

# ***Core Stability for Athletes***

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## Introduction

Since the fitness boom of the 1980s, different exercise methodologies have been presented and marketed with varying levels of success. However, sometimes what appears to be a new exercise methodology is really not new at all; but just a new perspective that seeks to improve on an old methodology based on current trends. This appears to be the case with core stability training, a trend that has become popular in commercial fitness centers and athletic strength and conditioning facilities.

A core stability exercise can be defined as “any exercise that channels motor patterns to ensure a stable spine through repetition” (20). Based on this definition, athletes have been performing core stability exercises for many years. For example, any type of exercise that is performed while standing and holding or supporting a weight across the shoulders would qualify as a core stability exercise. Examples of such exercises may include the back squat, deadlift, overhead press, Olympic lifts, and unilateral variations of these exercises performed while standing (14, 19, 30).

Prior to the invention of selectorized exercise devices (e.g. Nautilus), athletes relied exclusively on free weights. This may have resulted in greater overall stimulation to the core musculature, especially for some exercises in which athletes had to clean the weight prior to performing the exercise (e.g. barbell overhead press). Therefore, core stability training is not a novel concept for athletes that have emphasized standing free weight lifts in their programs (14, 19, 30).

However, the current trend toward core stability training in commercial fitness centers may have originated from physical therapy methodology (8, 21, 26). When performed in this setting, core stability exercises are different from the aforementioned free weight lifts in that the emphasis is on isometric muscle actions (e.g. prone or supine bridging) performed with body mass or relatively light loads (3, 9). Furthermore, these exercises are often performed while lying, seated, or standing on unstable equipment such as a Swiss ball, wobble board, low density mat, or air-filled disc.

The use of unstable equipment has increased in popularity among healthy athletes. Various forms of unstable equipment have been claimed effective training tools for improving strength and power (10, 13, 24, 27). The term functional is often used in conjunction with these claims to convey the apparent specificity and transferability of these types of exercises to athletic performance (7).

During the last five years, a great amount of research has been published to examine the validity of these claims for healthy individuals and athletes (1, 2, 5, 6, 11, 12, 16, 17, 18, 25, 28, 29). Although this research is still in its infancy, sports scientists have reached some tentative conclusions on how core stability exercises should be prescribed based on individual needs and yearly training cycles. Therefore, the purpose of this brief review is to present the latest research on core stability training and make recommendations concerning how exercise prescription might be improved to address core stability in athletes.

## Importance of Core Stability for Sports Performance

The core of the body is a term used to refer to the trunk or more specifically the lumbopelvic region. Several muscles attach to the lumbar spine or pelvis and may function as stabilizers or prime movers depending on the nature of the task being performed. Muscular support in this region is critical to maintain the integrity of the spine to support body mass plus additional loads that are supported during resistance training and sports activities (22, 23).

When applied to sports performance, the stability of the core provides a foundation upon which the upper and lower extremities may contract to accelerate or decelerate body segments (15). For example, athletes that perform throwing type joint actions may benefit from greater core stability as ground reaction forces are transferred up through the lower extremities, across the trunk, and out to the throwing arm. Therefore, the core can be considered the kinetic link between the lower and upper extremities.

During throwing type joint actions, the kinetic energy of the ball or implement gradually increases, which allows for maximal velocity at the point of release. However, deconditioned core muscles may not effectively transfer kinetic energy, with greater compensatory stress being placed on the muscles, joints, and connective tissues of the arm in order to maintain high throwing velocity. Under such conditions, the athlete is more likely to sustain an injury.

Strength and conditioning coaches have the important role of selecting resistance exercises that allow for conditioning of the core muscles based on the specific performance requirements of a given sport. Different positions within a sport may also require different approaches in the way that core stability is addressed. The use of resistance exercises is typically targeted toward specific muscular characteristics such as muscular endurance, muscular strength, or muscular power (4). Improvements in core stability may result from increases in any of these characteristics if specifically integrated into practice of the requisite sports skills (28). From this perspective, the challenge for strength and conditioning coaches might be choosing the best resistance exercises to target each of these characteristics, based on the needs of the athlete, the time of year, and the performance demands of a given sport.

### **What the Research Has Indicated**

Research from the rehabilitation literature has demonstrated the effectiveness of core stability type exercises for treating or preventing lower back and lower and upper extremity injuries (3, 8, 9, 21, 26). Core stability exercises performed for rehabilitation purposes are often performed on unstable equipment such as a Swiss ball, wobble board, low density mat, or air-filled disc (29). Sports scientists have compared different exercises performed on unstable equipment versus stable ground or benches. Generally, the findings have indicated that as the degree of instability increased, the degree of core muscle activity increased proportionally. Vera-Garcia, Grenier, and McGill (25) evaluated muscle activity in the upper and lower regions of the rectus abdominis during curl-ups performed on a Swiss ball versus a stable bench. The results demonstrated that performing the curl-up on a Swiss ball resulted in significantly greater abdominal muscle activity (50% vs. 21% of maximal activity).

Marshall and Murphy (17) compared muscle activity in the rectus abdominis, transversus/internal oblique abdominis, external oblique abdominis, and erector spinae when push-ups were performed on a Swiss ball versus a stable floor. The results demonstrated that at the top portion of the push-up, with the hands positioned on a Swiss ball, there was significantly greater activity in the rectus abdominis (35% vs. 9% of maximal activity) and transversus/internal oblique abdominis (33% vs. 13% of maximal activity). Research has also demonstrated similar findings for the dumbbell chest press when performed on a Swiss ball (16) and for the barbell back squat when performed with each foot supported on an air-filled disc (1). However, what practitioners need to realize from the results of these studies was that in most cases, the level of muscle activity elicited by the unstable equipment was less than 50% of maximum (1, 16, 17, 25).

This level of activity is far less than what can potentially be achieved with heavy ground-based free weight lifts, and may not meet the level needed by healthy athletes for gains in core strength and power. Although core power might be developed effectively at lower intensities (i.e. less than 50% MVC) and high velocities of contraction; performing resistance exercises on unstable equipment has been shown to result in tentative movement patterns, which negate the stimulus for power development (28, 29). Four studies have demonstrated reductions in several key factors when training on unstable equipment that may weaken the stimulus for sports performance improvements. Anderson and Behm (2) demonstrated that the maximal force output of the pectoralis major decreased 60% when chest presses were performed on a Swiss ball versus a stable bench. McBride, Cormie, and Dean (18) demonstrated that maximal force output and rate of force development were 45.6% and 40.5% less when squats were performed on balance discs versus the ground.

Drinkwater, Pritchett, and Behm (12) demonstrated clinically meaningful differences when comparing the ground-based free weight squat versus the BOSU free weight squat with a 10RM load. Clinically meaningful differences were determined using effect size (ES) statistics, with values of .2, .6, and 1.2 being considered small, moderate, and large, respectively. Moderate to large differences between squat surfaces were demonstrated for concentric power (ES = 1.3), concentric force (ES = .82), concentric velocity (ES = .80), squat depth (ES = 1.73), and eccentric power (ES = 1.42). The authors hypothesized that these variables were reduced for the BOSU condition due to a stiffening strategy that involved co-contraction of agonist and antagonist muscle groups.

Behm et al. (6) demonstrated that maximal force output of the leg extensor (LE) and plantar flexor (PF) muscle groups decreased 70.5% (LE) and 20.2% (PF) when these joint actions were performed on a Swiss ball versus a stable bench. Conversely, for the antagonistic muscle groups, muscle activation was 40.2% (LE) and 30.7% (PF) greater when contractions were performed on a stability ball. Although increased antagonist activity may contribute positively to balance development and joint protective responses, it could also contribute negatively to strength and power development by opposing the intended direction of motion. Therefore, the use of unstable equipment may not provide a sufficient stimulus for core strength and power development in healthy athletes.

When considered collectively, resistance exercises performed on unstable equipment might be most effective for development of core muscular endurance (9). The relatively light loads, long tension times, and low movement velocities that characterize such lifts may provide a beneficial training stimulus for injured athletes attempting to regain normal levels of core functioning (3, 21). Healthy athletes could also benefit during off-season training cycles to maintain general muscular fitness and provide a break from the rigors of heavy training. However, during in-season training cycles, resistance exercises should be performed on stable ground which allows for the utilization of heavier loads, higher rates of force development, and higher movement velocities conducive to the development of core strength and power (2, 4, 6, 11, 12, 14, 18, 28, 29, 30).

## Practical Applications

Core stability can be developed with exercises that are structured to emphasize muscular characteristics such as endurance, strength, or power (4). However, exercises designed to develop these characteristics should be performed to mimic the movement patterns encountered during sports participation. Therefore, the majority of core stability exercises should be performed with free weights while standing (28). The traditional free weight lifts (e.g. back squat, deadlift, overhead press, and Olympic lifts) commonly performed while standing on stable ground provide a great foundation for further core stability training (30). However, all of these lifts emphasize trunk movement and stabilization in the sagittal plane. Therefore, athletes should consider performing other lifts that involve trunk movement and stabilization in the frontal, transverse, and diagonal planes. Many times an athlete must execute a skill while supported on a single leg, and research has demonstrated higher core muscle activity when resistance exercises were performed unilaterally versus bilaterally (5). Therefore, ground-based free weight lifts should be modified periodically to focus on unilateral strength and power development.

## Conclusion

Core stability training should receive some attention in the training programs of all athletes. The ability to stabilize the core region allows for efficient transfer of force between links in the kinetic chain (15). Thus, from a scientific perspective, core stability in athletes should be addressed with varying methods, depending on the phase of training and the health status of the athlete.

Exercises performed on unstable equipment might be most effective for the development of core muscular endurance. These types of core stability exercises should be performed during off-season training cycles for the purpose of injury prevention and rehabilitation or to provide a break from the wear and tear associated with constant heavy training. Conversely, during pre-season and in-season training cycles the focus might shift to address performance needs. This is when ground-based free weight lifts are the best choice, due to the force, velocity, and core stabilizing requirements of such lifts that are similar to the demands of sports skills (28).

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