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A Guide to Assessing Mobility for Strength and Conditioning Coaches

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By [Louis Howe](#)

Strength and conditioning (S&C) coaches are commonly responsible for programming mobility exercises for their athletes, with the goal to either improve movement quality or reduce injury risk. If you ask a room full of coaches to list the mobility exercises they regularly program, you'll no doubt receive an endless list of movements along with countless variations. Ask the same group of coaches to list tests they employ that accurately and reliably identify deficits or changes in an athlete's mobility, and the list will generally be significantly shorter. This is likely the reason so many athletes are prescribed countless shoulder, thoracic, hip, and ankle mobility exercises as part of their routines—if you can't assess something, better do the exercises to develop it, just in case.

S&C coaches should possess a basic skill set that allows them to reliably measure an athlete's range of motion (ROM), which

programs with little return for improvements in performance. To avoid valuable training time being wasted performing needless mobility exercises, S&C coaches should possess a basic skill set that allows them to reliably measure an athlete's range of motion (ROM), which underpins fundamental movements.

The goal of this two-part series will be to demonstrate ROM assessments that require no specialized equipment, but produce data that is reliable and valid, in order to direct the training process. Part 1 will focus on lower extremity assessments, while Part 2 will cover tests for the upper extremities.

Why Should Coaches Perform ROM Assessments?

Mobility underpins our ability to perform exercises through a full ROM, allowing us to adhere to our technical model for any given movement. This is an important consideration, as the ability to safely load an exercise through full ROM may support greater development in muscle hypertrophy¹ and maximal strength². However, when an anatomical region lacks ROM, movement quality will be compromised, and the consequence may be compensatory movements that have the potential to increase injury risk.

The squat is an example of this for a lower extremity exercise. During the high bar [back squat](#), up to approximately 40 degrees of ankle dorsiflexion ROM is needed in order to allow an athlete to maintain a relatively upright torso while breaking parallel³(although this value depends on anthropometric dimensions and the strategy the athlete adopts). In instances where an athlete possesses significantly less ankle dorsiflexion ROM, reduced depth⁴, greater knee valgus⁵, increased forward trunk lean⁶, and excessive spinal flexion⁷ may occur as a compensation to achieve squat depth.

An example for the upper extremity is an athlete struggling to extend their thoracic spine, where overhead pressing may be compromised. Thoracic spine extension, a capacity that is becoming significantly compromised in today's technology-driven society⁸, is fundamental to an athlete's ability to perform the overhead press.

Generally speaking, athletes likely need approximately 15 degrees of thoracic spine extension⁹ to facilitate scapulothoracic motion (although this value likely depends on the athlete's start position). When an athlete demonstrates poor thoracic spine extension, shoulder ROM will be compromised¹⁰, leading to trouble with locking out. A compensation may be to sway the pelvis forward and hyperextend the lower segments of the lumbar spine, to orient the barbell over the

Assessing ROM requires S&C coaches to have a skillset that allows us to collect objective data that can highlight if an athlete lacks mobility in any anatomical region. Traditionally, ROM assessments have required us to have access to, and experience in, using specialized equipment (e.g., inclinometers and goniometers), along with excellent palpatory skills that many S&C coaches do not possess. However, the accessibility of smartphones offers S&C coaches the opportunity to bypass this obstacle.

Smartphones equipped with gyroscopes are able to determine the orientation of the phone in space and allow for the measurement of angles using free applications. As a result, innovative research has shown smartphones can accurately and reliably measure joint angles during various ROM assessments if used in a similar fashion to inclinometers.^{11,12,13}

Innovative research has shown smartphones can accurately and reliably measure joint angles during various ROM assessments if used in a similar fashion to inclinometers, says @LouisHowe_SandC.

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Within this article, I'll focus on commonly used ROM assessments, demonstrating how to perform and collect objective data for the following ROM assessments:

- Supine active hip flexion test
- Thomas test
- Modified Thomas test
- Supine active hip abduction test
- Active hip rotation test (internal and external)
- Active knee extension test
- Modified weight-bearing lunge test

Using a Smartphone to Perform ROM Assessments

Before we discuss techniques, it's important we cover some ground rules for using smartphones to measure ROM in order to standardize our procedures:

1. Prior to testing, remove your phone case, which may potentially alter the contour of the phone.

ROM ASSESSMENTS.

3. There isn't much evidence for this, but I'd suggest (at least until there is evidence that says otherwise) that coaches be cautious about using different phone models interchangeably. Measuring the inclination of a bony landmark with an iPhone SE may produce different results than using a more recent and larger model.
4. Again, there is little evidence for this, but I would caution against using different applications interchangeably.

Palpating Bony Landmarks

For most S&C coaches, identifying anatomical landmarks can be a difficult skill to master and this may limit their ability to perform ROM assessments. However, it is important to locate some landmarks in order for us to optimize our phone placement and take reliable measures. For all of the assessments shown here, I've kept the number of landmarks for coaches to identify at a minimum. Below is an image of all relevant anatomical regions that we need to locate for the lower extremity assessments.

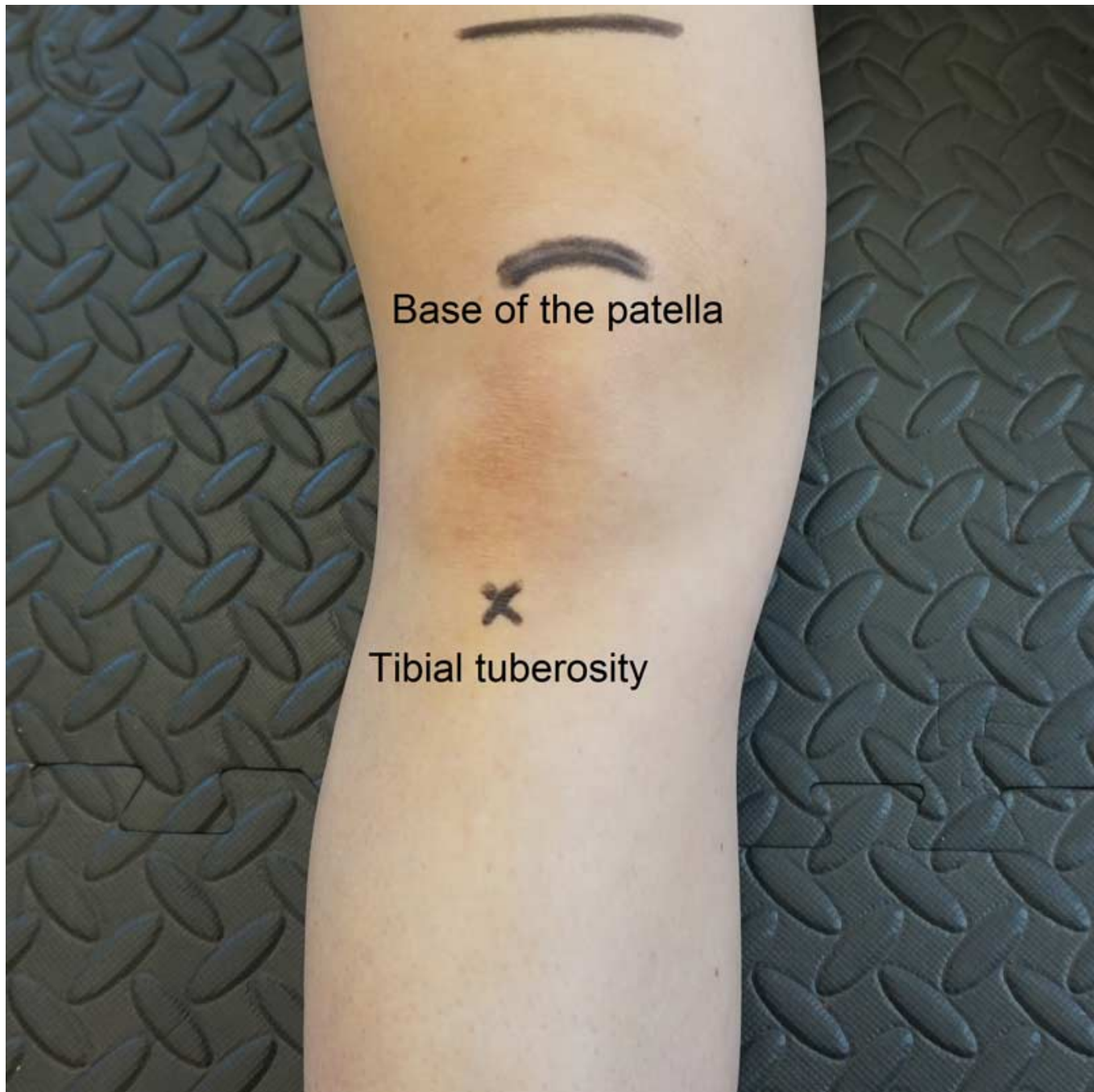


Figure 1. These are all the relevant anatomical regions that we need to locate for lower extremity assessments.

To give coaches a reference for what may be normal, I've provided some values for performance variables that can help decision-making. This is always a very superficial process, so please treat any normative values provided in this next section with caution. The importance of the values derived from ROM assessments should be determined on an individual basis.

Supine Active Hip Flexion Test

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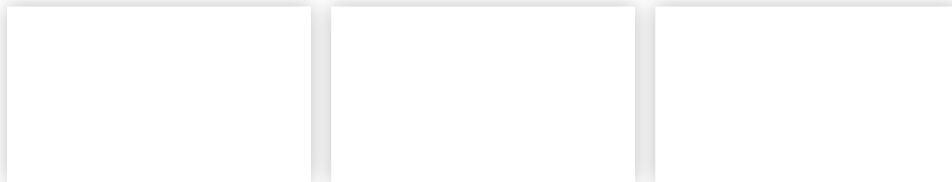
than 20 degrees possess more than enough hip flexion to perform deep squats.

Starting position: Athlete lies in a supine position with the legs extended.

Movement: Athlete maximally flexes at the hip while simultaneously flexing at the knee.

Measurement: Prior to performing the test, locate the base (top) of the patella. Draw a line 5 centimeters above the base of the patella that runs in a transverse direction (see figure 1). At maximum flexion, align the top of the phone with this line (set in portrait and calibrated to a vertical reference).

Video 1 shows how to assess hip flexion ROM.



Video 1. Flexibility of the hip is often seen as only “interesting” in some coaching and therapy circles, but if combined with other data sets, it could be revealing.

Thomas Test

This version of the Thomas test is used to identify restriction of the uniarticular hip flexor muscles (i.e., iliacus, psoas major, and tensor fascia lata) and passive structures of the anterior hip (i.e., joint capsule and extracapsular ligaments). In my experience, restriction in hip extension is actually relatively rare for the athletic population. When most athletes present with

When most athletes present with restriction in hip extension, it's most commonly due to a lack of extensibility for the biarticular hip flexors, says @LouisHowe_SandC.

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Starting position: Athlete lies in a supine position with both hips and knees maximally flexed so that the pelvis is posteriorly rotated and the lumbar spine is flat against the ground.

Movement: Athlete maximally extends the test leg in an attempt to make contact between the back of the thigh and the ground. Importantly, coaches should monitor the position of the non-test leg, making sure the hip remains maximally flexed throughout the test.

Measurement: Prior to performing the test, locate the base (top) of the patella. Draw a line 5 centimeters above the base of the patella that runs in a transverse direction (see figure 1). At maximum hip extension, align the top of the phone with this line (phone set in landscape and calibrated to a horizontal reference).

Video 2 shows how to assess hip extension ROM.

00:45



Video 2. When testing the hip, make sure you don't reduce risk or function to maximal range

MODIFIED THOMAS TEST

The modified Thomas test (this variation is sometimes called the Kendall test) allows coaches to identify a lack of extensibility in the rectus femoris muscle—a biarticular muscle that both flexes the hip and extends the knee. When an athlete struggles to maintain an upright trunk or neutral spine alignment during a lunge pattern, the common culprit is the rectus femoris muscle. As this test measures tibia angle relative to vertical, full ROM would be an athlete achieving an angle of 0 degrees.

When an athlete struggles to maintain an upright trunk or neutral spine alignment during a lunge pattern, the common culprit is the rectus femoris muscle, says @LouisHowe_SandC.

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Starting position: Athlete lies in a supine position on a plinth or high bench (important that the foot can clear the floor), so that the knees hang over the table/bench by a few inches. The start position for this test is the finish position for the Thomas test: The knee of the test leg is extended, and the back of the thigh contacts the table/bench, while the non-test leg is maximally flexed at the hip to posteriorly rotate the pelvis.

Movement: Athlete is cued to maximally flex the knee on the test leg. Again, coaches should monitor the non-test leg to make sure the hip remains maximally flexed throughout the test.

Measurement: Prior to performing the test, locate the tibial tuberosity (see figure 1). At maximum knee flexion, align the phone with this anterior border of the tibia just below the tibial tuberosity (phone set in portrait and calibrated to a vertical reference).

Video 3 shows how to assess the biarticular rectus femoris extensibility.

00:34

Video 3. Modified Thomas tests are still very useful for coaches and therapists to see changes from a training program, but don't expect big changes overnight. One variable helps paint a picture, but can never be a magic bullet for analysis purposes.

Active Hip Rotation Test (Internal and External)

To test hip rotation, athletes can be in either a seated or supine position. The decision is yours, and you should base it on the demands imposed on the athlete. For example, if you want to know why an athlete keeps spinning their feet out during the descent phase of the squat, checking while they're in a seated position with the hip flexed is more relevant.

Normative values for hip internal and external rotation are 35 degrees and 45 degrees, respectively.¹⁵ However, these values will be heavily influenced by the bony architecture of the acetabulum and femur¹⁵. Therefore, coaches should show caution when interpreting these results.

Starting position: With the athlete either lying supine or seated on a plinth or high bench, position the knees so they are a few inches over the table/bench and flexed to 90 degrees. The athlete moves the non-test leg off the edge of the table/bench without rotating the pelvis.

Movement: Athlete is cued to maximally internally (foot away from the midline) or externally (foot towards the midline) rotate the hip while maintaining alignment of the pelvis and knee.

Measurement: Prior to performing the test, draw a line 10 centimeters above the tip of the lateral malleolus (the bottom of the ankle bone on the outside of the lower leg). At maximum

00:56

Video 4. Hip rotation assessments are great when they are active, as there is more to them than isometric strength. Combining strength and mobility is a great way to see how an athlete uses their range of motion in isolation.

Supine Hip Abduction Test

In my experience, hip abduction ROM is hugely underrated as a potential cause for limited [squat depth](#). During the squat, the hip flexes while simultaneously abducting to approximately 30-40 degrees (the knee moving away from the midline of the body).³The cues “sit into the hole,” “knees out,” or “spread the floor” facilitate getting the hip into an abducted position. This is important to optimize squat mechanics.

Athletes with long torsos relative to their femurs will require less ankle dorsiflexion ROM to achieve any given trunk angle during the squat. We obviously can't alter their femur length structurally, but we can functionally. If we cue our athletes to abduct their hips (get the knees out), the athletes will reduce their femur length in the anterior-posterior direction while maintaining their torso length. This results in a functional shortening of the femur relative to the torso in the sagittal plane and, therefore, reduces ankle ROM demands during squatting.¹⁶

As a side note, this is why the functional movement screen deep squat biases athletes with excellent ankle dorsiflexion ROM. By forcing the athletes to have their feet pointed straight ahead, athletes must demonstrate exceptional levels of ankle ROM.¹⁷ Even just a small amount of toe-out, which increases hip abduction, can improve overhead squat performance.¹⁸

For this assessment, the value produced is relative to vertical, so values greater than 40 degrees are likely sufficient for most activities.

Starting position: Athlete lies in a supine position with the legs extended. The test leg is flexed at the hip and knee to 90 degrees.

Movement: The athlete maximally abducts at the hip (moves the knee away from the midline of the pelvis) while the coach stabilizes the pelvis, preventing rotation from occurring.

Measurement: At the point of maximal hip abduction, place the phone on the medial surface at approximately mid-thigh (phone set in portrait and calibrated to a vertical reference).

Video 5 shows how to assess hip abduction ROM.

00:38



Video 5. You can do another hip evaluation supine, if guided properly. You may need to escalate athletes who have pain to sports medicine staff if they are visually uncomfortable while performing the movement.

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deadlifts (or any hinging exercise where the knee is relatively extended) should be checked for hamstring extensibility using the active knee extension test. This test provides values relative to vertical, with normal for the active knee extension considered to be less than 20 degrees.¹⁹

You should check athletes who show minimal hip flexion before losing their neutral spine alignment during Romanian deadlifts for hamstring extensibility using the active knee extension test.

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Starting position: Athlete lies in a supine position with the legs extended. The test leg is flexed to 90 degrees at the hip and knee, while the foot is maintained in a neutral position.

Movement: The athlete maximally extends the knee while maintaining hip and foot alignment.

Measurement: At the point of maximal knee extension, place the phone on the anterior border of the tibia below the tibial tuberosity (phone set in portrait and calibrated to a vertical reference).

Video 6 shows how to assess hamstring extensibility.

00:37

MODIFIED WEIGHT-BEARING LUNGE TEST

Ankle dorsiflexion ROM can impact squat mechanics.^{4,6,8,17} To measure ankle dorsiflexion ROM, weight-bearing methods are more functionally relevant to closed-chain exercises than non-weight-bearing methods. This is commonly shown in research where weight-bearing lunge test performance correlates with movement quality during squatting and landing tasks, and non-weight-bearing techniques do not.⁴

Video 7 below demonstrates how to measure ankle dorsiflexion ROM using the modified weight-bearing lunge test. For this assessment, a value of 0 degrees represents the tibia being upright and the ankle in a neutral alignment. As activities like the deep squat require approximately 40 degrees of ankle dorsiflexion ROM¹⁴, you can use this value to determine a deficit. However, I generally want my athletes to achieve 45 degrees for this test, as this allows me some leeway for the error associated with this assessment.

Starting position: Athlete sets up in a half-kneeling position, with the front foot half a foot length ahead of the back knee. They position the front leg so the knee is located directly over the toes to encourage a neutral alignment of the foot. The pelvis faces forward and the trunk is positioned relatively upright. The athlete may hold onto a stable object (e.g., the wall) to help maintain balance.

Movement: The athlete reaches the front knee as far forward as possible, while cued to maintain pelvic alignment and keep the heel down. Coaches must be sure that the athlete does not pronate at the foot (represented as a collapse of the medial longitudinal arch during the movement) to prevent the midtarsal joint contributing to the assessment outcome.

Measurement: At the point of maximal ankle dorsiflexion prior to heel lift, place the phone on the anterior border of the tibia below the tibial tuberosity (phone set in portrait and calibrated to a vertical reference).

Video 7 shows how to assess ankle dorsiflexion ROM.

00:40 |

Video 7. Modifications to the conventional lunge are a sound option for those with attention to detail. You can test athletes quickly and effectively with this variation.

What to Do Next?

Now that we've covered how to perform ROM assessments using a smartphone, all that's left is for you, as a coach, to practice the techniques shown and develop expertise. In my experience, a few hours of practice are all you need to reach the reliability values commonly reported in the literature. On that note, I highly recommend you start to establish your own reliability values now in order to perform this test repeatedly.

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Louis Howe has been coaching international level athletes since 2007, and previously worked for one of London's top university elite athlete scholarship programs. He currently lectures for the University of Cumbria on the Sport Rehabilitation program. Prior to this position, Howe lectured for the Strength and Conditioning undergraduate and postgraduate degrees at St Mary's University, where he also provided strength and conditioning services to a group of international track and field athletes. Howe is an accredited strength and conditioning coach with the U.K. Strength and Conditioning Association and is currently completing his Ph.D., investigating compensatory movement strategies derived from ankle dorsiflexion range of motion restrictions during landings.

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Paul Warren says

July 17, 2019 at 12:52 am

Great article, plenty of take aways for this club athletics coach trying to better himself. Is there any angle app you would recommend (android user)?

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Louis says

July 17, 2019 at 1:39 am

Thanks Paul. I've used a few but my preference is iHandy Level. It's all you need, allowing you to rotate the phone both vertically and horizontally, along with holding the final angle.

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Ed Lippie says

July 19, 2019 at 11:30 am

Great article, very thorough! This is a great application of technology to get objective values. Thank you!

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