

IMPLEMENTING CORE TRAINING CONCEPTS INTO STRENGTH TRAINING FOR SPORT

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Progressive development of the core musculature is a key component to creating a successful strength training program. Developing the muscles surrounding the pelvis, hips, lower back, and abdomen may help to build strength and stability. Interest in core strengthening involving athletes has increased over the years. This has created concepts and best practices that strength and conditioning coaches utilize in their own ways. For strength and conditioning coaches to effectively implement core training practices into strength training with athletes, at any level, they need to possess a solid understanding of the structure and function of the core and be able to create a program that will help their athletes best reach their performance goals.

This article will provide an understanding of the role the core plays during execution of athletic movements and provide evidence-based concepts that help to strengthen the core and maximize movement performance. Additionally, this article will identify some of the essential concepts to training the core and review sample exercises that strength and conditioning coaches can use to create their own approach with athletes.

STRUCTURE OF THE CORE

The core is comprised of a series of muscles and connective tissues that incorporates the lumbar spine, pelvic girdle, hip joint, and abdominal complex. Collectively, this series of body regions is also referred to as the lumbo pelvic hip complex (LPHC). Also included are the muscles that expand directly from the lumbar spine to the thoracic and cervical spine, which play significant roles in trunk stability (9).

Most core muscles are predominantly composed of slow-twitch muscle fibers and act as stabilizers, contracting isometrically,

to protect the spine and maintain proper posture (2). If core stabilizers are poorly developed, then postural issues like lordosis (swayback) or kyphosis (roundback) can develop (2). To strengthen the core stabilizers, hip extension exercises like back extensions, good mornings, or hip thrusts with a neutral spine can be implemented. These exercises can be loaded in various ways and when the spine remains neutral, the spinal erectors statically contract, stabilize the spine, and allow the glutes and hamstrings to contract dynamically to extend the hips.

Weak core stabilizer muscles can also limit the body's ability to generate force (6). Consider an athlete performing a front squat with the barbell resting between their anterior deltoids and collarbone. At the start of the exercise, the trunk is in an upright position. As the exercise begins, the knees and hips flex simultaneously. The bar descends until the athlete reaches a parallel position and drives the barbell back up to the starting position by extending their knees and hips. Maintaining a neutral spine and upright posture through the entire lift is crucial in order to protect the spine. For this to happen, the core stabilizers need to synergistically contract in sequence with appropriate timing and tension (7,8). When core stabilizers are weak, they provide less stability and neuromuscular control at the LPHC (2). This could cause the athlete to inadvertently round their back at any point during a front squat, increasing their risk of back problems or injury.

MUSCLE FUNCTIONS

To help better understand the complexity of the core, researchers and practitioners have broken down its many muscle groups into three separate layers based on their location and function. These layers are the local stabilizers, the global stabilizers, and the upper and lower extremity core-limb transfer muscles (12). The local

TABLE 1. CORE MUSCLES AND FUNCTIONS (13)

LAYER	MUSCLES	FUNCTION
Local Stabilizers (Inner Layer)	Transverse abdominis, diaphragm, pelvic floor, segmental multifidus, and psoas major	Provide sensory feedback to and from central nervous system (CNS)
		Provide stiffness (injury prevention) in anticipation of movements
Global Stabilizers (Middle Layer)	Internal obliques, external obliques, superficial multifidus, gluteus medius, medial quadratus lumborum, deep medial gluteus maximus, and proximal adductors	Postural control and body alignment
		Active at low levels of resistance and during endurance activities
		Control of motion during rotational or deceleration movements
Global Movers, Core-Limb Transfer Muscles (Outer Layer)	Rectus abdominis, erector spinae, quadratus lumborum, latissimus dorsi, adductor longus, adductor magnus, and lateral gluteus maximus	Trunk stabilization during high load movements in the sagittal plane
		Generation of force and acceleration of joint structures
		Shorten and tighten at higher resistance levels and during more powerful movements

stabilizers are the smaller muscles located closest to the spine and contribute sensory information to and from the central nervous system. The global stabilizers are larger muscles that provide mechanical control of postural alignment during rotational and deceleration movements. The upper and lower extremity core-limb transfer muscles are also referred to as global movers. They are the largest and most superficial muscles and they generate the bulk of joint movements. Table 1 breaks down each layer based on its function.

The importance of properly training the stabilizers and the global movers cannot be emphasized enough. When they work efficiently, the result is appropriate distribution of forces, optimal control and efficiency of movements, and adequate absorption of excessive compressive, translational, or shearing forces on the joints throughout the entire kinetic chain (3).

THE KINETIC CHAIN

The strength and stability of the core has a substantial influence on the structures located around it (4). Core muscles attach the upper and lower extremities providing an essential link in the body's kinetic chain. Athletic movements from an array of sports require the transference of forces through the core. Consider dynamic movements in sports like tennis and baseball. The forces generated for a tennis serve or baseball pitch start in the lower extremities and are transferred through the core muscles into the upper extremities. Weaker core muscles may fail in this essential role and limit the athlete's ability to perform (2).

ESSENTIAL TRAINING CONCEPTS

Proper development of core muscles is considered important in the development of many strength training programs. Even though each sport offers its own set of demands and nuances that may shift the training focus, strength and conditioning coaches can use some of these established training concepts to build core training into their strength training program. Below are concepts that address the needs of core strengthening for athletic performance:

Use a variety of open- and closed-chain exercises: Open-chain exercises allow the distal aspects to move freely and isolate muscle groups while working them (e.g., leg raises or superman extensions) (5). Closed-chain exercises tend to mimic the movements of sports and the distal aspects are fixed to the ground or stationary (e.g., deadlifts or Pallof holds) (5).

Work in multiple planes of motion: The muscles that make up the LPHC provide varying levels of function in the sagittal, frontal, and transverse planes. Whether they are acting in isolation or co-contracting to increase intra-abdominal pressure and trunk stiffness, working in multiple planes of motion will increase the active elements that contribute to core strength and stability.

Use loaded and unloaded conditions: Implementing loaded dumbbell carry variations (e.g., farmer's carries, waiter's carries, or suitcase carries) offers the benefit of building mechanical strength, refining motor control, and enhancing synergistic neuromuscular coordination throughout the LPHC (11). Loaded conditions test varying levels of trunk stability and strengthen the deeper transverse abdominis muscles to increase spinal stiffness.

Use stable and unstable positions: Tasks performed in sports are often performed with unstable body positioning (e.g., kicking, pitching, running, or shooting a goal). As such, it may benefit athletes to perform core exercises on unstable surfaces or positions (e.g., stability ball, Swiss ball, or stability disc). Research shows that exercises using balance boards or stability discs reduce the likelihood of lower extremity injuries because of their greater demand for postural control (12,15).

Work unilateral and bilateral: Bilateral exercises require a simultaneous contraction from the same muscles in both limbs (e.g., bench press). Unilateral exercises limit the contraction of that muscle to one limb at a time (e.g., single-arm dumbbell press). When resistance exercises, like the bench press, are performed unilaterally, they invoke significantly greater activation of core musculature because of the added destabilization component (14). This is important to remember when structuring workouts because there may be times throughout a training cycle where athlete do not have time to directly address core training exercises.

An important caveat is that this is not meant to be a comprehensive list of guidelines. These are proposed concepts that can be considered by strength and conditioning coaches to assist athletes in reaching their performance goals.

IMPLEMENTING THE PROGRAM

Greater core strength and stability may benefit athlete performance by providing a foundation for greater force production throughout the upper and lower extremities (13). When creating a program, thought should be given to the development of motor control and muscular strengthening throughout the core musculature (10). Taking an approach that focuses on a variety of exercises through a variety of movement and stability patterns, with the intent to develop motor potential, is crucial to the success of the program (12). Exercise selection will vary based on the phase of training and the available amount of time to train.

A strength and conditioning coach may incorporate core prehabilitation and activation drills during the warm-up or movement preparation to target specific muscle groups or train optimal movement patterns prior to the training session. Strength and conditioning coaches could also include core exercise into the strength training session by placing them among the primary and auxiliary lifts for that day; creating a within-training approach that breaks the core training into more manageable blocks of time

while providing a period of active recovery between primary lifts and minimizing the overall time spent training (1). An example of the within-training approach is provided in Table 2.

TABLE 2. WITHIN-TRAINING APPROACH

EXERCISE	SETS X REPS
1A. Primary Exercise	4 x 7
1B. Auxiliary Exercise 1	4 x 10
1C. Auxiliary Exercise 2	4 x 10
1D. Core Exercise	3 x 12

There are instances where strength and conditioning coaches may want to step back from isolated core training and focus more on multi-joint exercises, like Olympic-style lifts, deadlifts, and squat variations, to improve neuromuscular coordination of the LPHC and help facilitate the transmission of forces between upper and lower extremities. Exercises like these involve compound movements that require the activation and stabilization of muscles located throughout the LPHC. Regardless of the approach, careful consideration of exercise selection should be made. Table 3 provides some sample core exercises that can be used to help create a core training program.

CONCLUSION

A well-thought-out core training program helps create a strong and stable core. A strong core may generate more force, while stable core muscles may provide proper posture during athletic movements. Being able to create a core training program that effectively influences both these variables creates a foundation of movement competency for athletes. Proper assessment of the athlete and their sport, along with implementation of the program, may ensure continual development of deficiencies throughout the kinetic chain. Each sport offers its own set of training demands that must be considered. Using these essential training concepts can help strength and conditioning coaches create adaptable core training programs that best influence athletes from any sport.

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TABLE 3. SAMPLE CORE EXERCISES

ACTIVATION EXERCISES	EXPLANATION
Abdominal Bracing (Figure 1)	Lay down on your back with both knees bent, feet flat against the floor. Find your anterior superior iliac spine with your fingertips and bring your fingertips toward the midline of your body by two inches. Draw your stomach in toward your spine while simultaneously rotating your pelvis toward your belly button. Feel the area beneath your fingertips contract.
Single-Leg Supine Straight-Leg Raise (Figures 2 and 3)	Lay down on your back with one knee bent, foot flat on the floor. The other knee is extended, with the heel resting on the ground and the ankle in a dorsiflexed position. Flex at the hip of the extended leg while maintaining dorsiflexion. Raise the extended leg to a position that is at least parallel with the other leg, then slowly lower it back to the ground.
Bird Dog (Figures 4 and 5)	From a quadruped position, simultaneously extend opposite arm and leg. Try to maintain a straight spinal position through the entire spinal column. Slowly flex the extended arm and leg while lowering back to the starting position. As the opposite elbow and knee draw closer to each other, gently touch them together and go right back into extension while raising them up.
DYNAMIC EXERCISES	EXPLANATION
Medicine Ball Trunk Rotation (Figures 6 and 7)	Stand upright with feet shoulder-width apart. Hold a light weight or medicine ball in front of you with arms extended. Begin the movement by rotating your upper torso in either direction keeping the arms extended. Return to the starting position or through the other side by rotating your torso in the opposite direction. Complete this movement in each direction to demonstrate your active range of motion in your upper torso and pelvis.
Superman Extension (Figures 8 and 9)	Start in a prone position with your arms and legs extended. Keep your hands open with palms facing in toward each other. Simultaneously raise your arms and legs off the ground while maintaining a neutral neck position. Once at the top, slowly lower your arms and legs together, back to the ground and repeat this movement for the desired amount of repetitions.
Stability Ball Pike (Figures 10 and 11)	Start in a high plank position with a stability ball placed comfortably under your shins. Make sure your feet are plantar flexed. Keeping your legs as straight as possible, flex at the hips and hike your body up in the air as your shins move up the stability ball. Maintain your balance and raise your hips as high as you can, bringing the stability ball to your toes. Slowly return to the starting position and repeat the movement for the desired amount of repetitions.
Hanging Straight-Leg Raise (Figures 12 and 13)	Start this exercise hanging from a pull-up bar with your back in a vertical position. Bring your feet together and keep your legs as extended as possible through the entire range of motion. Flex at the hips and bring your straight legs out in front of you until they are parallel with the ground. Slowly return your legs to the starting position. Perform each repetition while keeping your back as vertical as possible.
LOADED CARRIES	EXPLANATION
Waiter's Carry (Figure 14)	Bring a kettlebell to the front rack position and raise it above your head. Completely extend the arm overhead with your palm facing forward. While maintaining this vertical position from your trunk through your extended arm, walk a specified distance. Be careful to maintain a neutral wrist and walk as normal as possible while bracing your core.
Farmer's Carry (Figure 15)	Place yourself between each of the weights you will be carrying. Squat down to the weights and bring them to a standing position using an overhand grip. Maintain an upright posture, balanced shoulder position, and fully extended arms while keeping the weights from brushing against your body. Walk a specified distance then slowly lower the weights back to the ground.
Suitcase Carry (Figure 16)	Start by standing next to the weight you will be carrying. Squat down to the weight and bring it to a standing position using an overhand grip. Maintain an upright posture, balanced shoulder position, and fully extended arm while keeping the weight from brushing against your body. Walk a specified distance then slowly lower the weight back to the ground.



FIGURE 1. ABDOMINAL BRACING



FIGURE 2. SINGLE-LEG SUPINE STRAIGHT-LEG RAISE—START



FIGURE 3. SINGLE-LEG SUPINE STRAIGHT-LEG RAISE—FINISH



FIGURE 4. BIRD DOG—START



FIGURE 5. BIRD DOG—FINISH



FIGURE 6. MEDICINE BALL TRUNK ROTATION—START



FIGURE 7. MEDICINE BALL TRUNK ROTATION—FINISH



FIGURE 8. SUPERMAN EXTENSION—START



FIGURE 9. SUPERMAN EXTENSION—FINISH



FIGURE 10. STABILITY BALL PIKE—START



FIGURE 11. STABILITY BALL PIKE—FINISH



FIGURE 12. HANGING STRAIGHT-LEG RAISE—START



FIGURE 13. HANGING STRAIGHT-LEG RAISE—FINISH



FIGURE 14. WAITER'S CARRY



FIGURE 15. FARMER'S CARRY

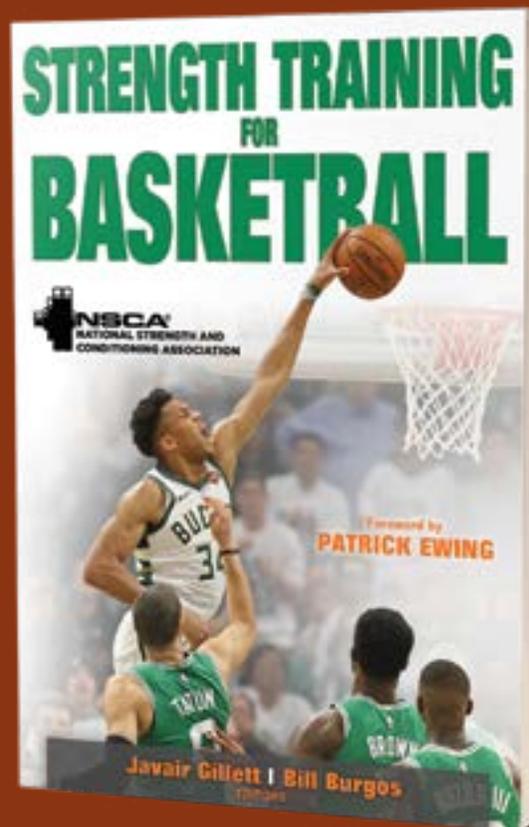


FIGURE 16. SUITCASE CARRY

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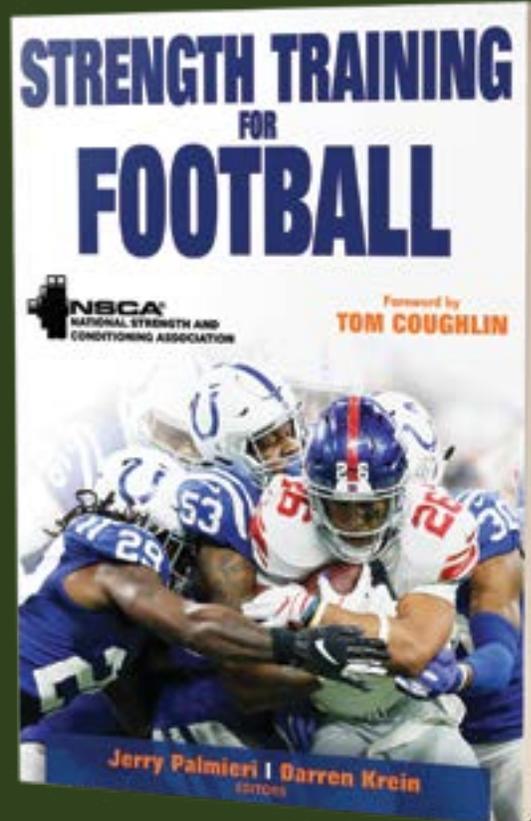
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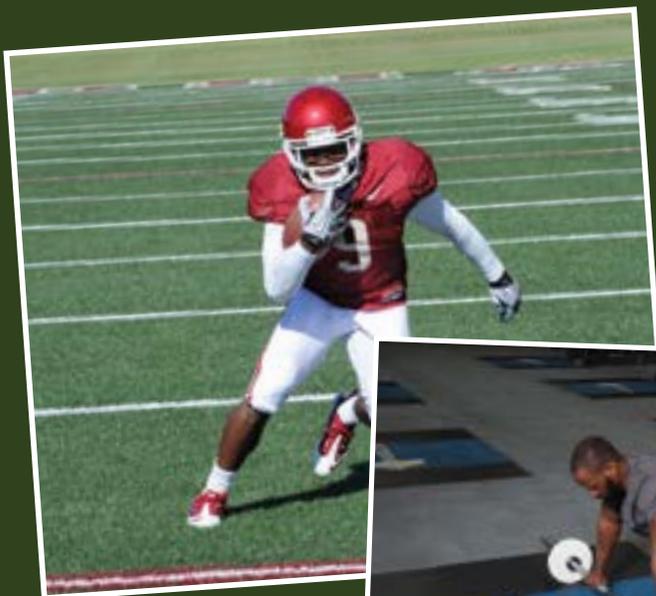
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