

Core Stability and Bicycling

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ASPLUND, C. and M. ROSS. Core stability and bicycling. *Curr. Sports Med. Rep.*, Vol. 9, No. 3, pp. 155–160, 2010. *Bicycling is a popular fitness activity in the United States and around the world. Because of the nature of the bicycling position, the neck and back are at risk for injury. One method to prevent these injuries is to ensure that the body's "core" is strong and stable. A strong and stable core also provides a platform to maximize power transfer, improving performance. Core exercises also may enhance recovery from intense bicycling efforts. Simple stability exercises can improve performance and may prevent injuries in bicyclists.*

INTRODUCTION

Participation in cycling has increased steadily over the past 10 yr. Individuals looking for a low-impact alternative to running and other aerobic activities have found cycling to meet these needs. In fact, the American Bureau of Transportation Statistics estimates that more than 49 million Americans ride bicycles at least monthly, with over 5 million people riding at least 20 d·month⁻¹ (20). With more people riding for fitness, there is a higher focus on performance, but with increased participation and intensity, the number of cycling-related injuries also has risen.

Neck and back pain is common in cyclists because of the body's positioning during riding. Several studies have demonstrated that neck and back injuries are some of the most common overuse injuries evaluated following multiday long-distance bicycle tours (6,21,22). Wilber *et al.* found that 44.2% of male and 54.9% of female recreational cyclists presented for medical treatment of neck pain, while approximately 30% presented with back pain (22). Weiss also reported that 66.4% of recreational cyclists reported neck and shoulder symptoms after an 8-d, 500-mile bicycle tour (21). The prevalence of such injuries, especially in recreational riders, suggests that more understanding is needed by riders and their health care providers to prevent such injuries by proper education and fit and to treat these injuries when they occur. A better understanding of the pathologic mechanism of musculoskeletal overuse injuries, specifically in cyclists, is important in developing good preventive and treatment strategies for the neck and back injuries they frequently

experience. A stronger core may be the answer in the prevention of these cycling related injuries.

In the last few years, there has been a considerable increase in the emphasis on stabilizing the "core" of the body. The body's core, which includes the back and abdominal muscles, can be a weak link for many cyclists. Because of the extended aerodynamic positions, cyclists may be able to generate ideal power early in the event, but then low back fatigue and pain contribute to a loss of power. Most riders lose significant pedal power because of weak low back and abdominal muscles. The legs perform most of the work in cycling, but a strong core will increase stability on the bike and increase power transfer to the pedals. In addition, a strong lower back will allow the rider to remain in a more aerodynamic position for longer periods of time without discomfort or injury.

Core stability is crucial in efficiently transferring power from your lower body to your upper body and vice versa. In other words, core strength prevents wasted energy by ensuring that any power exerted to move your body forward isn't wasted by twisting or rocking of the torso. A strong and stable core allows one to maintain proper body positioning and form with fatigue, which translates to maintaining speed and power for longer periods of time.

WHAT IS CORE STABILITY?

Kibler defines core stability as "the ability to control the position and motion of the trunk over the pelvis to allow optimum production, transfer, and control of force and motion to the terminal segment in integrated athletic activities" (12). Spinal stability has been defined as consisting of three subsystems, passive components of the spinal column, active control by spinal muscles, and neuromuscular control or coordination. When the muscles in the hips, shoulder girdle, and trunk work together, they form a functional segment called the core (16).

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TABLE. Plank time and assessment of core strength.

Time	Result	Recommendation
Less than 1 min	Fair	Minimal handlebar/saddle differential
1–2 min	Good	Several-centimeter differential
More than 2 min	Excellent	Set handlebar height as low as can be tolerated

Core muscle activity is best understood as the preprogrammed integration of local, single-joint muscles and multi-joint muscles to provide stability and produce motion. This results in proximal stability for distal mobility, a proximal to distal patterning of generation of force, and the creation of interactive moments that move and protect distal joints (12).

DOES CORE STABILITY PREVENT INJURIES?

It would seem to make sense that a stable core would prevent injury, but is there evidence to support this? On the basis of observational studies that activation delay or weakness of the core muscles is related to low back pain (LBP) and lower extremity injury, interventions aimed at restoring core stability therefore should reduce the risk of injury (8,13). Recent prospective studies suggest that deficiencies in core muscle capacity may increase risk for lower extremity injury. In a study of rugby athletes, Devlin *et al.* demonstrated that fatigue of the abdominals was a contributing factor in lower extremity injury (7). Another study in firefighters also suggests that development and implementation of functional movement enhancement programs prevents injuries in high-risk individuals (17). In a cycling-specific study, two groups of cyclists were observed, those with LBP and those without. The cyclists in the back pain group showed a trend toward increased lumbar flexion and rotation with an associated loss of stabilization of the lumbar spine. These findings suggest that altered motor control and kinematics of the lower lumbar spine are associated with the development of LBP in cyclists (4).

The overall evidence either for or against the use of core strengthening exercises for injury prevention or rehabilitation is limited. While clinical experience appears to be providing motivation for the continued use of such exercises,



Figure 1. Plank exercise: elbows directly under shoulders and body held in a linear position. The abdominal muscles and back muscles are contracted to keep the trunk parallel to the ground.



Figure 2. Note how some of the cyclists are able to maintain a stable position when rising out of the saddle (A), which is a sign of a strong core. Core stability is most apparent when standing out of the saddle and keeping the nose, pelvis, and tire contact patch in the vertical plane. When the core is fatigued, the trunk deviates from this plane (B).

systematically designed investigations are needed to determine their effectiveness.

DOES INCREASING CORE STABILITY ENHANCE RECOVERY FROM INJURY?

Research supports the theory that stability exercises prevent recurrences of back pain. Athletes with back pain who participated in stabilization exercises were shown to have nine times less back pain at 3 yr compared with controls (10). Muscular strength is able to compensate for some structural problems, which is a premise behind exercise training as the mainstay of treatment to improve stabilization (3).

The overall evidence either for or against the use of core strengthening exercises for injury prevention or rehabilitation is limited. Clinically, it would appear that core stability exercises are beneficial in the prevention of injuries; however, further prospective studies are needed to determine effectiveness.

DOES CORE STABILITY IMPROVE PERFORMANCE?

Controversy exists as to whether greater core muscle stability actually improves athletic performance (9). Roetert reported that core stability and balance are critical for good performance in almost all sports and activities including bicycling (18). A lack of core strength and stability also is thought to result in an inefficient technique, which predisposes to injury and poor performance (11). A recent cycling-specific study by Abt *et al.* supports this concept.

The purpose of Abt's study was to determine whether cycling mechanics are affected by core stability. A weak core potentially could inhibit power production, since the pelvis is the "lever" for the cycling-specific power muscles. If the lower extremities are not aligned properly and the lever is in an incorrect position, then power output will be compromised (1). Improved core stability and endurance could promote better alignment of the lower extremity when riding

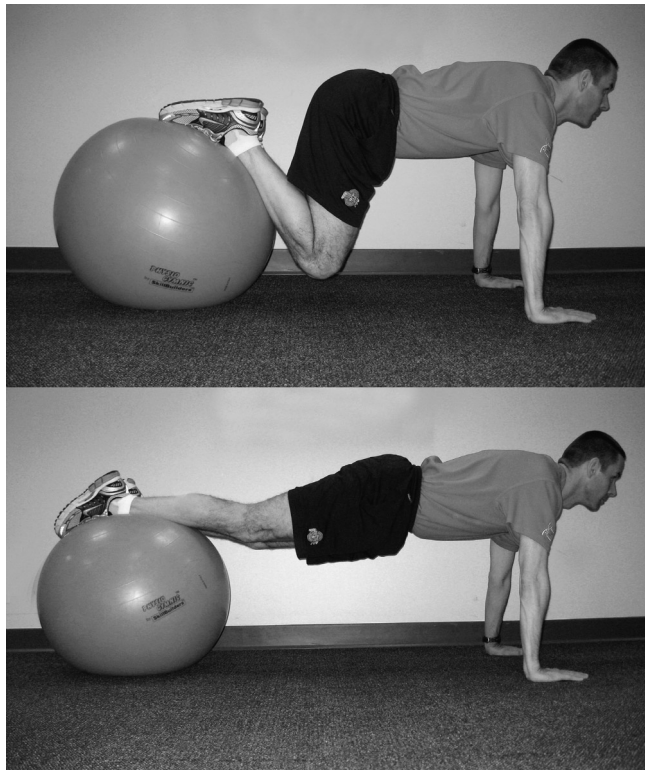


Figure 3. Swiss ball exercises. By stabilizing the body while the legs are bent and straightened, the core is activated in three planes.

for an extended duration (1). Improvements in core strength could promote greater torso stability within the saddle and maintenance of lower extremity alignment to apply greater force transmission to the pedals (1). When the core is stable, the peripheral muscles will require less forceful contractions to produce the same amount of power (2).

As part of the study, the cyclists performed a core fatigue workout prior to testing, which then was shown to alter the mechanics of the lower extremity during cycling. Prolonged cycling with altered lower extremity mechanics as a result of a fatigued core might increase the risk of overuse injury from malalignment. Abt suggested that cyclists should integrate a year-round, core conditioning program into current training to promote better lower extremity alignment while cycling.

A recent study by Navalta *et al.* showed that incorporation of core stability exercises into a cool-down period following muscular work may result in benefits to both lactate clearance, as well as enhanced postural control (15). Further results show that a dynamic neuromuscular training program focusing on core stability, as well as including some balance and movement training, not only decreases biomechanical risk factors, but also may provide performance enhancement effects (14).

Currently, there is limited evidence to show that improving core stability improves athletic performance or prevents injury. Most of the current scientific studies largely are based in the rehab setting and focus on low load, slow movements rather than on sporting activities, which use high load, resisted, dynamic movements. The lack of specific performance effect observed in many studies may be from the core

training programs not being functional enough to translate into improvements in sporting performance (9).

HOW TO EVALUATE CORE STABILITY?

Evaluation of the core should be dynamic and include evaluation of the specific functions (trunk control over the planted leg) and directions of motions (three-planar activity). Rehabilitation should include the restoring of the core itself but also include the core as the base for extremity function (12).

Core stability is more challenging to measure than core muscle strength as it requires incorporating parameters of coordination and balance. If we look to the definition of core strength as proximal stability for distal movement, we can think of ways to test the core. The simplest way to isolate the core is to have the core suspended with the limbs anchored. For cycling specifically, the back should be horizontal or as close to horizontal as it would be when riding. To meet these criteria, we prefer a plank exercise. To perform a plank, the back should be horizontal. The elbows should be under the shoulders, and the legs should be straight, allowing a slight bend at the hips (Figure 1).

Once in position, have the patient hold this position for as long as he or she can. Watch for sagging of the low back, scapulae lifting off of the thorax, or lateral tilt of the pelvis. Failure of the ability to maintain a plank position gives clues as to which muscle groups need to be strengthened.

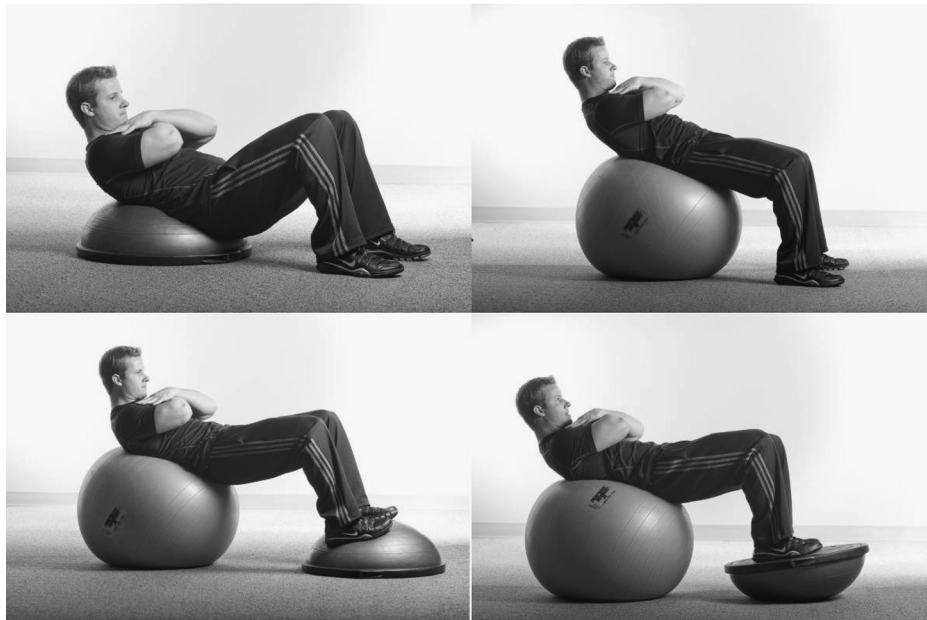
To assess which of the core muscles are weakest, look for fatiguing muscles, specifically, which way the back and limbs move during the plank. When the scapular stabilizers are fatigued, the medial scapulae borders will separate from the back, and the shoulders will sink. Similarly, if the rectus abdominus is weak, the lower back will sag. If the hip stabilizers (abductors) and obliques are weak, the back will tilt to one side. If the scapulae are the first to move, the scapular stabilizers need to be strengthened. Similarly, if the low back sags, the rectus abdominus and erector spinae need strengthening. If the pelvis tilts to the side, work on the obliques and the hip external rotators.

In our experience, those with adequate core strength can hold a plank for greater than 2 min. Those with a weak core will have difficulty maintaining this position for more than 30 secs (Table).

The plank can frequently be used as a diagnostic test to elicit the cycling-specific pain that people may be experiencing. As fatigue sets in, and the weaker muscles begin to fail, have the patients move their elbows forward a few inches. This is usually the position that most cyclists keep their elbows when riding. Moving the elbows forward will frequently reproduce the LBP that cyclists generally feel.

The more dynamic way of evaluating core strength in a cyclist is looking at how the cyclist rides. As with the plank, if their back is sagging while they ride, there is weakness. The dynamic scapular stabilizer strength is assessed by watching the shoulders. The shoulders should remain square to the handlebars when pedaling in a seated position, keeping the nose over the front tire. Weakness is revealed when the

A



B

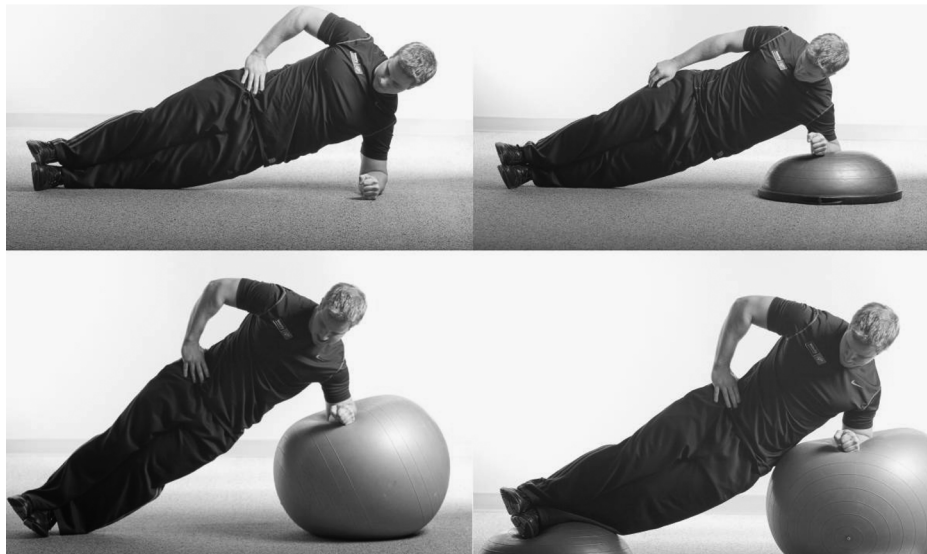


Figure 4. A and B. Several different Swiss ball exercises designed to reduce stability in an effort to promote use of the core and strengthening of the core. Note how each exercise is made more difficult through the use of progressively decreasing stability rather than progressively increasing weight.

shoulders move left to right or when they tilt during seated climbing. Hip abductor/external rotator and oblique muscle weakness is best evaluated by having the rider stand on the pedals. When transitioning from sitting to standing, a stable core will keep the torso in the same plane as the bicycle. If the hips move from side to side during this transition, oblique/hip strength is deficient (Figure 2).

Diagnosing weakness often leads to the diagnosis of cycling-specific problems. When the core is weak and/or the position on the bike is too aggressive than the core can support (flat back, hands too far forward,) the hands take on the pressure of the upper body. This can lead to carpal tunnel and ulnar neuropathy symptoms. As the core fatigues, the

elbow musculature contracts to support the upper body, and medial and/or lateral epicondylitis frequently develops.

LBP is a frequent complaint seen in those who have a position that is too aggressive for the erector spinae to support. This can come from having the hands too far forward or the handlebars significantly lower than the seat.

When setting up a rider on a bicycle, there are many factors that come into play, such as pedaling style, flexibility, and previous injuries. However, as far as the use of core strength is concerned, it is our experience that a position of stability off the bike has to be reflected by the same position on the bike. If a plank cannot be maintained for 1 min, the arms should be placed on a



Figure 5. Bosu ball push-ups. Bosu ball shown here being used to work on stability of the upper “core” or upper and mid back.

platform approximately 1 ft high. If a plank cannot be maintained in this position, the arms should be elevated again. Once a position is found that can be maintained, the angle between the back and the horizontal should be noted. The handlebar height/reach should be set so that this angle of comfort from the plank test is reproduced on the bicycle.

HOW TO IMPROVE CORE STABILITY?

Cyclists should integrate a year-round core conditioning program into current training to promote lower extremity alignment while cycling. This program should include both sagittal and frontal plane exercises (Figure 3).

Willardson recommends Swiss ball exercises including isometrics, small loads, and long tension times for increases in core endurance (23). There is not one single exercise that activates and challenges all of the core musculature; therefore a combination of exercises is required to result in core stability and strength enhancement (5).

Strengthening the core, especially for endurance sports, should focus more on decreasing stability than on increasing weight (19). Exercises should then focus on sport-specific needs. In cycling, for example, the arms are used for pushing against the handlebars when descending or cornering and for pulling on the handlebars when climbing or when standing out of the saddle. Therefore, the core should be strengthened in a functional movement pattern while arms are used for pushing and pulling exercises.

Any truncal flexion/extension exercises can be increased in intensity by removing stability as well. Crunches on a stability ball and back extensions on a stability ball can be made more difficult by placing the feet on rollers or small balls or by performing them on one foot (Figure 4).

For example, to strengthen scapular stabilizers as they would be used in cycling, perform pushups or planks with the arms on a stability ball or Bosu ball. As one progresses through this exercise, place another Bosu ball or stability ball under the feet. The Bosu board can be inverted for more instability (Figure 5).

Other scapula stabilizing exercises would include seated rowing type of exercises. Instead of performing these on a

bench, stability can be decreased by sitting on a ball, standing on a Bosu board, or by keeping the feet on two different Bosu boards.

Strengthening core not only involves using muscles in a functional pattern and avoiding single joint exercise, but adding the component of instability to the exercise before adding weight. Frequently, body weight and instability will be sufficient to strengthen the core for endurance sports.

CONCLUSION

Athletes must display appropriate core strength, stability, and dynamic control of the lumbo-pelvic-hip complex to produce efficient movements. A strong core is necessary for force absorption and transfer from a proximal to distal fashion. A thorough evaluation of the core must take place to determine areas of weakness, and these weak links must be corrected. An athlete with a strong stable core will be able to transfer energy efficiently with more power and less stress distally — making for a productive, successful cyclist. An athlete with a stable core may decrease the likelihood of injury as a result of increased efficiency of movement.

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