### Core Training

Core training is critical for improving posture, enhancing performance, increasing resistance to injury, and accelerating injury rehabilitation. A properly designed core training program can be a key component of an overall training plan used to achieve a broad range of goals. The objective of core training is the development of core stability, endurance, strength, and power. Core stability and core endurance refer to the ability of an individual to maintain proper spinal and hip posture while the extremities (i.e., arms and legs) are moving. Core strength refers to the ability to contract the torso in all directions (i.e., flexion, extension, rotation), and core power involves explosive movements of the core musculature. There are multiple muscle groups that make up the core region, which are commonly characterized as local or global musculature. To properly stabilize and strengthen the core, both local and global core muscles must work together. This chapter discusses the importance of core training and how to design and incorporate core training into a client’s overall training program. Future chapters discuss balance and plyometric training and how these additional methods can be incorporated into a training program that will enhance overall functional efficiency.

**Core musculature**

Certified Personal Trainers must have a basic understanding of functional anatomy to understand the principles of core training. The core, also known as the lumbo-pelvic-hip complex (LPHC), includes a space within the body that has the following boundaries: diaphragm superiorly, abdominal muscle anteriorly and laterally, lumbar spine and gluteal muscles posteriorly, and pelvic floor and hip musculature inferiorly. In simpler terms, the core region is at the body’s centre of gravity and includes (but is not limited to) the abdominals, hips, gluteal complex, and low-back area. The core musculature can be divided into two unique categories: the local muscles and the global muscles. To maintain optimal stability and function of the core, it is important to systematically condition all muscles of the core. Together, the local and global muscles work to stabilize the spine while producing efficient arm and leg movements. These muscles work together to produce strong, effective movements of the trunk while continuing to stabilize the spine. Optimal lengths of muscles (or length-tension relationships) and recruitment of muscles (or force-couple relationships) of the LPHC, along with coordinated joint motions, are important for producing effective and efficient movements.

| **Examples of Local Muscles** | **Primary Actions** |
| --- | --- |
| Rotatores | Stabilize and rotate spinal segments |
| Multifidus | Stabilize, extend, and rotate spine |
| Transverse abdominis | Increase intra-abdominal pressure |
| Diaphragm | Regulate inspiration |

| **Examples of Local Muscles** | **Primary Actions** |
| --- | --- |
| Pelvic floor musculature | Support the contents of the pelvis |
| Quadratus lumborum | Lateral flexion of spine; elevation of pelvis |
| Rectus abdominis | Trunk/spine flexion, rotation, and lateral flexion |

| **Examples of Global Muscles** | **Primary Actions** |
| --- | --- |
| External abdominal obliques | Spinal flexion, lateral flexion, and contralateral rotation |
| Internal abdominal obliques | Spinal flexion, lateral flexion, and ipsilateral rotation |
| Erector spinae | Trunk/spine extension, rotation, and lateral flexion |
| Latissimus dorsi | Trunk/spine rotation (in addition to shoulder extension, adduction, and internal rotation) |

| **Examples of Global Muscles** | **Primary Actions** |
| --- | --- |
| Iliopsoas (iliacus + psoas) | Hip flexion (in addition to hip adduction and external rotation) |
|

**Local muscles**

Local muscles generally attach on or near the vertebrae and often have short attachments ranging between one and two vertebrae segments. Local muscles provide dynamic control of the spinal segments that limit excessive compression, shear, and rotational forces between spinal segments. This is important for stabilizing the vertebrae and limiting strain on passive stabilizing structures, including intervertebral discs and ligaments. Local muscles consist primarily of type I (slow twitch) muscle fibres, which have a high density of muscle spindles and are important for assisting in proprioception of the spine. Therefore, the appropriate function of local core muscles is important for maintaining proper posture of the vertebral column during strengthening exercises and other dynamic movements.

CRITICAL

Developing movement strategies that effectively stabilize the spine by activating local muscles, prior to the initiation of extremity movements, is important for minimizing improper loading of the spine and reducing the risk of injury. These strategies are discussed later in the chapter.

Additionally, appropriate posture throughout the spine is important for ensuring proper extremity movements, thereby enhancing the performance of the entire neuromuscular system. It is important to remember that dysfunction of local core musculature can be present in individuals with strong global core musculature. Therefore, exercises that activate, strengthen, and build endurance in local core muscles should still be incorporated into all core training programs.

**Global muscles**

Global core musculature is positioned more superficial on the trunk when compared to local core musculature. The global muscles of the core act to move the trunk, transfer loads between the upper and lower extremities, and provide stability of the spine by stabilizing multiple segments together as functional units. These muscles are primarily responsible for concentric force production and eccentric deceleration during dynamic activities. The primary global muscles of the core include (but are not limited to) the rectus abdominis, external obliques, latissimus dorsi, gluteus maximus, hip flexors, and extrinsic (superficial) erector spinae.

Collectively, all of the muscles within each system provide dynamic stabilization and neuromuscular control of the entire core. The global muscles produce force (concentric actions), attenuate force (eccentric actions), and provide stabilization in all planes of movement during dynamic activities. In isolation, global muscles do not effectively achieve stabilization of the LPHC; rather it is through their cooperative functioning with the local musculature that they enhance stability and neuromuscular control. To better understand how these muscles work to stabilize the LPHC, it helps to view the systems from the inside out (local muscles → global muscles). In other words, training the global muscles before training the local muscles would not be ideal from both a structural and biomechanical standpoint. Doing so could be compared to building a house without a foundation. The foundation must be developed first to provide a stable platform for the remaining components of the house to be built on. One must first be stable to move efficiently.

**Importance of properly training the core muscles**

Some active individuals have developed strength, power, and muscular endurance of the global muscles of the core, which enables them to perform dynamic activities. Few people, however, have properly trained the local muscles required for intervertebral stabilization. The local muscles have to function efficiently for an individual to effectively use the strength, power, and endurance that has been developed in the prime movers (i.e., arms, legs). If the global muscles are strong and the local muscles are weak, forces along the kinetic chain might not be transferred or used properly. This leads to compensation, inefficient movements, and the potential for injury. Weakness of the global and local core musculature is a fundamental problem that causes inefficient movement and can lead to poor posture, decreased athletic performance, increased risk of injury, and inability to adequately return to activity following a previous injury. For this reason, properly training local and global core musculature is essential for maintaining proper posture and improving performance, as well as increasing injury resilience and enhancing injury rehabilitation.

**Scientific rationale for core training**

When designing a core training program, it is important to incorporate exercises specific to the needs of each client. Core training has multiple benefits; therefore, core training may be considered fundamental to many overall training programs for the vast majority of clients. Scientific evidence exists to support the importance of core training for the following key areas: optimizing posture, performance, injury resistance, and rehabilitation.

Optimising posture

The human spine demonstrates naturally occurring curvatures that alternate between lordotic (inward/concave) curvatures in the cervical and lumbar spine and kyphotic (outward/convex) curvatures in the thoracic and sacral spine. These spinal curvatures develop naturally as individuals move from crawling to walking. Maintenance of these spinal curvatures throughout the life span is important for proper energy distribution throughout the spine. Proper core muscle function is critical for maintaining natural spinal curvatures, which can be increased or decreased as a result of improper core muscle balance. Overactivity of the hip flexors and superficial erector spinae and underactivity of the abdominals have been correlated with increased anterior pelvic tilt, which is associated with increased lumbar (low-back) lordosis. Conversely, overactivity of the hamstrings and rectus abdominis and underactivity of the erector spinae can rotate the pelvis posteriorly, known as a posterior pelvic tilt.

While the spine may exhibit small deviations from midline in the frontal plane, large curvatures of the spine away from midline are considered abnormal and may be classified as scoliosis. While scoliosis can often result from altered bone shape through the spine (structural scoliosis), functional scoliosis (nonstructural scoliosis) can be influenced by muscle imbalances, particularly muscle imbalances between right and left sides of the body. This leads to altered alignment of the spine in the frontal plane. Core muscle strengthening has been found to improve spinal alignment in individuals with functional scoliosis.

Additionally, hip musculature (e.g., gluteus medius) functions to maintain a level position of the pelvis. Improper positioning of the pelvis may result in improper postures of the spine. It is not clear if altered posture causes low-back pain (LBP) or if LBP results in altered posture. Gluteus medius weakness is common in individuals with LBP and should be addressed as a way to manage the link between abnormal posture and LBP. Therefore, proper core strength and stability are linked to proper posture, which is the reason maintaining proper body positioning, or form, should be emphasized while exercising as well as performing activities of daily life.

STRETCH YOUR KNOWLEDGE

Posture, Injury Prevention, and the Core

* The young female dancers who added Pilates-based core training to typical dance class participation improved both trunk and low-back posture, as well as body awareness, compared to the dancers who took part in dance classes only.
* In patients with neck pain and cervical disc herniation, 8 weeks of core training with cervical stability training was effective at relieving pain, improving muscle strength and endurance, and decreasing fear of movement (kinesiophobia).
* In healthy adults, the highest activity within the external oblique, internal oblique, and transversus abdominis muscles during breathing activities was accomplished while in a standing position compared to sitting and kneeling postures, suggesting that the positioning of clients during core training is important for facilitating proper muscle activity.
* Exercises involving single-leg stance with the addition of elastic resistance generated the greatest EMG values.

Key Takeaways

* Core training can improve trunk and low-back posture, as well as body awareness.
* Core training with cervical stability training can be effective at relieving pain and improving muscle strength and endurance.
* The positioning of clients during core training is important for facilitating proper muscle activity.
* Exercises involving unstable stances (single-leg stance) with external resistance can create greater muscle activation.
* Core training can improve abdominal/low-back strength and motor control.

### Performance

A strong and stable core is important for generating strong and explosive movements needed for optimal physical performance.

The core can be thought of as a foundation for producing and transmitting strong and controlled movements to the lower extremity and generating force production for the upper extremities. Therefore, improving core performance, including strength, endurance, and coordinated muscle activation, should be viewed as a critical component of improving movements requiring upper and lower limb speed, strength, and endurance. There is evidence that core muscles activate prior to movements in the lower extremity, suggesting that proper core muscle function is essential for preparing the primary lower extremity movers to generate force. Core stability and core strength are associated with increased lower extremity muscle strength (and increased take-off velocity of a vertical jump, as well as maximal squat performance.

Core muscle strengthening programs have been linked to improved speed and kicking performance, as well as dynamic balance and jumping distance. Core muscle endurance is also critical to lower extremity muscle performance. Previous research has demonstrated that core muscle fatigue can result in altered cycling biomechanics. Similarly, fatiguing the core musculature results in decreased shoulder strength, suggesting that core endurance is critical for upper extremity muscle performance. Preparatory trunk movements occur prior to moving the upper limb extremity, suggesting proper trunk stability is needed to maximize upper extremity performance. Additionally, improving core strength results in increased shoulder strength. Athletes who participate in throwing activities strengthened gluteal function, which is connected to better pelvis and torso biomechanics, and sling-based core training, which involves suspension of the limbs using unstable sling or cord systems, results in improved throwing velocity. Core training improved 50-meter swimming sprint times, suggesting core training can translate to improved performance in nonweight-bearing activities that engage both upper and lower extremity function.

Injury resistance

Core muscle function is critical for proper extremity movements. Therefore, optimal core muscle function has been considered a factor that may modify injury risk. A prospective cohort study demonstrated that lower postural control, hip muscle strength, and core muscle endurance were predictive of individuals who developed overuse musculoskeletal injuries over a 1.5-year period. Core muscle training has been found to improve balance, and a meta-analysis concluded that core strength training was an important factor in fall prevention. Core stability has become a key component of prevention programs aimed at decreasing acute lower extremity injuries, such as anterior cruciate ligament tears. The ability to properly stabilize the trunk during jump landing is critical to achieving optimal landing mechanics that may decrease the risk of knee injury. In a randomized controlled trial, 4 weeks of core stability training produces similar decreases in forces at the knee during jump landing in female high school athletes to individuals who participated in 4 weeks of plyometric training.

Rehabilitation

LBP is one of the leading causes of global disability, and core muscle training is commonly used to rehabilitate patients with LBP. Researchers have found that individuals with chronic LBP have decreased activation of certain muscles or muscle groups, including the transverse abdominis, internal obliques, pelvic floor muscles, multifidus, diaphragm, gluteal complex, and deep erector spinae. A meta-analysis evaluating more than 2,400 individuals demonstrated that core exercise is effective in improving outcomes in those with LBP. Core stabilization exercises restore the size, activation, and endurance of the multifidus (deep spine muscle) in individuals with LBP. The addition of core stability exercises to traditional rehabilitation for people with LBP demonstrates improvements in pain compared to traditional rehabilitation.

CRITICAL

It is important for fitness professionals to work closely alongside healthcare providers, who are trained to diagnose and treat individuals with injuries. It is beyond the scope of practice for a Certified Personal Trainer to diagnose an injury or perform the functions of a licensed rehabilitation specialist (e.g., physical therapist, physiotherapist, chiropractor, orthopedist).

Clients with LBP can be taught to improve functionality of core muscles to improve core stability and reduce LBP. For example, performing an abdominal drawing-in maneuver increases muscle activation of the transverse abdominis. Transverse abdominis activation improves with 4 weeks of training in those with and without LBP. Using proper exercise techniques can reduce pain in those with LBP. Using hyperextension exercises without proper LBP stabilization has been shown to increase pressure on the discs to dangerous levels. These unsupported exercises can cause damage to the ligaments that support the vertebrae, which may lead to a narrowing of the vertebrae openings that spinal nerves pass through. Therefore, it is crucial for fitness professionals to incorporate a systematic, progressive approach when training the core, ensuring the local core muscles that stabilize the spine are strengthened before or in conjunction with the global musculature that moves the spine and extremities.

HELPFUL HINT

Electromyography is a procedure that measures the electrical conducting function of nerves in muscles. An electromyography is able to identify differences in muscle or muscle group activation when performing different movements or exercises.

**Drawing-in manoeuvre**

Research has demonstrated that electromyography activity is increased during pelvic stabilization and transverse abdominis activation when an abdominal drawing-in manoeuvre is initiated before activity. Research has found that the transverse abdominis, when properly activated, creates tension in the thoracolumbar fascia (connective tissue of the low-back area), contributing to spinal stiffness, and compresses the sacroiliac joint, increasing stability. These findings have led other researchers to further understand and demonstrate the important role of the transverse abdominis on spinal stability and LBP. To perform the drawing-in manoeuvre, pull in the region just below the navel toward the spine and maintain the cervical spine in a neutral position. Maintaining a neutral spine, or the normal curvatures of the spine during core training helps improve posture, muscle balance, and stabilization. If a forward protruding head is noticed during the drawing-in manoeuvre, the sternocleidomastoid is preferentially recruited. If the sternocleidomastoid muscle is overactive and extends the upper cervical spine, the pelvis rotates anteriorly to realign the eyes. This can lead to muscle imbalances and decreased pelvic stabilization.

**Abdominal bracing**

Bracing is referred to as a co-contraction of global muscles, such as the rectus abdominis and external obliques. Bracing is also commonly referred to as a “bearing down” or tightening of the global muscles by consciously contracting them. Research has shown that muscular endurance of global and local musculature, when contracted together, create the most benefit for those with LBP compared with traditional LBP training methods, such as solely emphasizing range of motion at the spine. Bracing focuses on global trunk stability, not simply on segmented vertebral stability, meaning that the global muscles, given the proper endurance training, will also work to stabilize the spine.

However, both the drawing-in manoeuvre and bracing can be implemented in a core training program to help retrain the strength, endurance, and motor control of local and global muscular systems and movement musculature. Activation of the local stabilization system and the global stabilization system has been demonstrated to preferentially activate these specific muscles during core training.

**Guidelines for core training**

A comprehensive core training program should be systematic, progressive, and functional and emphasize the entire muscle action spectrum focusing on force production (concentric), force reduction (eccentric), and dynamic stabilization (isometric). A core training program should regularly manipulate planes of motion, ranges of motion, body position, speed of execution, and specific acute training variables (e.g., sets, reps, intensity, tempo, frequency).

When designing a core training program, the fitness professional should initially create a proprioceptively enriched training environment. Proprioception training offers a controlled yet unstable training environment with a selection of appropriate exercises to elicit a maximal training response and involves activities that emphasize awareness of body position in space. Core exercises performed in an unstable environment (such as with a stability ball) have been demonstrated to increase activation of the local and global stabilization system.

TRAINING TIP

The use of weight belts for apparently healthy adults engaging in a moderately intense exercise program is not recommended. Weight belts may raise an individual’s heart rate and systolic blood pressure and often give individuals a false sense of security and the misconception that they can lift heavier loads. Instead, fitness professionals need to educate their clients as to appropriate exercise technique and proper activation of the body’s natural belt: the core musculature.

|  |  |
| --- | --- |
| Planes of motion   * Sagittal * Frontal * Transverse | Volume   * Sets   + Low   + Moderate   + High * Repetitions   + Low   + Moderate   + High |
| Range of motion   * Full * Partial * End range | Progression   * Little or no motion of spine * Controlled spinal flexion, extension, rotation * Explosive trunk movements |
| Speed of motion   * Slow * Medium * Fast * Explosive | Resistance   * Body weight * Light * Medium * Heavy |
|  | Exercise equipment   * Tubing * Cables * Medicine balls * Free weights * Balance equipment (e.g., foam pad, wobble board, balance disc) |

STRETCH YOUR KNOWLEDGE

Core Training for Rehabilitation and Sport Performance

* Linde et al. (2018) found that abdominal bracing during a single-leg squatting task led to greater activity of the global abdominal muscles in healthy females when compared to abdominal hollowing and control conditions.
* Motealleh evaluated trunk postural balance on an unstable sitting platform in young women with and without patellofemoral pain syndrome (PFPS). They found impaired trunk postural control in the women with PFPS, suggesting that rehabilitation for these patients should incorporate isolated core training to improve recovery and function.
* Tsai investigated whether core training through control and strength of the trunk and hip would improve landing biomechanics and muscle strength in adolescent male volleyball athletes. Following a 6-week core training program, athletes demonstrated a more controlled (upright) trunk posture during landing and improved strength of key hip and knee musculature, suggesting that core training may be important to incorporate into training programs for jumping athletes.
* Lima found that adults with a history of LBP and disability who underwent a 10-week core and mobility training program, including guidelines for the most appropriate core posture during work and activities of daily living, had reduced LBP intensity perception and low-back functional disability compared to individuals who did not follow this program.
* Sung demonstrated that an integrated and specialized 8-week core training and nondominant arm strength training program resulted in larger improvements in drive distance compared to golfers who did no exercise or core-only exercise for 8 weeks.

Key Takeaways

* Abdominal bracing during a single-leg squatting leads to greater activity of the global abdominal muscles.
* Rehabilitation for patients with PFPS should incorporate core training.
* Core training may improve landing mechanics after jumping.
* Core exercises can help reduce LBP.
* Core training can improve golf performance.

**Designing a core training program**

The goal of core training is to develop optimal levels of stability, muscular endurance, strength, and power. Increasing proprioceptive demand by using a multisensory environment and using multiple exercise modalities (balls, bands, balance equipment) is more important than increasing the external resistance. The quality of movement should be emphasized more than quantity, and the focus of the program should be on coordinated movement across the kinetic chain.

CRITICAL

Neural adaptations become the focus of the program instead of striving for absolute strength gains.

The following is an example of an integrated core training program. The client begins at the highest level at which they are able to maintain stability and optimal coordinated movement. The client progresses through their program after mastering the exercises in the previous level while simultaneously demonstrating intervertebral and lumbopelvic stability. To evaluate appropriate intervertebral stability, the client will be able to maintain the drawing-in position while performing various exercises. The client would have appropriate lumbopelvic stability when they are able to perform functional movement patterns, such as squats, lunges, and step-ups, without excessive spinal motion.

Core training programs must be designed to achieve the following functional outcomes. The sequence is critical for optimizing function:

1. Intervertebral stability (stabilization of individual spinal segments)
2. Lumbopelvic stability (stabilization of lumbo-pelvic-hip complex)
3. Movement efficiency (improved movement quality and force output)

**Core training progressions**

When initiating a core training program, exercises should initially focus on stabilization through the spine and pelvis without gross movement of the trunk. These exercises are designed to improve neuromuscular efficiency and intervertebral stability, focusing on drawing-in and then bracing during the exercises. These exercises primarily target the local core muscles discussed earlier in the chapter. Sample exercises that follow this protocol include (but are not limited to) the following:

* Marching
* Floor bridge
* Ball bridge
* Floor cobra
* Ball cobra
* Fire hydrant
* Plank
* Side plank
* Dead bug
* Bird dog
* Pallof press
* Farmer’s carry.

The next progression is to involve more dynamic eccentric and concentric movements of the spine throughout a full range of motion. In other words, these exercises involve flexion, extension, and rotation of the trunk. It is always important for the fitness professional to communicate with a client’s healthcare provider to determine if there are any underlying medical conditions that may warrant avoiding certain exercises. In this progression, specificity, speed, and neural demands are also increased using moderate to fast repetition tempos. These exercises are designed to improve lumbopelvic stability, concentric strength (force production), eccentric strength (force reduction), and neuromuscular efficiency (coordination) of the core. Sample exercises that follow this protocol include (but are not limited to) the following:

* Floor crunch
* Ball crunch
* Back extension
* Reverse crunch
* Knee-up
* Cable rotation
* Cable lift
* Cable chop.

The last progression includes exercises that are designed to improve the rate of force production (power) and movement efficiency of the core musculature and extremities. These forms of exercise prepare an individual to dynamically stabilize and generate force at more functionally applicable (explosive) speeds. Example exercises include (but are not limited to) the following:

* Medicine ball rotation chest pass
* Ball medicine ball pullover throw
* Front medicine ball oblique throw
* Side medicine ball oblique throw
* Medicine ball soccer throw
* Medicine ball woodchop throw
* Medicine ball overhead throw.

### Five kinetic chain checkpoints

As with any training method, proper form and technique must be mastered to ensure proper muscle activation and avoid injury. The skill for core training requires adequate focus and practice. Without inward focus and conscious attention to technique, injury may occur, especially as exercises become more explosive. Honing all skills with exquisite technique for each exercise is essential. Moreover, as with all exercises, improving quality should always come before increasing quantity or weight, and the five kinetic chain checkpoints should be monitored:

1. *Feet*: Approximately shoulder-width apart (when appropriate) and pointing straight ahead (when appropriate)
2. *Knees*: In line with the second and third toes (avoid allowing knees to cave inward)
3. *Hips*: Level and in a neutral position
4. *Shoulders*: Neutral position (not protracted or elevated)
5. *Head*: Cervical spine in a neutral position (chin tuck)

**Core exercises**

Marching

Make sure to keep the abdominals drawn in throughout the entire exercise to target the local core muscles. Abdominal protrusion indicates poor activation of the local core.

### Floor Bridge

SAFETY

When performing a bridge, do not raise the hips too far off the floor (hyperextending the low-back). This places excessive stress to the lumbar spine. Make sure at the end position, the knees, hips, and shoulders are in alignment and the gluteal muscles are fully contracted.

Ball bridge

Make sure to rest the head and shoulders on top of the stability ball to maximize comfort and reduce stress on the head and neck. Like the floor bridge, do not allow hyperextension of the low-back.

Floor Cobra

Like the ball bridge, do not come too high off the floor (hyperextending the low-back). The focus of the exercise is to retract and depress the shoulder blades. As such, be sure to externally rotate both arms and point the thumbs into the air.

Ball Cobra

Perform this exercise like the floor cobra, but it is best to place the feet against a sturdy object for extra support (not shown).

Fire Hydrant

Perform this exercise with the abdominals drawn in and head in a neutral position. This exercise helps strengthen the hip external rotators.

Plank

If this version of the exercise is too difficult for a client to perform, some regression options include the following:

* Perform in a standard push-up position
* Perform in a push-up position with the knees on the floor
* Perform with the hands on a bench and the feet on the floor

Side Plank

Keep all kinetic chain checkpoints in alignment; do not allow the pelvis to drop toward the floor. This is an excellent exercise to target the transverse abdominis muscle.

Dead Bug

This is another excellent exercise to target the local core muscles, but it may take some practice to coordinate all movements. As with other core exercises, maintain a neutral spine and core activation throughout the duration of the exercise.

Bird Dog

Keep the spine in a neutral position throughout the exercise and point the thumbs straight up toward the sky. Do not allow the low-back to excessively arch.

Kneeling Palloff Press

The Pallof press is an antirotation exercise designed to target the local core muscles. Be sure to keep the hips and shoulders square and maintain all five kinetic chain checkpoints during the exercise.

Farmer’s Carry

This is an advanced exercise depending on the load (weight) used. During this exercise, it is important to brace the abdominals and avoid excessive rotation or lateral flexion of the spine. Instead, keep an upright posture.

Floor Crunch

Do not perform a full sit-up. Rather, the movement only involves lifting the shoulder blades off the floor. This limits recruitment of the hip flexor muscles and may be safer for the low-back.

Ball Crunch

Make sure to keep the chin tucked while performing the exercise. This will take stress off of the muscles of the cervical spine.

Back Extension

At the end position of the exercise, makes sure the ankles, knees, hips, shoulders, and ears are all in alignment. Do not hyperextend the low-back.

Reverse Crunch

Do not swing the legs when performing this exercise. Once you have positioned the lower extremities during the setup, they should not move during the execution of the exercise. Swinging the legs increases momentum, increasing the risk of injury and decreasing the effectiveness of the exercise.

Knee-Up

The knee-up is performed in a similar fashion to the reverse crunch except the knees are fully extended. During the concentric phase, extend the feet toward the ceiling by lifting the hips off the bench then slowly lowering the hips back to the starting position.

Cable Rotation

To decrease stress to the low-back, make sure to pivot the back leg into triple extension:

* Hip extension
* Knee extension
* Ankle plantarflexion (extension)

This also ensures proper coordination of the muscles that extend the lower extremities (gluteus maximus, quadriceps, and calves).

Cable Lift

Do not hyperextend the low-back at the top position. Keep a neutral spine throughout. Like the cable rotation, the back leg should pivot into triple extension at the end of the movement.

Cable Chop

The cable chop is an opposite motion of the cable lift exercise. This time the back leg will be in flexion rather than extension.

Medicine Ball Rotation Chest Pass

It is imperative that clients demonstrate proper stabilization and strength before performing explosive core exercises. Performing these exercises without proper stabilization and strength may lead to movement compensations, muscle imbalances, and injury.

Ball Medicine Ball Pullover Throw

It is important that an individual has proper extensibility of the latissimus dorsi before performing this exercise to decrease stress to the low-back and shoulders.

Front Medicine Ball Oblique Throw

From an athletic position, bring the medicine ball to one hip and then explosive toss the ball to a wall or partner in front of you while keeping your hips and feet pointing straight ahead. Repeat on the opposite side.

Side Medicine Ball Oblique Throw

The back leg should pivot into triple extension after tossing the medicine ball.

Medicine Ball Soccer Throw

It may be easier to perform this exercise using a D-ball (a medicine ball that does not bounce back) or close to a wall to bounce the medicine ball off.

Medicine Ball Woodchop Throw

In most cases, do not use an overly heavy medicine ball. The goal of this exercise is to increase the rate of core force production versus absolute strength.

Medicine Ball Back Extension Throw

Most of the rotational motion should come from the thoracic spine instead of the lumbar spine.