

## Canadian Society for Exercise Physiology position stand: The use of instability to train the core in athletic and nonathletic conditioning

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**Abstract:** The use of instability devices and exercises to train the core musculature is an essential feature of many training centres and programs. It was the intent of this position stand to provide recommendations regarding the role of instability in resistance training programs designed to train the core musculature. The core is defined as the axial skeleton and all soft tissues with a proximal attachment originating on the axial skeleton, regardless of whether the soft tissue terminates on the axial or appendicular skeleton. Core stability can be achieved with a combination of muscle activation and intra-abdominal pressure. Abdominal bracing has been shown to be more effective than abdominal hollowing in optimizing spinal stability. When similar exercises are performed, core and limb muscle activation are reported to be higher under unstable conditions than under stable conditions. However, core muscle activation that is similar to or higher than that achieved in unstable conditions can also be achieved with ground-based free-weight exercises, such as Olympic lifts, squats, and dead lifts. Since the addition of unstable bases to resistance exercises can decrease force, power, velocity, and range of motion, they are not recommended as the primary training mode for athletic conditioning. However, the high muscle activation with the use of lower loads associated with instability resistance training suggests they can play an important role within a periodized training schedule, in rehabilitation programs, and for nonathletic individuals who prefer not to use ground-based free weights to achieve musculoskeletal health benefits.

*Key words:* resistance training, trunk muscles, back, balance, stability.

**Résumé :** L'utilisation d'appareils et d'exercices de déstabilisation pour l'entraînement des muscles profonds du tronc fait partie du scénario de base de plusieurs centres et programmes d'entraînement. Le propos ici est de formuler des recommandations sur le rôle de l'instabilité dans les programmes d'entraînement à la force des muscles profonds. Ce noyau musculosquelettique de l'organisme est constitué du squelette axial et de tous les tissus mous dont l'insertion proximale est sur le squelette axial, quelle que soit la zone d'insertion distale, sur le squelette axial ou appendiculaire. La stabilité du noyau musculosquelettique est le résultat combiné de l'activation des muscles et de la pression intra-abdominale. Le contreventement abdominal est, preuve à l'appui, plus efficace que le creusement abdominal quand il est question d'optimiser la stabilité abdominale. Même si l'activation des muscles profonds du tronc et des membres est, dit-on, plus grande quand les mêmes exercices sont accomplis en condition d'instabilité, on peut observer une activation semblable ou même supérieure au moyen d'exercices au sol avec des poids libres comme la levée olympique, l'extension des membres inférieurs et le soulevé de terre. Du fait que l'ajout d'une base instable lors de la réalisation d'exercices de force suscite une diminution de la force, de la puissance, de la vitesse et de l'amplitude de mouvement, on ne le recommande pas comme mode principal d'entraînement dans les séances de conditionnement physique. En revanche, l'importante activation musculaire lors d'exercices à faible charge en condition d'instabilité souligne l'utilité de ces derniers dans la périodisation de l'entraînement, dans les programmes de réadaptation et auprès d'individus non sportifs préférant ne pas faire d'exercices avec des poids libres quand le but est d'améliorer la santé musculosquelettique.

*Mots-clés :* entraînement à la force, muscles du tronc, dos, équilibre, stabilité.

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## Rationale

Training of the core musculature is an important facet that has gained renewed emphasis in the scientific and professional literature, as well as in the sports training and rehabilitation fields. For the average healthy individual, training the core musculature is emphasized to maintain musculoskeletal health, especially related to the prevention of low back pain (Behm and Anderson 2006). For the injured individual, training the core musculature is used to treat and rehabilitate trunk-related musculoskeletal injuries (Caraffa et al. 1996; Cumps et al. 2007; Forestier and Toschi 2005). For the athletic individual, training the core musculature is not only advocated for the prevention of injury, it also enhances performance (Behm and Anderson 2006). According to the principle of training specificity (Behm 1995; Behm and Sale 1993), and since motion for some sports may occur on relatively unstable surfaces (e.g., skiing, snowboarding), training must attempt to closely address the demands of the sport. Instability-based exercises are a very popular means of attempting to address this aspect of sports performance. A significant body of scientific literature has evaluated the role of instability in resistance training programs designed to train the core musculature.

The anatomical core is defined as the axial skeleton and all soft tissues with a proximal attachment originating on the axial skeleton, regardless of whether the soft tissue terminates on the axial or appendicular skeleton (Behm et al. 2010). Achieving sufficient spinal stability represents the complex interaction of passive (i.e., spinal ligaments, intervertebral discs, and facet articulations) and active muscle and neural subsystems (Panjabi 1992); thus, a single muscle or structure cannot be identified as the most important spinal stabilizer. The combination of core muscles recruited is dependent on the task demands (i.e., posture, external forces).

The global axial skeleton stabilizers include the large, superficial muscles (e.g., rectus abdominis, external oblique abdominis, erector spinae group) that provide multisegmental stiffness over a greater range and also act as prime movers during dynamic activities (Behm et al. 2010). Other core muscles might be considered axial-appendicular transfer muscles that connect the trunk (i.e., axial skeleton) to the upper and lower extremities (i.e., appendicular skeleton) via the pelvic girdle and shoulder girdle, respectively (Behm et al. 2010). These core muscles function in transferring torques and angular momentum during the performance of integrated kinetic chain activities, such as throwing or kicking (Cresswell and Thorstensson 1994; Kibler et al. 2006; Willardson 2007). Weakness in the core musculature may interrupt the transfer of torques and angular momentum, resulting in decreased performance.

Spinal stability is dependent on the appropriate combination and intensity of muscle activation and the generation of intra-abdominal pressure. Abdominal bracing appears to be more effective than abdominal hollowing to optimize spinal stability (Grenier and McGill 2007). Specific training practices aimed at targeting the spinal stabilizing muscles (core) are an important consideration for activities of daily living, athletic performance, and the rehabilitation of low back pain (Abenham et al. 2000).

Instability applied to resistance training provides different

responses than training under stable conditions. Performing resistance exercises on unstable surfaces is reported to increase activation of the core musculature, compared with performing the same exercises under stable conditions, whether the instability is derived from a platform (Anderson and Behm 2004, 2005; Marshall and Murphy 2006*b*; Santana et al. 2007) or the movement of the limbs (Gaetz et al. 2004; Holtzmann et al. 2004; Marshall and Murphy 2006*a*).

However, unilateral resisted actions (whether ground-based or supported on an unstable base) can also provide a disruptive moment arm (torque) to the body, providing an additional means of increasing the core musculature (Behm et al. 2003). Exercises performed on unstable surfaces can not only increase core muscle activation, but can also increase limb muscle activation (Anderson and Behm 2005; Marshall and Murphy 2006*a*, 2006*b*) and co-contractions (Behm et al. 2002). However, other research demonstrates that ground-based lifts, such as squats and dead lifts, provide even higher core activation than callisthenic-style exercises performed on unstable surfaces (Hamlyn et al. 2007). Furthermore, unstable resisted actions can result in decreased force (Anderson and Behm 2004; Behm et al. 2002; McBride et al. 2006), power (Drinkwater et al. 2007; Kornecki and Zschorlich 1994), velocity, and range of motion (Drinkwater et al. 2007). Resistance trained individuals with years of experience performing ground-based free-weight lifts may not respond with higher activation of the core musculature when performing exercises on moderately unstable bases (Wahl and Behm 2008). Training programs must be structured so that athletes are prepared for the wide variety of postures and external forces encountered during sports participation. This is best accomplished through the performance of a wide variety of exercises that encompass all planes of movement and varying loads.

## Recommendations

### Athletes

Athletes training for maximal strength, power, and velocity of movement should emphasize higher-intensity ground-based lifts (e.g., Olympic lifts, squats, and dead lifts) and not limit the training program to instability-based resistance exercises. Because spinal stability is required for efficient execution of sports skills, a comprehensive program should include resistance exercises that involve a destabilizing component. The destabilizing component may involve instability devices, but can also be achieved with ground-based free weights that provide a destabilizing torque to the centre of gravity or a transverse stress to the core musculature. Specific training of the core musculature should be periodized, just like any other component of athletic development. From a performance standpoint, unstable devices should not be utilized when hypertrophy, absolute strength, or power is the primary training goal, because force generation, power output, and movement velocity are impaired and may be insufficient to stimulate the desired adaptations, especially in trained athletes.

### Rehabilitation

From a rehabilitation standpoint, the utilization of unstable devices has been shown to be effective in decreasing

the incidence of low back pain and increasing the sensory efficiency of soft tissues that stabilize the knee and ankle joints. Such training may promote agonist–antagonist co-contractions with shorter latency periods, which allow for rapid stiffening and protection of joint complexes. These outcomes can provide some protection from injury or enhance recovery from an injury to the core or elsewhere, and, therefore, can be included as part of an overall prehabilitative or rehabilitative exercise program.

### General population

For fitness and health conscious individuals and athletes at all levels (i.e., recreational to elite), ground-based free-weight lifts (e.g., back squats, dead lifts, Olympic lifts, and lifts that involve trunk rotation) should form the foundation of exercises to train the core musculature. Such closed chain lifts are characterized by moderate levels of instability that allow for the simultaneous development of upper and lower extremity strength, thereby addressing all links in the kinetic chain. Closed chain exercises can also be implemented with instability devices incorporating lower loads. The instability-induced high core activation with lower force output can still provide sufficient stress on the system to induce or maintain health benefits; however, maximal strength or power development may be compromised. Open chain isolation exercises for the core musculature (e.g., trunk flexion supported on either a stable or unstable surface) might be most useful for localized muscular endurance development or for aesthetic-related goals (e.g., bodybuilding). Development of power, absolute strength, or localized muscular endurance can potentially contribute to increased spinal stability if incorporated through the specific practice of relevant sports skills. Individuals who are training for health-related fitness, or who cannot access or are less interested in the training stresses associated with ground-based free-weight lifts, can also receive beneficial resistance training adaptations with instability devices and exercises to achieve functional health benefits.

### Conclusion

Ground-based free-weight lifts are highly recommended for athletic conditioning of the core musculature because they can provide the moderately unstable environments to augment core and limb muscle activation while still providing maximal or near maximal force and power outputs. However, the concept of periodization illustrates the need to modulate volumes and intensities of training over time; thus, during phases involving lower loads, instability training devices and exercises can stimulate high muscle activation. Based on the relatively high proportion of type I fibers, the core musculature might respond particularly well to multiple sets that involve many repetitions (e.g., >15 per set). However, the characteristics of a given sport may necessitate repetition ranges that emphasize strength and power development (e.g., <6 per set).

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