STABILITY AND WEIGHTLIFTING: TRAINING STABILITY—PART 3

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This article is the third installment of a four-part series on stabilization in weight training. The first article covered proper spinal (or trunk) stabilization strategy and the second discussed a common compensatory trunk stabilization strategy called the Extension/Compression Stabilizing Strategy (ECSS) and introduced the concept of "functional capacity." The ECSS is a stabilizing strategy pervasive in the athletic population, particularly in training sports, such as powerlifting and Olympic weightlifting. Both of these sports utilize a profound amount of bilateral hip-hinging exercises that hyper-activates the posterior chain (e.g., back squat, deadlift, clean, good mornings, and Romanian deadlifts [RDLs]). This article will cover how to train trunk stability and how to decrease the dominance of the ECSS often perpetuated during training.

To effectively train trunk stability, one needs to have a sound understanding of how stabilization of the trunk and spine actually occurs. Previously, a detailed explanation of the trunk stabilization process was provided (*Stability and Weightlifting: Mechanisms of Stabilization—Part 1*, in *NSCA Coach* 4.1), but to summarize briefly, it is generated via two main mechanisms:

1. Co-contraction of the torso musculature (e.g., abdominal wall, pelvic floor, diaphragm, and spinal extensors)

2. Intra-abdominal pressure (IAP)

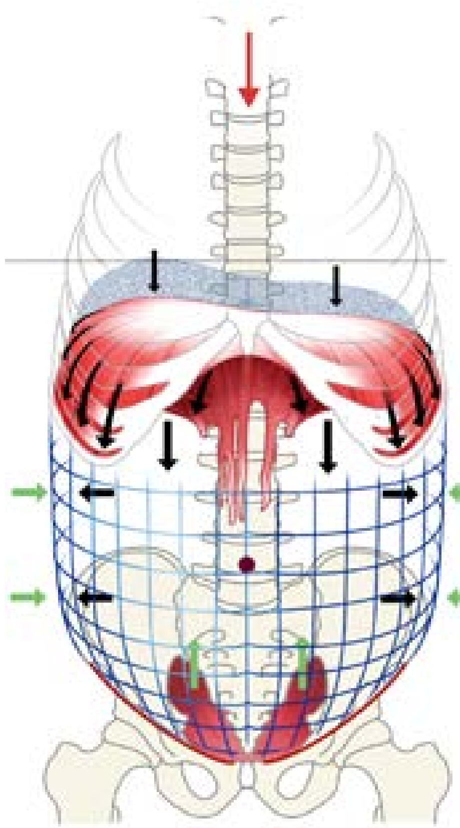

FIGURE 1. PRESSURE IN THE ABDOMEN (PROPER)

Co-contraction of the abdominal musculature involves not only the abdomen, but also the pelvic floor, spinal extensors, and the thoracic diaphragm. These muscles all work together to control the strength of the co-contraction and magnitude of IAP, the sum of which results in increased stabilization of the trunk and spine (2,5,7,12,13,14,16,19). When the diaphragm concentrically contracts, its central tendon is pulled downward towards the pelvis (10,19). This motion compresses the abdominal contents, pushing them downward and outward into the abdominal musculature. Reacting to this outward-pushing force, the abdominal wall and pelvic floor eccentrically activate resulting in the aforementioned co-contraction, thereby increasing stability of the trunk (2,5,7,12,13,14,16,19). If the trunk stability requirements are small, for example, while walking up the stairs or reaching for a cup of coffee, the majority of the stability is created by this co-contraction (7,18). If, however, the movement requires higher magnitudes of stabilization (e.g., during a one repetition maximum [1RM] attempt in the deadlift) then the diaphragm will continue to contract, its central tendon will further approximate with the pelvis, and the abdominal wall and pelvic floor will become more active to resist the outward-pushing force created by the descending diaphragm (12). This action not only increases the strength of the co-contraction of the torso musculature, but it shrinks the intra-abdominal volume (IAV) as well, resulting in an increase in IAP via the Ideal Gas Law, which states that pressure and volume are inversely related (3,5,7,12,18). At higher thresholds of stabilization (e.g., bracing for a maximal clean attempt), trunk stability is generated by a combination of the outward-pushing force of the IAP and a strong co-contraction of the abdominal musculature (12,16).

Athletes often train at intensities and durations that impede their ability to maintain the above stabilizing strategy and are forced to compensate. A common compensatory stabilizing strategy in the athletic population is the ECSS. As the name indicates, instead of using balanced, co-contraction of the abdominal musculature combined with IAP to stabilize the trunk and spine, the athlete will use hyperactive recruitment of the spinal erectors and hip flexors to generate the necessary trunk stability. This imbalanced hyperactivity extends and compresses the spine in an attempt to stabilize it. For a more detailed explanation of the ECSS, please reference the previous article in this series (*Compensatory Stabilization: the Extension/Compression Stabilizing Strategy* in *NSCA Coach* 4.2).

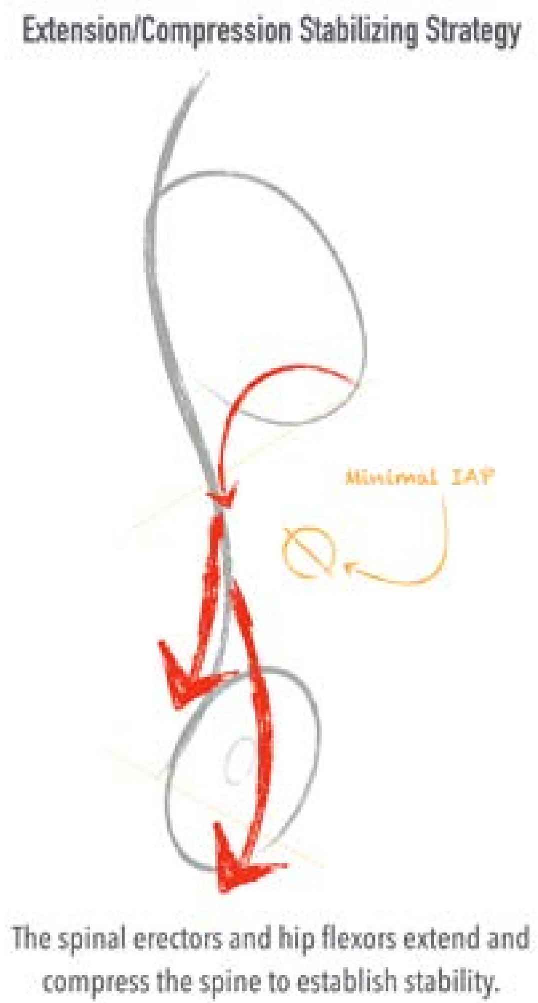

FIGURE 2. ECSS DIAGRAM

While the ECSS does provide some trunk stability, it is a compensatory stabilizing strategy and, therefore, comes at a cost that may increase an athlete's risk for injury and limit performance. The following is a list of the potential risks associated with utilization of the ECSS:

1. Hyperlordosis of the lumbar spine places unnecessary force in the facet joints, implicated in pars fractures and spondylolisthesis (back bone fracture) (4)
2. Hyper-compression of the spine raises the intra-disc pressure increasing the athlete's risk for disc pathology (18)
3. Pronounced anterior pelvic tilt alters the orientation of the acetabulum (hip joint) affecting the hip's range of motion
4. Hyperactivity of the spinal erectors prevents the athlete from achieving a neutral spine, which is necessary for executing a full depth squat, among other movements

TRUNK STABILITY TRAINING

There are many misconceptions about trunk stability training (TST) with weight training. For instance, one popular exercise approach teaches that trunk stability only involves improving the strength of the abdominals, back, and hip flexors. Another common misconception about TST is the notion that "all you have to do to improve trunk stability is squat more." While both of these statements are partially correct, TST involves more than just strengthening the back and abs or just doing exercises like the squat or deadlift more.

Much of traditional "core" training focuses on strengthening the back or abdominal muscles, the individual components involved in trunk stability. Such training is definitely an important part of improving trunk stability, but it is not the only component. Emphasis should be placed on the quality of the athlete's stabilizing strategy. This rather important aspect of TST is often overlooked in resistance training. As mentioned in both of the previous articles, the quality of one's stabilizing strategy directly affects movement, function, technique, and performance. It is important to remember that stabilization precedes movement (6,12,16,18). Therefore, the quality of an athlete's stability affects the quality of their movement. For this reason, the primary goal of TST should be to improve the quality of the athlete's stabilizing strategy. It is not just as easy as increasing the abdominal strength or improving the strength of the posterior chain. Improving the quality of the athlete's stabilization strategy (the muscular technique with which they stabilize) will improve the quality of the athlete's movements. It will preserve proper joint alignment, movement efficiency, potentially reducing their risk of injury and even improving performance (12). Focusing on improving an athlete's posterior chain strength, for example with Supermans or glute-ham developer hyperextensions, may lead to an increase in performance because the back is stronger; however, this trains the pathological ECSS into the athlete which comes with the consequences mentioned above and in the previous article.

FIGURE 3. HYPEREXTENSIONS ON THE GLUTE-HAM DEVELOPER

The first goal in TST is to improve the quality of the athlete's stabilizing strategy. The second goal is to raise the athlete's functional capacity (FC) for proper trunk stability in their respective sport. In the previous article, FC was discussed in detail. FC is the range within which an athlete is able to maintain proper movement (in this case stabilization) strategies. There are three primary thresholds or three different ways in which the nervous system can be challenged, potentially pushing the athlete outside their FC:

1. The body is required to generate a lot of force (force threshold), such as a maximal bench press attempt

2. The body is required to move very quickly (speed threshold), such as plyometrics

3. The body is required to generate force for a long period of time (duration threshold), such as running a marathon or doing a high-repetition set like the 20RM in the back squat

With each of these nervous system stressors, when the threshold has been exceeded, the athlete is no longer capable of moving properly and compensation, therefore, must occur. For a more detailed explanation of FC, please reference the previous article in this series: *Compensatory Stabilization: the Extension/Compression Stabilizing Strategy* in *NSCA Coach* 4.2.

The point at which an athlete is no longer able to maintain proper movement strategies, and therefore must compensate, is called the functional threshold (FT). Training above FT is normal and even necessary in sports, but training above FT without any effort to improve the athlete's FC for proper stabilization may produce a pathological tight posterior chain (i.e., ECSS). The posterior chain is commonly trained in virtually all sports, even being intentionally hyper-emphasized in many programs. Because training above FT is common in sports, the ECSS is often activated to different degrees by the training itself. This is a normal and common consequence of athletes pushing themselves. It is, therefore, important that athletes perform specific exercises to diminish the hyperactivity of the posterior chain. This will ensure that the ECSS does not become pathological and will help minimize the effects that ECSS might have on the athlete outside of training and competition. Controlling or containing the ECSS below pathological levels will preserve muscular balance within the athlete, preserving better movement strategies.

TRUNK STABILITY TRAINING GOALS

1. Improve, reinforce, and train proper technique of the athlete's stabilizing strategy

2. Raise the athlete's FC for their sport (e.g., load, speed, and duration)

3. Correct or reset the stabilizing strategy that may have been altered by the day's training

Unless the athletes have suffered an injury that exposed their inadequate trunk stability, producing an injury such as a disc herniation, or hip impingement, perhaps even sidelining them from "real training," then doing TST probably is not that interesting; however, it should be. As mentioned above, stabilization precedes movement, which means that any inadequacies in an athlete's stability may not only affect his or her training, but his or her performance as well. TST may not always be as fun as squatting, but it is oftentimes equally as important.

A logical question now is: what is the appropriate training volume, frequency, and timing for trunk stability? It depends on the athlete's trunk stability, the athlete's FC, the sport for which the athlete is training, and the level within the sport they hope to achieve.

FREQUENCY OF TRUNK STABILITY TRAINING

In the author's clinical experience, TST should be performed multiple times per week. Due to the fact that stabilization precedes movement, the quality of an athlete's stability is profoundly important, affecting an athletes' functional competence, technique, ability to handle training loads, resilience, and ultimately performance (6,7,18). The importance of having high levels of trunk stability cannot be over-estimated, which is why the author suggests performing TST frequently.

In addition, TST is often necessary to restore proper trunk stabilization strategies after training. Most forms of strength and conditioning, particularly in training sports, such as powerlifting and Olympic weightlifting and other high-intensity interval training programs, inevitably activate or intensify the ECSS. Because the ECSS is so prevalent in weight training populations, it is important that efforts are applied daily after training to reset the athlete's stabilizing strategy and to bring balance back between the anterior and posterior chains. Hruska, creator of the Postural Restoration Institute (PRI) refers to this as "neurological reset" (8). After training, athletes need to "reset" the nervous system to prevent a pathological imbalance from occurring. The purpose behind these exercises is more neurological than physiological. Instead of physically stretching out the posterior chain, the athlete is resetting the brain's postural activity of the muscles (12).

WHEN SHOULD TRUNK STABILITY TRAINING BE PERFORMED?

As mentioned above, TST can be performed following training to diminish the ECSS, but it can also be incorporated into the actual workouts—between sets or before training—to activate proper stabilizing strategies. If the goal is to teach the athlete how to integrate proper trunk stabilizing strategies into their sport or if the programming is designed to raise the athlete's FC, then putting trunk stability exercises between sets can be effective. The trunk stability exercises give the athlete the sensation of proper stability so that they can better feel and apply it to more complex movements such as the squat or the clean.

Performing exercises with the purpose of decreasing the magnitude of or shutting off the ECSS is very useful between sets as well, particularly in heavy posterior chain-centric exercises like deadlifts or back squats, which have a higher propensity to activate the ECSS. In this case, the trunk stability exercises are functioning to diminish the activity of the hyper-activated posterior chain.

While it may be beneficial to perform TST exercises between lifting sets, it may be best to perform the majority of the trunk stabilization exercises after training. This is a perfect time to diminish the recently activated ECSS. Because no further training will follow the TST, the athlete can also work on trunk stabilization more thoroughly, even to fatigue. Completely fatiguing the trunk stabilizers and then performing complex movements such as heavy deadlifts is not recommended. Excessive fatigue may put the athlete at risk for injury because they cannot maintain proper alignment of the spine, but it also will compromise their execution of the bigger movements, which may affect the productivity of the training session as well.

HOW MUCH SHOULD TRUNK STABILITY WORK BE PERFORMED?
There are many different dosing strategies for TST and research is not clear as to which method is superior. Oftentimes, strength and conditioning coaches will program a single day during the week where the majority of the TST occurs, typically during an active recovery day. This strategy may not be as effective as consistently training and stimulating the spinal stabilizers on a daily basis. This is because much of the improvement in trunk stability results from neurological adaptation, or motor learning, and not just from physiological adaptation (2). Dr. Sturt McGill demonstrated that isometric training exercises "can induce immediate changes in core stiffness," which is why performing it daily has value (15).

As discussed above, there are two main reasons why one would perform TST: reset proper stabilizing strategies and improve an athlete's FC. If an athlete is trying to reduce the magnitude of the ECSS after training, then they would only need enough time to neurologically relax the posterior chain (about 3 – 5 min). In this case, the athlete is simply working to reset the nervous system back to a more balanced stabilizing strategy. If, however, the goal is to improve FC, then the strength and conditioning coach would need to program higher volume and intensity. Given that every athlete is unique, there is not a perfect recipe for everyone.

Below is a collection of trunk stabilization exercises that may be successful in both injured and healthy athlete populations. Many of these exercises are influenced by the work of Pavel Kolar—a physiotherapist from the Prague School of Rehabilitation and creator of Dynamic Neuromuscular Stabilization (DNS). Being that DNS is relatively new, these exercises do not have a large body of research like, for instance, a side-bridge might have. However, these exercises can be very effective in improving an athlete's trunk stability. While this is by no means a comprehensive list of the exercises that can be used for TST, the suggested sets and repetitions in this section are based on available research in addition to the author's clinical experience.

REDUCING THE ECSS
First, it is important to understand exercises that can be used to reduce the ECSS. The primary goal of trunk stabilization exercises is to improve the quality of the athlete's stabilization strategy. However, proper stabilization cannot occur if the ECSS is activated (12). Proper stabilization involves balanced co-activation of the trunk musculature. If the posterior chain is hyper-activated, this balanced co-activation is not possible. To relax or reduce the ECSS, these exercises place the athlete either passively or actively in a position with the spine flexed. It is important to note that this position does not train proper stabilization, but instead over-corrects the position to reduce the ECSS more quickly.

FIGURE 4. BACK BREATHING IN SQUAT

BACK BREATHING IN SQUAT
This is an easy, but powerful exercise to reduce the activity of an over-active posterior chain. It can be used between taxing posterior chain-centric lifting sets (e.g., back squat, deadlift, and Romanian deadlifts) or at the end of the training session. It is a relaxation exercise rather than an aggressive stretch.

How to: Stand with the feet and knees together about 12" from the squat rack upright. Grab the upright with both hands at waist-height. Lower down into a passive, full-depth squat, allowing the lumbar spine to flex and the pelvis to tilt posteriorly. In this position, perform breathing exercises to relax the posterior chain.

During inspiration, focus on breathing into the abdomen. The athlete should feel the breath expand into the abdominal wall and spinal erectors, relaxing them and elongating the spine. They should not feel their head or shoulders elevate, which results from cervical and thoracic extension. This is an indication that the athlete is activating the spinal extensors to breathe in, a commonality in athletes who use the ECSS. During expiration, focus on relaxing the spinal extensors and allowing the pelvis to drop lower towards the floor. The athlete should be able to keep the entire spine passively flexed during both inspiration and expiration.

Suggested repetition scheme: five sets of 10 breaths after training, or one set of 10 – 15 breaths between sets. If the ECSS is completely deactivated, the athlete should not feel any stretch in the lower back during inspiration or expiration.

FIGURE 5. BACK BREATHING IN QUADRUPED POSITION ON ELBOWS (BANDED)

BACK BREATHING IN QUADRUPED POSITION ON ELBOWS WITH FLEXION OVER-CORRECTION

The previous exercise was an exercise designed to relax the posterior chain (ECSS). This is a powerful activation/strengthening exercise that not only reduces the activity of the ECSS, but also improves trunk stability by strengthening the abdominal wall. It can be used between sets or following training. Figure 5 features a banded version of the exercise; however, it is suggested to use the banded version only if performing after training and use the non-banded exercise between sets.

How to: Assume a quadruped position on the elbows with the hips flexed to approximately 70˚ and the shoulders flexed to about 120˚. Place both the knees and the elbows shoulder-width apart. Place the spine, particularly the lumbar region, in a flexed position. This is not maximal flexion and it is important to pay attention to where the flexion is occurring. Often, athletes flex the thoracic spine and do not flex the lumbar spine. Addressing the ECSS requires having the lumbar spine in a flexed position.

In this position, during inspiration, breathe into the back. The spine should elongate, the spinal erectors should relax, and the IAP should rise. On the expiration, focus on maintaining IAP, which requires activating the abdominal obliques to pull the ribs toward the pelvis. It is important that IAP is maintained. The athlete should avoid sucking the belly inward (i.e., hollowing the belly). Maintain the IAP to preserve balanced co-activation of the torso musculature in favor of over-emphasis on the transverse abdominus and rectus abdominus.

The strength and conditioning coach can increase the difficulty of this exercise by adding band resistance (such as Figure 5). This will require taking a resistance band and hooking it on the rig low to the ground. Place the band across the athlete's thoraco-lumbar junction. This applies a force that pulls the athlete's spine into extension; resisting this motion or force will activate the athlete's abdominal muscles. Be careful with this modification because it is difficult. Remember, the IAP must be maintained during both inspiration and expiration.

Suggested repetition scheme: When the exercise is being performed between lifting sets, 20 – 30 s holds or 5 – 10 breaths is sufficient. If performed after training, 8 – 10 rounds of 20 s on and 10 s off is recommended.

TRAINING PROPER SPINAL STABILITY

The previous two exercises place the spine in a flexed position to address an over-active posterior chain. It is, again, important to note that this position does not train or resemble proper stability strategies, but is useful in addressing the ECSS. Once the ECSS has been abated, the athlete will be able to more easily train proper trunk stabilization. The following set of exercises primarily focus on improving the quality of the athlete's stabilization and also to improve his or her FC for stabilization. These exercises emulate proper trunk alignment and proper mechanism of stabilization (IAP and co-contraction of the trunk musculature). With each of these exercises, the spine should be elongated (not in a flexed position), the ribcage should be down (bringing the diaphragm and pelvic floor into a parallel relationship), and IAP should be actively maintained during both inspiration and expiration. Strength and conditioning coaches and athletes must consciously focus on training up to FT and not beyond with these exercises. If an athlete's FT is exceeded, they will no longer be training proper stabilization, but actually the ECSS. As referenced above and discussed in detail in the previous article, as the intensity of the exercise increases, or as the athlete fatigues, the spinal extensors will activate, the spine will extend, and the ribs will begin to elevate. This change might be subtle, but it is happening. We want to make sure that the exercise prescription is such that the athlete must focus on maintaining proper positioning and proper stabilizing strategy, but not so challenging that they are unable to do so. A pertinent example of this is a plank hold. Oftentimes with this common "core exercise," the athlete is asked to hold this position for as long as they can before dropping to the floor from fatigue. Assuming the athlete started in the correct position, maintaining trunk stability via IAP and co-activation of the trunk muscles, by the time the athlete drops to the floor from fatigue, they will have been holding the position with the ECSS. This is undesirable because it can reinforce pathological stabilizing strategies such as the ECSS. Training at or around FT is important, but frequent training over FT may result in pathological levels of activity of the ECSS.

FIGURE 6. THREE-MONTH BREATHING

BREATHING IN THREE-MONTH POSITION

In his work formulating DNS, Pavel Kolar created a comprehensive set of exercises utilizing positions and movements seen in early development (12). This exercise is performed in a landmark position in childhood development that should be achieved at three months under normal physiological and neurological conditions. This is a particularly important position because it is the first time in childhood development when the diaphragm, pelvic floor, and abdominal wall first begin to work together to stabilize the trunk and spine, and the IAP contributes to trunk stability (12).

How to: Lay supine with the calves supported on a bench (the bench is not pictured in Figure 6). In this position, the spine should be elongated with the hips and knees flexed at 90˚. Place the hands on the hips, above the iliac crest, with the index fingers in the front and the thumbs in the back. Take a breath into the abdomen in such a way that both hands (fingers and thumbs) expand and move away from each other. The athlete should feel the abdomen expand in all directions, not just forwards (anterior) into the belly. What the athlete is feeling is co-contraction of the abdominal wall as well as the descending diaphragm pushing the abdominal contents outward, resulting in eccentric activation of the abdominal musculature. Once the abdomen is activated, lift the calves off the bench 1 – 2", attempting to minimize movement of the trunk. Breathe in and out, holding this position with proper respiration, maintaining IAP the entire time. If the athlete cannot hold this position without activating the spinal extensors, simply leave the legs supported on the bench and practice maintaining the IAP and balanced co-activation of the abdominal wall.

Suggested repetition scheme: If the legs are supported on the bench, the athlete can start 10 – 20 s holds, but should eventually be able to breathe and maintain IAP for more than 60 s without difficulty. The athlete may be surprised how difficult it is to simply breathe correctly in this position. If the athlete is holding an unsupported three-month position, 5 – 10 sets of 10 breath holds or six sets of 30 s holds is recommended.

FIGURE 7. THREE-MONTH BREATHING WITH KETTLEBELL PULL-OVER

SUPPORTED BREATHING IN THREE-MONTH POSITION WITH KETTLEBELL PULL-OVER HOLD

This is a good exercise to emphasize the abdominal wall's role in trunk stabilization. It is an exercise in the three-month position with the abdominal wall more activated than in the previous exercise. Because the athlete has to generate more IAP to resist the pull created by the kettlebell, it creates an eccentric load on the abdominal wall. This exercise allows the athlete to strengthen the abdominal wall and to raise their FC for proper trunk stabilization.

How to: Lie supine with the calves supported on a bench, or with the feet flat on a wall (not pictured in Figure 7). In this position, the spine should be elongated with the hips and knees flexed at 90˚. Then, either with or without a kettlebell, bring the shoulders into 120˚ of flexion and hold in this position without any elevation of the ribs. Maintain the IAP during both inspiration and expiration. It is important to feel the abdominal wall activate (contract) on the expiration because it will have to work extra hard to keep the ribcage down against the pull of the kettlebell and to maintain the IAP as the central tendon of the diaphragm elevates.

Suggested repetition scheme: Due to the aggressive loading or taxing of the abdominal wall, it is not suggested to use this exercise between lifting sets; it is very fatiguing and may compromise the athlete's ability to maintain proper positioning of the trunk and spine during the other movements. If seeking to improve the athlete's FC for duration, the athlete can use lighter loads (no weight or 4 – 12 kg) and perform 20 – 30 s holds. Rest in between can be minimal. If attempting to improve the athlete's FC for force, then it might be best to do only five-second holds, but with much heavier weight (16 kg or more). Here, it is suggested to have the athlete do 10 rounds of five-second holds with 25 s of rest between sets. This is a very effective and challenging exercise. The strength and conditioning coach needs to make sure that the athlete is maintaining IAP rather than sucking the belly inwards. Start lighter and have the athlete work up to heavier loads.

CONCLUSION

The exercises and the exercise prescriptions in this article are based on current available research and the author's personal experience. TST is an often-omitted component of strength and conditioning; however, it has been demonstrated multiple times in research that stabilization precedes movement (6,7,12). Dysfunction, therefore, in the quality of an athlete's trunk stability may have a detrimental effect on their performance. High-quality TST may also improve the athlete's ability to maintain proper positioning of the trunk and spine in sports (i.e., increase the athlete's FC), which may result in improved performance, increased resilience to injury, and enhanced ability to handle training load.

Each of the exercises above provides examples of trunk stabilization exercises, but there are many more that can be used for the same purpose. Strength and conditioning coaches should keep in mind that the athlete's movement patterns trained in TST need to be properly integrated into the athlete's sport.

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