Balance Error Scoring System Normative Values in an Athletic Pediatric Sample
Olson B
South Dakota State University, Brookings, South Dakota

Introduction: Pediatric athletes experiencing concussions may demonstrate balance impairments. A balance assessment should be included in a clinician’s battery of tests to evaluate the severity and functional outcome from concussion. The Balance Error Scoring System (BESS) was established over a decade ago as an inexpensive, portable, reliable, and valid measure of balance. Baseline (preinjury) values are ideal for individual comparison postinjury; however, baseline scores are not always available. Establishing age and gender normative values may help to guide clinical decisions.

Rationale: Unfortunately, few studies have reported normative values of the BESS, and of those studies, none has specifically reported normative values for children (=18 years). The purpose was to (1) determine normative BESS data in an athletic pediatric sample, (2) determine if significant difference exists between male and female BESS scores, and (3) determine if significant difference exists between younger (11-13 years) and older (17-18 years) participants.

Methods: Healthy youth (N = 852) between the ages of 11-18 years (14.73±1.70) enrolled in interscholastic athletics participated in the study. Boys (N = 446) and girls (N = 406) were included. A younger cohort (11-13 years, N = 231) was compared with an older cohort (17-18 years, N = 173). The BESS was administered to athletic youth in 7 rural school districts during baseline concussion testing. BESS scores were excluded from the study if the student reported an injury within the past 6 months causing balance impairment. A research team who had satisfactorily completed interrater reliability training (ICC = 0.91) administered the BESS. Means and standard deviations describe the sample and normative data. An independent samples t test was used to determine significance between genders and between age cohorts. Significance level was set at P < .05 a priori.

Results: Normative BESS scores for the pediatric sample include firm surface total errors (3.34±2.47), foam surface total errors (9.15±2.82), and total BESS error score (12.49±4.45). No significant difference existed between boys and girls or between age cohorts.

Discussion: When preinjury BESS scores are not available, comparison against normative data may determine balance impairment postconcussion in athletic youth. No significant difference was demonstrated between genders or age cohorts representing the youngest and oldest participants, which may have been expected due to differences in developmental patterns. Participation in organized sports may improve body coordination development and explain the lack of variance among age and gender in this sample.

Importance: Research comparing BESS scores between athletic and nonathletic youth may assist in defining norms for clinicians managing concussions of nonathletic youth.

An innovative Canadian Solution for Improved Access to Care for Knee Injuries Using “Non-Physician Experts”: The Calgary Acute Knee Injury Clinic
Lau BH, Lafave MR, Mohtadi, NG, Chan DS
Mount Royal University, Calgary, Alberta, Canada

Introduction: The Canadian health care system depicts a clinical care pathway for musculoskeletal (MSK) disorders that is inefficient and ineffective. This results in delays in management and treatment, which increases the economic burden to the health care system and risk of chronic disease and morbidity development.

Rationale: The purpose of the study was to describe and evaluate a new team-based approach to evaluation, management, and treatment of MSK patients in Calgary, Alberta, Canada: the Calgary Acute Knee Injury Clinic.
Injury Knee Clinic model (C-Acute Knee Injury clinic [C-AKIC]). The C-AKIC used web-based screening technology and introduced a new health care practitioner, the “non-physician expert” (NPE).

**Methods:** This paper is a prospective study. The first stage of the study (1) developed a 6-step NPE curriculum development model, which trained certified athletic therapists as NPEs specializing in clinical skills. Quantitative and qualitative assessment scores were used to evaluate the curriculum. The next stage (2) conducted a needs assessment to identify the logistics of operating the C-AKIC within an urban setting. The final stage (3) assessed the effectiveness and acceptability of the C-AKIC compared with the current clinical care pathway for acute knee injuries using a Healthcare Access and Patient Satisfaction Questionnaire (HAPSQ).

**Results:** (1) Quantitative results for the NPEs showed an average improvement of 12% after comparing pretest and posttest multiple choice examination scores and Objective Structured Clinical Examination (OSCE) scores on 2 stations (29.7% and 37.3%). Qualitative feedback for the NPEs favored positively, noting excellent interpersonal and physical examination skills and identifying improvements to attention to detail; interpretation of diagnostic investigations; and making differential diagnoses. (2) Two areas of need were identified: physical space and personnel. Physical space requirements included 8 examination rooms, in-house diagnostic imaging, and computer technology. Personnel requirements included administrative staff, information technology experts, 2 NPEs, and 1 supervising physician. As part of a team-based approach, the NPE and the physician would reach final consensus-based diagnoses and management plans for each patient. (3) Patients who received care through the current clinical care pathway resulted in longer wait times (7.24 versus 2.09 months) and lower patient satisfaction.

**Discussion:** The NPE model increased capacity in care using certified athletic therapists without compromising the traditional roles of health care workers that are currently in high demand. It also addressed the strategy of using the C-AKIC model to increase effectiveness and accessibility for MSK patient care.

**Importance:** The NPE model demonstrated a unique and efficient approach to evaluating and managing acute knee injuries in an urban setting.

---

**ABSTRACTS**

**Catastrophizing and Fear of Pain Are Related to Increased Pain and Fatigue Measures After DOMS**

Dover GC, Onofrio MC
Concordia University, Montréal, Quebec, Canada

**Introduction:** Increased pain can reduce sleep quality. Pain related fear can influence pain perception, but the influence of these variables on sleep is unclear.

**Rationale:** To assess the relationship between fear avoidance measures and self-reported sleep and fatigue after delayed-onset muscle soreness (DOMS) induction.

**Methods:** Single group pretest–posttest. DOMS testing was completed in a research laboratory and sleep measures occurred at the participants’ homes. Thirteen healthy students (5 men and 8 women, height = 171.9 ± 89.1 cm, mass = 69.5 ± 9.2 kg, age = 21.3 ± 1.9 years). Participants were involved in a larger study. Measures of right shoulder range of motion (ROM) and pain were recorded at baseline. Participants completed an eccentric exercise protocol involving shoulder external rotation using an isokinetic dynamometer until they could generate only 50% of their maximum voluntary isometric muscle contraction. DOMS posttest measures were recorded 48 hours after the exercise. The participants completed a sleep diary that included visual analogue scales (VAS) for sleep and fatigue during the 3 following days. The DASH questionnaire was used to measure function. In addition, fear avoidance was assessed using the Tampa Scale of Kinesiphobia, the Pain Catastrophizing Scale, and the Fear of Pain Questionnaire–III. The sleep diary included a VAS for present pain, night pain, sleep quality, and fatigue. Paired sample t tests were used to analyze shoulder ROM, pain, and function. In addition, Pearson correlations were used to identify relationships between self-reported fatigue and pain measures and fear avoidance (α = 0.05).

**Results:** A significant decrease in internal ROM (pretest = 61.3° ± 11.8°; posttest = 52.7° ± 14.1°; P < .005) and a significant increase in pain was noted after exercise (VAS [mm] pretest = 0.23 ± 0.59; posttest = 29.2 ± 20.2; P < .001). In addition, there was a significant decrease in function (DASH pretest = 0.89 ± 1.1; posttest = 22.3 ± 12.9; P < .001). High levels of catastrophizing were correlated to elevated levels of night pain experienced on the first night (r = 0.60, P = .03). Also, high levels of catastrophizing were correlated to high levels of self-reported fatigue on the third morning fol-
lowing exercise ($r = 0.57$, $P = .04$). In addition, there was a trend toward a relationship between fear of pain and self-reported fatigue on day 3 ($r = 0.48$, $P = .098$). No significant relationship was noted between kinesiophobia and any of the self-report measures ($P = .425–.239$).

**Discussion:** DOMS was successfully induced in all participants. Elevated catastrophizing and fear of pain are related to elevated levels of pain and fatigue.

**Importance:** These preliminary findings suggest that a relationship between fear avoidance, pain, and fatigue may be relevant for athletes who are injured and receiving rehabilitation.

**Steps Toward the Validation of the Trendelenburg Test: The Effect of Experimentally Reduced Hip Abductor Muscle Function on Frontal Plane Mechanics**

Kendall KD, Patel C, Wiley JP, Pohl MB, Ferber R, University of Calgary, Calgary, Alberta, Canada; Emery CA, University of Kentucky, Lexington, Kentucky

**Introduction:** The Trendelenburg Test (TT) is used to assess the functional strength of the hip abductor muscles (HABD), their ability to control frontal plane motion of the pelvis, and the ability of the lumbopelvic complex to transfer load into single-leg stance.

**Rationale:** Although a standard method to perform the test has been described for use within clinical populations, no study has directly investigated Trendelenburg’s hypotheses. Our purpose was to investigate the validity of the TT using an ultrasound-guided nerve block (UNB) of the superior gluteal nerve and determine whether the reduction in HABD strength would result in the theorized mechanical compensatory strategies measured during the TT.

**Methods:** Quasi-experimental design using a convenience sample of 9 healthy male participants. Only participants with no current or previous injury to the lumbar spine, pelvis, or lower extremities and no previous surgeries were included. Force dynamometry was used to evaluate HABD strength (% BW). Two-dimensional mechanics were used to evaluate contralateral pelvic drop (cPD), change in contralateral pelvic drop ($\Delta$cPD), ipsilateral hip adduction (iHADD) and ipsilateral trunk sway (TRUNK) measured in degrees ($^\circ$). All measures were collected prior to and following a UNB on the superior gluteal nerve performed by an interventional radiologist.

**Results:** Participants’ median age was 31 years (interquartile range [IQR] = 22–32 years); and median weight was 73 kg (IQR = 67–81 kg). An average 52% reduction of HABD strength ($z = 2.36$, $P = .02$) resulted following the UNB. No differences were found in cPD or $\Delta$cPD ($z = 0.01$, $P = .99$; $z = –0.67$, $P = .49$, respectively). Individual changes in biomechanics show no consistency between participants and nonsystematic changes across the group. One participant demonstrated the mechanical compensations described by Trendelenburg.

**Discussion:** The TT should not be used as a screening measure for HABD strength in populations demonstrating strength greater than 30% BW but reserved for use with populations with marked HABD weakness.

**Importance:** This study presents data regarding a critical level of HABD strength required to support the pelvis during the TT.

**Assessment of Muscle Activation Between Genders During a Drop Jump Task With an External Motivator**

Lattimer LJ, Lakehead University, Thunder Bay, Ontario, Canada; Gage MJ, Demchak TJ, Dominguese DJ, Indiana State University, Terre Haute, Indiana

**Introduction:** Females are 6–8 times more likely to suffer a noncontact ACL injury than males competing in the same activities. Noncontact ACL injuries are common in sports that involve jumping, cutting, rapid deceleration, or quick changes in direction. Literature is limited on prelanding and postlanding muscle activation between genders during a functional drop jump followed by another task (external motivator).

**Rationale:** The purpose of this study was to examine muscle activation prelanding and postlanding between genders during a functional drop jump with an external motivator (target height).

**Methods:** Drop jump landings with an external motivator were performed from a 30-cm box onto a force platform followed by an immediate jump to reach for the target height on the external motivator that was placed at a 40° angle (anterior–lateral direction) from the force platform. The target height was 75% of the participants’ maximal single-leg vertical jump. The dependent variable was muscle activation. Muscle activation was measured using the Myomonitor IV (Delsys,
**ABSTRACTS**

**Methods:** Single group repeated measures. University laboratory and practice facility. Twenty-two healthy male football players (age = 21.7 ± 1.7 years, weight = 99.2 ± 18.8 kg, height = 184.0 ± 5.8 cm). Participants wore a wrist accelerometer, the Actiwatch Score (AS) (Philips Respironics, Andover, Massachusetts), during 5 days in the preseason and the in-season, with the last recording being the night before a game. All athletes also completed a self-report measures sleep diary before bedtime and upon awakening. Performance measures were recorded at the end of 5 days during the off-season and on the morning of game day during the in-season. Sleep efficiency (SE), a measure of overall sleep quality, and total sleep time (TST) were calculated using wake-quiet activity from the AS. The performance testing completed by participants in the off-season and the in-season included reaction time, handgrip strength, vertical jump, and the agility test. We used repeated measures ANOVAs to compare the 5 nights of SE and TST between both seasons. Paired sample t tests were used to analyze performance measures between off-season and in-season (α = .05).

**Results:** There was no significant change in SE between off-season and in-season (71.2% ± 7.9% and 73.3% ± 8.1%, f = 1.4, P = .909). A trend toward an increase in in-season TST (349.5 ± 45.9 minutes and 370.0 ± 43.41 minutes, t = –1.73, P = .097) was seen. There were no significant changes in performance measures between off-season and in-season (P = .952 to .105).

**Discussion:** There was no significant change in SE between off-season and in-season in university football players. However, the approximate 71% average of SE is alarmingly low. Previous studies have indicated a SE of 80% or below in significantly overtrained athletes, individuals with cystic fibrosis, and women with postpartum depression. The rigid student-athletes’ schedule may contribute to poor sleep.

**Importance:** Considering the amount of attention and resources that are spent on coaching, training, and nutrition in football, sleep quality is an area of interest. Future studies are needed to examine sleep in football because improved sleep can help with recovery and performance.

compiled and edited by Richard DeMont, Phd, CAT(C), ATC Concordia University, Montréal, Quebec, Canada

The author has no financial or proprietary interest in the materials presented herein.

doi:10.3928/19425864-20120427-03

Boston, Massachusetts). Mean and peak normalized muscle activation of the transverse abdominus and internal oblique (TrA/IO), rectus abdominus (RA), vastus lateralis (VL), biceps femoris (BF), and gluteus medius (GMed) were assessed. Muscle activation was assessed before (100 ms) and after (250 ms) initial contact. Maximal voluntary contractions were used to normalize muscle activation data. Independent t tests were used to compare differences in muscle activation between gender (pre-initial contact and post-initial contact).

**Results:** Fourteen males (22 ± 3 years, 78.8 ± 7.6 kg, 78.5 ± 4.8 cm) and 14 females (22 ± 2 years, 66.7 ± 7.8 kg, 65.0 ± 5.2 cm) were matched according to gender and leg dominance. No differences were observed in mean (TrA/IO: P = .184; RA: P = .894; VL: P = .985; BF: P = .973; GMed: P = .661) and peak (TrA/IO: P = .389; RA: P = .829; VL: P = .424; BF: P = .671; GMed: P = .949) muscle activation before landing. Differences were not observed in mean (TrA/IO: P = .352; RA: P = .998; VL: P = .527; BF: P = .916; GMed: P = .820) and peak (TrA/IO: P = .344; RA: P = .903; VL: P = .196; BF: P = .824; GMed: P = .674) muscle activation following initial contact.

**Discussion:** These data contradict previous research that reported gender differences in muscle activation during a functional task.

**Importance:** It appears that an external motivator may influence a patient’s muscle recruitment and may be a factor to include in injury prevention programs.

**Poor Sleep In and Out of Season May Result in No Change in Performance in University Football Players**

Onofrio MC, Dover GC
Concordia University, Montréal, Quebec, Canada

**Introduction:** Athletes require sleep to recover and to perform well physically. Poor sleep quality leads to a decrease in performance and cognitive function. Information regarding change in sleep in football players from off-season to in-season and its correlation to performance is lacking. We hypothesized that starting football players would not sleep as well the night before a game, affecting their performance on game day.

**Rationale:** To objectively measure athletes’ sleep and performance over a 5-day period in off-season and in-season leading up to a regular season game.

Compiled and edited by Richard DeMont, Phd, CAT(C), ATC Concordia University, Montréal, Quebec, Canada

The author has no financial or proprietary interest in the materials presented herein.

doi:10.3928/19425864-20120427-03