

The Core: Where Are We and Where Are We Going?

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The buzzwords in sports rehabilitation and performance training during the 1990s were *functional rehab* or *functional training*. In this decade, the focus has shifted to the core, with terms such as *core training*, *core strength*, and *core stability*. These terms can be found in peer-reviewed journal articles, performance training programs, and clinical reports of physicians, physical therapists, and athletic trainers. A recent review of core strengthening listed *lumbar stabilization*, *dynamic stabilization*, *neuromuscular retraining*, *neutral spine control*, *muscular fusion*, and *trunk stabilization* as terms synonymous or near-synonymous with *core strengthening*.¹ Despite the popularity and interest in the core, a variety of definitions for these terms has been used somewhat interchangeably, leading to perhaps inconsistent interpretations. Herein, we highlight some of these inconsistencies and propose an alternative concept for standardized usage in the future.

Despite the recent gain in popularity, the concept of core strength is not new. As early as the 1920s, Joseph Pilates talked about developing a girdle of strength by recruiting the deep trunk muscles. Today, Pilates has regained popularity and fame as authoring an effective way to train the core. Additionally, physical therapy educational programs have historically taught the concept that stability of proximal segments is required for effective mobility of distal segments (eg, a stable pelvis and trunk are needed for controlled movement at the knee and ankle).

In an attempt to understand core stability and core strength, we need to look closer at the terminology. Merriam-Webster's dictionary² offers the following definitions for each key term:

Core is "a central and often foundational part usually distinct from the enveloping part by a difference in nature"

Strength is "the power to resist or exert force"

Stability is "the property of a body that causes it when disturbed from a condition of equilibrium or steady motion to develop forces or moments that restore the original condition"

Initially, the core was referred to as the lumbo-pelvic musculature.^{3,4} More recently, this has been expanded by some to also include muscles of the hip⁴ and even the scapulothoracic musculature.⁵

Hodges and Richardson³ popularized the term *core stability* in the late 1990s. They described the spine as inherently unstable and requiring active support from intra-abdominal pressure and tensioning of the thoracolumbar fascia and deep lumbar stabilizers. Thus, core strength was considered to be the muscular support about the lumbar spine necessary to achieve and maintain functional stability.¹ Core strength has also been expanded beyond the lumbar spine to include the trunk as a whole (pelvis, lumbar spine, and scapulothoracic region), with adequate strength in these regions providing a solid base of support for powerful extremity movement.⁵ Good core strength contributing to adequate core stability has been suggested to be necessary in maintaining the correct lumbar and pelvic posture and alignment during movement and sport.⁶ Similarly, inadequate core strength leading to poor core stability may decrease biomechanical efficiency and increase risk for injury. It should be noted, however, may be that neither of these assertions appear to be supported by peer-

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reviewed science. The lack of consensus regarding what constitutes a core-strengthening program has been cited as a major contributing factor for this absence of research.¹

A recent article began to establish a relationship between core stability and injury by comparing core stability measures between male and female athletes and their incidence of lower extremity injury.⁴ Athletes of both genders who did not sustain a lower extremity injury during the season demonstrated significantly stronger isometric contractions of the hip abductors and external rotators when compared with athletes who had sustained an injury. Further, it was found that isometric hip external rotation strength was a useful predictor of injury status. The authors concluded, "core stability has an important role in injury prevention."⁴ While the findings from this article are important, it is worth noting that core stability was not actually measured. The ability of the lumbo-pelvic region to resist perturbations (core stability) is not accurately represented through isometric strength testing of associated musculature. Although isometric testing does provide a measure of muscle strength, it does not reflect how or if that strength is used in a stabilizing manner. Additionally, straps and bolsters were used to support and stabilize the lumbo-pelvic-hip region for all isometric measurements with the exception of the side bridge test for quadratus lumborum endurance. The use of these external devices arguably makes it very difficult to view these tests as sole measures of stability. While the findings of this article shed some light on understanding and predicting lower extremity injury, conclusions regarding the relationship between core stability and injury may be limited.

There is a large body of research investigating the effects of trunk stabilization or core stability training on patients with low back pain, particularly with regards to muscle timing, activation, and response. Patients with low back pain have been observed to display altered trunk muscle activation patterns and larger postural sway when compared with healthy controls during perturbation testing.^{7,8} The inclusion of stabilization exercises targeted to the deep abdominal and lumbar multifidi muscles has been shown to reduce low back pain significantly among patients with spondylolysis or spondylolisthesis.⁹ Stabilization exercises have also been found to be more effective in reducing low back pain and improving function when compared with manual therapy alone.¹⁰ In comparison to no exercise or nonspecific home exercises, stabilization exercises elicited greater functional outcomes in patients who had undergone microdiscectomy.¹¹

To determine the effect of core strengthening in the clinical outcome of acute hamstring strain injuries, we recently demonstrated that the inclusion of progressive agility and trunk stabilization exercises produced a 90% reduction in the number of hamstring reinjuries compared with a program consisting only of traditional hamstring stretching and strengthening exercises.¹² These data provide strong support for the use of core strengthening exercises; however, the direct effects of

the intervention on muscle strength or neuromuscular stability cannot be determined from this study.

Clinical experience and these studies provide excitement and motivation for further investigations involving core strength and stabilization as it pertains to the prevention and treatment of musculoskeletal injury. To provide the most effective and efficient programs for athletes and patients, we need to investigate the mechanisms and actions by which strength contributes to stability and how stability is achieved and maintained during static and dynamic tasks. Although we may have passed the point of no return for using ambiguous terms such as *core* in public discussion, future research and professional dissemination need to critically evaluate true and accurate measures of core stability and core strength. The term *core* should perhaps be delineated as spinal, lumbo-pelvic, pelvic-hip, or lumbo-pelvic-hip. Where *strength* is a muscle's or muscle group's ability to exert or resist force, the use of *stability* should be specific to the maintenance of either static or dynamic balance/equilibrium, encompassing both muscular strength and neuromuscular control. Ideally, consistent terminology will allow for well designed research and collaboration, which will eventually translate to the development of clinical tests to measure strength and stability accurately. In the end, this will allow for the development of effective and efficient rehabilitation, injury prevention, and sports performance programs.

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