INSTABILITY TRAINING: to balance or not?

How many great training words can you hear in this clip?

Definitions

Neuromuscular

Neuromuscular training could be defined as training enhancing unconscious motor responses by stimulating both sensory feedback and motor response mechanisms responsible for dynamic joint control. (Risberg et al. J Orthop Sports Phys 31: 11, November 2001)

BALANCE

Balance training includes equilibrium control exercises that are repetitive and graded in complexity that enhance balance by improving sway control and inhibiting inappropriate motor responses. (Steadman et al. JAGS 51:847–852, 2003)
PROPRIOCEPTION
- Proprioception is the afferent input of joint position sense (i.e. awareness of position or movement)
- However, proprioception in a broader sense includes neuromuscular control.

INSTABILITY
- The definition of instability is a loss of stiffness.
- Joint instability is a lack of support in the joints, which puts a person at risk for the joints to become displaced or dislocated, leading to injury.
- Stiffness is the rigidity of an object and can be thought of as the extent to which it resists deformation in response to an applied force.

MUSCLE ACTIVATION
- The process by which the signal to contract is transmitted from the CNS to the contractile units in the muscle.

FORCE PRODUCTION
- Excitation (or neural excitation) refers to the motor neuron action potentials or electric stimuli transmitted to the muscle.
- The term activation (or muscle activation) designates the set of events linking the excitation with the contractile units resulting in force production.

Evidence Pyramid
- Google scholar
- Key words + systematic review
- E.g. balance + strength + systematic review

Will balance training activities help improve movement function?
Key Point 1

**Balance training does not transfer to different tasks**

- Balance adjustment required is often so specific and detailed that training occurs only to the specific demand.
- Transfer to different tasks does not occur in any substantial way regardless of similarity in body position and balance demands.

**Kummel et al 2016**

Balance training improves performance only in the balance tasks that were explicitly performed during the training and that the transfer of performance improvements from trained to non-trained balance tasks is very small or even non-existent.


- coaches should identify exactly those tasks that need improvement, implement these tasks into the training program, and also use them as a part of the test battery that evaluates the efficacy of the training program.
- Generic balance tasks—such as one-leg stance—may have little value on overall balance measures or when assessing the efficacy of specific training interventions.

**Giboin et al. 2015**

- There was no transfer to different tasks even when the device used was the same or when the direction of perturbation was the same.
- The effects of balance training can be highly task-specific, with little – if any – transfer to other balance tasks.

- Task-specificity of balance training – Human Movement Science August 2015

**Does training on a balance board reduce risk of injury?**
Key Point 2
Balance board training may reduce injury risk if they’ve had a previous similar injury.

Sensory time loop
- The initial automatic postural response (APR) is approximately 70–120 ms after surface displacement with functional responses occurring between 120 and 180 ms. (Trivedi et al. 2010)
- Injuries such as ankle sprains occur less than 40-50 ms after foot contact. (Chan et al. 2010)
- Balance training cannot change these times.

Peterson et al. 2013
- The most important risk factor for an ankle sprain is a previous ankle sprain.
- Reduced ankles sprains in people with previous injury due to reduced proprioception from the injury which may be improved.
- Strengthening ankle evertors and dorsiflexors is critical.

Leppanen et al. 2013
- Balance board training seems to be effective especially in reducing the risk of ankle injuries, but also to some extent, when part of neuromuscular training, of other injuries of the lower extremities.

Schiftan et al. 2015
- Proprioceptive training reduces the risk of sustaining an ankle sprain among sporting populations.
- Preventive effects have been established in mixed populations and in those with a history of ankle injury.
- The effectiveness of this intervention for participants without a history of ankle sprain was found to be inconclusive.

Cooper et al. 2015
- Proprioceptive and balance exercise may improve outcomes in people with ACL deficiency.
- There are some modest benefits apparent for people who have undergone ACL reconstruction.
- These comments are based on a limited amount of research, with only four papers that investigated rehabilitation for people with ACL deficiency and one paper investigating rehabilitation following ACL reconstruction.
Myer et al. 2013
- When considering all age categories, balance training alone did not appear to provide the needed stimulus to reduce ACL injury risk.
- Isolated balance training without feedback-driven instruction appeared to be the least effective approach.
- Balance training may be most effective for injury prevention when it is combined with other types of training – especially strength training.

Is balance training best activity to reduce risk of falls in elderly?

Key Point 3
A multi-component exercise intervention program appears to be the best strategy for improving gait, balance, and strength, as well as reducing the rate of falls in elderly individuals.

Mansfield et al. 2015
- Perturbation-based balance training appears to reduce fall rates among older adults and individuals with Parkinson disease but the effect was small.
- The optimal dose of perturbation training for causing lasting changes in reactive balance control is unknown.
- There may be potential benefit of “booster” training after an initial period of training.

Silva et al. 2013
- Physical exercise is effective to prevent falls in long term care residents only if a combination of different types of exercise (always including balance exercise) is used.
- Programs are more effective when applied for more than 6 months with a frequency of 2-3 times per week.

Cadore et al. 2013
- Intervention programs consisting of strength, endurance, and balance training improved gait, balance, and strength, reduced the rate of falls in elderly individuals and maintained their functional capacity during aging.
- Studies which used systematic resistance training (either alone or as part of multi-component) revealed greater strength gains and similar outcomes.


‘Effects of Different Exercise Interventions on Risk of Falls, Gait Ability, and Balance in Physically Frail Older Adults: A Systematic Review’ – Rejuvenation Research 2013
Will balance training improve neuromuscular and postural control?

Key Point 4
Balance training can be effective for postural and neuromuscular control improvements

Functional Performance
- Balance training vs no training – slight improvements in postural sway using stable and unstable platforms
- Balance training vs Strength/Plyo – poor evidence but suggest strength/plyo activities more effective
- Balance training is an effective treatment to improve balancing motor skills, but for optimal performance enhancements other training methods are more effective

Entropy Training vs no training – slight improvements in postural sway using stable and unstable platforms

Neuromuscular Control
- Balance training vs no training – small EMG changes in various muscles of lower limb with balance training
- Balance training vs strength training – inconclusive
- Inconclusive outcomes reported on neuromuscular control and the discussion of underlying mechanisms of balance training adaptation remains speculative

Rossi et al. 2013
- Balance training improved neuromuscular responses such as muscle reaction time and ankle muscle activation and aided the body’s ability to maintain correct centre of pressure.
- After 6 weeks of detraining this gain was lost for most of the assessed variables.
- The effects of a perturbation-based balance training on the reactive neuromuscular control in community-dwelling older women: a randomized controlled trial – Human Movement 2013

Should you train on an unstable surface?
Key Point 5
Unstable surface training does not provide systematic training-specific balance advantages over stable surface.

Behm et al, 2015 - Elite
- The challenges to postural stability may be greater during an exercise on an unstable surface, the present results demonstrate that this greater degree of stress does not lead to greater systematic balance improvements in adolescents and young adults.
- The mean force deficit with unstable surface training compared with similar stable surface exercises was 29%.

Behm et al, 2015 - Non-elite
- Unstable surface training may be employed by the non-elite training population to improve strength and power and to achieve functional health benefits.
- The approximate 30% force deficit could be viewed alternatively as a benefit, as the lower forces produced might decrease the chance or incidence of training-related injuries or might be more beneficial for rehabilitation of an injured muscle group.

Behm et al, 2015 - Conclusion
- When compared with no training or regular training only unstable surface training is effective in improving strength performance in adolescents, young adults and old adults, as well as power and balance performance in young and old adults.
- The application of unstable surface training compared with stable has limited additional effects on measures of muscle strength, power and balance in healthy adolescents and young adults.

Canadian Society for Exercise Physiology position stand
- “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.”

Is there any value in increasing muscle EMG activity from unstable surface?

**Key Point 6**
Unstable surface training increases EMG activity in related muscles

**Increased activation**
- The use of unstable platforms as a resistance training modality for strength gains can be employed to allow high muscle activation levels to be developed through an increased reliance on stabilising functions. (Behm et al 2005)
- Trunk muscle activity increased from machine squats to BB squats to BB squats on dura-disc but little or no change in activity of prime movers. (Anderson & Behm 2005)

**Possible benefits**
- EMG activity in squat, deadlift and overhead press not significantly different in trunk muscles when comparing 75% of 1RM on stable surface to 50% of 1RM on BOSU (Willardson et al 2009)

**Take Home Message**
Balance training will not improve response time to perturbations
- Balance training needs to be specific to whatever task, sport, activity the balance is required for
- Unstable surface training has some benefits – but be aware of its limitations
- Force output is greater on stable surface but none elite and young people can still benefit from unstable surface training