CONTENTS

ACE GROUP FITNESS INSTRUCTOR FITNESS ASSESSMENT PROTOCOLS

THE FITNESS ASSESSMENTS PRESENTED HERE ARE NOT INTENDED TO SERVE AS comprehensive coverage of the topic, but rather as an introduction to various assessments that fall within the scope of practice of an ACE Certified Group Fitness Instructor (GFI). For full coverage of the appropriate use of fitness assessment protocols and sequencing guidelines, refer to the *ACE Personal Trainer Manual*.

CARDIORESPIRATORY-FITNESS TESTING

Maximal and submaximal exercise tests using the treadmill or bicycle ergometer are not well-suited for measuring the cardiorespiratory fitness of groups. In the group fitness setting, field tests for measuring cardiorespiratory endurance, such as the YMCA submaximal step test, are more appropriate because they are easy to administer, practical, inexpensive, and less time-consuming than the treadmill and bicycle ergometer tests. One important consideration for administering a cardiorespiratory field test with a group of individuals is that participants must be taught how to accurately measure their heart rates.

YMCA Submaximal Step Test

The YMCA submaximal step test is one of the most popular step tests used to measure cardiorespiratory endurance and is considered suitable for low-risk, apparently healthy, nonathletic individuals between the ages of 20 and 59. This particular test uses any 12-inch (30.5 cm) step, with the Reebok® step being utilized most frequently in fitness settings (four risers plus the platform).

CONTRAINDICATIONS

Due to the nature of step testing, this assessment may not be appropriate for:

- Individuals who are extremely overweight
- Individuals with balance concerns
- Individuals with orthopedic problems (e.g., knee or low-back)
- Individuals who are extremely deconditioned, as the intensity of the test may require near-maximal effort
- Individuals who are short in stature, as they may have trouble with the step height

Figure 1
Three-minute step test—stepping cycle

Equipment:
- 12-inch (30.5 cm) step
- Stopwatch
- Metronome
- Stethoscope (optional)

Pre-test procedure:
- After explaining the purpose of the YMCA submaximal step test, set the metronome to a cadence of 96 "clicks" per minute, which represents 24 steps cycles/minute (or 96 foot placements).
  - ✓ Describe and demonstrate the four-part stepping motion ("up," "up," "down," "down").
  - ✓ Either foot can lead the step sequence.
  - ✓ Permit a short practice to allow participants to familiarize themselves with the cadence.
- The goal of the test is to step up and down on a 12-inch riser for three minutes (Figure 1).
- Explain to the participant that heart rate will be measured through palpation (or auscultation) for one full minute upon completion of the test, counting the number of beats during that first minute of recovery. It is important for the participant to sit down immediately following the test and remain quiet to allow the instructor to accurately assess heart rate.

Test protocol and administration:
- On the instructor's cue, the participant begins stepping and the stopwatch is started.
- The instructor can coach the initial steps to make sure the participant is keeping pace with the metronome. Cue the time remaining to allow the participant to stay on task.
- At the three-minute mark, the test is stopped and the participant immediately sits down. Count the participant's heart rate (HR) for one entire minute.
  - ✓ The test score is based on the fact that the immediate post-exercise HR will decrease throughout the minute cycle.
  - ✓ It is important that the HR check begin within five seconds of test completion. (Placing a stethoscope to the participant's chest enhances the tester's ability to count the actual heartbeats. In some cases, the participant may be uncomfortable with this procedure, in which case a radial pulse check will also suffice.)
- The participant's one-minute post-exercise HR is recorded.
- Encourage a three- to five-minute cool-down followed by stretching of the lower extremities. The participant may experience post-exercise dizziness or other signs of distress if no cool-down is performed (i.e., blood pooling in the extremities and accelerated HR).
- Classify the participant's score using Table 1 or 2 and record the values.
- Continue to observe the participant, as negative symptoms can arise post-exercise.

For those who score "below average" to "very poor," it will be necessary to be conservative in the initial exercise program. Keeping exercise duration and intensity to a minimum will be important. For those who score "above average" to "excellent," it would be appropriate to focus on exercise duration as well as intensity.

Table 1

Post-exercise Heart Rate Norms for YMCA Submaximal Step Test (Men)

		Age					
Rating	**% Rating**	**18–25**	**26–35**	**36–45**	**46–55**	**56–65**	**66+**
Excellent	100	50	51	49	56	60	59
	95	71	70	70	77	71	74
	90	76	76	76	82	77	81
Good	85	79	79	80	87	86	87
	80	82	83	84	89	91	91
	75	84	85	88	93	94	92
Above average	70	88	88	92	95	97	94
	65	90	91	95	99	99	97
	60	93	94	98	101	100	102
Average	55	95	96	100	103	103	104
	50	97	100	101	107	105	106
	45	100	102	105	111	109	110
Below average	40	102	104	108	113	111	114
	35	105	108	111	117	115	116
	30	107	110	113	119	117	118
Poor	25	111	114	116	121	119	121
	20	114	118	119	124	123	123
	15	119	121	124	126	128	126
Very poor	10	124	126	130	131	131	130
	5	132	134	138	139	136	136
	0	157	161	163	159	154	151

Table 2

Post-exercise Heart Rate Norms for YMCA Submaximal Step Test (Women)

		Age (years)					
Rating	**% Rating**	**18–25**	**26–35**	**36–45**	**46–55**	**56–65**	**66+**
Excellent	100	52	58	51	63	60	70
	95	75	74	77	85	83	85
	90	81	80	84	91	92	92
Good	85	85	85	89	95	97	96
	80	89	89	92	98	100	98
	75	93	92	96	101	103	101
Above average	70	96	95	100	104	106	104
	65	98	98	102	107	109	108
	60	102	101	104	110	111	111
Average	55	104	104	107	113	113	116
	50	108	107	109	115	116	120
	45	110	110	112	118	118	121
Below average	40	113	113	115	120	119	123
	35	116	116	118	121	123	125
	30	120	119	120	124	127	126
Poor	25	122	122	124	126	129	128
	20	126	126	128	128	131	129
	15	131	129	132	132	135	133
Very poor	10	135	134	137	137	141	135
	5	143	141	142	143	147	145
	0	169	171	169	171	174	155

MUSCULAR STRENGTH AND ENDURANCE TESTING

GFIs can measure participants' dynamic muscular fitness using calisthenic-type strength and endurance tests. These tests are based on specific exercises, such as the push-up and curl-up, and require the participant to perform a maximum number of repetitions for each exercise during the assessment.

Push-up Test

The push-up test measures upper-body endurance, specifically of the pectoralis muscles, triceps, and anterior deltoids. Due to common variations in upper-body strength between men and women, women should be assessed while performing a modified push-up. The push-up is not only useful as an evaluation tool for measuring upper-body strength and endurance, but is also a prime activity for developing and maintaining upper-body muscular fitness.

CONTRAINDICATIONS AND CONSIDERATIONS

This test may not be appropriate for participants with shoulder, elbow, or wrist problems. Alternate muscular-endurance tests or the Cooper 90-degree push-up test (where the elbows do not exceed a 90-degree angle) may be more appropriate. A major problem associated with tests that require performance to fatigue is that the point of "exhaustion" or fatigue is highly influenced by an individual's level of motivation. Novice exercisers may not push themselves to the maximal point of exertion.

Equipment:
- Mat (optional)
- Towel or foam block

Pre-test procedure:
- After explaining the purpose of the push-up test, explain and demonstrate the correct push-up version (standard or modified) (Figure 2).
- The hands should point forward and be positioned shoulder-width apart, directly under the shoulders. The hips and shoulders should be aligned (i.e., rigid trunk) and the head should remain in a neutral to slightly extended position.
- The goal of the test is to perform as many consecutive and complete push-ups as possible before reaching a point of fatigue. The push-ups must be steady, without any rest between repetitions. Explain that only correctly performed push-ups are counted.
- Encourage the participant to perform a few practice trials before the test begins.

Figure 2
Push-up test

Standard push-up position

Modified bent-knee position

Test protocol and administration:
- The test starts in the "down" position and the participant can begin the test whenever he or she is ready.
- Count each complete push-up until the participant reaches fatigue. A complete push-up requires:
  - ✓ Full elbow extension with a straight back and rigid torso in the "up" position

✓ The chest touching the instructor's fist, a rolled towel, or a foam block, without resting the stomach or body on the mat in the "down" position

- The test is terminated when the participant is unable to complete a repetition or fails to maintain proper technique for two consecutive repetitions.
- Record the score.
- Classify the participant's score using Table 3. For example, if a 46-year-old female participant completed a total of 23 modified push-ups, she would be classified as "very good," which signifies that her upper-body muscular endurance scored very well.

Table 3

Fitness Categories for the Push-up by Age and Sex

	Age (years)									
Category	**20–29**		**30–39**		**40–49**		**50–59**		**60–69**	
Sex	**M**	**W**	**M**	**W**	**M**	**W**	**M**	**W**	**M**	**W**
Excellent	36	30	30	27	25	24	21	21	18	14
Very good	29–35	21–29	22–29	20–26	17–24	15–23	13–20	11–20	11–17	12–16
Good	22–28	15–20	17–21	13–19	13–16	11–14	10–12	7–10	8–10	5–11
Fair	17–21	10–14	12–16	8–12	10–12	5–10	7–9	2–6	5–7	2–4
Needs improvement	16	9	11	7	9	4	6	1	4	1

Note: M = Men; W = Women

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Participants who are sedentary or unaccustomed to working the upper body are likely lacking in upper-body strength and endurance. If the muscles of the upper body are weak, this can lead to poor posture and a variety of musculoskeletal problems.

There are a variety of strength-training activities that can be incorporated into group fitness classes that would help increase muscular fitness in the pectoralis, triceps, and deltoid muscle groups, individually or collectively. The push-up itself is a great exercise for developing muscular strength, endurance, and overall tone in the upper body. Push-ups do not require any equipment and can be performed virtually anywhere.

Curl-up Test

The curl-up test is used to measure abdominal strength and endurance. Like the push-up test, this test requires the participant to perform to fatigue. The curl-up is preferred over the full sit-up because it is a more reliable indicator of abdominal strength and endurance and is much safer for the exerciser. The full sit-up requires additional recruitment of the hip flexors, which places increased loads across the lumbar spine. Many participants are also inclined to pull on the neck in an effort to generate momentum during a full sit-up, potentially increasing the risk for injury in the cervical region. Most participants will be able to perform the curl-up test unless they suffer from low-back problems. The curl-up test is an easy and inexpensive method of evaluating abdominal strength and endurance.

CONTRAINDICATIONS

The following issues should be considered prior to the performance of abdominal strength assessments:

- Participants with low-back concerns should check with their physicians prior to attempting this test.
- Participants with cervical neck issues may find that this exercise exacerbates their pain. All participants should be encouraged to relax the neck and rely on their abdominal muscles to do the work.

Figure 3
Curl-up test

Curl-up test: Down position. Head support is optional.

Curl-up test: Up position

Equipment:

- Mat

Pre-test procedure:

- After explaining the purpose of the curl-up test, explain and demonstrate proper body position and movement technique. The starting position requires the participant to be supine, with feet flat on the floor, both knees bent to a 90-degree angle, and arms crossed at the chest (Figure 3).
- Cue the participant to perform a controlled curl-up to lift the shoulder blades off the mat (approximately 30 degrees of trunk flexion), and then to lower the torso back down to momentarily rest the shoulders completely on the mat (the head does not need to touch the mat).
- Instruct the participant to exhale on the way up and inhale on the way down.
- Encourage the participant to perform a few practice or warm-up repetitions prior to the test.

Test protocol and administration:

- The participant starts in the "down" position and begins on the instructor's cue.
- Count each complete curl-up until the participant reaches fatigue.
- Make sure the participant is not holding his or her breath during the test.
- The participant must not flex the cervical spine by curling the neck.
- Record the participant score as the maximum number of curl-ups completed.
- Classify the participant's score using Table 4 or 5. For example, if a 27-year-old male participant completes a total of 36 curl-ups, he would be classified in the upper range of "below average," signifying that his abdominal endurance needs improvement.

Table 4

Norms for Curl-up Test (Men)

		Age (years)					
Rating	**% Rating**	**18–25**	**26–35**	**36–45**	**46–55**	**56–65**	**66+**
Excellent	100	99	80	79	78	77	66
	95	83	68	65	68	63	55
	90	77	62	60	61	56	50
Good	85	72	58	57	57	53	44
	80	66	56	52	53	49	40
	75	61	53	48	52	48	38
Above average	70	57	52	45	51	46	35
	65	54	46	44	47	43	32
	60	52	44	43	44	41	31
Average	55	49	41	39	41	39	30
	50	46	38	36	39	36	27
	45	43	37	33	36	33	26
Below average	40	41	36	32	33	32	24
	35	40	34	31	32	31	23
	30	37	33	29	29	28	22
Poor	25	35	32	28	25	25	21
	20	33	30	25	24	24	19
	15	29	26	24	21	21	15
Very poor	10	27	21	21	16	20	12
	5	23	17	13	11	17	10
	0	14	7	6	6	5	5

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Table 5

Norms for Curl-up Test (Women)

		Age (years)					
Rating	**% Rating**	**18–25**	**26–35**	**36–45**	**46–55**	**56–65**	**66+**
Excellent	100	91	70	74	73	63	54
	95	76	60	60	57	55	41
	90	68	54	54	48	44	34
Good	85	64	50	48	44	42	33
	80	61	46	44	40	38	32
	75	58	44	42	37	35	31
Above average	70	57	41	38	36	32	29
	65	54	40	36	35	30	28
	60	51	37	35	33	27	26
Average	55	48	36	32	32	25	25
	50	44	34	31	31	24	22
	45	41	33	30	30	23	21
Below average	40	38	32	28	28	22	20
	35	37	30	24	27	20	18
	30	34	28	23	25	18	16
Poor	25	33	26	22	23	15	13
	20	32	24	20	21	12	11
	15	28	22	19	19	11	10
Very poor	10	25	20	16	13	8	9
	5	24	17	14	9	7	8
	0	11	7	4	2	1	0

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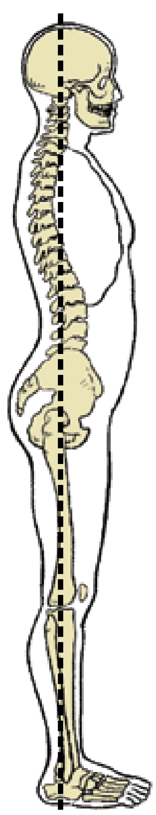
Figure 4
Neutral spine alignment with slight anterior (lordotic) curves at the neck and low back and a posterior (kyphotic) curve in the thoracic region



STATIC POSTURAL ASSESSMENT

Static posture represents the alignment of the body's segments, or how the person holds him- or herself "statically" or "isometrically" in space (Figure 4). Holding a proper postural position involves the actions of multiple postural muscles, which are generally the deeper muscles that contain greater concentrations of type I muscle fibers and function to hold static positions or low-grade isometric contractions for extended periods. Good posture or structural integrity is defined as that state of musculoskeletal alignment and balance that allows muscles, joints, and nerves to function efficiently (Kendall et al., 2005). However, if a participant exhibits deviations in his or her static position from good posture, this may reflect muscle-endurance issues in the postural muscles and/or potential imbalance at the joints (Tables 6 through 8 and Figure 5). Movement begins from a position of static posture. Therefore, the presence of poor posture is a good indicator that movement may be dysfunctional. Although movement screens offer valuable information related to neuromuscular efficiency, a static postural assessment is considered very useful and serves as a starting point from which a GFI can identify muscle imbalances and potential movement compensations associated with poor posture (Kendall et al., 2005; Sahrmann, 2002). A static posture assessment may offer valuable insight into:

- Muscle imbalance at a joint and the working relationships of muscles around a joint
  - ✓ Muscle imbalance often contributes to dysfunctional movement.
- Altered neural action of the muscles moving and controlling the joint
  - ✓ For example, tight or shortened muscles are often overactive and dominate movement at the joint, potentially disrupting healthy joint mechanics.

Table 6

Muscle Imbalances Associated With Kyphosis-lordosis Posture

Facilitated/Hypertonic (Shortened)	Inhibited (Lengthened)
Hip flexors	Hip extensors
Lumbar extensors	External obliques
Anterior chest/shoulders	Upper-back extensors
Latissimus dorsi	Scapular stabilizers
Neck extensors	Neck flexors

Table 7

Muscle Imbalances Associated With Flat-back Posture

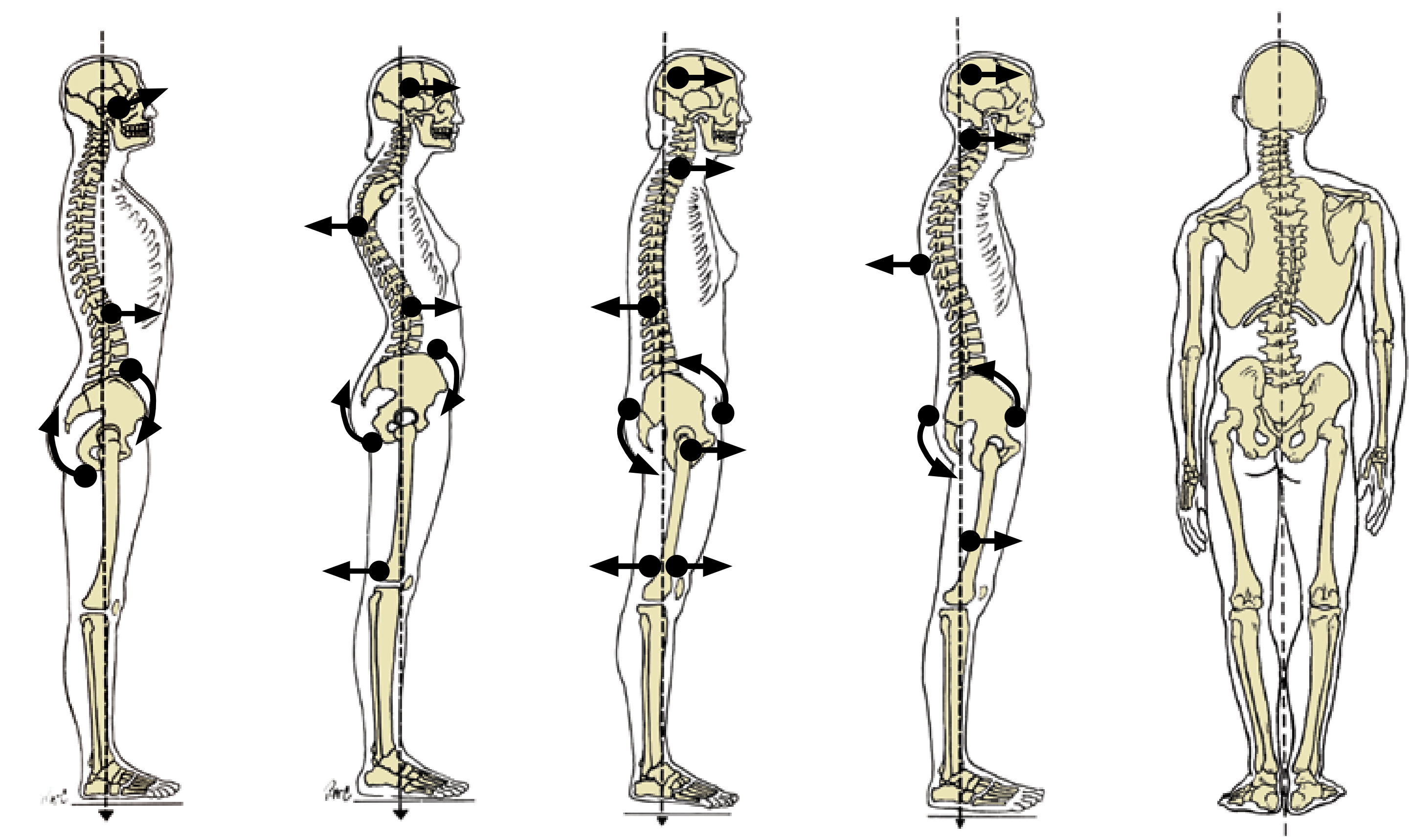
Facilitated/Hypertonic (Shortened)	Inhibited (Lengthened)
Rectus abdominis	Iliacus/psoas major
Upper-back extensors	Internal oblique
Neck extensors	Lumbar extensors
Ankle plantarflexors	Neck flexors

Table 8

Muscle Imbalances Associated With Sway-back Posture

Facilitated/Hypertonic (Shortened)	Inhibited (Lengthened)
Hamstrings	Iliacus/psoas major
Upper fibers of posterior obliques	Rectus femoris
Lumbar extensors	External oblique
Neck extensors	Upper-back extensors
	Neck flexors

Figure 5
Postural deviations



a. Lordosis: increased anterior lumbar curve from neutral

b. Kyphosis: increased posterior thoracic curve from neutral

c. Flat back: decreased anterior lumbar curve

d. Sway back: decreased anterior lumbar curve and increased posterior thoracic curve from neutral

e. Scoliosis: lateral spinal curvature often accompanied by vertebral rotation

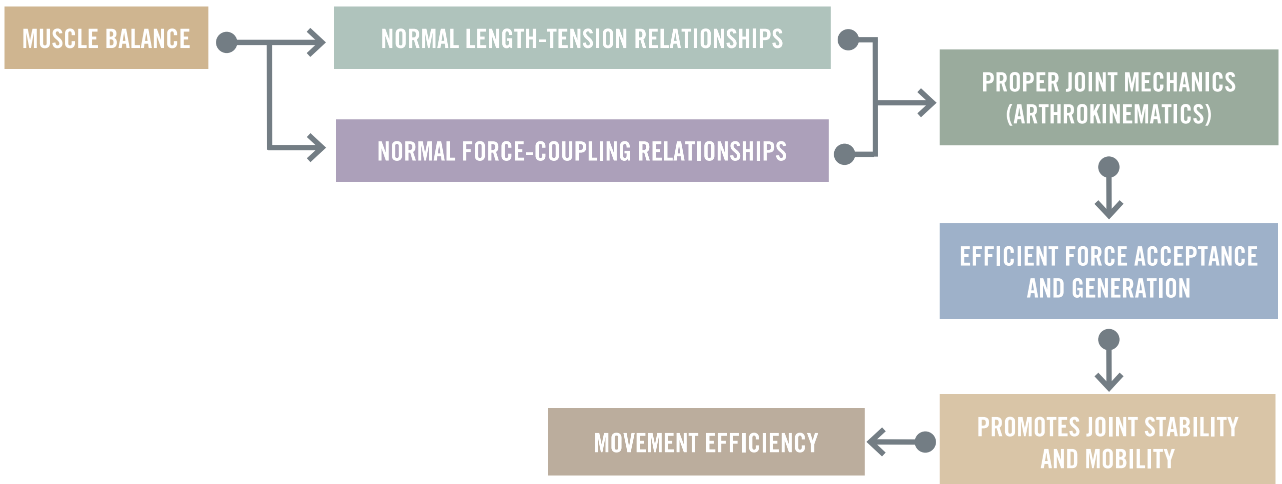
Muscle imbalance and postural deviations can be attributed to many factors that are both correctible and non-correctible, including the following:

- Correctible factors:
  - ✓ Repetitive movements (muscular pattern overload)
  - ✓ Awkward positions and movements (habitually poor posture)
  - ✓ Side dominance
  - ✓ Lack of joint stability
  - ✓ Lack of joint mobility
  - ✓ Imbalanced strength-training programs

- Non-correctible factors:
  - ✓Congenital conditions (e.g., scoliosis)
  - ✓Some pathologies (e.g., rheumatoid arthritis)
  - ✓Structural deviations (e.g., tibial or femoral torsion, or femoral anteversion)
  - ✓Certain types of trauma (e.g., surgery, injury, or amputation)

Proper postural alignment promotes optimal neural activity of the muscles controlling and moving the joint. When joints are correctly aligned, the length-tension relationships and force-coupling relationships function efficiently. This facilitates proper joint mechanics, allowing the body to generate and accept forces throughout the kinetic chain, and promotes joint stability and mobility and movement efficiency. Figure 6 illustrates the importance of muscle balance and its contribution to movement efficiency. Given how an individual's static posture reflects potential muscle imbalance, it stands to reason that instructors should consider conducting a static postural assessment on their participants as an initial assessment.

Figure 6
Movement efficiency pattern



Given the propensity many individuals have toward poor posture, an initial focus of GFIs should be to restore stability and mobility within the body and attempt to "straighten the body before strengthening it." The instructor can therefore start by looking at a participant's static posture following the right-angle rule of the body (Kendall et al., 2005). This model demonstrates how the human body represents itself in vertical alignment across the major joints—the ankle (and subtalar joint), knee, hip, and shoulder, as well as the head. This model allows the observer to look at the individual in all three planes to note specific "static" asymmetries at the joints (e.g., front to back and left to right). As illustrated in Figure 7, the right-angle model implies a state in the frontal plane wherein the two hemispheres are equally divided, and in the sagittal plane wherein the anterior and posterior surfaces appear in balance. The body is in good postural position when the body parts are symmetrically balanced around the body's line of gravity, which is the intersection of the mid-frontal and mid-sagittal planes and is represented by a plumb line hanging from a fixed point overhead.

While this model helps GFIs identify postural compensations and potential muscle imbalances, it is important to recognize that limitations exist in using this model.

Plumb Line Instructions

Using a length of string and an inexpensive weight (e.g., a washer), GFIs can create a plumb line that suspends from a ceiling or fixed point to a height 0.5 to 1 inch (1.3 to 2.5 cm) above the floor. It is important to select a location that offers a solid, plain backdrop or a grid pattern with vertical and horizontal lines that offer contrast against the participant. When conducting these assessments, the GFI should instruct the participant to wear form-fitting athletic-style clothing to expose as many joints and bony landmarks as possible, and have the participant remove his or her shoes and socks. The use of adhesive dots placed upon the bony landmarks may assist instructors in identifying postural deviations.

Figure 7
The right-angle rule (frontal and sagittal views)

a. Frontal view (anterior)   b. Frontal view (posterior)   c. Sagittal view

The objective of this assessment is to observe the participant's symmetry against the plumb line and the right angles that the weightbearing joints make relative to the line of gravity. Individuals will consciously or subconsciously attempt to correct posture when they are aware they are being observed. GFIs should encourage participants to assume a normal, relaxed posture, and utilize distractions such as casual conversation to encourage this relaxed posture. It is important to remember that while postural assessments provide valuable information, they are only one piece to the movement efficiency puzzle, and thus should not be overemphasized.

GFIs should focus on the obvious, gross imbalances and avoid getting caught up in minor postural asymmetries. Instructors should bear in mind that the body is rarely perfectly symmetrical and that overanalyzing asymmetries is time-consuming, potentially intimidating to participants, and may induce muscle fatigue in the participant that can alter his or her posture even further. Therefore, when looking for gross deviations, the instructor should select an acceptable margin of asymmetry that he or she will allow and focus on larger, more obvious discrepancies. For example, start by focusing on gross deviations that differ by a quarter-inch (0.6 cm) or more between the compartments of the body.

Plumb Line Positions

Anterior and Posterior Views

Source: Kendall et al., 2005

- For the anterior view, position the participant between the plumb line and a wall, facing the plumb line with the feet equidistant from the suspended line (using the inside of the heels or medial malleoli as a reference) (see Figure 7a).
- With good posture, the plumb line will pass equidistant between the feet and ankles, and intersect the pubis, umbilicus, sternum, mandible (chin), maxilla (face), and frontal bone (forehead).
- For the posterior view, position the individual between the plumb line and a wall, facing away from the plumb line with the insides of the heels equidistant from the suspended line (see Figure 7b).

- With good posture, the plumb line should ideally bisect the sacrum and overlap the spinous processes of the spine.

Sagittal View

Source: Kendall et al., 2005

- Position the individual between the plumb line and the wall, facing sideways with the plumb line aligned immediately anterior to the lateral malleolus (anklebone) (see Figure 7c).
- With good posture, the plumb line should ideally pass through the anterior third of the knee, the greater trochanter of the femur, and the acromioclavicular (A-C) joint, and slightly anterior to the mastoid process of the temporal bone of the skull (in line with, or just behind, the ear lobe) (see Figure 4).

Transverse View

Source: Kendall et al., 2005

- All transverse views of the limbs and torso are performed from frontal- and sagittal-plane positions.

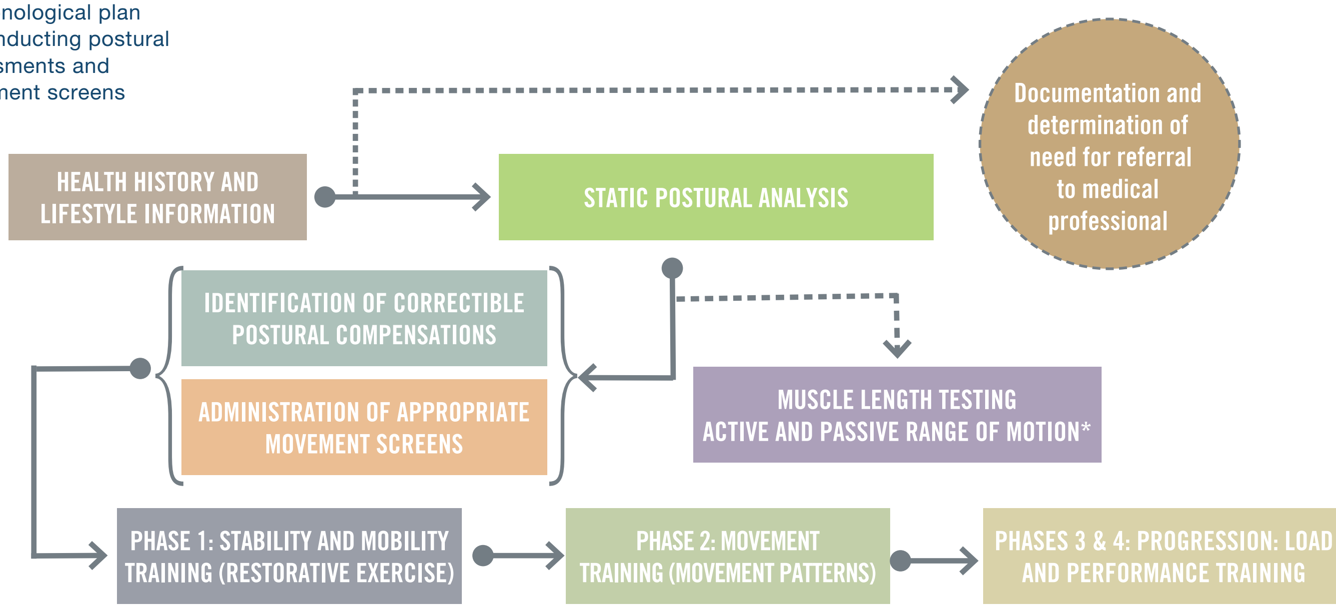
GFIs must respect scope of practice when performing a postural assessment on participants, particularly in the presence of pain or injury. They must understand the need for referral to more qualified healthcare professionals when pain or underlying pathologies are present (e.g., scoliosis).

When conducting assessments of posture and movement, the following key components should be included (Figure 8).

- Participant history—written and verbal
  - ✓Collect information on musculoskeletal issues, congenital issues (e.g., scoliosis), trauma, injuries, pain and discomfort, the site of pain or discomfort, and what aggravates and relieves pain or discomfort (e.g., with discomfort in the upper back, the participant may feel temporary relief by hunching forward and rounding the shoulders).
  - ✓Collect lifestyle information, including occupation, side-dominance, and habitual patterns (information regarding these patterns may take time to gather).
- Visual and manual observation
  - ✓Identify observable postural deviations.
  - ✓Verify muscle imbalance as determined by muscle-length testing.
  - ✓Determine the impact on movement ability or efficiency by performing movement screens.
  - ✓Distinguish correctible from non-correctible compensations

While postural assessments can be performed in great detail, the following sections address five key postural deviations that occur frequently in individuals.

Figure 8
A chronological plan for conducting postural assessments and movement screens



*if necessary

Deviation 1: Ankle Pronation/Supination and the Effect on Tibial and Femoral Rotation

Both feet should face forward in parallel or with slight (8 to 10 degrees) external rotation (toes pointing outward from the midline, as the ankle joint lies in an oblique plane with the medial malleolus slightly anterior to the lateral malleolus) (see Figure 7). The toes should be aligned in the same direction as the feet and any excessive pronation (arch flattening) or supination (high arches) at the subtalar joint should be noted.

Deviation 2: Hip Adduction

In standing and in gait, hip adduction is a lateral tilt of the pelvic that elevates one hip higher than the other (also called "hip hiking"), which may be evident in individuals who have a limb-length discrepancy (Sahrmann, 2002). If a person raises the right hip as illustrated in Figure 9, the line of gravity following the spine tilts over toward the left, moving the right thigh closer to this line of gravity. Consequently, the right hip is identified as moving into adduction. This position progressively lengthens and weakens the right hip abductors, which are unable to hold the hip level (Table 9). Sleeping on one's side can produce a similar effect, as the hip abductors of the upper hip fail to hold the hip level.

Figure 9
Normal hip position versus right hip adduction (posterior view)

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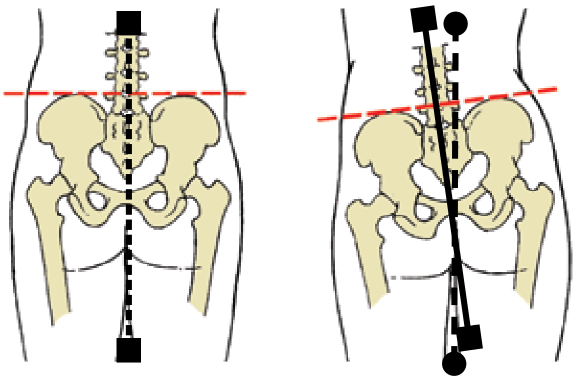
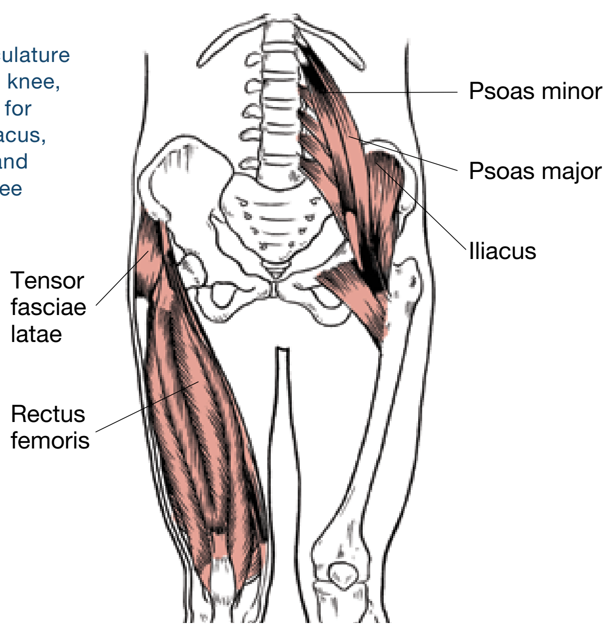


Table 9
Hip Adduction

Observation	Position	Plumb Line Alignment	Plane of View
Right hip adduction	Elevated (vs. left side)	Hips usually shifted right	View from front
Left hip adduction	Elevated (vs. right side)	Hips usually shifted left	View from front

Figure 10
Anterior musculature of the hip and knee, prime movers for hip flexion (iliacus, psoas major and minor) and knee extension



Deviation 3: Pelvic Tilting (Anterior or Posterior)

Anterior tilting of the pelvis frequently occurs in individuals with tight hip flexors, which is generally associated with sedentary lifestyles where individuals spend countless hours in seated (i.e., shortened hip flexor) positions (Kendall et al., 2005) (Figure 10). With standing, this shortened hip flexor pulls the pelvis into an anterior tilt (i.e., the superior, anterior portion of the pelvis rotates downward and forward) (Figure 11). As illustrated in Figure 12, an anterior pelvic tilt rotates the superior, anterior portion of the pelvis forward and downward, spilling water out of the front of the bucket, whereas a posterior tilt rotates the superior, posterior portion of the pelvis backward and downward, spilling water out of the back of the bucket. Figure 13 illustrates the alignment of the anterior superior iliac spine and posterior superior iliac spine in neutral alignment, as well in anterior and posterior pelvic tilts.

Figure 11
Muscular control of the pelvis by the abdominals and hip flexors (iliopsoas and rectus femoris) anteriorly and the spinal extensors (erector spinae) and hamstrings posteriorly

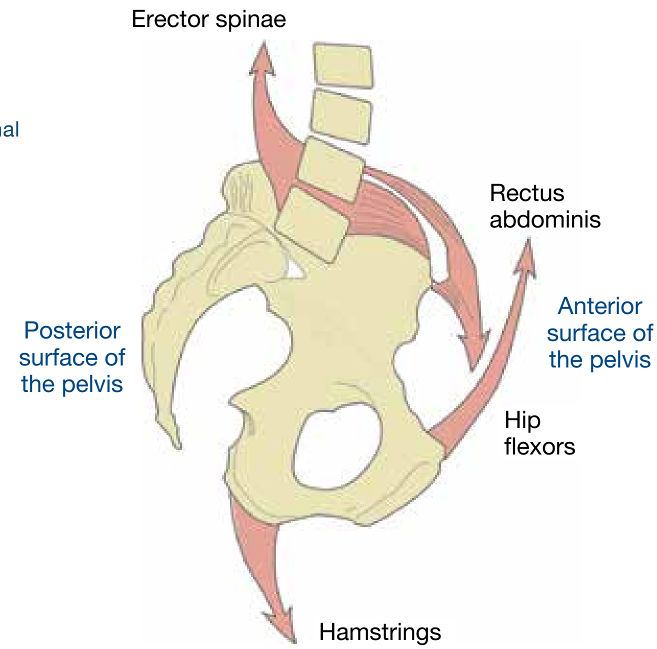


Figure 12
Anterior and posterior tilting of the pelvis—sagittal (side) view

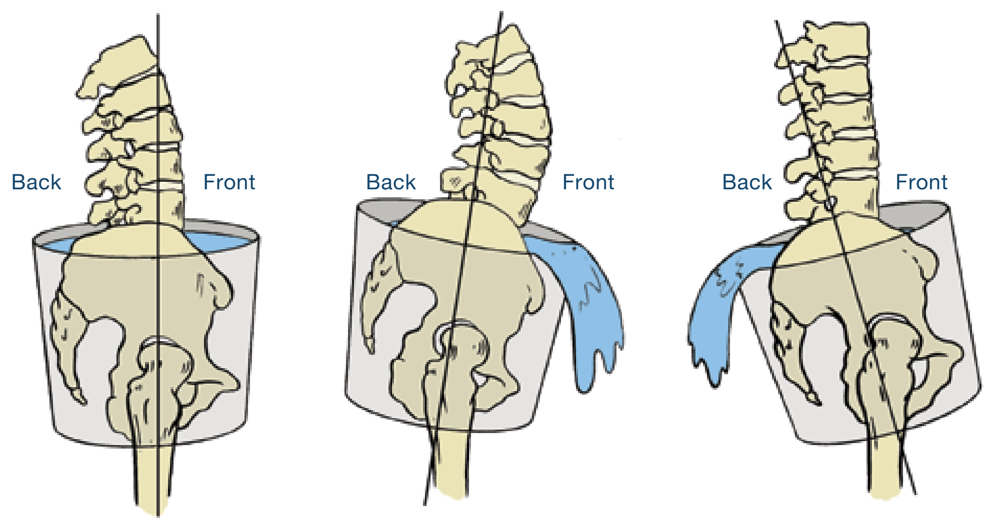
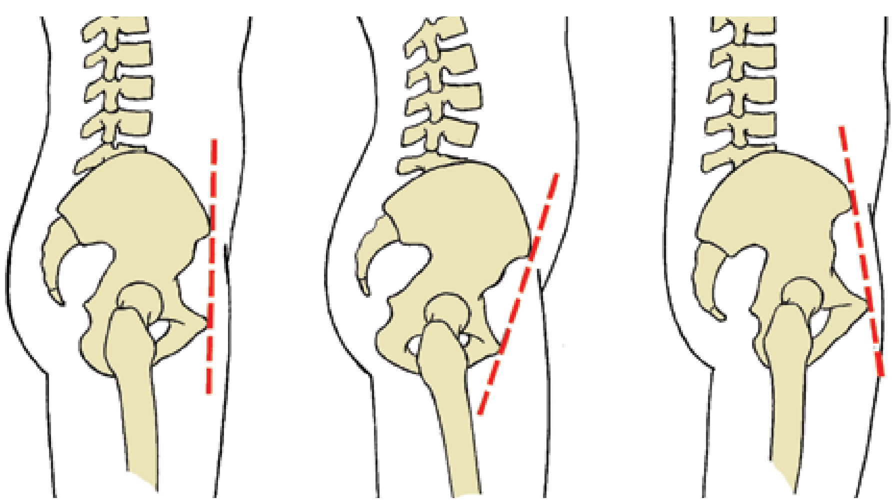


Figure 13
Alignment of the ASIS and pubic bone

Source: LifeART image copyright 2008 Wolters Kluwer Health, Inc., Lippincott Williams & Wilkins. All rights reserved.



Tight or overdominant hip flexors are generally coupled with tight erector spinae muscles (Figure 14), producing an anterior pelvic tilt, while tight or overdominant rectus abdominis muscles are generally coupled with tight hamstrings, producing a posterior pelvic tilt (Table 10). This coupling relationship between tight hip flexors and erector spinae is defined by Vladimir Janda as lower-cross syndrome (Morris et al., 2006). With foot pronation and accompanying internal femoral rotation, the pelvis may tilt anteriorly to better accommodate the head of the femur, demonstrating the point of an integrated kinetic chain whereby foot pronation can increase lumbar lordosis due to an anterior pelvic tilt (Sahrmann, 2002).

Figure 14
The erector spinae muscles and hamstrings (posterior view)

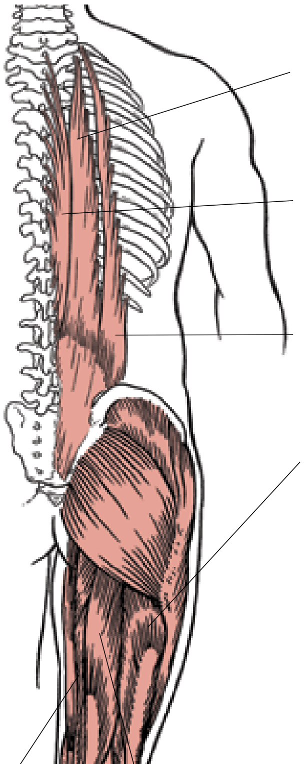


Table 10

Pelvic Tilt

Observation	Rotation	Muscles Suspected to Be Tight	Muscles Suspected to Be Lengthened	Plane of View
Anterior tilt	ASIS tilts downward and forward	Hip flexors, erector spinae	Hamstrings, rectus abdominis	Sagittal
Posterior tilt	ASIS tilts upward and backward	Rectus abdominis, hamstrings	Hip flexors, erector spinae	Sagittal

Note: ASIS = Anterior superior iliac spine

Deviation 4: Shoulder Position and the Thoracic Spine

Limitations and compensations to movement at the shoulder occur frequently due to the complex nature of the shoulder girdle design and the varied movements performed at the shoulder. While the glenohumeral joint is highly mobile and perhaps a less stable joint, the scapulothoracic joint is designed to offer greater stability with less mobility. However, it is important to remember that it still contributes approximately 60 degrees of movement in raising the arms overhead, with the glenohumeral joint contributing the remaining 120 degrees. The scapulothoracic joint also promotes many important movements of the scapulae (Figure 15). Collectively, however, they allow for a diverse range of movements in the shoulder complex. Observation of the position of the scapulae in all three planes provides good insight into a participant's quality of movement at the shoulders.

Figure 16 illustrates the "resting" position of the scapulae, which can vary considerably from person to person. The vertebral (medial) border of the scapula is typically positioned between the second and seventh ribs and vertically about 3 inches (7.6 cm) from the spinous processes (Houglum, 2010; Kendall et al., 2005). While the glenoid fossa is tilted upward 5 degrees and anteriorly 30 degrees to optimally articulate with the head of the humerus, the scapulae usually lie flat against the rib cage (Kendall et al., 2005). While the scapulae should appear flat against the rib cage, their orientation depends on the size and shape of the person and the rib cage.

Scapular Winging and Scapular Protraction

GFIs can perform a quick observational assessment to identify scapular winging and scapular protraction. While looking at the participant from the posterior view, if the vertebral (medial) and/or inferior angle of the scapulae protrude outward, this indicates an inability of the scapular stabilizers (primarily the rhomboids and serratus anterior) to hold the scapulae in place. Noticeable protrusion of the vertebral (medial) border outward is termed "scapular protraction" (Figure 17a), while protrusion of the inferior angle and vertebral (medial) border outward is termed "winged scapulae" (Figure 17b).

Scapular protraction can also be identified from the anterior view. If the palms face backward instead of to the sides, this generally indicates internal (medial) rotation of the humerus and/or scapular protraction (Figure 18). Table 11 lists key deviations of the thoracic spine and shoulders in various planes of view.

Figure 15
Scapular movements

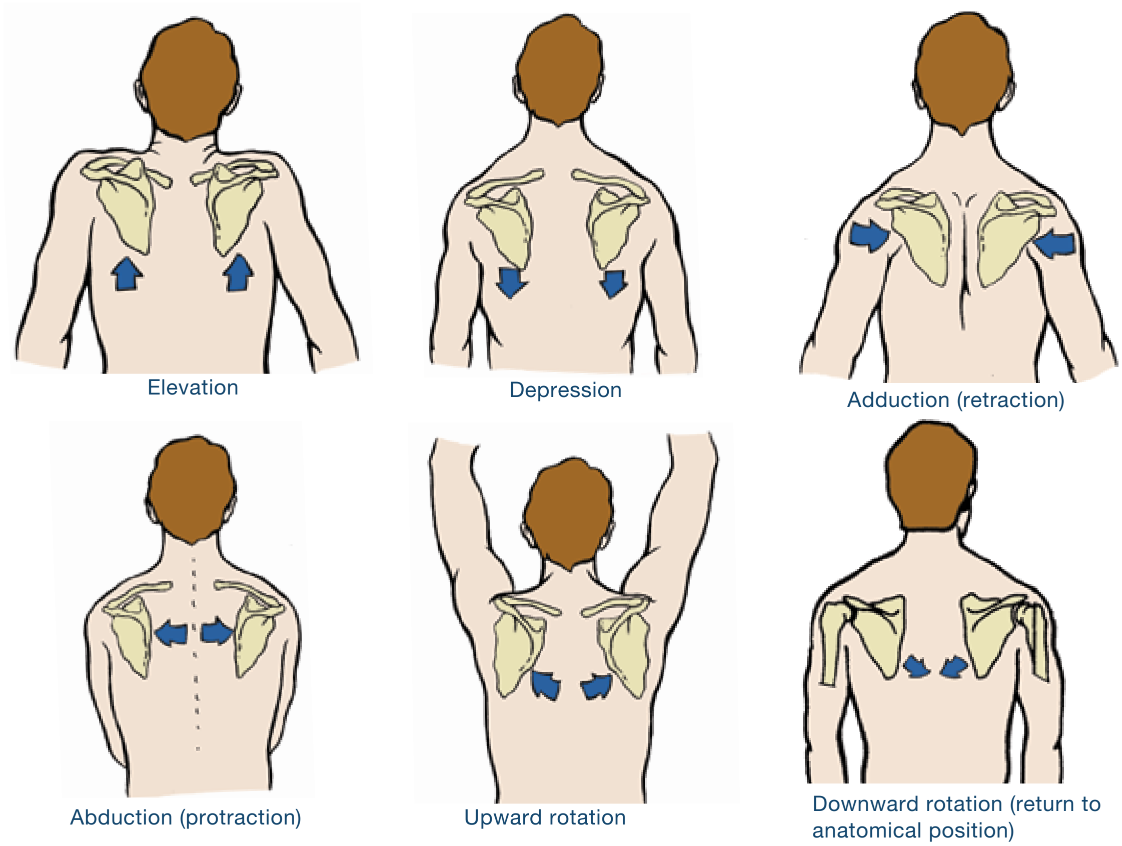
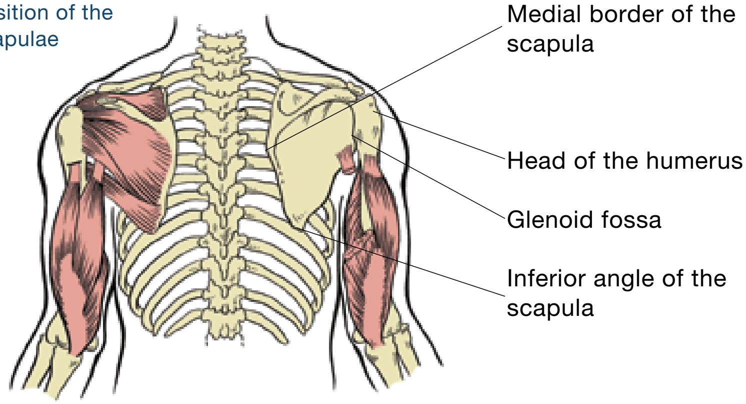


Figure 16
The normal position of the scapulae



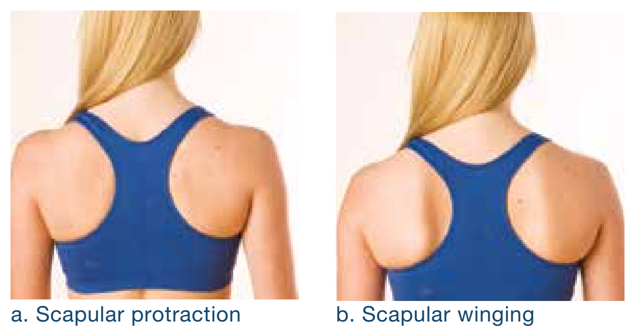


Figure 17
Scapular protraction and winging: Posterior view

Figure 18
Scapular protraction: Anterior view

Table 11
Shoulder Position

Observation	Muscles Suspected to Be Tight	Plane of View
Shoulders not level	Upper trapezius, levator scapula, rhomboids	Frontal
Asymmetry to midline	Lateral trunk flexors (flexed side)	Frontal
Protracted (forward, rounded)	Serratus anterior*, anterior scapulo-humeral muscles, upper trapezius	Sagittal
Medially rotated humerus	Pectoralis major, latissimus dorsi, subscapularis	Frontal
Kyphosis and depressed chest	Shoulder adductors, pectoralis minor, rectus abdominis, internal oblique	Sagittal

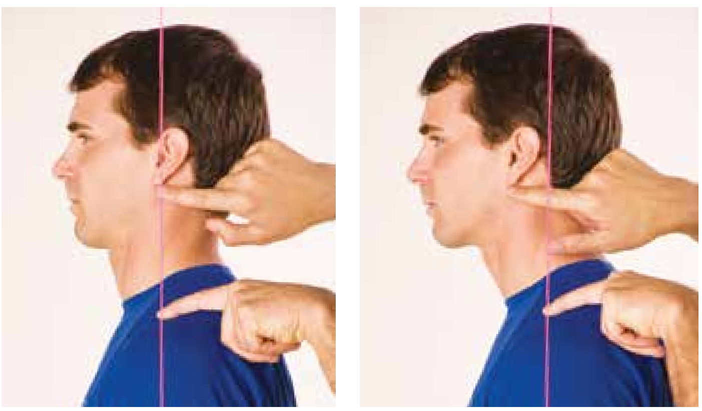
*Serratus anterior is usually tight with scapular protraction and is usually lengthened with scapular winging.

DEVIATION 5: HEAD POSITION

With good posture, the earlobe should align approximately over the acromion process, but given the many awkward postures and repetitive motions of daily life, a forward-head position is very common (Table 12) (Kendall et al., 2005). This altered position does not tilt the head downward, but simply shifts it forward so that the earlobe appears significantly forward of the acromioclavicular (AC) joint. To observe the presence of this imbalance, use the sagittal view, aligning the plumb line with the AC joint, and observe its position relative to the ear (Figure 19) (Price, 2010). A forward-head position represents tightness in the cervical extensors and lengthening of the cervical flexors. To demonstrate this point, an instructor can place one thumb on his or her manubrium (top of the sternum) and the index finger of the same hand on the chin. Slowly slide the head forward and observe how the spacing between the fingers increases, representing the change in muscle length. An alternative option for observing forward-head position is via the alignment of the cheek bone and the collarbone. With good posture, they should almost be in vertical alignment with each other. To demonstrate this point, have a participant place one finger on his or her collar bone (aligned under the cheek) and place another finger on the cheek bone (aligned under the eye) as illustrated in Figure 20 (Price, 2010). From the sagittal plane, the instructor can observe the vertical alignment of the two fingers.

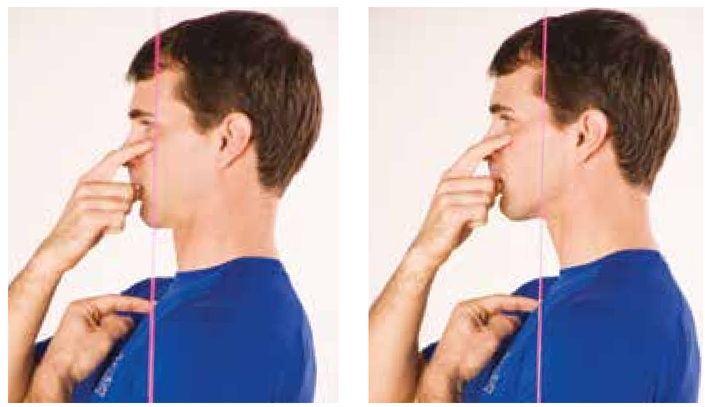
Table 12
Head Position

Observation	Muscles Suspected to Be Tight	Plane of View
Forward-head position	Cervical spine extensors, upper trapezius, levator scapulae	Sagittal



Good posture | Forward-head position

Figure 19
Alignment of the acromioclavicular joint with the ear



Good posture | Forward-head position

Figure 20
Alignment of the collar bone and cheek bone

Postural Assessment Checklist and Worksheets

When performing basic postural assessments, GFIs can use the checklist provided in Figure 21 to guide themselves through their observations, and complete the worksheets provided in Figures 22 and 23 to mark any postural compensations they identify.

MOVEMENT SCREENS

Observing active movement is an effective method to determine the contribution that muscle imbalances and poor posture have on neural control, and also helps identify movement compensations (Whiting & Rugg, 2012; Sahrmann, 2002). When compensations occur during movement, it is usually indicative of some form of altered neural action, commonly referred to as "faulty neural control," which normally manifests due to muscle tightness or an imbalance between muscles acting at the joint.

Movement can essentially be broken down and described by five primary movements that people perform during many daily activities (Cook, 2010):

- Bending/raising and lifting/lowering movements (e.g., squatting)
- Single-leg movements
- Pushing movements (in vertical/horizontal planes) and resultant movement
- Pulling movements (in vertical/horizontal planes) and resultant movement
- Rotational movements

FRONTAL VIEW	
☐	Overall body symmetry: symmetrical alignment of the left and right hemispheres
☐	Ankle position: observe for pronation and supination
☐	Foot position: observe for inversion and eversion
☐	Knees: rotation and height discrepancies
☐	Hip adduction and shifting: observe for shifting to a side as witnessed by the position of the pubis in relation to the plumb line
☐	Alignment of the iliac crests
☐	Alignment of the torso: position of the umbilicus and sternum in relation to the plumb line
☐	Alignment of the shoulders
☐	Arm spacing: observe the space to the sides of the torso
☐	Hand position: observe the position relative to the torso
☐	Head position: alignment of the ears, nose, eyes, and chin
POSTERIOR VIEW	
☐	Overall body symmetry: symmetrical alignment of the left and right hemispheres
☐	Alignment of the spine: vertical alignment of the spinous processes (may require forward bending)
☐	Alignment of the scapulae: inferior angle of scapulae and presence of winged scapulae
☐	Alignment of the shoulders
☐	Head: alignment of the ears
SAGITTAL VIEW	
☐	Overall body symmetry: symmetrical alignment of load-bearing joint landmarks with the plumb line
☐	Knees: flexion or extension
☐	Pelvic alignment for tilting: relationship of ASIS to PSIS
☐	Spinal curves: observe for thoracic kyphosis, lumbar lordosis, or flat-back position
☐	Shoulder position: forward rounding (protraction) of the scapulae
☐	Head position: neutral cervical curvature (versus forward position) and level (position above the clavicle)

Note: ASIS = Anterior superior iliac spine; PSIS = Posterior superior iliac spine

Figure 21
Postural assessment checklist

ANTERIOR VIEW:			POSTERIOR VIEW:		
L	R	DEVIATION	L	R	DEVIATION
☐	☐	1.	☐	☐	1.
☐	☐	2.	☐	☐	2.
☐	☐	3.	☐	☐	3.
☐	☐	4.	☐	☐	4.
☐	☐	5.	☐	☐	5.
☐	☐	6.	☐	☐	6.
☐	☐	7.	☐	☐	7.

CIRCLE OR MARK OBSERVED DEVIATIONS	CIRCLE OR MARK OBSERVED DEVIATIONS

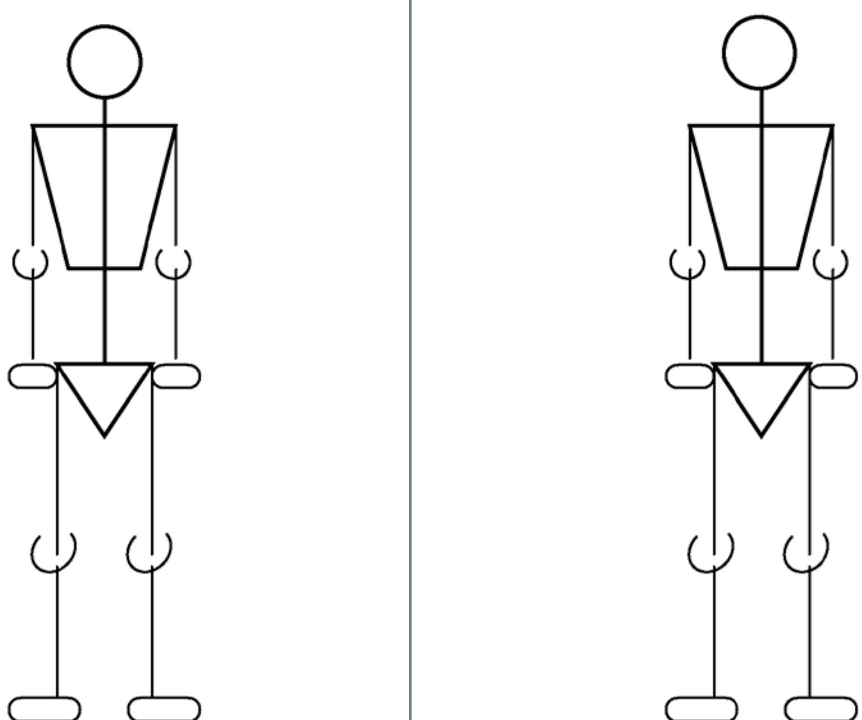


Figure 22
Anterior/posterior worksheet

SAGITTAL: LEFT SIDE		SAGITTAL: RIGHT SIDE	
L	DEVIATION	R	DEVIATION
☐	1.	☐	1.
☐	2.	☐	2.
☐	3.	☐	3.
☐	4.	☐	4.
☐	5.	☐	5.
☐	6.	☐	6.
☐	7.	☐	7.
CIRCLE OR MARK OBSERVED DEVIATIONS		CIRCLE OR MARK OBSERVED DEVIATIONS	

Figure 23
Sagittal worksheet

Activities of daily living (ADL) are essentially the integration of one or more of these primary movements. For example, the action of picking up a child and turning to place the child in a car seat involves a squatting movement, a rotational movement, a possible single-leg movement if stepping is involved, a pushing movement, and finally a pulling movement to resist the effects of gravity as the child is lowered into the seat.

Movement screens help GFIs observe the ability and efficiency with which a participant performs many ADL. The movement screens, however, must be skill- and conditioning-level appropriate, and be specific to the participant's needs. It is important to remember that almost any screen can evaluate functional capacity, as long as it is relevant to participant needs and challenges, and provides useful feedback on movement efficiency (Sahrmann, 2002). Screens generally challenge participants with no recognized pathologies to perform basic movements and evaluate their ability to demonstrate appropriate levels of stability and mobility throughout the entire kinetic chain—namely, at the feet, knees, lumbo-pelvic-hip complex, shoulders, and head. If the participant experiences pain during a movement screen, the test should be stopped and the participant should be referred to his or her healthcare provider to have the painful area evaluated before performing that type of movement in a future exercise session.

Bend and Lift Screen

Objective: To examine symmetrical lower-extremity mobility and stability, and upper-extremity stability during a bend-and-lift movement

Equipment:

- Two 2- to 4-foot (0.6- to 1.2-m) dowels or broomsticks

Instructions:

- Briefly discuss the protocol so the participant understands what is required.
- Ask the participant to stand with the feet shoulder-width apart with the arms hanging freely to the sides.
- Place the two dowels on the floor adjacent to the outside of each foot.
- Ask the participant to perform a series of basic bend-and-lift movements (i.e., a squatting movement) to grasp the dowels and lift them off the floor, holding the lowered position for one to two seconds to allow the instructor to make some brief observations before returning to the starting position. The number of repetitions performed is determined by the number needed to make the necessary evaluations.
  - ✓ Ask the participant to pretend the dowels are 25-pound weights.
  - ✓ It is important to remember not to cue the participant to use good technique, but instead observe his or her natural movement.

Observations (Table 13):

- Frontal view (Figure 24):
  - ✓ First repetition: Observe the stability of the foot (i.e., evidence of pronation, supination, eversion, or inversion).
  - ✓ Second repetition: Observe the alignment of the knees over the second toe.
  - ✓ Third repetition: Observe the overall symmetry of the entire body over the base of support (i.e., evidence of a lateral shift or rotation).
- Sagittal view (Figure 25):
  - ✓ First repetition: Observe whether the heel remains in contact with the floor throughout the movement.
  - ✓ Second repetition: Determine whether the participant exhibits "glute" or "quadriceps" dominance (i.e., does he or she initiate the downward phase by driving the knees forward or pushing the hips backward?).
  - ✓ Third repetition: Observe whether the participant achieves a parallel position between the tibia and torso in the lowered position (sometimes referred to as the "figure-4" position), while also observing whether he or she controls the descent to avoid resting the hamstrings against the calves.
  - ✓ Fourth repetition: Observe the degree of lordosis in the lumbar/thoracic spine during the lowering movement and while the participant is in the lowered position (i.e., flat-to-

neutral or demonstrated increased lordosis) and watch for excessive thoracic extension in the lowered position.

✓ Fifth repetition: Observe any changes in head position during the lowering phase.

General interpretations:

- Identify origin(s) of movement limitation or compensation.
- Evaluate the impact on the entire kinetic chain.

Table 13

Bend and Lift Screen

	View	Joint Location	Compensation	Key Suspected Compensations: Overactive (Tight)	Key Suspected Compensations: Underactive (Weak)
☐	Anterior	Feet	Lack of foot stability: Ankles collapse inward/feet turn outward	Soleus, lateral gastrocnemius, peroneals	Medial gastrocnemius, gracilis, sartorius, tibialis group
☐	Anterior	Knees	Move inward	Hip adductors, tensor fascia latae	Gluteus medius and maximus
☐	Anterior	Torso	Lateral shift to a side	Side dominance and muscle imbalance due to potential lack of stability in the lower extremity during joint loading	
☐	Sagittal	Feet	Unable to keep heels in contact with the floor	Plantarflexors	None
☐	Sagittal	Hip and knee	Initiation of movement	Movement initiated at knees may indicate quadriceps and hip flexor dominance, as well as insufficient activation of the gluteus group	
☐	Sagittal	Tibia and torso relationship Contact behind knee	Unable to achieve parallel between tibia and torso Hamstrings contact back of calves	Poor mechanics, lack of dorsiflexion due to tight plantarflexors (which normally allow the tibia to move forward) Muscle weakness and poor mechanics, resulting in an inability to stabilize and control the lowering phase	
☐	Sagittal	Lumbar and thoracic spine	Back excessively arches Back rounds forward	Hip flexors, back extensors, latissimus dorsi Latissimus dorsi, teres major, pectoralis major and minor	Core, rectus abdominis, gluteal group, hamstrings Upper back extensors
☐	Sagittal	Head	Downward Upward	Increased hip and trunk flexion Compression and tightness in the cervical extensor region	

Data from: Abelbeck, K.G. (2002). Biomechanical model and evaluation of a linear motion squat type exercise. *Journal of Strength and Conditioning Research*, 16, 516–524; Cook, G. (2003). *Athletic Body in Balance.* Champaign, Ill.: Human Kinetics; Donnelly, D.V. et al. (2006). The effect of directional gaze on kinematics during the squat exercise. *Journal of Strength and Conditioning Research,* 20, 145–150; Fry, A.C., Smith J.C., & Schilling, B.K. (2003). Effect of knee position on hip and knees torques during the barbell squat. *Journal of Strength and Conditioning Research,* 17, 629–633; Kendall, F.P. et al. (2005). *Muscles Testing and Function with Posture and Pain* (5th ed.). Baltimore, Md.: Lippincott Williams & Wilkins; Sahrmann, S.A. (2002). *Diagnosis and Treatment of Movement Impairment Syndromes.* St. Louis, Mo.: Mosby.

Figure 24
Bend and lift screen: Frontal view

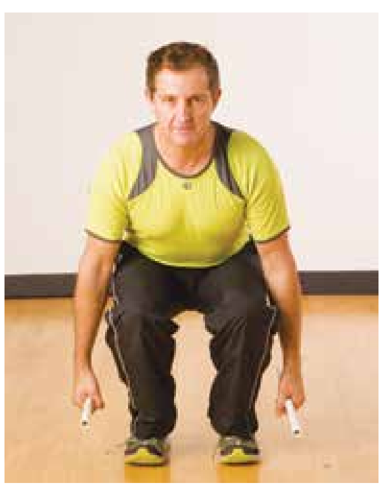


Figure 25
Bend and lift screen: Sagittal view

Hurdle Step Screen

Objective: To examine simultaneous mobility of one limb and stability of the contralateral limb while maintaining both hip and torso stabilization during a balance challenge of standing on one leg

Equipment:

- Two uprights to anchor string (chair or table legs)
- 36-inch (0.9-m) piece of string
- 48-inch (1.2-m) wooden or plastic dowel

Instructions:

- Briefly discuss the protocol so the participant understands what is required.
- Fasten a piece of string spanning two points at a height even with the underside of the foot positioned parallel with the floor, when it is raised to a height that flexes the hip to 70 degrees (approximately just above halfway up the tibia).
- Have the participant stand with both feet together and the front edge of the toes aligned directly beneath the string.
  - ✓ Ultimately, this test should be performed with the feet positioned at gait-width apart [i.e., 2.8 to 3.5 inches (7 to 9 cm)] to simulate single-leg support during walking.
- Place the dowel across the participant's shoulders, holding it parallel to the floor (similar to the placement of the bar during the traditional barbell squat).
- Instruct the participant to load onto one leg and slowly lift the opposite leg over the string, flexing the hip to clear the string and then gently touching the heel of the raised leg to the floor in front of the string before returning to the starting position.
  - ✓ The foot only needs to clear the string and does not need to be lifted as high as possible.
  - ✓ It is important to remember not to cue the participant to use good technique, instead observing the natural movement.
  - ✓ Repetitions need to be performed slowly and with control.
- Have the participant repeat the movement with the opposite leg, completing a series of repetitions with each leg so that the instructor can make the necessary evaluations.
- Allow sufficient practice trials to accommodate learning before administrating the test screens.

Observations (Table 14):

- Frontal view (Figure 26):
  - ✓ First repetition: Observe the stability of the foot (i.e., evidence of pronation, supination, eversion, or inversion).
  - ✓ Second repetition: Observe the alignment of the stance-leg knee over the foot (i.e., evidence of knee movement in any plane).
  - ✓ Third repetition: Watch for excessive hip adduction greater than 2 inches (5.1 cm) as measured by excessive stance-leg adduction or downward hip-tilting toward the opposite side (Figure 27).
  - ✓ Fourth repetition: Observe the stability of the torso (i.e., evidence of torso movement in any plane as demonstrated by movement of the dowel) (see Figure 27).
  - ✓ Fifth repetition: Observe the alignment of the moving leg (i.e., lack of dorsiflexion at the ankle, deviation from the sagittal plane at the knee or ankle, or hiking of the moving hip) (see Figure 27).
- Sagittal view (Figure 28):
  - ✓ First repetition: Observe the stability of the torso and stance leg.
  - ✓ Second repetition: Observe the mobility of the hip (i.e., allowing 70 degrees of hip flexion without compensation—anterior tilting).

General interpretations:

- Identify the origin(s) of movement limitation or compensation.
- Evaluate the impact on the entire kinetic chain.

Table 14

Hurdle Step Screen

View		Joint Location	Compensation	Key Suspected Compensations: Overactive (Tight)	Key Suspected Compensations: Underactive (Weak)
☐	Anterior	Feet	Lack of foot stability: Ankles collapse inward/ feet turn outward	Soleus, lateral gastrocnemius, peroneals	Medial gastrocnemius, gracilis, sartorius, tibialis group, gluteus medius and maximus—inability to control internal rotation
☐	Anterior	Knees	Move inward	Hip adductors, tensor fascia latae	Gluteus medius and maximus
☐	Anterior	Hips	Hip adduction >2 inches (5.1 cm) Stance-leg hip rotation (inward)	Hip adductors, tensor fascia latae Stance-leg or raised-leg internal rotators	Gluteus medius and maximus Stance-leg or raised-leg external rotators
☐	Anterior	Torso	Lateral tilt, forward lean, rotation	Lack of core stability	
☐	Anterior	Raised-leg	Lack of ankle dorsiflexion Limb deviates from sagittal plane Hiking the raised hip	Ankle plantarflexors Raised-leg hip extensors Stance-leg hip flexors—limiting posterior hip rotation during raise	Ankle dorsiflexors Raised-leg hip flexors
☐	Sagittal	Pelvis and low back	Anterior tilt with forward torso lean Posterior tilt with hunched-over torso	Stance-leg hip flexors Rectus abdominis and hip extensors	Rectus abdominis and hip extensors Stance-leg hip flexors

*Hip adduction involves weight transference over the stance leg while preserving hip, knee, and foot alignment. This weight transference requires a 1- to 2-inch (2.5- to 5-cm) lateral shift over the stance-leg, with a small hike in the stance-hip of 4 to 5 degrees or less.

Data from: Cook, G. (2003). *Athletic Body in Balance.* Champaign, Ill.: Human Kinetics; Kendall, F.P. et al. (2005). *Muscles Testing and Function with Posture and Pain* (5th ed.). Baltimore, Md.: Lippincott Williams & Wilkins; Sahrmann, S.A. (2002). *Diagnosis and Treatment of Movement Impairment Syndromes.* St. Louis, Mo.: Mosby.

Figure 26
Hurdle step screen: Anterior view

Figure 27
Hurdle step screen: Anterior view with compensations

Figure 28
Hurdle step screen: Sagittal view

Shoulder Push Stabilization Screen

Figure 29
Shoulder push stabilization screen

Objective: To examine stabilization of the scapulothoracic joint and core control during closed-kinetic-chain pushing movements

Instructions:

- Briefly discuss the protocol so the participant understands what is required.
  - ✓ The participant presses his or her body off the ground as the instructor evaluates the ability to stabilize the scapulae against the thorax (rib cage) during pushing-type movements (Figure 29).
- Instruct the participant to lie prone on the floor with arms abducted in the push-up position or bent-knee push-up position.
- Ask the participant to perform several push-ups to full arm extension.
  - ✓ Subjects should perform full push-ups; modify to bent-knee push-ups if necessary.
  - ✓ It is important to remember not to cue the participant to use good technique, but instead observe his or her natural movement.
  - ✓ Repetitions need to be performed slowly and with control.

Observations (Table 15):

- Observe any notable changes in the position of the scapulae relative to the rib cage at both end-ranges of motion (i.e., the appearance of scapular "winging") (Figure 30).
- Observe for lumbar hyperextension in the press position.

General interpretations:

- Identify the origin(s) of movement limitation or compensation.
- Evaluate the impact on the entire kinetic chain.

Table 15

Shoulder Push Stabilization Screen

View		Joint Location	Compensation	Key Suspected Compensations
☐	Sagittal	Scapulothoracic	Exhibits "winging" during the push-up movement	Inability of the parascapular muscles (i.e., serratus anterior, trapezius, levator scapula, rhomboids) to stabilize the scapulae against the rib cage. Can also be due to a flat thoracic spine.
☐	Sagittal	Trunk	Hyperextension or "collapsing" of the low back	Lack of core, abdominal, and low-back strength, resulting in instability

Data from: Sahrmann, S.A. (2002). *Diagnosis and Treatment of Movement Impairment Syndromes.* St. Louis, Mo.: Mosby; Kendall, F.P. et al. (2005). *Muscles Testing and Function with Posture and Pain* (5th ed.). Baltimore, Md.: Lippincott Williams & Wilkins.

Figure 30
Shoulder push stabilization screen with scapular winging

Thoracic Spine Mobility Screen

Objective: To examine bilateral mobility of the thoracic spine. Lumbar spine rotation is considered insignificant, as it only offers approximately 15 degrees of rotation.

Equipment:

- Chair
- Squeezable ball or block
- 48-inch (1.2-m) dowel

Instructions:

- Briefly discuss the protocol so the participant understands what is required.
- Instruct the participant to sit upright toward the front edge of the seat with the feet together and firmly placed on the floor. The participant's back should not touch the backrest.
- Place a squeezable ball or block between the knees and a dowel across the front of the shoulders, instructing the participant to hold the bar in the hands (i.e., front barbell squat grip) (Figure 31).

- While maintaining an upright and straight posture, the participant squeezes the block to immobilize the hips and gently rotates left and right to an end-range of motion without any bouncing (Figure 32).
  - ✓ It is important to remember not to cue the participant to use good technique, but instead observe his or her natural movement.
  - ✓ Ask the participant to perform a few repetitions in each direction, slowly and with control.

Observation (Table 16):

- Observe any bilateral discrepancies between the rotations in each direction.

General interpretations:

- Identify the origin(s) of movement limitation or compensation. As an individual rotates, the facet joints of each vertebra experience shearing forces against each other. One way to reduce this force and promote greater movement is to laterally flex the trunk during the movement or at the end-range of movement. This screen evaluates trunk rotation in the transverse plane. Therefore, any lateral flexion of the trunk (dowel tilting up or down) must be avoided.
- Evaluate the impact on the entire kinetic chain. Remember that the lumbar spine generally exhibits limited rotation of approximately 15 degrees (Sahrmann, 2002), with the balance of trunk rotation occurring through the thoracic spine. If thoracic spine mobility is limited, the body strives to gain movement in alternative planes within the lumbar spine (e.g., increase in lordosis to promote greater rotation).

Figure 31
Thoracic spine mobility screen: Starting position

Figure 32
Thoracic spine mobility screen: End position

Table 16
Thoracic Spine Mobility Screen

View		Joint Location	Compensation	Possible Biomechanical Problems
☐	Transverse	Trunk	None if trunk rotation achieves 45 degrees in each direction	
☐	Transverse	Trunk	Bilateral discrepancy (Assuming no existing congenital issues in the spine)	Side-dominance Differences in paraspinal development Torso rotation, perhaps associated with some hip rotation *Note:* Lack of thoracic mobility will negatively impact glenohumeral mobility

Data from: Sahrmann, S.A. (2002). *Diagnosis and Treatment of Movement Impairment Syndromes.* St. Louis, Mo.: Mosby.

BALANCE AND THE CORE

Given the importance of balance and the condition of the core musculature to fitness and overall quality of life, these baseline assessments should be collected to evaluate the need for comprehensive balance training and core conditioning during the early stages of a conditioning program. While dynamic balance correlates more closely with people's daily activities, these tests are generally movement-specific and quite complex. Consequently, GFIs should aim to first evaluate the basic level of static balance that a participant exhibits by using the sharpened Romberg test or the stork-stand test. Figure 33 can be used to record the participant's performance on the balance and core assessments presented here.

Figure 33
Balance worksheet

Balance Worksheet			
Balance	**Right Leg**	**Left Leg**	**Difference**
Sharpened Romberg test	_______ seconds	_______ seconds	_______ seconds
Stork-stand balance test	_______ seconds	_______ seconds	_______ seconds

Figure 34
Sharpened Romberg test

Sharpened Romberg Test

Sources: Black et al., 1982; Newton, 1989

Objective: To assess static balance by standing with a reduced base of support while removing visual sensory information

Equipment:

- Flat, non-slip surface
- Stopwatch

Instructions:

- Explain the purpose of the test.
- Instruct the participant to remove his or her shoes and stand with one foot directly in front of the other (tandem or heel-to-toe position), with the eyes open.
- Ask the participant to fold his or her arms across the chest, touching each hand to the opposite shoulder (Figure 34).
- Allow sufficient practice trials. Once the participant feels stable, instruct him or her to close his or her eyes. Start the stopwatch to begin the test.
- Always stand in close proximity as a precaution to prevent falling.
- Continue the test for 60 seconds or until the participant exhibits any test-termination cue, as listed in the Observations section.
- Allow up to two trials per leg position and record the best performance on each side.

Observations:

- Continue to time the participant's performance until one of the following occurs:
  - ✓The participant loses postural control and balance.
  - ✓The participant's feet move on the floor.
  - ✓The participant's eyes open.
  - ✓The participant's arms move from the folded position.
  - ✓The participant exceeds 60 seconds with good postural control.

General interpretations:

- The participant needs to maintain his or her balance with good postural control (without excessive swaying) and not exhibit any of the test-termination criteria for 30 or more seconds.
- The inability to reach 30 seconds is indicative of inadequate static balance and postural control.


Figure 35
Stork-stand balance test: Starting position

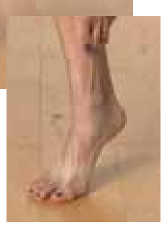



Figure 36
Stork-stand balance test: Test position

Stork-stand Balance Test

Source: Johnson & Nelson, 1986

Objective: To assess static balance by standing on one foot in a modified stork-stand position. This is a more challenging variation of the blind stork-stand test, where the stance foot remains flat on the floor, but the test is conducted with the eyes closed.

Equipment:

- Flat, non-slip surface
- Stopwatch

Instructions:

- Explain the purpose of the test.
- Ask the participant to remove his or her shoes and stand with feet together, hands on the hips.
- Instruct the participant to raise one foot off the ground and bring that foot to lightly touch the inside of the stance leg, just below the knee (Figure 35).
  - ✓ The participant must raise the heel of the stance foot off the floor and balance on the ball of the foot (Figure 36).
  - ✓ Stand behind the participant for support if needed.
  - ✓ Allow 1 minute of practice trials.
  - ✓ After the practice trial, perform the test, starting the stopwatch as the heel lifts off the floor.
  - ✓ The test is performed with the eyes open.
- Repeat with the opposite leg.
- Allow up to three trials per leg position and record the best performance on each side.

Observations:

- Timing stops when any of the following occurs:
  - ✓ The hand(s) come off the hips.
  - ✓ The stance or supporting foot inverts, everts, or moves in any direction.
  - ✓ Any part of the elevated foot loses contact with the stance leg.
  - ✓ The heel of the stance leg touches the floor.
  - ✓ The participant loses balance.

General interpretation:

- Use the information provided in Table 17 to categorize the participant's performance

Table 17

The Stork-stand Balance Test

Rating	Excellent	Good	Average	Fair	Poor
Males	>50 seconds	41–50 seconds	31–40 seconds	20–30 seconds	<20 seconds
Females	>30 seconds	25–30 seconds	16–24 seconds	10–15 seconds	<10 seconds

Data from: Johnson B.L. & Nelson, J.K. (1986). *Practical Measurements for Evaluation in Physical Education* (4th ed.). Minneapolis, Minn.: Burgess.

FLEXIBILITY AND MUSCLE-LENGTH TESTING

Evaluating participants' ranges of motion using flexibility tests is a great way to determine areas of the body that may need an emphasis on stretching. Stiff, inflexible muscles and joints pose a risk for injury and may adversely affect the performance of the simplest tasks. During the initial assessments of posture and movement, a GFI may opt to assess the flexibility of specific muscle groups that he or she suspects demonstrate tightness or limitations to movement. Figure 37 can be used to keep records when conducting the flexibility assessments presented in this section.

Figure 37
Worksheet for conducting flexibility assessments

SIT-AND-REACH TEST

Distance reached:____________________ Additional notes:____________________

THOMAS TEST

Left hip: Normal ❑ Tight ❑ Right hip: Normal ❑ Tight ❑

Additional notes:____________________ Additional notes:____________________

PASSIVE STRAIGHT-LEG RAISE

Left Hamstrings: Normal ❑ Tight ❑ Right Hamstrings: Normal ❑ Tight ❑

Additional notes:____________________ Additional notes:____________________

SHOULDER FLEXION

Left shoulder: Normal ❑ Tight ❑ Right shoulder: Normal ❑ Tight ❑

Additional notes:____________________ Additional notes:____________________

SHOULDER EXTENSION

Left shoulder: Normal ❑ Tight ❑ Right shoulder: Normal ❑ Tight ❑

Additional notes:____________________ Additional notes:____________________

INTERNAL ROTATION

Left shoulder: Normal ❑ Tight ❑ Right shoulder: Normal ❑ Tight ❑

Additional notes:____________________ Additional notes:____________________

EXTERNAL ROTATION

Left shoulder: Normal ❑ Tight ❑ Right shoulder: Normal ❑ Tight ❑

Additional notes:____________________ Additional notes:____________________

APLEY'S SCRATCH TEST

Left reach-under: Normal ❑ Tight ❑ Right reach-under: Normal ❑ Tight ❑

Additional notes:____________________ Additional notes:____________________

Left reach-over: Normal ❑ Tight ❑ Right reach-over: Normal ❑ Tight ❑

Additional notes:____________________ Additional notes:____________________

Sit-and-Reach Test

The sit-and-reach test is used to assess low-back and hip-joint flexibility. Due to the possibility of injury to the low back and hamstrings, participants should refrain from fast, jerky movements during this assessment. Instead, they should perform the test trials slowly and with control. Participants with a history of low-back dysfunction and/or pain should avoid performing this test.

Equipment:

- Exercise mat
- Tape
- Yardstick

Procedure:

- Participants should perform a light warm-up prior to testing. However, if this test follows a cardiorespiratory-fitness test, participants may proceed without a warm-up. Additional light stretching of the low back and hamstrings (e.g., modified hurdler stretch) is recommended before test administration.
- Place a yardstick on the floor and put a piece of tape at least 12 inches long on the 15-inch mark on the yardstick.
- Review and demonstrate the proper execution of the test. With the shoes off, sit on the floor with the yardstick parallel between extended legs. The zero mark of the yardstick should be toward the body.
- The feet should be placed approximately 12 inches apart with the heels aligned with the tape at the 15-inch mark.
- Extend the arms in front of the chest and place one hand on top of the other, with fingertips aligned. Inhale in the upright position and exhale while leaning forward, dropping the head toward or between the arms. The fingers should maintain contact with the yardstick and knees should remain in full extension (Figure 38).
- Instruct participants to begin the test by slowly reaching forward with both hands as far as possible, holding this position for approximately two seconds. Remind them to keep their hands parallel and not to lead with one hand. The score is the farthest point on the yardstick reached after three trials (Table 18).

Figure 38
Sit-and-reach flexibility test

Table 18

Norms for Trunk-Flexibility Test Fitness Categories (inches)

	MEN							WOMEN					
Ages	**18–25**	**26–35**	**36–45**	**46–55**	**56–65**	**>65**	**Ages**	**18–25**	**26–35**	**36–45**	**46–55**	**56–65**	**>65**
% Rating							% Rating						
90	22	21	21	19	17	17	90	24	23	22	21	20	20
80	20	19	19	17	15	15	80	22	21	21	20	19	18
70	19	17	17	15	13	13	70	21	20	19	18	17	17
60	18	17	16	14	13	12	60	20	20	18	17	16	17
50	17	15	15	13	11	10	50	19	19	17	16	15	15
40	15	14	13	11	9	9	40	18	17	16	14	14	14
30	14	13	13	10	9	8	30	17	16	15	14	13	13
20	13	11	11	9	7	7	20	16	15	14	12	11	11
10	11	9	7	6	5	4	10	14	13	12	10	9	9

The following may be used as descriptors for the percentile rankings: Well above average (90), above average (70), average (50), below average (30), and well below average (10).

Group fitness instructors should be aware of the limitations associated with the sit-and-reach test. First, variations in arm, leg, and trunk length can make comparisons between individuals—such as when comparing participants' scores to those listed in the norm tables—misleading. That is, participants with long arms and/or short legs will get a better result, while those with short arms and/or long legs will be at a disadvantage. Second, as noted earlier, individuals with a history of low-back pain should avoid this test due to the end ranges of motion required in hip and spine flexion to perform it. An option for assessing the length of the hamstrings while sparing the back is the passive straight-leg (PSL) raise test.

Figure 39
Thomas test: Starting position

Thomas Test for Hip Flexion/Quadriceps Length

Objective: To assess the length of the muscles involved in hip flexion. This test can actually assess the length of the primary hip flexors.

- Hip flexors or iliopsoas
- Rectus femoris (one of the four quadriceps muscles)

This test should not be conducted on participants suffering from low-back pain, unless cleared by their physician.

Equipment:

- Stable table

Instructions:

- Given the nature of the movement associated with this test, the instructor may want to consider draping a towel over the participant's groin area.
- Explain the objective of the test and allow a warm-up.
- Instruct the participant to sit at the end of a table with the mid-thigh aligned with the table edge (Figure 39). Place one hand behind the participant's back and the other under his or her thighs.
- While supporting the participant, instruct him or her to gently flex both thighs toward the chest, and gradually assist as the participant rolls back onto the table to touch the back and shoulders to the table top.
  - ✓ Instruct the participant to slowly pull one thigh (hip) toward the chest, reaching with both hands to grasp the thigh or the area behind the knee without raising or moving the torso.
  - ✓ Ask the participant to slowly relax the opposite leg, allowing the knee to slowly fall toward the table and the lower leg to hang freely off the table edge [a 1-inch (2.5 cm) spacing between the back of the knee and the table edge is adequate] (Figure 40).

Figure 40
Thomas test: Test position

Observations:

- Observe whether the back of the lowered thigh touches the table (hips positioned in 10 degrees of extension).
- Observe whether the knee of the lowered leg achieves 80 degrees of flexion.
- Observe whether the knee remains aligned straight or falls into internal or external rotation.

General interpretations:

- Use the information provided in Table 19 to determine the location and identity of the tight or limiting muscles.

Table 19

Interpretation of the Thomas Test

Movement/Limitation	Suspected Muscle Tightness
With the back and sacrum flat, the back of the lowered thigh does not touch the table and the knee does not flex to 80 degrees.	Primary hip flexor muscles
With the back and sacrum flat, the back of the lowered thigh does not touch the table, but the knee does flex to 80 degrees.	The iliopsoas, which is preventing the hip from rotating posteriorly and inhibiting the thigh from being able to touch the table
With the back and sacrum flat, the back of the lowered thigh does touch the table, but the knee does not flex to 80 degrees.	The rectus femoris, which does not allow the knee to bend

Data from: Kendall, F.P. et al. (2005). *Muscles Testing and Function with Posture and Pain* (5th ed.). Baltimore, Md.: Lippincott Williams & Wilkins.

Passive Straight-leg (PSL) Raise

Objective: To assess the length of the hamstrings

Equipment:

- Stable table or exercise mat

Instructions:

- Explain the objective of the test and allow a warm-up.
- Instruct the participant to lie supine on a mat or table with the legs extended and the low back and sacrum flat against the surface.
- Place one hand under the calf of the leg that will be raised while instructing the participant to keep the opposite leg extended on the mat or table. Restrain that leg from moving or rising during the test.
- Slide the other hand under the lumbar spine into the space between the participant's back and the mat or table (Figure 41).
- Advise the participant to gently plantarflex his or her ankles to point the toes away from the body. This position avoids a test limitation due to a tight gastrocnemius muscle (which would limit knee extension with the ankle in dorsiflexion). Additionally, a straight-leg raise with dorsiflexion may increase tension within the sciatic nerve and create some discomfort.
- Slowly raise the one leg, asking the participant to keep that knee loosely extended throughout the movement.
- Continue to raise the leg until firm pressure can be felt from the low back pressing down against the hand (Figure 42).
  - This indicates an end-range of motion of the hamstrings with movement now occurring as the pelvis rotates posteriorly.
  - Throughout the movement, the participant needs to maintain extension in the opposite leg and keep the sacrum and low back flat against the mat or table.
    - ✓ If the test is performed with the opposite hip in slight flexion, this allows the pelvis more freedom to move into a posterior tilt, allowing a greater range of motion and falsely increasing the length of the hamstrings.

Figure 41
PSL raise: Trainer's hand position

Figure 42
PSL raise: Test position

Observation:

- Note the degree of movement attained from the table or mat that is achieved before the spine compresses the hand under the low back or the opposite leg begins to show visible signs of lifting off the table or mat.
  - ✓ The mat or table represents 0 degrees.
  - ✓ The leg perpendicular to the mat or table represents 90 degrees.

General interpretation:

- Use the information provided in Table 20 to determine the limitation(s).

Table 20

Interpretation of the Passive Straight-leg Raise

Movement/Limitation	Hamstrings Length
The raised leg achieves ≥80 degrees of movement before the pelvis rotates posteriorly.	Normal hamstrings length
The raised leg achieves <80 degrees of movement before the pelvis rotates posteriorly or there are any visible signs in the opposite leg lifting off the mat or table.	Tight hamstrings

Data from: Kendall, F.P. et al. (2005). *Muscles Testing and Function with Posture and Pain* (5th ed.). Baltimore, Md.: Lippincott Williams & Wilkins.

Shoulder Mobility

Apley's scratch test involves multiple and simultaneous movements of the scapulothoracic and glenohumeral joints in all three planes. This represents a challenge in evaluating shoulder movement and identifying movement limitations. To identify the source of the limitation, GFIs can first have participants perform various isolated movements in single planes to locate potentially problematic movements. Consequently, the scratch test is completed in conjunction with:

- The shoulder flexion-extension test
- An internal-external rotation test of the humerus

Shoulder Flexion and Extension

Objective: To assess the degree of shoulder flexion and extension. This test should be performed in conjunction with Apley's scratch test to determine if the limitation occurs with shoulder flexion or extension.

Equipment:

- Exercise mat
- Pillow (optional)

Instructions:

- Explain the purpose of the test.
- Shoulder flexion:
  - ✓ Instruct the participant to lie supine on a mat, with the back flat and a bent-knee position [knees and second toe aligned with the anterior superior iliac spine (ASIS)], and with the arms at the sides.
  - ✓ Have the participant engage the abdominal muscles to hold a neutral spine without raising the hips from the mat.
  - ✓ Instruct the participant to raise both arms simultaneously into shoulder flexion, moving them overhead, keeping them close to the sides of the head, and bringing them down to touch the floor or as close to the floor as possible (Figure 43).
    - o The participant must maintain extended elbows and neutral wrist position (the arms will naturally rotate internally during this movement).
    - o Have the participant avoid any arching in the low back during the movement.
    - o Have the participant avoid any depression of the rib cage, which may pull the shoulders off the mat.
- Shoulder extension:
  - ✓ Instruct the participant to lie prone, extending both legs, with arms at the sides, and resting the forehead gently on a pillow or the mat.
  - ✓ Ask the participant to slowly raise both arms simultaneously into extension, lifting them off the mat while keeping the arms close to the sides (Figure 44) (the arms will naturally rotate internally during this movement).
    - o A small amount of extension in the thoracic spine is acceptable during the movement.
    - o The participant should avoid any arching in the low back or any rotation of the torso during the movement.
    - o The participant should avoid any attempts to lift the chest or head off the mat during the movement.

Figure 43
Shoulder flexion test

Figure 44
Shoulder extension test

Observations:

- Measure the degree of movement in each direction.
- Note any bilateral differences between the left and right arms in performing both movements.

General interpretations:

- Use the information provided in Table 21 to determine the limitation(s) in these shoulder flexibility tests.

Table 21

Interpretation of the Shoulder Flexion and Extension Test

Movement/Limitation—Flexion	Shoulder Mobility
Ability to flex the shoulders to 170–180 degrees (hands touching/nearly touching floor)	Good shoulder mobility
Inability to flex the shoulders to 170 degrees or discrepancies between the limbs	Potential tightness in the pectoralis major and minor, latissimus dorsi, teres major, rhomboids, and subscapularis • Tightness in the latissimus dorsi will force the low back to arch. • Tightness of the pectoralis minor may tilt the scapulae forward (anterior tilt) and prevent the arms from touching the floor. • Tight abdominals may depress the rib cage, tilting the scapulae forward (anterior tilt), and prevent the arms from touching the floor. • Thoracic kyphosis may round the thoracic spine and prevent the arms from touching the floor.
Ability to extend the shoulders to 50–60 degrees off the floor	Good shoulder mobility
Inability to extend the shoulders to 50 degrees or discrepancies between the limbs	Potential tightness in pectoralis major, abdominals, subscapularis, certain shoulder flexors (anterior deltoid), coracobrachialis, and biceps brachii • Tightness in the abdominals may prevent normal extension of the thoracic spine and rib cage. • Tightness in the biceps brachii may prevent adequate shoulder extension with an extended elbow (but may permit extension with a bent elbow).

Data from: Kendall, F.P. et al. (2005). *Muscles Testing and Function with Posture and Pain* (5th ed.). Baltimore, Md.: Lippincott Williams & Wilkins; Houglum, P.A. (2010). *Therapeutic Exercise for Musculoskeletal Injuries* (3rd ed). Champaign, Ill.: Human Kinetics.

Internal and External Rotation of the Humerus at the Shoulder

Objective: To assess internal (medial) and external (lateral) rotation of the humerus at the shoulder joint. This test should be performed in conjunction with Apley's scratch test to determine if the limitation occurs with internal or external rotation of the humerus.

Equipment:

- Mat

Instructions:

- Explain the purpose of the test.
- Instruct the participant to lie supine, with his or her back flat on a mat in a bent-knee position (knees and second toe aligned with the ASIS).
- Ask the participant to abduct the arms to 90 degrees, with a 90-degree bend at the elbows and the forearms perpendicular to the mat (i.e., pointing up toward the ceiling).
  - ✓ The upper arms must remain aligned with the shoulders throughout the test.
  - ✓ The backs of the upper arms should rest against the mat throughout the test.
- External (lateral) rotation to evaluate medial rotators
  - ✓ Ask the participant to slowly rotate his or her forearms backward toward the mat, aiming to rest the forearms and the backs of the hands on the mat adjacent to the head, while maintaining the 90-degree bend at the elbows (Figure 45).
    - o The participant should engage the abdominals to avoid arching the low back, and avoid flexing the spine forward.
    - o The participant should maintain a neutral wrist position throughout the movement.
- Internal (medial) rotation to evaluate lateral rotators
  - ✓ Have the participant return to the starting position (forearms perpendicular to the mat).
  - ✓ Ask the participant to slowly rotate the forearms forward toward the mat, turning the palms downward while maintaining the 90-degree bend at the elbows (Figure 46).
    - o The participant should avoid raising the shoulders off the table or flexing the spine forward.
    - o The participant must maintain a neutral wrist position throughout the movement.

Observations:

- Measure the degree of movement in each direction.
- Note any bilateral differences between the left and right arms in performing both movements.

General interpretation:

- Use the information provided in Table 22 to determine the limitation(s) in this flexibility test.

Figure 45
External (lateral) shoulder rotation

Figure 46
Internal (medial) shoulder rotation

Table 22

Interpretation of the External and Internal Rotation Test

Movement/Limitation—External/Lateral Rotation	**Shoulder Mobility**
Ability to externally rotate the forearms 90 degrees to touch the mat	Good mobility in the internal (medial) rotators, allowing the joint to move through the full range
Inability to reach the floor or discrepancies between the limbs	Potential tightness in the medial rotators of the arm (i.e., subscapularis) The joint capsule and ligaments may also be tight and limit rotation.
Movement/Limitation—Internal/Medial Rotation	**Shoulder Mobility**
Ability to internally rotate the forearms 70 degrees toward the mat (i.e., forearms are 20 degrees off the mat)	Good mobility in the external (lateral) rotators, allowing the joint to move through the full range
Inability to internally rotate the forearm 70 degrees, or discrepancies between the limbs	Potential tightness in the lateral rotators of the arm (i.e., infraspinatus and teres minor) The joint capsule and ligaments may also be tight and limit rotation.

Data from: Kendall, F.P. et al. (2005). *Muscles Testing and Function with Posture and Pain* (5th ed.). Baltimore, Md.: Lippincott Williams & Wilkins; Hougium, P.A. (2010). *Therapeutic Exercise for Musculoskeletal Injuries* (3rd ed). Champaign, Ill.: Human Kinetics.

Apley's Scratch Test for Shoulder Mobility

Objective: To assess simultaneous movements of the shoulder girdle (primarily the scapulothoracic and glenohumeral joints)

Movements include:

- Shoulder extension and flexion
- Internal and external rotation of the humerus at the shoulder
- Scapular abduction and adduction

Instructions:

- Explain the purpose of the test and allow a warm-up (e.g., forward and rearward arm circles).
- Shoulder flexion, external rotation, and scapular abduction
  - ✓ From a sitting or standing position, the participant raises one arm overhead, bending the elbow and rotating the arm outward while reaching behind the head with the palm facing inward to touch the medial border of the contralateral scapula or to reach down the spine (touching vertebrae) as far as possible (Figure 47).

✓ The participant should avoid any excessive arching in the low back or rotation of the torso during the movement.

✓ Have the participant repeat the test with the opposite arm.

- Shoulder extension, internal rotation, and scapular adduction

✓ From a sitting or standing position, the participant reaches one arm behind the back, bending the elbow and rotating the arm inward with the palm facing outward to touch the inferior angle of the contralateral scapula or to reach up the spine (touching vertebrae) as far as possible (Figure 48).

✓ The participant should avoid any excessive arching in the low back or rotation of the torso during the movement.

✓ Have the participant repeat the test with the opposite arm.

Observations:

- Note the participant's ability to touch the medial border of the contralateral scapula or how far down the spine he or she can reach with shoulder flexion and external rotation.
- Note the participant's ability to touch the opposite inferior angle of the scapula or how far up the spine he or she can reach with shoulder extension and internal rotation.
- Observe any bilateral differences between the left and right arms in performing both movements.

General interpretations:

- Use the information provided in Table 23 to determine the limitation(s) in this flexibility test.

Figure 47
Apley's scratch test: Shoulder flexion, external rotation, and scapular abduction

Figure 48
Apley's scratch test: Shoulder extension, internal rotation, and scapular adduction

Table 23

Interpretation of Apley's Scratch Test

Movement/Limitation	Shoulder Mobility*
Ability to touch specific landmarks	Good shoulder mobility
Inability to reach or touch the specific landmarks or discrepancies between the limbs	Requires further evaluation to determine the source of the limitation (i.e., which of the movements is problematic) • Shoulder flexion and extension • Internal and external rotation of the humerus • Scapular abduction and adduction

*Tightness of the joint capsules and ligaments may also contribute to limitations. It is common to see greater restriction on the dominant side due to increased muscle mass.

Data from: Kendall, F.P. et al. (2005). *Muscles Testing and Function with Posture and Pain* (5th ed.). Baltimore, Md.: Lippincott Williams & Wilkins.

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