to the lateral malleolus, the results were almost identical for lengths measured to the medial malleolus (see Supplemental Figures 1 and 2, available online at http://dx.doi.org/10.4085/1062-6050-52.8.02.S1 and http://dx.doi.org/10.4085/1062-6050-52.8.02.S2).

## Lower Limb Length Measurement Method

The lower limb was longer when measured from the ASIS to the lateral malleolus than to the medial malleolus ($t_{91} = -5.423$, $P < .001$; Figure 3); however, this difference was almost certainly (99.9% likelihood) trivial (ES = –0.09,

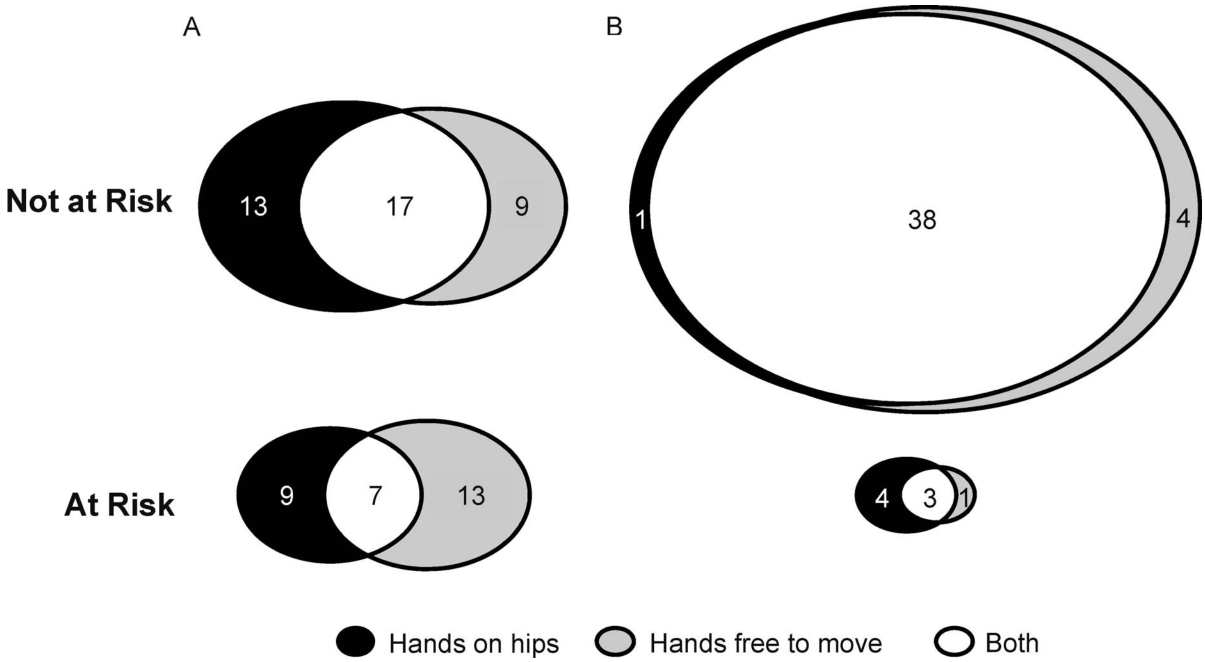


**Figure 2. Venn diagram illustrating the numbers of participants classified as at risk and not at risk when performing the Lower Quarter Y-Balance Test with the hands on the hips and the hands free to move on the basis of the A, anterior-reach–distance difference (≥4 cm) and, B, composite-reach score (≤94%) normalized to lower limb length measured from the anterior-superior iliac spine to the lateral malleolus. Diagrams are not precisely to scale.**

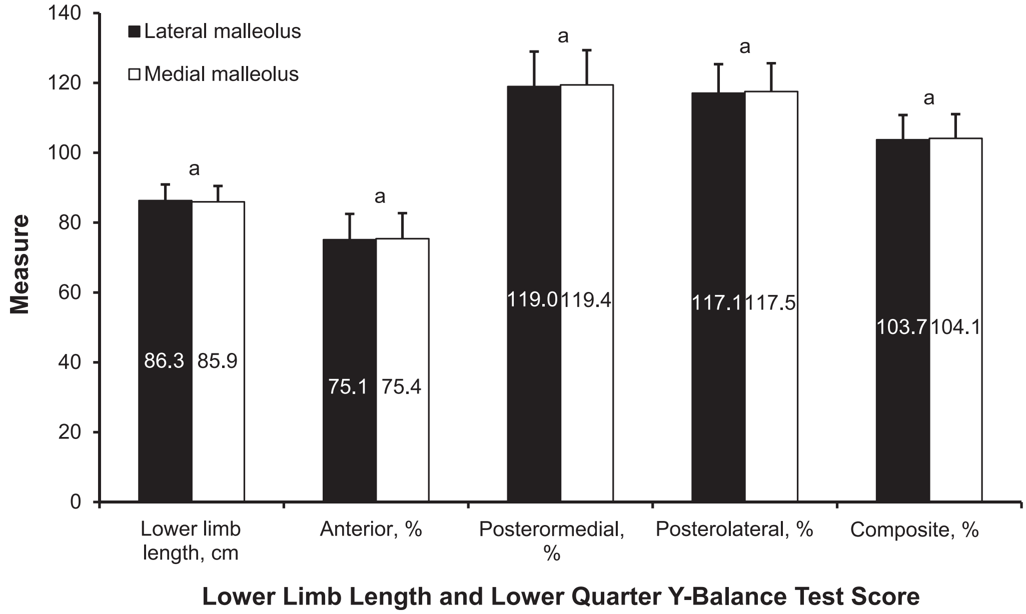


**Figure 3. The effect of lower limb length measurement method (anterior-superior iliac spine to the lateral malleolus versus anterior-superior iliac spine to the medial malleolus) on lower limb length and Lower Quarter Y-Balance Test scores normalized to lower limb length when performed with the hands on the hips. Error bars represent standard deviations. [a] Indicates difference between conditions ($P < .05$).**

90% CL = ±0.04). Similarly, whereas significant, the differences in the normalized anterior ($t_{91} = 5.497$, $P < .001$; ES = 0.04, 90% CL = ±0.01)-, posteromedial ($t_{91} = 5.386$, $P < .001$; ES = 0.05, 90% CL = ±0.01)-, posterolateral ($t_{91} = 5.362$, $P < .001$; ES = 0.06, 90% CL = ±0.02)-, and composite-reach ($t_{91} = -4.093$, $P < .001$; ES = 0.06, 90% CL = ±0.02) scores between lower limb length measurement methods were almost certainly (99.9% likelihood) trivial.

The proportions of the cohort identified as at risk and not at risk based on the normalized composite score were nearly identical ($P > .99$) when measured using the lateral malleolus (n = 10 [22%] and n = 36 [78%], respectively) and the medial malleolus (n = 11 [24%] and n = 35 [76%], respectively). Only 1 participant was categorized differently between the 2 measurement methods. Whereas the results pertaining to the effect of the lower limb length measurement method are for data from the LQ-YBT performed with the hands on the hips, the results were almost identical when the hands were free to move (see Supplemental Figure 3, available online at http://dx.doi.org/10.4085/1062-6050-52.8.02.S3).

## DISCUSSION

The purpose of this study was to investigate the effects of hand position and method of measuring lower limb length on LQ-YBT scores and their interpretation using the original injury-risk cutoff thresholds established by Plisky et al.[4] As anticipated, participants reached farther when their hands were free to move than when they were placed on their hips, with nontrivial differences detected for the normalized posteromedial-, posterolateral-, and composite-reach scores. Whereas a similar number of individuals were identified as at risk for lower limb injury (ie, anterior-reach distance difference ≥4 cm or composite-reach score ≤94%) with the hands on the hips and the hands free to move, only a subset of these individuals were categorized as at risk under both conditions, suggesting that different aspects of dynamic balance were involved. Measuring lower limb length from the ASIS to the lateral malleolus compared with the medial malleolus affected most comparisons, but the method of measuring lower limb length had an almost certainly trivial effect on these comparisons (ie, lower limb length values and normalized anterior-, posteromedial-, posterolateral-, and composite-reach scores). Furthermore, the classification of participants based on the normalized composite scores was the same between lower limb length measurement methods, with the exception of 1 individual whose scores were on the borderline of the cutoff threshold. Hence, clinicians and scientists should consider that hand position during the LQ-YBT can significantly and nontrivially affect test scores and their interpretation and may elicit different neuromuscular-control strategies. In contrast, whether the lateral or medial malleolus is used to measure lower limb length for subsequent score normalization is a minimal concern.

When using the LQ-YBT in a preparticipation examination of 200 National Collegiate Athletic Association Division I collegiate athletes, Smith et al[6] found that athletes with an anterior-reach–distance difference of ≥4 cm had greater odds of injury; however, the normalized composite-reach score did not predict injury incidence. In that study, athletes completed the task with their hands free to move, and the researchers measured lower limb length from the ASIS to the medial malleolus with the athletes standing and evenly distributing their weight between the lower limbs. Smith et al[6] proposed assessing anterior-reach–distance difference as part of a preparticipation screening to identify individuals at risk for injury and eliminating the posteromedial- and posterolateral-reach directions, thereby reducing the time needed for LQ-YBT assessment and allowing either more individuals or more tests to be included in a preparticipation examination of fixed duration. If a clinician is assessing only the anterior-reach distance difference, measuring lower limb length would become unnecessary because the metric represents the absolute difference (in centimeters) between the right and left anterior-reach distances (ie, no normalization). In this study, the anterior-reach distance did not differ between the 2 hand positions examined ($P = .19$), suggesting less concern about upper body position when assessing this particular metric. However, more prospective studies are needed to verify whether the anterior-reach–distance difference on the LQ-YBT is sufficient to identify individuals as at risk for lower limb injury.

In the current study, the anterior-reach–distance difference identified a greater number of (approximately 3 times more) participants at potential risk for lower limb injury than did the composite score, which was likely due to the lack of sensitivity and specificity of the composite cutoff score used (≤94% of lower limb length) to identify individuals as at risk. The composite cutoff score should be based on sex, sport, and age.[8,24] In the absence of population-specific cutoff scores or access to the Move2Perform injury-risk algorithm (monthly paid subscription; Move2Perform LLC, Evansville, IN), the threshold of 94% is often used as a clinical guideline or scientific reference,[6,7,10,19] which was the reason for using this threshold in the current study. That aside, only 1 of the 7 participants identified as at risk in my study using the composite score was also identified as at risk using the anterior-reach–distance difference when the hands were placed on the hips. In contrast, when the hands were free to move, 3 of 4 participants categorized as at risk using the composite score were also categorized as at risk using the anterior-reach–distance difference. These results highlight that, particularly with the hands on the hips, anterior-reach distance difference and composite-reach scores may identify individuals with distinct functional movement-impairment patterns.

Similarly, whereas the proportion of the cohort categorized as at risk for injury was similar between the 2 hand positions investigated, the individuals categorized as at risk were not necessarily the same. These findings suggest a shift in the neuromuscular-control strategies used to perform the LQ-YBT when the upper limbs are restricted compared with free moving, which is supported by empirical evidence of change in dynamic task performance when upper limb motion is restricted.[16,25,26] For instance, limiting upper limb motion during running increases shoulder and pelvic rotations about the vertical axis[25] and can impede the recovery of gait-stability measures after external perturbations.[26] In my study, restricting upper limb motion led to a change in the categorization of certain individuals from at risk to not at risk for injury (and vice versa). More in-depth investigations are required to further explain the individual responses to change in the relative contribution of the upper limb to LQ-YBT score observed in this study. Comparing LQ-YBT scores between restricted and free upper limb motion may provide a method for assessing the effectiveness of using the upper limb for dynamic balance, with implications for balance recovery after an unexpected disturbance in athletes or the elderly population. For now, clinicians and scientists should consider that upper limb position during the LQ-YBT can influence the categorization of individuals within a cohort.

Authors[10,11,13,14] of an increasing body of literature have provided data pertaining to the LQ-YBT in various population groups. Several factors influence LQ-YBT scores, including age,[14] sex,[17,19] and level[27] and type[28] of sport participation. In addition, variations in protocols and procedures affect LQ-YBT performance. For instance, anterior-reach distance is greater and associated with less hip flexion at the point of maximal reach when executed from the ground without using a reach indicator than on the Y-Balance Test kit using a reach indicator.[29] This study provided additional insights into the LQ-YBT by highlighting that performance differences also exist between hands-on-hips and hands-free-to-move protocols, which are both frequently used. In future studies, researchers may seek to compare the kinematics of the LQ-YBT using the 2 hand positions to better understand the movement control of this task. Restricting upper limb motion during functional performance testing is believed to provide a more specific assessment of lower limb function,[15,30] whereas permitting upper limb motion is believed to be more natural and functional.[31,32] I cannot recommend using 1 protocol over another because the clinical aims need to be considered. Within health, research, and sport centers, consistently using 1 protocol is important to establish baseline scores, track changes over time, and determine population-specific injury-risk cutoff scores. When using published LQ-YBT data as a reference, following the protocols described is important, as variations could influence scores and the classification of individuals as at risk or not at risk. As such, placing the hands on the hips is advised if adhering to the cutoff scores established by Plisky et al,[4] whereas allowing the hands to move freely can be recommended if referring to cutoff scores provided by Butler et al.[7] When reporting results from the LQ-YBT, clinicians and scientists alike should specifically describe the upper limb placement for replication purposes using both photographs and explicit writing to avoid misinterpretation of protocols. A direct comparison or agglomeration of results among studies involving the LQ-YBT without accounting for hand position is not advised; however, the concern is minimal regarding whether lower limb length is measured from the ASIS to the lateral or medial malleolus because of a trivial effect on LQ-YBT scores and almost no effect on the categorization of individuals.

## CLINICAL RELEVANCE

The LQ-YBT is a convenient, reliable, and valid tool used to assess dynamic balance and predict the occurrence of lower limb injuries in athletes.[5,6,9] Across studies and health, research, and sport centers, hand position and the method for measuring lower limb length have differed, with no previous knowledge about how such variations could influence test scores and their interpretation. This study provided evidence that hand position does significantly and nontrivially affect LQ-YBT scores and their interpretation, whereas the effect of lower limb length measurement method is trivial. Direct comparisons between, or inferences from, different studies or centers without considering hand position is not advised. More in-depth investigations into individual responses to a change in hand position on LQ-YBT performance are required to further comprehend the mechanistic contribution of upper limb motion to this dynamic task. When using the LQ-YBT, upper limb placement needs to be clearly documented for replication purposes.

## ACKNOWLEDGMENTS

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## SUPPLEMENTAL MATERIAL

### Supplemental Figure 1.

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### Supplemental Figure 2.

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