



Science Articles About Balance Training

ACL and Lower Leg Involvement: Anterior Tibialis is important for balance, women have weak hip abductor strength and control of the knee when landing, landing should increase knee flexion angle, 75% of ankle injury in elite field hockey occurred during a match. ACL patients have decreased muscle activation and greater postural sway.

Shimokochi Y, Shultz SJ. Mechanisms of noncontact anterior cruciate ligament injury. *J Athl Train*. 2008;43(4):396-408.

Increasing knee flexion angle during deceleration and acceleration tasks and preventing excessive quadriceps contraction while increasing hamstrings muscle cocontractions, especially at near-full knee extension, may protect the ACL. Combined valgus and knee internal rotation moments also produced higher ACL tensile force.

Lysholm M, Ledin T, Odkvist LM, Good L. Postural control--a comparison between patients with chronic anterior cruciate ligament insufficiency and healthy individuals. *Scand J Med Sci Sports*. 1998;8(6):432-8.

ACL deficient subjects displayed more postural sway on a single limb balance on the injured leg and had impaired postural control in the antero-posterior direction with prolonged reaction time when subjected to antero-posterior perturbations.

Pereira HM, Nowotny AH, Santos AB, Cardoso JR. Electromyographic activity of knee stabilizer muscles during six different balance board stimuli after anterior cruciate ligament surgery. *Electromyogr Clin Neurophysiol*. 2009;49(2-3):117-24.

Patients with ACL reconstructions show decreased muscular activity of the lower leg and especially of the vastus lateralis and gastrocnemius on balance board tests.

Naicker M, McLean M, Esterhuizen TM, Peters-Futre EM. Poor peak dorsiflexor torque associated with incidence of ankle injury in elite field female hockey players. *J Sci Med Sport*. 2007;10(6):363-71.

Elite field hockey players in 2004 with previous ankle injuries showed decreased ability to maintain balance and poor peak isokinetic torque of the dorsiflexors of injured leg. All injuries occurred on turf and 75% during a match.

Jacobs, CA, Uhl, TL, Mattacola CG, Shapiro R, Rayens WS. Hip abductor function and lower extremity landing kinematics: sex difference. *J Athl Train*. 2007;42(1):76-83.

Women display weak hip abduction peak torque and valgus peak joint displacement when landing from a jump. Hip abduction strength is more important for neuromuscular control of the knee for women compared to men.

Di Giulio I, Maganaris C, Baltzopoulos V, Loram ID. The proprioceptive and agonist roles of gastrocnemius, soleus and tibialis anterior muscles in maintaining human upright posture. *J Physiol*. 2009 Mar 16. [Epub ahead of print]

Tibialis anterior vs soleus and gastrocnemius may be better source of proprioceptive feedback.

Amiridis I, Arabatzi F, Violaris P, Stavropoulos E, Hatzitaki V. Static balance improvement in elderly after dorsiflexors electrostimulation training. *Eur J Appl Physiol*. 2005 Jul;94(4):424-33.

Elderly adults in the training group for 4 weeks, 4 days a week and for 40 minutes were subject to dorsiflexor electrostimulation training then tested on three static balance tests. The training group showed decreased postural sway and greater ankle stability.



Effects of Fatigue: Fatigue protocols decreases postural stability and static and dynamic balance.

Surenkok O, Kin-Isler A, Aytar A, Gültekin Z. Effect of trunk-muscle fatigue and lactic acid accumulation on balance in healthy subjects. *J Sport Rehabil.* 2008;17(4):380-6.

After fatigue protocol on trunk extension and flexion, no significant affect of lactic acid on balance. Trunk muscle fatigue was significant for decreasing static and dynamic balance.

Twist C, Gleeson N, Eston R. The effects of plyometric exercise on unilateral balance performance. *J Sports Sci.* 2008;26(10):1073-80.

Latent impairment of balance ability 24 hours after plyometric exercises of 200 counter-movement jumps to elicit symptoms of muscle damage. Skill based activities may be compromised and increase risk of injury after high-intensity plyometric training.

Dickin DC, Doan JB. Postural stability in altered and unaltered sensory environments following fatiguing exercise of lower extremity joints. *Scand J Med Sci Sports.* 2008;18(6):765-72.

Impairments in postural sway and control were evident 10 and 30 minutes following a bout of lower leg fatiguing exercises.

Gribble PA, Hertel J, Denegar CR, Buckley WE. The Effects of Fatigue and Chronic Ankle Instability on Dynamic Postural Control. *J Athl Train.* 2004;39(4):321-329.

Subjects with chronic ankle instability engaged in lower leg fatigue protocols followed by testing on the SEBT for dynamic postural control. Fatigue and CAI disrupted stability especially in the sagittal plane reaching distance.

Shoulder Injuries: Close chain exercises are beneficial, fatigue protocol decreases joint sense, swiss ball push-ups increase rectus abdominis and triceps activation. Injury rate is 3 times more likely during competition with 57% player to player and 22% contact with ground for high school athletes.

Tripp BL, Yochem EM, Uhl TL. Recover of upper extremity sensorimotor system acuity in baseball athletes after a throwing-fatigue protocol. *J Athl Train.* 2007;42(4):452-457.

Baseball players threw using a fatigue protocol of Borg RPE scale or 160 throws at maximal effort. Fatigue hampers SMS acuity and in arm cocked position the glenohumeral joint acuity failed to recover in 10 minutes, where other joint angles and mechanics recovered within 4-7 minutes.

Prokopy MP, Ingersoll CD, Nordenschild E, Katch FI, Gaesser GA, Weltman A Closed-kinetic chain upper-body training improves throwing performance of NCAA Division I softball players. *J Strength Cond Res.* 2008;22(6):1790-8.

Softball players on a 12 week training program for 3 days a week showed better throwing velocity by 2 mph vs 0.3 mph for closed chained exercises compared to open chained exercises. Closed chained exercise group increased shoulder torque and power.

Lehman GJ, MacMillan B, MacIntyre I, Chivers M, Fluter M. Shoulder muscle EMG activity during push up variations on and off a Swiss ball. *Dyn Med.* 2006; 9;5:7

Push-ups on a swiss ball show increased rectus abdominis and triceps activation while feet are on the ground. The pectoralis activation did not increase. No muscles showed increased activation when the feet were on the ball while completing a push-up. Push-up plus increased activation of the external oblique.



Bonza JE, Fields SK, Yard EE, Comstock RD. Shoulder injuries among United States high school athletes during the 2005-2006 and 2006-1007 school years. *J Athl Traing.* 2009;44(1):76-83.

Shoulder injury 3 times more likely during competition. Common injuries were sprain/strain followed by dislocation/separation and contusions. Player to player contact accounted for 57% of injury, 22% contact with playing surface and 10% non-contact. There are specific sport by sport and gender differences in injury rate, type and mechanism. Football injuries from tackling, being tackled and blocking. Girls soccer injuries from dribbling and goaltending. Basketball injuries from defending and rebounding. Volleyball injuries from serving and spiking. Wrestling injuries from takedowns. Baseball injuries from throwing.

Body Weight: Increased body weight decreases postural stability. Balance may be affected by body weight fluctuations.

Menegoni F, Galli M, Tacchini E, Vismara L, Cavigioli M, Capodaglio P. Gender-specific Effect of Obesity on Balance. *Obesity.* 2009 Mar 26. [Epub ahead of print]

During static posture obese men had less balance on anterior/posterior and medial/lateral axis. Obese women only had anterior/posterior balance deficits in static posture. Weight was directly correlated to AP balance.

Fontana MP, Menegoni F, Vismara L, Galli M, Romei M, Bergamini E, Petroni ML, Capodaglio P. Balance in patients with anorexia and bulimia nervosa. *Eur J Phys Rehabil Med.* 2009 Feb 17. [Epub ahead of print]

Anorexia patients did not have significant postural sway compared to bulimia nervosa patients when compared to controls. Body weight fluctuations of the BN patients may affect patients significantly in the anterior/posterior plane.

Maffiuletti NA, Agosti F, Proietti M, Riva D, Resnik M, Lafortuna CL, Sartorio A. Postural instability of extremely obese individuals improves after a body weight reduction program entailing specific balance training. *J Endocrinol Invest.* 2005;28(1):2-7.

Extremely obese individuals showed greater postural sway and decreased balance maintenance compared to lean counterparts. Subjects were divided into body weight reduction with or without 6 sessions of balance training. Both groups increased postural stability and balance maintenance however the weight reduction and balance training did better.

Spinal Health: Spinal position affects stability and functional exercises should be multi-planar with strategic contraction rhythm for spinal stability. Whole body training is better for fall prevention.

Ishikawa Y, Miyakoshi N, Kasukawa Y, Hongo M, Shimada Y. Spinal curvature and postural balance in patients with osteoporosis *Osteoporos Int.* 2009 Apr 3. [Epub ahead of print]

Patients with lumbar kyphosis and osteoporosis had more postural sway and may increase risk factor for falls. Thoracic kyphosis was not significant.

McGill SM, Karpowicz A, Fenwick CM, Brown SH. Exercises for the torso performed in a standing posture: spine and hip motion and motor patterns and spine load. *J Strength Cond Res.* 2009; 23(2):455-64.

Maximal muscle activation can be seen in single-plane tasks. Multi-plane exercises, “functional-exercises”, could not perform maximal contractions because it would upset the balance of the 3 spinal axis and decrease spinal stability. Strength training muscles may not help in “functional exercises” that are multi-planar.



Marigold DS, Misiaszek JE. Whole-body responses: neural control and implications for rehabilitation and fall prevention. *Neuroscientist*. 2009; 15(1):36-46.

Program designs using whole-body responses are effective to reduce falls and improve functional mobility in older adults. Proprioceptive pathways of the lumbar and cervical patterns will allow for the coordination of the spinal cord.

Core Strength: Balance training will improve reactive ability to reduce lower body injury, core training should be in post-season and can be tested with endurance tests. Swiss ball prone bridges increase rectus abdominis and external oblique activation.

Nesser TW, Huxel KC, Tincher JL, Okada T. The relationship between core stability and performance in division I football players. *J Strength Cond Res*. 2008;22(6):1750-4.

Holding a back extension, side bridge and trunk flexion for core strength measures moderately correlated to better strength and performance for sprinting, vertical jump, shuttle run, power clean, bench press, squat, and power clean 1RM. Concluded core training does not contribute significantly to strength and power.

Borghuis J, Hof AL, Lemmink KA. The importance of sensory-motor control in providing core stability: implications for measurement and training. *Sports Med*. 2008;38(11):893-916.

Sitting balance performance and trunk muscle times may be good indicators of core stability.

Willardson JM. Core stability training: applications to sports conditioning programs. *J Strength Cond Res*. 2007;21(3):979-85.

Review of literature concludes pre-season exercises should include free weights standing on a stable surface to increase core strength and power. Post-season training of Swiss ball exercises for isometric muscle action, small loads, and long tension are recommended to increase core endurance. Balance board and stability disc exercises performed with plyometric exercises will improve proprioceptive and reactive capabilities to reduce lower extremity injury.

Lehman GJ, Hoda W, Oliver S. Trunk muscle activity during bridging exercises on and off a Swiss ball. *Chiropr Osteopat*. 2005; 30;13:14.

During prone bridge exercises the rectus abdominis and external oblique have increased activation compared to supine bridge exercises which do not show increased trunk activity.

Balance Training Effects: Balance training programs are effective to prevent reoccurring ankle injury for athletes and elderly. Training is effective for symmetry of weight distribution for sedentary subjects after 4 weeks.

Couillandre A, Duque Ribeiro MJ, Thoumie P, Portero P. Changes in balance and strength parameters induced by training on a motorised rotating platform: a study on healthy subjects. *Ann Readapt Med Phys*. 2008;51(2):59-73.

SpineForce device rotating platform is a motorized wobble board. Static postural control was positively effected with training and would be good for a population with low initial physical activity level.

Mohammadi F. Comparison of 3 preventive methods to reduce the recurrence of ankle inversion sprains in male soccer players. *Am J Sports Med*. 2007;35(6):922-6.

Proprioceptive training was effective in reducing the rate of reoccurring ankle sprains of male soccer players compared to controls, strength training or foot orthotics.



McHugh MP, Tyler TF, Mirabella MR, Mullaney MJ, Nicholas SJ. The effectiveness of a balance training intervention in reducing the incidence of noncontact ankle sprains in high school football players. *Am J Sports Med.* 2007;35(8):1289-94.

Cohort study taking players with high body mass index and previous ankle sprain completed 5 minutes of balance pad single leg standing 5 days a week for 4 weeks in pre-season and twice per week during the season. Results show a 77% reduction in injury incidence for noncontact inversion ankle sprains.

McGuine TA, Keene JS. The effect of a balance training program on the risk of ankle sprains in high school athletes. *Am J Sports Med.* 2006 Jul;34(7):1103-11.

High school soccer and basketball players were placed on a balance training program vs the control that only did standard conditioning. Balance training reduced the rate of ankle sprain and the risk of ankle sprain by 50%.

Mononen K, Kontinen N, Viitasalo J, Era P. Relationships between postural balance, rifle stability and shooting accuracy among novice rifle shooters. *Scand J Med Sci Sports.* 2007;17(2):180-5.

Postural stability is decreased in mediolateral postural sway and vertical deviation of aiming point.
 Postural balance is important in shooting performance.

Nagy E, Feher-Kiss A, Barnai M, Domján-Preszner A, Angyan L, Horvath G. Postural control in elderly subjects participating in balance training. *Eur J Appl Physiol.* 2007;100(1):97-104.

After 8 weeks of postural stability training body sway was analyzed for elderly subjects. Improvements in mediolateral balance and postural sway were found.

Gioftsidou A, Malliou P, Pafis G, Beneka A, Godolias G, Maganaris CN. The effects of soccer training and timing of balance training on balance ability. *Eur J Appl Physiol.* 2006;96(6):659-64.

A 12 week balance training program at 3 times a week for 20 minutes a session showed improved balance ability on a Biodex for both groups that trained after soccer practice and before soccer practice compared to a control group. The group training after practice improved more than the group training before practice.

Adedoyin RA, Olaogun MO, Omotayo K, Olawale OA, Egwu MO. Effects of wobble board training on weight distribution on the lower extremities of sedentary subjects. *Technol Health Care.* 2008;16(4):247-53.

Six week at 3 times a week of wobble board exercises for sedentary subjects showed significant improvements in symmetry of body weight distribution at the 4th and 6th week.

Dynamic Postural Control: Posture controls is better in the morning. Female basketball players lack postural control compared to gymnasts and soccer players.

Gribble PA, Tucker WS, White PA. Time-of-day influences on static and dynamic postural control. *J Athl Train.* 2007;42(1) 35-41.

Participants used single limb stance for static postural control and Star Excursion Balance Test for dynamic posture. Dynamic postural control was better in the morning compared to the afternoon. Static control did not differ during time of day.

Bressel E, Yonker JC, Kras J, Heath EM. Comparison of static and dynamic balance in female collegiate soccer, basketball, and gymnastics athletes. *J Athl Train.* 2007;42(1):42-46.

Using BESS test and SEBT, gymnastics had better BESS scores compared to soccer and basketball.
 Basketball had inferior SEBT scores compared to soccer and gymnastics.



Concentration: Postural control equates with drawing accuracy of children and distraction of baseball players in clinical and on field sites.

Miyahara M, Piek JP, Barrett NC. Effect of postural instability on drawing errors in children: a synchronized kinematic analysis of hand drawing and body motion. *Hum Mov Sci.* 2008;27(5):705-13.

Children tested on drawing accuracy and movement of the head, shoulder and elbows showed inaccurate drawing was a result of postural instability of the head and shoulder vs fidgeting caused by inattention or hyperactivity.

Onate JA, Beck BC, Van Lunen BL. On-field testing environment and balance error scoring system performance during preseason screening of healthy collegiate baseball players. *J Athl Train.* 2007;42(4):446-451.

Healthy collegiate baseball players performed worse on the BESS test for MHI during sideline testing