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YBT™

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Y Balance Test Introduction

The Y Balance Test Overview

As an integral part of Functional Movement Systems, the Y Balance Test is a thoroughly researched, yet easy way to test a client's motor control as well as demonstrate functional symmetry.

The Y Balance Test allows us to quarter the body and look at how the core and each extremity function under body weight loads. The Y Balance Test Protocol was developed through years of research in injury prevention and identification of motor control changes that occur after injury. This device and protocol are highly accurate and can be used for measuring pre and post rehabilitation performance, improvement after performance enhancement programs, dynamic balance for fitness programs, and return to sport readiness. The Y Balance Test is divided into two components - the Lower Quarter and Upper Quarter:

The Y Balance Test – Lower Quarter (YBT-LQ) is a dynamic test performed in single leg stance that requires adequate strength, flexibility, core control, and proprioception at the limit of the client's stability. This test requires most, if not all, of the components of motor control – an essential component of proper function.

The Y Balance Test - Upper Quarter (YBT-UQ) is a dynamic upper quadrant test performed in a single arm push up position at the limit of stability. This test requires shoulder girdle and core stability, as well as adequate shoulder and thoracic mobility in the closed kinetic chain.

The Y Balance Test – Lower Quarter (YBT-LQ)

The YBT-LQ is a simplified version of the Star Excursion Balance Test (SEBT) in which only 3 reach directions (instead of the original 8 directions of the SEBT) are performed using a specific testing protocol and device to improve reliability and ease of administration of the SEBT. In a systematic review and subsequent prospective cohort studies of the SEBT and YBT-LQ, researchers concluded that they are reliable tests of dynamic balance, predictive of injury, able to identify balance deficits after injury, and modifiable. Researchers have suggested including one of these tests in screening prior to activity participation.

The goal of the YBT-LQ is to maintain single limb stance while reaching as far as possible with the contralateral leg. Because limb length is a small, but significant factor in how far someone reaches, limb length needs to be measured. Prior to administering the test, 6 practice trials are first performed. Next, 3 trials in each of the 3 directions for each foot are collected and the maximum reach in each direction is used for analysis.

The predictive ability of the Y Balance Test have been examined by Plisky et al, Butler et al., Smith et al, and Teyhen et al. These authors found that high school and collegiate athletes and military personnel with asymmetries of greater than 4 cm between the right and left reach distance in the anterior direction and/or a composite score below the age, sex, and sport/activity risk cut-off had an increased risk of lower extremity injury. A person is at risk of losing time from activity if there is a side to side asymmetry in reach distance or decreased performance compared to the person's peer group. In addition, by combining the results of the Functional Movement Screen, injury history, and sport/gender specific Y Balance Test results into the Move2Perform algorithm, researchers were able to accurately predict time loss from sport (Lehr et al 2014).

The composite score gives a snapshot of the client's overall performance and is relative to his body. The composite score is the sum of the greatest reach in each of the three reach directions (anterior, posteromedial, posterolateral) divided by three times the limb length, and then multiplied by 100. Boys and girls high school basketball players with anterior asymmetry of greater than 4 cm were at increased risk of injury and girls with a composite score below 94% (in the bottom third of their peers) were 6 times more likely to get injured. In collegiate football, players with a composite score of less than 89% (note that the composite risk cut-point needs to be based on age, sex, and sport) were more likely to get injured. Thus, since the injury risk cut point is different in each population, the composite score should not be less than the cut points that are specific for the age, sex, and sport/activity of the client. Finally, improving the SEBT can reduce injury risk. In a randomized controlled trial with 226 youth female soccer players, researchers found that if performance on the SEBT is improved, injury risk is reduced.

The Y Balance Test – Upper Quarter (YBT-UQ)

The YBT-UQ is performed by starting the athlete in the up position of a push up with feet shoulder width apart. Closed kinetic chain motor control is measured by reaching in the following three directions: medial, inferolateral, and superolateral. Following a warm up trial, the best of three attempts are recorded for each reach direction. The composite score is calculated in a similar way as the YBT-LQ by taking the sum of all three reach directions, dividing by the upper extremity limb length and multiplying by 100. This composite score can be compared to the injury risk cut score for each population as determined by age, sex, and sport/activity.

Two published studies (Gorman et al 2012, Westrick et al 2012) found the YBT-UQ to be reliable. In addition, both studies found there was no difference in YBT-UQ performance between dominant and non-dominant limbs. This indicates that YBT-UQ performance serves as a good measure in return to sport testing when rehabilitating shoulder, upper limb, and spine injuries. In our current research, we are also finding right/left symmetry on the YBT-UQ in professional and collegiate baseball players (including pitchers).

How It Started?

The Y Balance Test has been developed through years of research and field-testing, but was originally created out of a frustration with the outcomes of our pre-participation physicals. Fifteen years ago, we began testing hundreds of athletes each year, but it nagged us as researchers and clinicians that effective injury prevention was not occurring.

An efficient and effective test, built and backed by high quality research, was needed to identify those who would lose time from their sport. At this time, there was some injury prediction research coming out for athletes. But either the testing took hours to perform or was only related to one type of injury (e .g. ACL tears). A gap existed between injury prediction research and the real world.

We hypothesized that balance was related to injury, but wanted a more challenging measure than static unilateral stance. Researchers were starting to use the Star Excursion Balance Test for identifying people who had chronically unstable ankles. However, because it had 8 different reach directions it didn't meet the criteria of being time efficient. We analyzed the research and reduced it to the 3 directions that would give us the most information in the shortest period of time.

At the beginning of the season, nearly 300 basketball players were measured at 8 high schools. Crawling around on the floor marking reach distances on tape measures didn't look very professional and was uncomfortable. Accuracy was lacking as well. The athletes were tracked for injuries over the course of the season. We found the test to be predictive, but also found areas that the reliability could be improved.

This led to the development of a protocol and test kit to boost the reliability and ease of administration of the test. Since it was developed, a normative database of over 60,000 tests has been accumulated. The database includes school age children, athletes of all levels, military personnel and even older adults after total joint replacement surgery. The database ranges in age from ages 6 to 88.

We also recognized that a body relative test was needed to look at the upper quadrants of the body, which led to the development of the Y Balance Test - Upper Quarter. A decade later, the Y Balance Test has been validated by multiple research studies, and can be performed efficiently in any setting.

Why Do We Need The YBT?

When a student takes a math or reading test in school, it establishes a baseline, assists in academic planning for the child, identifies competence in an area, and can show progress. But most importantly, testing can identify and lead to the resolution of problems that the student may have that could impact their learning and future success. Similarly, in training or rehabilitation, the Y Balance Test sets a baseline and can show progress or competence as a part of comprehensive return to activity testing.

Remember, a test gauges a person's ability and is a measurement that does not require interpretation. A comprehensive functional test would examine a client's ability across multiple domains and give a precise numerical rating that corresponds with aptitude in those domains. This is what the Y Balance Test does. It acts as a "functional goniometer" by allowing precise quantification of a client's body relative movement by simultaneously requiring strength, flexibility, neuromuscular control, core stability, range of motion, balance, and proprioception.

What is Unique?

Comparison to other tests

Compared to static balance tests or plank tests, the Y Balance Test requires dynamic motor control at the limit of stability. This is where the deficit is magnified. Right and left asymmetry is better identified and the composite score can be compared to others in the same population. To illustrate, a collegiate soccer player may be able to stand on one leg or plank for 30 seconds and so will most of his teammates. Since the Y Balance Test requires the player to reach at their limit of stability, differences between limbs and other players will become apparent in the presence of motor control deficits.

How is it used with the Functional Movement Screen?

The Functional Movement Screen separates movement patterns. The Y Balance Test brings all the patterns back together in tri-planar movement. In the Y Balance Test, mobility and stability within multiple planes of movement are challenged. The movements of the Y Balance Test require range of motion, strength, stability and coordination in multiple joints. Any one or a combination of multiple deficits can cause a failure of the test. Think about all of the areas that can cause a problem in the Y Balance Test Lower Quarter:

- Stability or mobility problems in the foot, ankle, knee, hip and spine
- Strength deficits anywhere in the limb or spine
- Coordination problems anywhere in the limb or spine

Therefore, the Y Balance Test is an excellent test for finding deficits in multiple systems in multiple areas of the body. That makes it a powerful test, but it does not help to identify where the problem lies. Our data indicate that approximately 20% of people who have a normal Functional Movement Screen score fail the Y Balance Test (and vice versa) . The Functional Movement Screen is extremely useful in identifying what movement pattern is dysfunctional. The Y Balance Test is the precise gauge that can measure the severity of motor control deficit found with the Functional Movement Screen. Thus both complement each other perfectly and are most powerful used in combination. If the client has pain or injury, the Selective Functional Movement Assessment can provide even greater detail by specifically identifying the location of the mobility or stability problem.

In What Populations is the Y Balance Test Useful?

The Y Balance Test has been effectively used in multiple populations from 1st graders to 85 year olds. While the Y Balance Test originated in sports and has become widely used in all major professional sports teams, it has been utilized widely in research and the field throughout the lifespan around the world.
Because the Y Balance Test has the unique ability to identify motor control deficits it has been used to test 1st through 5th graders to determine if they have dynamic motor control which is an essential foundation for higher level performance and skill acquisition.

In the military it has been extensively used both in the special forces (Army Rangers and Navy Seals), combat personnel, as well as support personnel. On the other end of the spectrum, the Y Balance Test has been used in numerous research studies involving older adults who underwent balance training programs or as an outcome measure after total hip, knee, or ankle replacement.

Y Balance Test–Lower Quarter

Purpose

Starting Position

The Lower Quarter Y Balance Test (YBT-LQ) is a dynamic test that requires stability, strength, flexibility, and proprioception of the lower quadrant of the body. This dynamic task requires the person to perform at his/her limit of stability.

It has been used to assess physical performance, identify chronic ankle and ACL instability, and identify athletes and military personnel at greater risk for lower extremity injury. Researchers have suggested including these tests in screening for activity participation. The YBT-LQ incorporates three movement directions (anterior, posteromedial and posterolateral). The goal of this test is to maintain single-leg stance on one leg while reaching as far as possible with the contralateral leg.

Description

After giving the testing procedure instructions, have the client perform six practice trials in each of the three directions prior to formal testing. Start by having the client stand with the foot on the center foot plate, with the most distal aspect of the toes just behind the red starting line. While maintaining a single-limb stance, have the client reach with the free limb in one of three directions (anterior, posteromedial or posterolateral), and then return to the starting position.

Once ready to complete the formal testing, have the participant start with the right foot on the center of the foot plate and perform three attempts while reaching in one of the three directions. Then the participant will place the left foot on the center foot plate and repeat with the opposite limb. Alternating stance legs between trials will ensure adequate rest for accurate results.

Figure 1

Figure 2

Figure 3

The maximal reach distance is measured by reading the tape measure at the edge of the reach indicator, at the point where the most distal part of the foot reached in half centimeters (e.g. 68.5, 69.0, 69.5 cm). Three trials in each direction for each foot will be collected and the maximal reach in each direction will be included for analysis. If there are failed attempts, perform a maximum of six trials in a single direction. If the participant has more than four failed attempts, a zero should be recorded for that trial.

Reach Directions And Testing Order

The leg that is being measured is the stance leg. This simply represents the pattern and does not imply the functional ability of a body part or side. Reach is named in terms of directional relationship to the stance leg.

Once you are ready to complete the formal testing, have the client start with the right foot on the center of the foot plate and perform three attempts while reaching anteriorly. The best of the three reach attempts is recorded as the score for the right anterior reach. Then the participant will place the left foot on the center foot plate and repeat with the opposite limb. Alternating stance legs between trials will ensure adequate rest for accurate results.
The specific testing order is—

1. Right anterior reach (3 trials)
2. Left anterior reach (3 trials)
3. Right posteromedial reach (3 trials)
4. Left posteromedial reach (3 trials)
5. Right posterolateral reach (3 trials)
6. Left posterolateral reach (3 trials)

Three trials in each direction for each foot will be collected and the maximal reach in each direction will be included for analysis.

Test Faults

Any of the following test faults invalidate a reach attempt:

- kicking push box
- not returning to starting position under control
- touching down during reach
- foot on top of stance plate

Practice Trials

After you give the testing procedure instructions, have the client perform six practice trials in each of the three directions prior to formal testing. This is because the Y Balance Test is a novel movement for most and it takes multiple trials for the client's learning effect to maximize.

Measuring Lower Limb Length

Determine the client's limb length by measuring the distance from the Anterior Superior Iliac Spine (ASIS) to the most distal aspect of the medial malleolus. Have the individual lie supine on a table, without socks and shoes. Start with both knees bent, feet flat on the table as if standing. Ask the client to raise the hips off the table, and return to the resting position. Straighten the individual's knees to fully extended. Pull on the legs at the malleoli to ensure legs are fully extended. On the client's right limb, palpate the most inferior distal surface of the ASIS and align it with the "0" zero line of a cloth tape measure. While holding the tape on the ASIS, extend the tape to the inferior distal surface of the medial malleolus of the right ankle. Record the measurement to the nearest 0.5 cm.

What do we look for on the YBT-LQ?

Researchers indicate that there should not be greater than four centimeter right and left reach distance difference in the anterior reach direction. There should not be greater than a six cm. reach distance difference in the posteromedial and posterolateral directions. Also, the composite score—the sum of three reach directions divided by three times limb length, then multiplied by 100—should not be less than the cut points specific for the age, gender and sport/activity of the individual.

Dorsiflexion Clearing Test

Starting Position:

1. Client will remove shoes for testing. Subject starts kneeling on one knee and the other foot aligned on the edge the stance plate of the YBT kit.
2. Align border of foot being tested (1st metatarsal to calcaneus) with the edge of the YBT stance plate.
3. A phone with the TiltMeter app or bubble inclinometer is placed 2 finger breadths under the tibial tuberosity
4. The subject will bring the knee forward and keep the knee over the 4th ray. Contact with the heel must be maintained and the client is directed to replace heel down if it does come up.
5. The degree measurement of the tibial angle is recorded at the maximum excursion of the tibia over the toe with the heel down.

Interpreting Results of Dorsiflexion Test

Optimal closed kinetic chain dorsiflexion is 40 degrees or greater. A minimum passing score is 35 degrees. Even more important than total angle, is asymmetry. There should be no greater than a 5 degree difference between the left and right closed kinetic chain dorisflexion measure.

Tips For Testing

- Shoes are off for Y Balance Testing.
- The leg that is being measured is the stance leg. This simply represents the pattern and does not imply the functional ability of a body part or side.
- Six practice trials on each leg in each direction should be performed prior to testing.
- Client must maintain unilateral stance on the platform.
- Be sure the client starts with toe up to, but behind the line and checking this position after each trial.
- Client must maintain reach foot contact with the reach indicator on the target area while it is motion (i.e. cannot kick the reach indicator). Foot must contact the red target area of the box.
- Client cannot use the reach indicator for stance support (i.e. place the foot on top of reach indicator).
- Client must return the reach foot to the starting position under control (i.e. return the reach foot to the floor behind the angle, next to the stance platform).
- The reach foot can return to the floor between reaches, but only returning to the starting position under control.
- Do not coach the movement; simply repeat the instructions if needed.

Verbal Instructions For the Lower Quarter Y Balance Test

The following is a script to use while administering the Lower Quarter Y Balance Test. For consistency throughout all testing, this script should be used during each test.

Please let me know if there is any pain while performing any portion of the test.

Please remove your shoes while performing the test.

Place your _____foot on the center of the foot plate with your toes just behind the starting line.

While maintaining the foot on the platform, push the reach indicator in the red target area as far as possible with the opposite leg.

The reach foot must maintain contact with the reach indicator on the target area while it is motion (i.e. cannot kick the reach indicator).

Do not use the reach indicator for stance support (i.e. place foot on top of reach indicator).

Return the reach foot to the starting position under control (i.e. return the reach foot to the floor behind the angle, next to the stance platform).

Do you understand the instructions?

The participant will perform each movement three times before alternating the supporting foot in the same direction. Once completed in the same direction for both feet, continue with the next direction.

Y Balance Test Lower Quarter Research

Reliability

The Y Balance Test has been shown to produce repeatable and consistent testing results demonstrated by multiple studies. In a military mass screening setting researchers found good reliability of the Y Balance Test Lower Quarter with multiple raters (e.g. testing 50 service members per hour).[1] The raters were trained and tested with live demonstration as well the online Y Balance Test certification course. The authors found Interrater test–retest reliability of the maximal reach had intraclass correlation coefficients (2,1) of 0.80 to 0.85 with a standard error of measurement ranging from 3.1 to 4.2 cm for the 3 reach directions (anterior, posteromedial, and posterolateral). In two other studies, Plisky et al[2] and Faigenbaum et al[3] reported good to excellent test re-test as well as interrater reliability in soccer players and grade school children.

The Y Balance Test can be performed reliability in single participant as well as large group testing settings with raters having minimal experience (with standardized training). The online course with certification examination as well as a live proficiency check-off by an experienced tester is recommended prior to testing large groups.

Injury Prediction

The predictive ability of the Y Balance Test Lower Quarter was first examined by Plisky et al[4] when the number of reach directions from the Star Excursion Balance Test were reduced from 8 to 3. Boys and girls high school basketball players were measured on the Y Balance Test Lower Quarter at the beginning of the season and then monitored for lower extremity injury throughout the season. These researchers found that high school basketball players with asymmetry of greater than 4 cm between the right and left reach distance in the anterior direction as well as a composite score below the age, sex, and sport risk cut-off had an increased risk of time loss lower extremity injury.[4]

In another prospective cohort study of 59 college football players, researchers found that those players who scored below 89.6% composite reach on the YBT-LQ were 3.5 times more likely to get injured.[5] While this study adds to the body of literature that the Y Balance Test is predictive of lower extremity injury in collegiate football players, it is important to note that the high school basketball player injury risk cut point was 94%, but collegiate football player cut point was 89.6%. This emphasizes the need to use risk cut points that are age, gender, and sport specific. In a similar prospective study of 100 male and female collegiate soccer players, players with an anterior reach asymmetry were almost 6 times more likely to sustain a lower extremity injury.

In another study, researchers prospectively performed the Y Balance Test Lower Quarter on 184 collegiate athletes from 13 collegiate sports and followed them for injuries through their competitive seasons.[6] They found that the "ROC curves determined asymmetry > 4 cm (Sensitivity=59%; Specificity=72%) as the optimal cut-point for predicting injury. Only anterior asymmetry was significantly associated with non-contact injury (odds ratio=2.33, 95% confidence interval [1.15-4.76])."[6] Similar to previous studies, anterior reach asymmetry of greater than 4cm was a risk factor for injury in collegiate athletes. The authors also found that you cannot apply one composite score risk cut point across multiple sports. Specifically, it is known that the mean composite Y Balance Test score varies among groups, the risk cut point for each sport and each gender in this sample should have been used for each sub group. In this study, one composite risk cut point was applied to men's basketball (n=9), women's basketball (n=2), men's cross country running (n=13), women's cross country running (n=17), men's football (n=68), women's golf (n=3), men's track and field (n=7), women's track and field (n=3), men's tennis (n=5), women's tennis (n=5), women's volleyball (n=8), women's soccer (n=27), and women's swim/dive (n=17).[6] The authors found that one cut point was not predictive which further emphasizes the need to use the age, gender, sport/activity specific cut points found in the Move2Perform software.

Since injury risk is multifactorial, current trends in injury prevention are to categorize individuals using multiple risk factors. Lehr et al[7] screened Division III college athletes in the pre participation physical exam and followed them for an entire competitive season. At the start of the season, 183 collegiate athletes across multiple sports (including soccer) were interviewed about their injury history and tested on the YBT-LQ and FMS. Scores were entered into the Move2Perform algorithm to classify the athlete into one of four risk categories.[7] The Move2Perform algorithm calculated and weighted the composite FMS score, individual FMS test scores, results of FMS clearing tests, presence of asymmetry on any of the five bilateral FMS movements, pain during testing, previous injury, YBT-LQ asymmetry, and YBT-LQ composite score below the risk threshold for the individual athlete. The YBT-LQ composite score risk threshold was determined by the software based on competition level (i.e., junior high, high school, college, and professional), sport, and sex of the athlete.[4,5,7] If athletes were in the moderate or substantial risk category, they were 3.4 times (95% CI, 2.0 to 6.0) more likely to get injured during that season. Not one athlete in the normal category got injured; in a subsequent unpublished analysis, there were 4 non-contact ACL injuries (3 in the high-risk group and 1 in the slightly increased risk group).[7]

A military study using an algorithmic approach to injury prevention measured numerous variables previously shown to be related to injury in attempt to find the fewest, yet most robust combination of risk factors related to preventable musculoskeletal injury in service members. 922 soldiers were measured and then followed prospectively for 1 year. The researchers found prior history of injury, prior work restrictions, lower perceived recovery from prior injury, asymmetrical ankle dorsiflexion, decreased or asymmetrical performance on the YBT-LQ or YBT-UQ, and pain with Functional Movement Screen or hop testing were associated with time loss injury. The odds ratio was 5.7 (95% CI: 4.1 to 7.9), relative risk was 2.5 (95% CI: 2.1 to 2.9), and an area under the curve was 0.73. Presenting with 2 or less variables resulted in a sensitivity of 0.87 (95% CI:0.84 to 0.90) and having 6 or more resulted in a specificity of 0.91 (95% CI:0.89 to 0.94).
The Y Balance Test Lower Quarter has been shown to be predictive in high school and collegiate athletes as well as in military personnel. Even greater injury prediction can be obtained by using the Move2Perform injury prediction software that combines previous injury history with multiple tests, including the Y Balance Test and Functional Movement Screen.

Lower Quarter Y Balance Test Relationship to UCL Injuries

Garrison et al[8] found that Y Balance Test Lower Quarter in athletes who had an ulnar collateral ligament injury in the elbow was lower than healthy controls. The authors hypothesized that the poor dynamic balance as measured by the Y Balance Test Lower Quarter may indicate an inefficient lower extremity base/motor control that could alter throwing and pitching mechanics, which could cause increase stress to the shoulder and elbow and lead to upper body injury. In a subsequent study, the researchers found that the Y Balance Test Lower Quarter was normalized after comprehensive rehabilitation following Ulnar Collateral Ligament reconstruction.[9]

Use as Return to Sport Test

Mayer et al[10] and Boyle et al[11] tested athletes at 6 and 9 months post op ACL reconstruction on the YBT-LQ and FMS. The test results indicated that many displayed deficits with testing even though many of the athletes had been "cleared" to return to sport. Based on this research, Sun et al[12] reported that the Functional Movement Screen (FMS) and the Lower Quarter Y Balance Test (YBT-LQ) are "possible objective tools for evaluating a patient's readiness to return to sports after ACL reconstruction. The results suggest that many patients clinically cleared continue to have measurable functional deficits and that both FMS and YBT-LQ may be used as additional tools for return to sports clearance." Further, Garrison et al found that an athlete's performance on the anterior reach of the Y Balance Test Lower Quarter correlated with functional performance when they returned to sport.[13]

Thus, because the Y Balance Test Lower Quarter is predictive of injury and can identify the motor control changes that occur after injury, it is imperative that it is included as part of the return to play criteria for athletes and discharge criteria for all patients.

Researchers have found that limb length is a small, but significant factor in how far someone reaches on the Y Balance Test. Therefore, limb length needs to be measured (from most inferior aspect of the anterior superior iliac spine to the inferior distal surface of the medial malleolus of the right ankle to the nearest 0.5 cm).[14]

Researchers have also found that there is a learning effect with the test which is why 6 practice trials are first performed and then 3 trials in each of the 3 directions for each foot (for a total of 9 trials on each limb). In the Y Balance Test research, the greatest reach (not the average reach) is used for for analysis.

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Lower Quarter Examples

EXAMPLE 1

Name:	Mike Jones
Date of Birth:	03/02/1970
Test Date:	12/22/2015
Report ID:	R23354C3

For questions about this report contact:
Jim Smith, CSCS
ProRehab, PC
812 492 4444

Summary Report

Wellness Screening

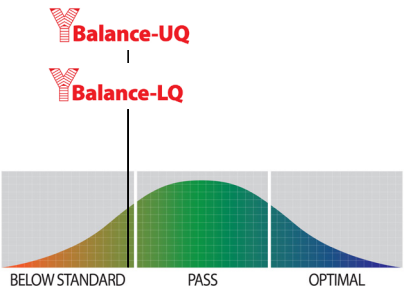
Lower Quarter Y Balance Test

	Left	Right	Difference	Standard
Anterior:	64	57.5	6.5	Below
Posteromedial:	120	117.5	2.5	Optimal
Posterolateral:	118	111	7	Below
Composite:	107.1	101.1		Optimal

Upper Quarter Y Balance Test

	Left	Right	Difference	Standard
Medial:	94	91	3	Optimal
Inferolateral:	84	79	5	Below
Superolateral:	82	79.5	2.5	Optimal
Composite:	94.2	90.2		Optimal

Here are your results compared to other 45 year old Moderate Fitness individuals.



Interpreting the YBT-LQ results requires a look at each of the four test standards. This includes examining for the presence asymmetry in each of three reach directions as well as looking at the composite score compared to the client's peer group.

In this example, there is 6.5 cm difference in the anterior reach direction and a 7 cm posterolateral asymmetry. Based on research, this is considered dysfunctional. The composite score is above the cut point for a 45 year old male involved in moderate level fitness activities. Therefore, his composite score is optimal.

It is important to note on the YBT-LQ that all four standards are components of testing motor control and determining injury risk (i.e. need to examine asymmetry in each direction and composite score).

EXAMPLE 2

Name:	Maria Wilson
Date of Birth:	05/23/1995
Test Date:	12/22/2015
Report ID:	B57E94C8

For questions about this report contact:
Joe Smith, PT
ProRehab, PC
812 492 4444

Summary Report

Pre-Season Physicals

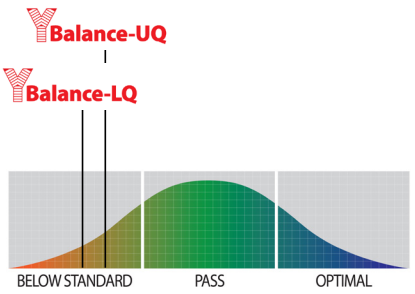
Lower Quarter Y Balance Test

	Left	Right	Difference	Standard
Anterior:	55.5	57	1.5	Optimal
Posteromedial:	99	98	1	Optimal
Posterolateral:	101.5	106	4.5	Pass
Composite:	91.4	93.5		Below

Upper Quarter Y Balance Test

	Left	Right	Difference	Standard
Medial:	77.5	79	1.5	Optimal
Inferolateral:	66.5	70	3.5	Pass
Superolateral:	69	72	3	Optimal
Composite:	76.8	80.1		Below

Here are your results compared to other College Football (Soccer) athletes.



In this example, asymmetries are not present in any of the three reach directions. However, the composite score of 91.4 is below standard for female collegiate soccer players. This means that when the best reaches in all directions were averaged and normalized for limb length, the composite score on one or both limbs was less than the cut point determined specifically for the age, gender and sport or activity (in this case, collegiate soccer).

An individual can have asymmetries in any or all of the three reach directions, but may still do very well on the composite score. Alternatively, asymmetries may be absent in all three reach directions, but the composite score may be below standard. Keep in mind that all four standards are very important and a below standard score in any of them will affect the plotting on the curve as well as the injury risk category on the Move2Perform report.

Lower Quarter FAQ

Q: Can the heel come up on the stance leg during the YBT-LQ?
A: The heel of the stance foot can come up during the test as long as the other criteria for a valid test are met. (The reach foot stays in contact with the red target area of the box, the reach foot does not touch down until the reach/return is completed, there is control when returning to the starting position and the toe is just behind the red line on the stance foot.)

Q: Do the hands have to remain on the hips during the reach attempts?
A: No. The participant is allowed to reach with the arms in any direction during the reach attempts.

Q: What does it mean to "return under control" after a reach attempt?
A: Returning to the starting position under control means that the client has little sway or loss of balance while completing the reach attempt or returning to the start. Single leg stance is maintained without the need to set the foot down immediately upon returning to the starting position to maintain balance. If you have a question if the client is returning under control, you can require the client to maintain the single leg stance position for 1 second after returning from a reach attempt.

Q: What is the reliability of YBT-LQ testing in children?
A: Faigenbaum et al found that the Y Balance Test can be used reliably in children 1st-5th grade.

Y Balance Test Upper Quarter

Purpose

The Upper Quarter Y Balance Test (YBT-UQ) is a dynamic test where upper quarter mobility and stability are both maximally challenged. Stability of the stance arm, shoulder girdle and trunk is challenged at the same time that mobility of the reach arm, shoulder girdle and trunk is challenged. During each reach component, scapular stability, mobility, thoracic rotation and core stability are combined as you encourage the client to reach as far as possible without losing balance. By reaching as far as possible outside of a narrow base of support, the client is required to use balance, proprioception, strength and full motion.

Starting Position

This test is designed to test an individual's trunk and upper extremity while in a pushup position. The goal of the test is to maintain a pushup position while on the center platform of the YBT device and push the reach indicator with one hand as far medially and diagonally across the body in the inferolateral and superolateral directions.

Description

Once you have given the client testing instructions, have the client perform two practice trials of all three reach directions sequentially on each arm prior to formal testing. The test will be completed with shoes off.

Start by having the participant place the right thumb just behind and parallel to the red line in a pushup position with feet shoulder-width apart and hands directly under the shoulders. The participant will push the reach indicator with the left hand in the red target area to the left as far as possible. While maintaining the same position, have the client push the inferolateral box as far as possible, and finally, push the superolateral box as far as possible without setting the reach hand down. Read the reach distances while the client rests, and then repeat the test two more times with the right hand on the stance plate. The client will then complete three trials in the same manner with the opposite limb. Unlike the lower quarter YBT, all three reach directions are performed sequentially, one right after another without setting the reach hand down between reach directions. When rested, the client will return to the starting position to perform the next trial.

Medial Reach

Inferolateral Reach

Superolateral Reach

Once ready to complete the formal testing, have the participant start with the right hand on the center plate and perform all three trials while reaching in the three directions in the specific testing order. Measure the maximal reach distance by reading the tape measure at the edge of the reach indicator, at the point where the most distal part of the hand reached in half centimeters (e.g. 68.5, 69.0, 69.5 cm). Three trials in each direction for each arm will be collected and the maximal reach in each direction will be included for analysis. If there are failed attempts, a maximum of six trials will be performed for any stance arm in a single direction. If the participant has more than four failed attempts, record a zero for that trial.

What Do We Look For On The YBT-UQ?

There should not be a greater than four centimeter right and left reach distance difference in the medial, inferolateral and superolateral reach directions. Also, the composite score—the sum of three reach directions is divided by three times limb length, then multiplied by 100—should not be less than the cut points that are specific for the age, gender and sport of the individual. This can be obtained by using the Move2Perform software available at www.move2perform.com.

Reach Directions And Testing Order

The upper extremity that is being measured is the stance arm. This simply represents the pattern and does not imply the functional ability of a body part or side. Reach is named in terms of directional relationship to the stance arm.

Start by having the participant place the right thumb just behind and parallel to the red line in a pushup position with feet shoulder-width apart and hands directly under the shoulders. The participant will push the reach indicator with the left hand in the red target area to the left as far as possible. While maintaining the same position, have the client push the inferolateral box as far as possible, and finally, push the superolateral box as far as possible. Read the reach distances while the client rests, and then repeat the test two more times with the right hand on the stance plate. The client will then complete three trials in the same manner with the opposite limb. Unlike the lower quarter YBT, all three reach directions are performed sequentially, one right after another without a break.

The specific testing order follows—

1. Right medial reach; right inferolateral reach; right superolateral reach
2. Left medial reach; left inferolateral reach; left superolateral reach

Reading The Measure

Measure the maximal reach distance by reading the tape measure at the edge of the reach indicator, at the point where the most distal part of the hand reached in half centimeters (e.g. 68.5, 69.0, 69.5 cm). Three trials in each direction for each arm will be collected and the maximal reach in each direction will be included for analysis. If there are failed attempts, a maximum of six trials will be performed for any stance arm in a single direction. If the participant has more than four failed attempts, record a zero for that trial.

Test Faults

- Shoving push box
- Not returning to starting position under control
- Touching down with reach hand before all three reach directions are completed
- Hand on top of stance plate
- Not maintain both feet in contact with the floor

Practice Trials

Once you have given the client the testing instructions, have the client perform two practice trials, two with each arm in each of the three directions prior to formal testing. The test will be completed with shoes off.

Note: Only two practice trials are performed for the Upper Quarter Y Balance Test due to the high demand of the test and fatigue becoming factor a,

Measuring Upper Limb Length

First, determine the client's arm length in standing by measuring the distance from the Cervical 7 (C7) spinous process—most bony prominence at the base of the neck—to the distal tip of the third digit to the nearest half centimeter with the arm elevated to 90 degrees—out to side. If you are unable to determine the location of the C7 spinous process, have the participant flex and extend the neck; the C7 spinous process will remain prominent throughout. Only measure the right arm.

Tips for Testing

- The test is performed with the shoes off.
- The arm that is being measured is the stance arm. This simply represents the pattern and does not imply the functional ability of a body part or side.
- Two practice trials for each arm in each direction should be performed prior to testing.
- Client must maintain unilateral stance on the platform.
- Client must maintain reach hand contact with the reach indicator on the target area while it is motion (i.e. cannot shove the reach indicator).
- Client cannot use the reach indicator for stance support (i.e. place hand on top of reach indicator).
- Client must keep both feet in starting position throughout the test.
- The three directions must follow this pattern: medial, inferolateral and superolateral directions.
- Client must return the reach hand to the starting position under control.
- Do not coach the movement; simply repeat the instructions if needed.
- The stance arm elbow may bend during the test.

Y Balance Test – Upper Quarter Research

Reliability, Baseline and Return to Sport Testing

Researchers have found the Y Balance Test Upper Quarter to have good reliability with ICC coefficients ranging from 0.80 to 1.0 for test-retest as well as intrarater reliability. [1-4] In addition, multiple studies found there was no difference in YBT-UQ performance between dominant and non-dominant limbs in professional and collegiate baseball players (including pitchers), collegiate swimmers, and the general population.[1-4] This indicates that YBT-UQ performance is a good measure in return to sport testing when rehabilitating shoulder and arm and back injuries or getting baseline measurements. Westrick et al[4] stated:

"Similarity on the UQYBT between dominant and non-dominant limbs indicates that performance on this test using a noninjured UE may serve as a reasonable measure for "normal" when testing an injured UE."

A Unique Measure of UE CKC Ability

When compared to other upper extremity tests such as the Closed Kinetic Chain Upper Extremity Stability Test (CKCUEST) and the One Armed Hop Test researchers found that the YBT-UQ requires stability at the person's limit of stability in a one-arm push up position. The stability required during the YBT-UQ is unlike planks, side bridges, trunk flexor/extensor endurance tests and the CKCUEST. Westrick et al[4] reported:

"There was a significant fair to moderate association between performance on the UQYBT and the CKCUEST, LTET, and push-ups. These results suggest the tests are interrelated but do not necessarily assess equal components of UE CKC ability."

Injury Prediction

A military study used the Y Balance Test Upper Quarter as part of an injury prediction algorithm. The researchers found prior history of injury, prior work restrictions, lower perceived recovery from prior injury, asymmetrical ankle dorsiflexion, decreased composite score or asymmetrical performance on the YBT-LQ or YBT-UQ, and pain with Functional Movement Screen or hop testing were associated with time loss injury in soldiers over a year period.

Thus, the Y Balance Test Upper Quarter is a reliable and valid means to determine a person's upper quarter functional symmetry for intake or return to sport/activity testing. Similar to the Y Balance Test Lower Quarter, the composite score needs to be compared to the age, gender, and sport/activity cut points which are found in the Move2Perform software.

References

1. Butler R, Arms J, Reiman M, et al. Sex differences in dynamic closed kinetic chain upper quarter function in collegiate swimmers. Journal of athletic training. 2014;49(4):442-446.
2. Butler RJ, Myers HS, Black D, et al. Bilateral differences in the upper quarter function of high school aged baseball and softball players. International journal of sports physical therapy. 2014;9(4):518-524.
3. Gorman PP, Butler RJ, Plisky PJ, Kiesel KB. Upper Quarter Y Balance Test: reliability and performance comparison between genders in active adults. Journal of strength and conditioning research / National Strength & Conditioning Association. 2012;26(11):3043-3048.
4. Westrick RB, Miller JM, Carow SD, Gerber JP. Exploration of the Y balance test for assessment of upper quarter closed kinetic chain performance. International journal of sports physical therapy. 2012;7(2):139-147.

Verbal Instructions For The Upper Quarter Y Balance Test

The following is a script to use while administering the Upper Quarter Y Balance Test. For consistency throughout all testing this script should be used during each test. Equipment needed: Y Balance Test kit and cloth tape measure

Instructions

Please let me know if there is any pain while performing any portion of the test.

Please remove your shoes while performing the test.

Place your _____ hand on the center of the stance plate with your thumb just behind and parallel to the red starting line with the other hand on top of the reach indicator.

While maintaining the _____ hand on the platform, push the reach indicator in the red target area as far as possible with the opposite hand out to the side, then under and across, and finally over and across without resting between directions.

The reach hand must maintain contact with the reach indicator on the target area while it is motion (i.e.. cannot shove the reach indicator).

Do not use the reach indicator for stance support (i.e. don't place hand on top of reach indicator).

Return the reach hand to the starting position under control.

Repeat two more times and then use the opposite arm in the same three directions.

Do you understand the instructions?

Have the participant perform each movement three times before alternating the supporting arm in the same direction.

Upper Quarter Examples

EXAMPLE 1

Name:	Kyle Howard
Date of Birth:	08/25/1987
Test Date:	12/22/2015
Report ID:	G43990BD

For questions about this report contact:
Joe Smith, PT
ProRehab, PC
812 492 4444

Comprehensive Report

Pre-Season Physicals

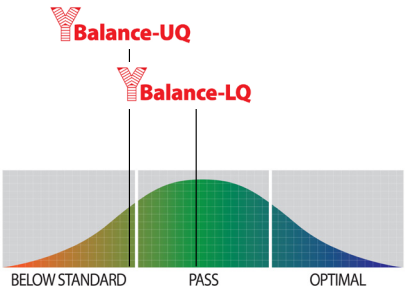
Lower Quarter Y Balance Test

	Left	Right	Difference	Standard
Anterior:	69.5	71	1.5	Optimal
Posteromedial:	106	109	3	Optimal
Posterolateral:	109.5	111	1.5	Optimal
Composite:	100.7	103.2		Pass

Upper Quarter Y Balance Test

	Left	Right	Difference	Standard
Medial:	79	83	4	Pass
Inferolateral:	80	85	5	Below
Superolateral:	66.5	72	5.5	Below
Composite:	81.5	87		Pass

Here are your results compared to other Professional Baseball athletes.



Interpreting the YBT-UQ results requires a look at each of the four test standards. This includes examining for the presence asymmetry in each of three reach directions as well as looking at the composite score compared to the client's peer group.

In this example, there is a 5 cm difference in the inferolateral reach direction and a 5.5 cm asymmetry in the superolateral reach. Based on research, this is considered dysfunctional. The right and left composite scores are above the cut point established for professional baseball players, therefore his composite score is in the passing standard.

It is important to note on the YBT-UQ that all four standards are components of testing motor control and determining functional symmetry (i.e. you need to examine asymmetry in each direction and composite score).

EXAMPLE 2

Name:	Maria Wilson
Date of Birth:	05/23/1995
Test Date:	12/22/2015
Report ID:	B57E94C8

For questions about this report contact:
Joe Smith, PT
ProRehab, PC
812 492 4444

Summary Report

Pre-Season Physicals

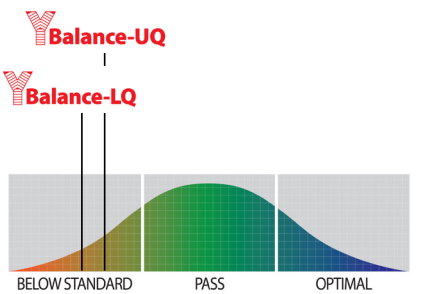
Lower Quarter Y Balance Test

	Left	Right	Difference	Standard
Anterior:	55.5	57	1.5	Optimal
Posteromedial:	99	98	1	Optimal
Posterolateral:	101.5	106	4.5	Pass
Composite:	91.4	93.5		Below

Upper Quarter Y Balance Test

	Left	Right	Difference	Standard
Medial:	77.5	79	1.5	Optimal
Inferolateral:	66.5	70	3.5	Pass
Superolateral:	69	72	3	Optimal
Composite:	76.8	80.1		Below

Here are your results compared to other College Football (Soccer) athletes.



In this example, asymmetries are not present in any of the three reach directions. However, the composite score of 76.8 is below standard for female collegiate soccer players. This means that when the best reaches in all directions were averaged and normalized for limb length, the composite score on one or both limbs was less than the cut point determined specifically for the age, gender and sport or activity (in this case, collegiate soccer).

An individual can have asymmetries in any or all of the three reach directions, but may still do very well on the composite score. Alternatively, asymmetries may be absent in all three reach directions, but the composite score may be below standard. Keep in mind that all four standards are very important and a below standard score in any of them will affect the plotting on the curve as well as the injury risk category on the Move2Perform report.

Upper Quarter FAQs

Q: Do you have expected normative data (published) for YBT-LQ and UQ for any age group/etc? If yes, are there published cut-off scores (or proposed scores) related to injury risk, etc?

A: The risk cut points are based on multiple published studies as well as studies presented at scientific meetings (specifically Butler 2013, Plisky 2006, Lehr 2013). When risk cut points for a specific group are not published, an algorithm is used to establish the cut point based on the database of over 60,000 tests. This method of establishing risk cut points was validated by Lehr et al 2013 in collegiate athletes. The cut points can be accessed on an individual client basis by using the Move2Perform software.

Q: I currently use the Y Balance Test in my practice. Is it possible to get the cut points without buying the software?

A: No. The cut points are specific for each age, gender and sport. Given the complexity of the injury risk algorithm (which utilizes the Y Balance Test Injury Risk cut points), you need to use the Move2Perform software to take full advantage of the latest research in return to sport/activity and pre-participation testing.

Q: When analyzing Y Balance Test results, why are cut points necessary for age, gender, sport/activity level?

A: The Y Balance Test is predictive of injury and is frequently used in pre-participation and return to sport decision making. However, researchers have found that a specific risk cut point MUST be used for each population:

- High school basketball player injury risk cut point was 94% (Plisky 2006)
- Collegiate football player cut point was 89% (Butler 2013)
- To best predict injury in collegiate athletes, a Y Balance Test composite score risk cut point was used based on age, gender and sport for 10 different sports across both genders (Lehr 2013)
- Professional soccer players score better than professional basketball players on the Y Balance Test (Plisky 2011 ACSM)
- Collegiate and Professional Soccer players performed better on the Y Balance Test than high school soccer players (Butler 2012)

Each age, gender, and sport/activity level has a different average composite score as well as a different injury risk cut point. In addition, remember that in 3 studies the injury risk cut points were different in high school vs. collegiate athletics and that the 2013 Lehr et al study validated using Y Balance Test risk cut points based on age, gender and sport.

How do we apply this information? When determining an athlete's readiness for return to sport or testing dynamic balance, we need to use population specific risk cut points and normative data for analyzing Y Balance Test results. The population specific risk cut points and normative database are applied by using the Move2Perform software.

Appendix A

TEST PERFORMANCE STANDARDS CHECKLIST

Y Balance Test Lower Quarter

Measuring Limb Length

- The subject's right limb, measured in centimeters from the anterior superior iliac spine to the most distal portion of the medial malleolus with a cloth tape measure in supine.
- Be sure to get into soft tissue area under ASIS and hook under ASIS and go past medial malleolus and measure at most distal tip.

Testing Order

- Right Anterior, Left Anterior; Right Posteriomedial, Left Posteriomedial; Right Posteriolateral, Left Posteriolateral.

Starting Position

- With socks and shoes off, have person stand on the stance platform with the right foot, tip of big toe at the start line. Reach leg is slightly touched down in triangular area formed by posterior pole and stance plate.
- Note foot placement after each trial (foot frequently moves or get repositioned, need to reset prior to next trial).

Reading the measure

- Read in half centimeters (69.0, 69.5, 70.0). If the reach indicator is over the number, it is that number. If the whole number is showing, it is that number plus a half. If the reach indicator is over the next number, it is that next whole number.

Identifying a Failed Reach Trial

- Failure to maintain unilateral stance on the platform (e.g. touched down to the floor with the reach foot or fell off the stance platform).
- Failure to maintain reach foot contact with the reach indicator on the target area while it was in motion (e.g. kicked the reach indicator).
- Using the reach indicator for stance support (e.g. placed foot on top of reach indicator).
- Failure to return the reach foot to the starting position under control.
- Failure to perform a successful trial in 6 attempts.
- Reports of pain during any trial.

Greatest or average reach?

- Greatest reach distance of three successful trials, for each direction, for each limb.

Do the hands need to be on the hips during the test?

- No

What is returning under control?

- If you are questioning whether or not the client is returning under control, require the client to maintain the single leg stance position for one second after returning from the reach attempt.

Does the heel have to stay down?

- No

What is the reliability of YBT-LQ testing in children?

- Faigenbaum et al found that the Y Balance Test can be used reliably in children 1st-5th grade.

Closed Kinetic Chain Dorsiflexion

Starting Position

- With the individual in a lunge position kneeling on the left knee and right foot out in front. Right ankle, knee and hip are at 90 degree angles; left knee and hip aligned under the shoulders and left foot dorsiflexed.

Reading the Measure

- While the individual is in the starting position place the bubble goniometer over the While the individual is in the starting position place the bubble goniometer over the tibial tuberosity of the lower leg (or two finger widths below tibial tuberosity if using phone inclinometer). Next, have the individual lunge forward bringing the right knee over the toes as far as they can without losing heel contact with the surface, read and record the degrees of motion at this point. Repeat on the other side. Be sure the knee tracks forward over the 4th ray and the heel maintains in contact with the surface. Next, have the individual lunge forward bringing the right knee over the toes as far as possible without losing ground contact with the right heel, read and record the degrees of motion at this point. Repeat on the other side.

Key Points

- Have foot straight forward (not externally rotated)
- Keep knee aligned over the 4th ray (typically person will deviate medially)
- Palpate between heel and kit (or ground) to determine when heel starts to lift off ground (pressure on finger gets less)

Y Balance Test Upper Quarter

Measuring Limb Length

- The subject's right limb, measured in centimeters from C7 to the most distal portion of the longest phalanx with a cloth tape measure.
- Have the subject look down chin to chest to palpate and identify the C7 vertebrae and then measure from C7 to the most distal tip of the longest finger.

Testing Order

- Right Medial, Right Inferolateral, Right Superolateral in succession for three (3) attempts. Then Left Medial, Left Inferolateral, Left Superolateral for three (3) attempts.

Starting Position

- With socks and shoes off, have the athlete begin by assuming a pushup position with feet shoulder width apart, right hand on the stance platform with the Right thumb along the start line. Left hand on the medial reach indicator at shoulder width.
- Shoulder Width: Place feet shoulder width apart by aligning the inside edge of the foot with the crease of the armpit

Reading the measure

- Read in half centimeters (69.0, 69.5, 70.0). If the reach indicator is over the number, it is that number. If the whole number is showing, it is that number plus a half. If the reach indicator is over the next number, it is that next whole number. When recording the scores, the stance arm indicates the limb being tested.

Identifying a Failed Reach Trial

- Failure to maintain unilateral stance on the platform (e.g. touched down to the floor with the reach hand or fell off the stance platform).
- Failure to maintain reach hand contact with the reach indicator on the target area while it was in motion (e.g. shoved the reach indicator).
- Using the reach indicator for stance support (e.g. placed fingers on top of reach indicator).
- Failure to return the reach hand to the starting position under control.
- Failure to perform a successful trial in 3 attempts.

SHOES ARE OFF IN YBT – UQ!

The feet need to stay in contact with ground

Unlike the Y Balance Test Lower Quarter, all three reach directions are performed sequentially without touching down or a break. A break is allowed between trials.

Can the elbow be bent or remain straight during the YBT-UQ?

- The elbow can bend during the YBT-UQ

Greatest or average reach?

- Greatest reach distance of three successful trials, for each direction, for each limb.

Appendix B

YBT™ Y BALANCE TEST

SCORE SHEET

NAME:_____

DATE:_____/_____/_____

Lower Quarter: Right LE Limb Length: _____cm (Distal ASIS to Distal Medial Malleolus)

DIRECTION	GREATEST RIGHT	GREATEST LEFT
Anterior		
Posteromedial		
Posterolateral		

Upper Quarter: Right UE Limb Length: _____cm (C7 to tip of Longest Finger)

DIRECTION	RIGHT TRIAL 1	RIGHT TRIAL 2	RIGHT TRIAL 3
Medial			
Inferolateral			
Superolateral			

LEFT TRIAL 1	LEFT TRIAL 2	LEFT TRIAL 3

DIRECTION	GREATEST RIGHT	GREATEST LEFT
Medial		
Inferolateral		
Superolateral		

Composite Right Score: Upper_____ Lower_____

Composite Left Score: Upper_____ Lower_____

Composite Reach Distance:
Composite score = ((sum of the greatest reach in each direction) / (3 x Limb Length)) x 100.
Calculate the composite scores for left and right separately.

Research validated composite score cut points for age, gender, and sport/activity are available through the Move2Perform software www.move2perform.com