SPORT-SPECIFIC BALANCE

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Abstract

This review includes the latest findings based on experimental studies addressing sport-specific balance, an area of research that has grown dramatically in recent years. The main objectives of this work were to investigate the postural sway response to different forms of exercise under laboratory and sport-specific conditions, to examine how this effect can vary with expertise, and to provide examples of the association of impaired balance with sport performance and/or increasing risk of injury. In doing so, sports where body balance is one of the limiting factors of performance were analyzed. While there are no significant differences in postural stability between athletes of different specializations and physically active individuals during standing in a standard upright position (e.g., bipedal stance), they have a better ability to maintain balance in specific conditions (e.g., while standing on a narrow area of support). Differences in magnitude of balance impairment after specific exercises (rebound jumps, repeated rotations, etc.) and mainly in speed of its readjustment to baseline are also observed. Besides some evidence on an association of greater postural sway with the increasing risk of injuries, there are many myths related to the negative influence of impaired balance on sport performance. Though this may be true for shooting or archery, findings have shown that in many other sports, highly skilled athletes are able to perform successfully in spite of increased postural sway. These findings may contribute to better understanding of the postural control system under various performance requirements. It may provide useful knowledge for designing training programs for specific sports.

SPECIFIC MUSCLE SYNERGIES IN NATIONAL ELITE FEMALE ICE HOCKEY PLAYERS IN RESPONSE TO UNEXPECTED EXTERNAL PERTURBATION

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Abstract

This study aimed to investigate specific muscle synergies in elite ice hockey players indicating highly developed postural control strategies used to restore balance against unexpected external perturbations. Seven elite athletes (EA) on the women's national ice hockey team and 7 non-athletes (NA) participated in this study. Based on trajectories of centre of mass (COM), analysis periods were divided into an initial phase (a balance disturbance after perturbation onset) and a reversal phase (a balance recovery response), respectively. Muscle synergies were extracted at each phase by using non-negative matrix factorization. k-means cluster analysis was performed to arrange similar muscle synergies in all participants. EA showed significantly shorter recovery period of COM and smaller body sway than NA. In the initial phase, we identified 2 EA-specific synergies related to ankle plantar flexors or neck extensors. In the case of an NA-specific synergy, co-activation of the ankle plantar flexors and dorsiflexors was found. In the reversal phase, no specific muscle synergies were identified. As the results, EA-specific muscle synergies showed low co-activation strategy of agonists and antagonists in ankle and neck extensors. Our results could provide critical information for rehabilitation strategies in athletes requiring high postural stability.

POSTURAL AND TRUNK RESPONSES TO UNEXPECTED PERTURBATIONS DEPEND ON THE VELOCITY AND DIRECTION OF PLATFORM MOTION

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Abstract

This study compares postural and trunk responses to translating platform perturbations of varied velocities and directions. A group of 18 young and physically active subjects were exposed to a set of postural perturbations at varied velocities (5, 10, 15, and 20 cm/s) and directions of platform movement (forward, backward, left-lateral, and right-lateral). The center of pressure (CoP) displacement measurement, in addition to the trunk motion (representing the center of mass (CoM) displacement), were both monitored. Results identified that the CoP displacement increased from slow to faster velocities of platform motion more widely in both anterior and posterior directions (50.4 % and 48.4 %) as compared to the CoM displacement (17.8 % and 14.9 %). However a greater increase in the peak CoM velocity (70.3 % and 69.6 %) and the peak CoM acceleration (60.5 % and 53.1 %) was observed. The values in the anterior and posterior direction only differed significantly at the highest velocity of platform motion (i.e. 20 cm/s). A similar tendency was observed in the medio-lateral direction, but there were no significant differences in any parameter in the left-lateral and right-lateral direction. The velocity of the platform motion highly correlated with peak velocity ($r=0.92-0.97$, $P<0.01$) and moderately with amplitude of trunk displacement ($r=0.56-0.63$, $P<0.05$). These findings indicate that the velocity of perturbation alters peak CoM velocity rather than the magnitude of CoM displacement. The effect of the direction of perturbations on the trunk response emerges only at a high velocity of platform motion, such that the peak CoM velocity and peak CoM acceleration are significantly greater in anterior than posterior direction.

BALANCE ABILITY AND ATHLETIC PERFORMANCE

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Abstract

The relationship between balance ability and sport injury risk has been established in many cases, but the relationship between balance ability and athletic performance is less clear. This review compares the balance ability of athletes from different sports, determines if there is a difference in balance ability of athletes at different levels of competition within the same sport, determines the relationship of balance ability with performance measures and examines the influence of balance training on sport performance or motor skills. Based on the available data from cross-sectional studies, gymnasts tended to have the best balance ability, followed by soccer players, swimmers, active control subjects and then basketball players. Surprisingly, no studies were found that compared the balance ability of rifle shooters with other athletes. There were some sports, such as rifle shooting, soccer and golf, where elite athletes were found to have superior balance ability compared with their less proficient counterparts, but this was not found to be the case for alpine skiing, surfing and judo. Balance ability was shown to be significantly related to rifle shooting accuracy, archery shooting accuracy, ice hockey maximum skating speed and simulated luge start speed, but not for baseball pitching accuracy or snowboarding ranking points. Prospective studies have shown that the addition of a balance training component to the activities of recreationally active subjects or physical education students has resulted in improvements in vertical jump, agility, shuttle run and downhill slalom skiing. A proposed mechanism for the enhancement in motor skills from balance training is an increase in the rate of force development. There are limited data on the influence of balance training on motor skills of elite athletes. When the effectiveness of balance training was compared with resistance training, it was found that resistance training produced superior performance results for jump height and sprint time. Balance ability was related to competition level for some sports, with the more proficient athletes displaying greater balance ability. There were significant relationships between balance ability and a number of performance measures. Evidence from prospective studies supports the notion that balance training can be a worthwhile adjunct to the usual training of non-elite athletes to enhance certain motor skills, but not in place of other conditioning such as resistance training. More research is required to determine the influence of balance training on the motor skills of elite athletes.

THE EFFECT OF A BALANCE TRAINING PROGRAM ON THE RISK OF ANKLE SPRAINS IN HIGH SCHOOL ATHLETES

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Abstract

Background: Ankle sprains are the most common musculoskeletal injuries that occur in athletes, and they have a profound impact on health care costs and resources.

Hypothesis: A balance training program can reduce the risk of ankle sprains in high school athletes.

Study design: Randomized controlled clinical trial; Level of evidence, 1.

Methods: Seven hundred and sixty-five high school soccer and basketball players (523 girls and 242 boys) were randomly assigned to either an intervention group (27 teams, 373 subjects) that participated in a balance training program or to a control group (28 teams, 392 subjects) that performed only standard conditioning exercises. On-site athletic trainers recorded athlete exposures and sprains.

Results: The rate of ankle sprains was significantly lower for subjects in the intervention group (6.1%, 1.13 of 1000 exposures vs 9.9%, 1.87 of 1000 exposures; P = .04). Athletes with a history of an ankle sprain had a 2-fold increased risk of sustaining a sprain (risk ratio, 2.14), whereas athletes who performed the intervention program decreased their risk of a sprain by one half (risk ratio, 0.56). The ankle sprain rate for athletes without previous sprains was 4.3% in the intervention group and 7.7% in the control group, but this difference was not significant (P = .059).

Conclusion: A balance training program will significantly reduce the risk of ankle sprains in high school soccer and basketball players.

NEUROMUSCULAR TRAINING IMPROVES PERFORMANCE ON THE STAR EXCURSION BALANCE TEST IN YOUNG FEMALE ATHLETES

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Abstract

Study design: Controlled cohort repeated-measures experimental design.

Objectives: To determine if a neuromuscular training program (NMTP) focused on core stability and lower extremity strength would affect performance on the star excursion balance test (SEBT). We hypothesized that NMTP would improve SEBT performance in the experimental group and there would be no side-to-side differences in either group.

Background: The SEBT is a functional screening tool that is used to assess dynamic stability, monitor rehabilitation progress, assess deficits following an injury, and identify athletes at high risk for lower extremity injury. The SEBT requires lower extremity coordination, balance, flexibility, and strength.

Methods: Twenty uninjured female soccer players (13 experimental, 7 control) participated. Players trained together as a team, so group allocation was not randomized. The SEBT was administered prior to and following 8 weeks of NMTP in the experimental group and 8 weeks of no NMTP in the control group. A 3-way mixed-model ANOVA was used to determine the effect of group (experimental versus control), training (pretraining versus posttraining), and limb (right versus left).

Results: After participation in a NMTP, subjects demonstrated a significant improvement in the SEBT composite score (mean ± SD) on the right limb (pretraining, 96.4% ± 11.7%; posttraining, 104.6% ± 6.1%; P = .03) and the left limb (pretraining, 96.9% ± 10.1%; posttraining, 103.4% ± 8.0%; P = .04). The control group had no change on the SEBT composite score for the right (pretraining, 95.7% ± 5.2%; posttraining, 94.4% ± 5.2%; P = .15) or the left (97.4% ± 7.2%; 93.6% ± 5.0%; P = .09) limb. Further analysis identified significant improvement for the SEBT in the posterolateral direction on both the right (P = .008) and left (P = .040) limb and the posteromedial direction of the left limb (P = .028) in the experimental group.

Conclusion: Female soccer players demonstrated an improved performance on the SEBT after NMTP that focused on core stability and lower extremity strength.

EFFECTS OF BALANCE TRAINING ON BALANCE PERFORMANCE IN YOUTH: ROLE OF TRAINING DIFFICULTY

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Abstract

Background: Cross-sectional studies have shown that balance performance can be challenged by the level of task difficulty (e.g., varying stance conditions, sensory manipulations). However, it remains unclear whether the application of different levels of task difficulty during balance training (BT) leads to altered adaptations in balance performance. Thus, we examined the effects of BT conducted under a high versus a low level of task difficulty on balance performance.

Methods: Forty male adolescents were randomly assigned to a BT program using a low (BT-low: n = 20; age: 12.4 ± 2.0 yrs) or a high (BT-high: n = 20; age: 12.5 ± 2.5 yrs) level of balance task difficulty. Both groups trained for 7 weeks (2 sessions/week, 30-35 min each). Pre- and post-training assessments included measures of static (one-legged stance [OLS] time), dynamic (10-m gait velocity), and proactive (Y-Balance Test [YBT] reach distance, Functional Reach Test [FRT]; Timed-Up-and-Go Test [TUG]) balance.

Results: Significant main effects of Test (i.e., pre- to post-test improvements) were observed for all but one balance measure (i.e., 10-m gait velocity). Additionally, a Test x Group interaction was detected for the FRT in favor of the BT-high group (Δ + 8%, $p < 0.001$, $d = 0.35$). Further, tendencies toward significant Test x Group interactions were found for the YBT anterior reach (in favor of BT-high: Δ + 9%, $p < 0.001$, $d = 0.60$) and for the OLS with eyes opened and on firm surface (in favor of BT-low: Δ + 31%, $p = 0.003$, $d = 0.67$).

Conclusions: Following 7 weeks of BT, enhancements in measures of static, dynamic, and proactive balance were observed in the BT-high and BT-low groups. However, BT-high appears to be more effective for increasing measures of proactive balance, whereas BT-low seems to be more effective for improving proxies of static balance.

Trial registration: Current Controlled Trials ISRCTN83638708 (Retrospectively registered 19th June, 2020).