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## Health Services Utilization and Cost for an Innovative Model of Care for Knee Injuries: The Calgary Acute Knee Injury Clinic

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**Introduction:** Musculoskeletal (MSK) disorders affect a large proportion of the Canadian population and are a leading cause of illness and disability with 15.5 million visits made to ambulatory physicians annually. The current Canadian health care system depicts a clinical care pathway for MSK disorders that is inefficient, ineffective, and plagued by (1) too many patients; (2) deficiencies in the number of health care providers, services, and infrastructure; and (3) mismanagement of patients. Therefore, a new interdisciplinary team-based model of care for managing acute knee injuries was developed, the Acute Knee Injury Clinic (AKIC).

**Rationale:** The goal of this study was to evaluate and report on the appropriateness, efficiency, and effectiveness of the AKIC through health services utilization and costs associated with acute knee injuries.

**Methods:** This quasi-experimental study evaluated the efficiency, effectiveness, and safety of the AKIC for patients presenting with acute knee injuries and receiving care from 2 clinical care pathways: the AKIC (ie, experimental group) and the existing care pathway (ie, comparison group). Therefore, health care utilization and cost for patients receiving care through the AKIC were measured; health care utilization and cost for patients receiving care through the existing care pathway was measured; the distribution of utilization across provincial cost variables was determined; and total utilization and cost of patients receiving care in both pathways were compared. Data were collected using a Healthcare Access and Patient Satisfaction Questionnaire (HAPSQ).

**Results:** Analysis was performed on data obtained from 138 questionnaires in the experimental group and 136 in the comparison group. Overall, patients receiving care through the AKIC used significantly fewer resources and incurred 37% of the costs when compared with patients in the comparison group. Specifically, the total aggregate average cost for the AKIC group was \$2,549.59 compared with \$6,954.33 for the comparison group ( $P < .001$ ). A post hoc analysis did not determine significant differences between groups with respect to sociodemographic characteristics.

**Discussion:** Results evaluating the AKIC model of care demonstrated a unique and efficient approach to managing acute knee injuries in an urban setting. Overall, the AKIC was able to manage and treat patients with knee injuries using fewer resources and for less cost than the current state of health care delivery.

**Importance:** The AKIC is an appropriate, efficient, and effective model of clinical care for evaluating, managing, and treating acute knee injuries.

## Knee Bracing After Anterior Cruciate Ligament Reconstruction: An Evidence-Based Clinical Review

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**Introduction:** Range of motion (ROM)-limiting rehabilitation braces have traditionally been prescribed to patients immediately after surgery to protect the graft and reduce complications in regaining full knee extension. The use of these braces still remains controversial. Functional braces in later stages of rehabilitation and when returning to play have gained popularity in recent years despite little evidence to suggest they are advantageous compared with not wearing knee braces. Functional knee braces are thought to improve performance and reduce the risk of re-injury. In a clinical setting, surgeons frequently prescribe knee braces of different varieties and many patients inquire about whether or not they should be wearing a brace.

**Rationale:** This evidence-based review is designed to investigate the effect of both rehabilitation braces and functional braces on treatment outcomes, performance, and rates of re-injury.

**Methods:** Web of Science, Cochrane Library, and Medline databases accessed through York University Libraries were the primary outlets for finding relevant literature. Appropriate articles were limited to those available in full-text online and written or translated into the English language. Articles involving testing knee braces on healthy subjects and those about ACL-deficient knees rather than ACL-reconstructed (ACLr) knees were omitted from review.

**Results:** Overall, subjects who wore braces that restricted ROM did not have superior outcomes than those subjects who did not wear a knee brace. Only 2 studies found marginal benefits on subjective measures with functional braces at specific intervals of postoperative rehabilitation; however, no differences were found on these same measures at 2 years of follow up. One study showed a lower rate of knee injuries in skiers who wore a functional knee brace. Functional braces were related to improvements in lower limb kinematics during walking, jogging, and descending stairs.

**Discussion:** This evidence-based guideline disputes the use of ROM-limiting knee braces during early postoperative ACLr rehabilitation. This guideline supports the use of functional knee braces on an individual basis during later stages of postoperative rehabilitation and return to play due to the psychological benefits and the

potential positive role knee braces have on lower-limb kinematics; however, they are not necessarily recommended for the intent of reducing the risk of re-injury or improving performance.

**Importance:** The importance of this evidence-based review of the greater body of literature is to comprehensively evaluate the necessity of rehabilitation and functional knee braces after ACLr and to assist in accurately advising a patient whether he or she should wear a knee brace.

## An Online Tool to Help Evaluate Student Experiences at Athletic Therapy Field Internships

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**Introduction:** An online database was established in the fall of 2011 to assess the different experiences that undergraduate athletic therapy students have at their internship placements. The information collected in the database will enable us evaluate whether the appropriate amount of classroom and laboratory preparation is being delivered to students in advance of their placement.

**Rationale:** To quantify the incidence of the injury and the management of the injury by undergraduate athletic therapy students at internship placements.

**Methods:** Students reviewed and signed a consent form indicating that information from the online questionnaire could be used as part of a research project. The online questionnaire was completed for each injury seen by the internship student. Data were collected on injury rates, the involvement of the student in managing the injury, and the student's preparation and impressions of the injury being reported.

**Results:** A total of 2,094 injures were entered into the database by 93 students during a 16-month period. Lower extremity injuries made up 56% of all injures recorded. Head injuries, mostly concussions, comprised 12% of the responses for all injures recorded. Injuries occurred during practice sessions 35% of the time and during game situations 65% of the time. Less than 20% of the injuries occurred at the beginning of the activity, whereas 76% of the time the injury occurred during the middle or end of the activity. The student therapist was able to assess the majority (75%) of the injuries within the first 5 minutes from the time the injury occurred. Injuries were reassessed by certified athletic therapists, a physical therapist, a physician, and an emergency medical technician, via imaging or a more experienced student therapist 67% of the time. Students indicated that 36% of the time they managed all aspects of the injury when it occurred, whereas 11% of the time they observed someone else manage the injury. Students responded that the skills they used to manage the injury situation were taught to them in a classroom or in the laboratory setting 90% of the time, whereas 4.5% of the time they had received only minimal training on the skills required to handle the injury situation.

**Discussion:** To date, the database has been shown to be an effective tool to help the internship coordinator gain a better understanding of student activity at field internship placements. The information obtained from this project will be filtered back to the faculty and staff in the department so the athletic therapy program can adjust to the demands on the athletic therapy students.

**Importance:** The database provides important information for the department regarding the experiences of the internship students at their field placements.

## Altered Trapezius Activity in Computer Workers Suffering From Neck Pain During Three Different Simulated Computer Tasks

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**Introduction:** Shoulder and neck musculoskeletal disorders in computer and office workers are a significant problem. A low, constant level of muscle activity in the upper trapezius has been suggested as the cause of the pain, but this activity has not been measured across all fibers of the trapezius.

**Rationale:** To compare muscle activity across the trapezius in computer users during 3 different simulated computer tasks.

**Methods:** One group; repeated measures design. All testing occurred at the participants' workstation in the same postural position as when they work. Seven female university office workers with a history of neck and shoulder pain volunteered for the study (height =  $164.6 \pm 4.6$  cm, mass =  $70.8 \pm 6.6$  kg, age =  $44.7 \pm 8.1$  years). Inclusion criteria included neck and shoulder pain for more than 6 months and computer work for more than 4 hours per day. EMG muscle activity was measured at 5 locations of the trapezius muscle: neck, 2 on the upper trapezius, middle trapezius, and lower trapezius. Muscle activity was measured bilaterally for a total of 10 electrodes. Reference contractions were performed at rest and during mild resistance for the neck, upper trapezii, and middle and lower trapezii. Each contraction was repeated twice and held for 10 seconds. All participants completed 3 randomized, 10-minute computer tasks: typing, mousing, and typing and mousing combined. One  $3 \times 2 \times 5$  ANOVA was used to identify differences in overall muscle activity during the tasks. In addition, separate  $3 \times 2$  ANOVAs were used to identify differences in specific muscles between tasks  $\alpha = .05$ . The raw data were reduced and normalized and relative rest time (RRT) was determined by normalizing the muscle activity during the task compared with the reference contractions.

**Results:** The RRT was significantly lower during typing and typing-mousing compared with mousing (typing = 48.1%; mousing = 74.3%; typing-mousing = 45.8%;  $P < .001$ ). There was a significant task  $\times$  side interaction for the upper trapezius muscle in both locations (typing = 3.4%; mousing = 32.1%; typing-mousing = 4.7%;  $P = .029$ ; and typing = 9.1%; mousing = 36.6%;

typing–mousing = 4.4%;  $P = .022$ , respectively). In addition, there was a trend toward higher muscle activity in the neck location.

**Discussion:** Subjects with neck and shoulder pain have higher upper trapezius activity during typing and typing–mousing activity compared with mousing alone.

**Importance:** Office or computer workers with neck and shoulder pain should attempt more mousing activities compared with typing to reduce muscle activity and pain.

## Comparing Incidences of Severe Injury by Sex, Sport, and Segment of Season in Collegiate-Level Athletes: A Retrospective Cohort Design

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**Introduction:** To our knowledge, there is a lack of research on the absolute sex differences of injury severity across a variety of sports at the collegiate level. Furthermore, no studies have related injury severity to the time of season.

**Rationale:** To investigate whether there are differences in the severity of injuries, comparing injury severity between sexes, sport teams, and segments of the competitive season. A supplementary analysis of concussion rates for the same 3 variables is also included.

**Methods:** There were 1657 injuries recorded in this study. Participants were student athletes of a York University varsity sport team and were treated for their injuries at the Gorman-Shore Sport Injury Clinic at York University between August 1, 2008 and July 31, 2012. Injuries were categorized into severe injuries and non-severe injuries. Time of season that the injury occurred was determined for each respective team and subsequently divided into pre-season, regular season, and postseason.

**Results:** Overall, men in our sample were injured more than women (men,  $n = 1155$ ; women,  $n = 502$ ). However, women were 1.4 times more likely to experience a severe injury compared with men ( $P = .020$ ; 95% CI, 1.053–1.863). Women had a higher percentage of severe injuries in all sports, except volleyball. Only the comparison between men’s football and women’s rugby had significant results ( $P = .048$ ). No significant differences were found between incidence of severe injury and season ( $P = .128$ ). Eleven percent of all female injuries were concussions, significantly more than that among men (6.2%,  $P = .001$ ). Logistic regression showed that women were 1.9 times more likely than men in our sample to sustain a concussion than any other injury ( $P = .001$ ; 95% CI, 1.281–2.674). More than half of all concussions occurred during the regular season (55.9%). Significantly more concussions than any other injury or any other severe injury occurred during the regular season than the postseason ( $P = .007$  and  $P = .021$ , respectively).

**Discussion:** Women are at an increased risk for incurring a severe injury in varsity sport. Men typically had higher frequencies of injury, but women had higher proportions of severe injuries when looking

at sex-matched sports. Concussions accounted for approximately half of all severe injuries, with women incurring more concussions than men. Season did not have an effect on incidence of injury.

**Importance:** These findings suggest that qualified health care professionals, such as certified athletic therapists/trainers, should be employed in university and college varsity settings for the proper prevention and treatment of sport-related injuries, especially with female teams.

## Whole-Body Vibration Effect on the Height of the Navicular Tuberosity

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**Introduction:** Whole-body vibration (WBV) platforms have been used widely to benefit a variety of physiological measures. However, none of the studies using WBV have measured the effect of the vibration on the foot and the navicular height.

**Rationale:** To determine the height of the navicular tuberosity from the ground following exposure to WBV. Our hypothesis was that the navicular height would decrease following vibration. Analysis of the effects of WBV on the navicular height and arch of the foot could provide useful information for people with any foot-related conditions.

**Methods:** We performed a repeated measures design in an engineering and biomechanics research laboratory. Data were collected from 30 healthy, young female (age,  $21.7 \pm 3.1$  years, height,  $65.7 \pm 3.1$  inches, weight,  $137.3 \pm 19.8$  pounds) volunteers. Participants performed a 1-legged squat at  $40^\circ$  of knee flexion under 4 different parameters on an oscillating WBV platform (VibraFlex 600, Florida Orthometrix, Inc, Naples, Florida). Trials were performed barefoot and wearing shoes and separated by 5 minutes of rest before being repeated within subjects. Participants were exposed to four 15-second bouts of vibration consisting of 2 displacements (2 and 4 mm) and 2 vibration frequencies (15 and 30 Hz). Trials were presented in a counterbalanced order. Using a ruler, the navicular height was measured from the ground previbration (PreV), between conditions (BtwV), and postvibration (PostV). Arch height from the ground based on navicular tuberosity (mm) was collected on the dominant foot. A repeated measures ANOVA was used to compare the changes in the height following exposure to vibration.

**Results:** The navicular height from the ground was decreased by exposure to WBV. The navicular height PreV ( $40.82 \pm 5.38$ ) was significantly ( $F = 8.7$ ,  $P = .005$ ) higher than the height BtwV ( $40.2 \pm 5.13$ ). The navicular height BtwV ( $40.2 \pm 5.13$ ) was significantly ( $F = 5.796$ ,  $P = .019$ ) higher than the navicular height PostV ( $39.83 \pm 5.46$ ). The navicular height PreV ( $40.82 \pm 5.38$ ) was significantly ( $F = 16.78$ ,  $P < .001$ ) higher than the navicular height PostV ( $39.83 \pm 5.46$ ).

**Discussion:** The exposure to WBV does affect the navicular height from the ground. Although the mean difference is statisti-

cally significant, the clinical significance of a 1-mm variation in navicular height is questionable. These results warrant further investigation and exposure to WBV for a longer period to establish whether the arch would drop further than 1 mm.

**Importance:** The drop of the navicular postWBV could be of importance for orthotics makers and for rehabilitation of tibialis posterior-related issues.

## Two Focal Chondral Lesions in a Tug-of-War Athlete: A Case Report

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**Objective:** The purpose of this article is to present the unique case of a 38-year-old male tug-of-war athlete who underwent microfracture surgery for 2 acute focal chondral lesions in his left knee.

**Background:** Due to the high impact and rotational forces on the knee during tug-of-war competition, athletes are at risk for noncontractile tissue knee injuries, such as focal articular cartilage lesions. Articular cartilage injuries may present themselves similarly to ligamentous injuries.

**Differential Diagnosis:** Medial collateral ligament sprain, anterior cruciate ligament (ACL) sprain, fracture of the femoral condyle or tibial condyle, meniscus tear, chondral lesion.

**Treatment:** Following competition, the athlete made an appointment with an athletic therapist, who treated the patient as if he sustained an ACL rupture prior to imaging diagnostics. Following the diagnostic imaging, which showed a meniscus tear and partial ACL tear, the athlete scheduled a debridement of the medial meniscus. During the procedure, the surgeon found a chondral lesion on the medial tibial condyle and on the medial femoral trochlea. He decided to complete microfracture immediately without patient consent. The athlete completed a rigorous rehabilitation protocol set by the surgeon and athletic therapist. The goals were to regain full range of motion (ROM) and strength while ensuring proper healing of the lesion.

**Uniqueness:** Magnetic resonance imaging (MRI) showed a meniscus tear and partial ACL sprain following a left knee injury. The athlete had surgery for a debridement of the medial meniscus. The surgeon found 2 chondral lesions. The surgeon completed microfracture surgery on the 2 lesions, measuring  $10 \times 13$  mm and  $14 \times 16$  mm, respectively. There have been no previously documented reports of microfracture surgery on 2 chondral lesions; therefore, there was no precedent for prognosis. The rehabilitation consisted of 8 weeks instead of the typical 6 weeks of nonweight bearing, with no active contractions of the quadriceps.

**Conclusions:** Participation in sport can expose an athlete to articular cartilage lesions due to the compressive, shear, and tensile forces placed on the knee joint. Articular cartilage lesion requires surgical repair due to its inability to heal. When considering microfracture surgery, a surgeon must also consider a number of factors,

including age, activity level, and size of lesions. An athletic therapist must understand the phases of healing of injured tissue to appropriately return the athlete to sport or activities of daily living.

## Measuring Hip Strength and Power in Standing Using a Biodex Dynamometer

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**Introduction:** The ability to quantify hip neuromuscular strength and power in young people may aid in identifying deficiencies that increase the risk of injury. It is important to measure these variables in a functional and meaningful way. The Biodex Dynamometer (Biodex Medical Systems, Shirley, New York) is used in clinical and research environments and has the ability to measure both hip strength and power.

**Rationale:** However, the standard set up for hip testing, as described in the Biodex operational manual, involves the participant lying on his or her side (hip abduction/adduction) or supine (hip extension/flexion). Our purpose was to test the hip using the Biodex in a standing position, which may be a more functional alternative.

**Methods:** Fifty-two male and female athletes between the ages of 10 and 14 years were randomly recruited from local sports teams and tested using a standing hip protocol. Hip flexion, extension, abduction, and adduction movements were tested using the isometric, isotonic, and isokinetic modes on the dynamometer. Participants ranged from 131 to 173 cm in height and 26.5 to 81.5 kg in weight, which necessitated the use of a variety of configurations.

**Results:** All athletes were successfully tested and they did not have difficulty understanding the testing procedure. No athletes were deemed ineligible for the study because their stature was incongruous with the testing equipment.

**Discussion:** The hip strength and power of young athletes can be measured in a functional position using a standing protocol with a Biodex Dynamometer. The next step is to establish the reliability of these measurements in a young athletic population.

**Importance:** The standing hip test protocol used in this study was adaptable, required a minimal amount of extraneous equipment, and may be a viable alternative for therapists in testing the neuromuscular properties of the hip.

## Development of Alternative Testlets for the Standardized Assessment of Concussion Memory Sections

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**Introduction:** Sport-related concussions continue to be investigated because of the lack of evidence supporting many diagnostic and treatment protocols. Several concussive evaluation tools have

been developed for medical personnel to use, including the Standardized Assessment of Concussion (SAC). The SAC is used to provide medical personnel with baseline and post-injury measures of neurocognitive function. Previous research has demonstrated that the memory sections of the SAC lack psychometric validity and reliability.

**Rationale:** The purpose of this study is to improve the reliability of the immediate and delayed memory sections of the SAC using classic item analysis.

**Methods:** A cross-sectional design was used. One hundred fifty participants (male,  $n = 53$ ; female,  $n = 97$ ; age = 18 to 30 years, mean age = 20.89 years) with no history of head injury in the previous 6 months volunteered for this study. Researchers composed 3 new testlets, with 2 lists having 8 items (words) and 1 list using 10 items to replace the original memory sections of the SAC. The items were selected from a dictionary to be more difficult by increasing word length, assuring no intrinsic relationship between the items, and avoiding rhyming patterns. Item difficulty, item discrimination, and item determination were used to assess the psychometric properties of the new items on the alternative testlets. Item difficulty and item discrimination thresholds were set at  $(.10 \geq P \leq .92)$  and  $P \geq .10$ , respectively. Items that fell within ranges were considered acceptable.

**Results:** Overall, 21 (81%) of the 26 items in the immediate memory recall and 16 (62%) of the 26 items of the delayed memory recall were determined acceptable. For item difficulty, the immediate memory section found 1 (4%) of the items to be unacceptable, and delayed memory section found 3 (12%) unacceptable items. An item discrimination analysis of the immediate memory section showed 4 (15%) of the items to be unacceptable and delayed memory identified 6 (23%) unacceptable items.

**Discussion:** The results showed that the alternative version increased the reliability of the SAC. The memory sections should have more items per testlet, with multiple testlets used.

**Importance:** The increased reliability of the SAC assessment tool leads to an improved ability to diagnose and evaluate concussions.

## Improvement of Function and Depression Without a Change in Pain After Completion of a Chronic Pain Management Program

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**Introduction:** Chronic pain is a costly and debilitating condition affecting quality of life and function. However, pain-related fear may explain the development chronic pain from acute pain. Previous studies on successful programs have reported improvements in physical functioning and psychological factors with little changes in pain.

**Rationale:** To measure the efficacy of a Canadian chronic pain program on pain, pain-related fear, depression, and function.

**Methods:** A pre–posttest design was performed at a rehabilitation research center on 68 patients who were diagnosed with chronic pain for a minimum of 1 year prior to treatment. At the beginning of a 9-week intensive interdisciplinary program, all participants filled out 5 questionnaires and performed a 6-minute walk test. Patients performed the 6-minute walk test by walking as far as they could at a fast but comfortable pace. Following the initial evaluations, patients started the program, which included techniques to manage pain, relaxation strategies, and physical activity sessions. After completion of the program, patients completed the questionnaires and the 6-minute walk test again. The Pain Catastrophizing Scale (PCS) is a measure of catastrophizing, and the Tampa Scale of Kinesiophobia (TSK) questionnaire measures fear of movement. The McGill Pain Scale measures the patient’s pain level. The Pain Disability Index (PDI) measures the self-reported physical functioning and how much pain affects the patient’s ability to manage everyday activities, and the PHQ-9 measures depression. The 6-minute walk test is an objective measurement of the patient’s physical activity. Dependent *t* tests were performed to compare initial and final results of all questionnaires and the 6-minute walk test. Results were considered significant at  $P < .05$ .

**Results:** There were significant decreases in pain-related fear and depression, including the TSK, PCS, and PHQ-9 (TSK =  $41.4 \pm 9.8$  and  $36.7 \pm 10.0$ , and PCS =  $27.4 \pm 11.9$  and  $19.7 \pm 12.6$ , PHQ-9 =  $14.2 \pm 5.8$  and  $10.5 \pm 5.7$ , respectively;  $P < .001$  for all). In addition, there was a significant increase in self-reported function and walking (PDI =  $40.4 \pm 11.4$  and  $29.3 \pm 14.9$ , and  $364.9 \pm 106.5$  and  $417.9 \pm 102.6$ , respectively;  $P = .000$  for all). There were no significant changes in pain ( $35.7 \pm 14.1$  and  $35.9 \pm 16.3$ , respectively,  $P = .932$ ).

**Discussion:** On completion of the program, there were significant improvements in function and depression without a change in pain.

**Importance:** The results of the study suggest that pain-related fear may be more important than pain itself. Chronic pain programs may be advised to treat pain-related fear more than treating pain to see better improvement in their patients.

## Preseason Screening to Identify Predictive Factors for Concussion in Varsity Athletes in Contact and Collision Sports

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**Introduction:** The National Collegiate Athletic Association (NCAA) reported that 1.9 concussions occurred per 1000 player-hours during fall sports in 2011. Increased awareness and sensitivity to concussions by athletes, coaches, and medical personnel has improved in recent years.

**Rationale:** Preparticipation screening, including administration of questionnaires and baseline concussion testing, can be done at the start of the competitive season and may help identify athletes at greater risk for incurring future concussion. In studies to date, the only demonstrated predictive risk factor is a history of previous concussion. What about athletes who have not had a previous concussion? Are there other elements that can be identified in the preseason that might potentially be modifiable?

**Methods:** Varsity athletes in contact and collision sports (hockey, football, rugby, soccer, basketball, and wrestling) completed pre-season questionnaires and baseline concussion screening using both SCAT2 and ImPACT (ImPACT Applications Inc, Pittsburgh, Pennsylvania) over 3 successive seasons, from 2010-2011 through 2012-2013. Included were 356 athletes (218 men, 138 women), with a mean age of 20.02 years (range = 16 to 28 years).

**Results:** During a 2.5-year period, 42 (11.8%) of the athletes experienced a concussion. Male athletes sustained 30 of these concussions and female athletes 12 concussions, with respective incidence rates of 13.7% and 8.7%, respectively. In the men, 3 concussions occurred in hockey, 26 in football, and 1 in soccer. Women's hockey accounted for 5 concussions and women's rugby for 7 concussions. Multiple concussions were recorded in 3 men and 1 woman, none during the same season. Despite this latter finding, a Pearson chi-square test comparing concussed athletes with and without a history of previous concussion was not statistically significant for any increased risk.

**Discussion:** The number of varsity athletes in contact and collision sports experiencing concussions may be higher than expected. Although previous research has suggested that athletes with a history of previous concussion are more susceptible to future concussions, this predictive factor was not significant in our study.

**Importance:** Further research on preparticipation evaluations is needed to look for other potentially predictive risk factors for concussion; this would allow medical personnel to educate athletes and coaches on the importance of this injury and possible preventative measures. In addition, an individual athlete who experiences a concussion during the season may benefit from special attention, such as neck-strengthening exercises, technique changes, or visual or vestibular retraining to prevent a recurrence, either during the same season or in the next one.

## Student Athletes Have Poorer Sleep Compared With Students at the Same University

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**Introduction:** Sleep is important for athletes and students because it can affect their athletic and academic performance.

**Rationale:** There is a paucity of information on objective sleep measures in athletes. The rationale was to compare subjective and ob-

jective sleep measures of student athletes and students enrolled at the same university.

**Methods:** Two groups, repeated measures design was used. All sleep measurements occurred at each subject's residence. Thirteen healthy students from the university population (5 men and 8 women; height, 171.9 ± 9.1 cm; mass, 69.5 ± 9.2 kg; age, 21.3 ± 1.9 years) and 36 healthy male athletes from the university population (12 hockey players, 24 football players; height, 183.3 ± 5.8 cm; mass, 95.2 ± 17.7 kg; age, 21.3 ± 1.9 years) volunteered for this study. All subjects completed a self-report evaluation on sleep, including the SF-12, Pittsburgh Sleep Quality Index (PSQI), Epworth Sleepiness Scale (ESS), and received the Pittsburgh sleep diary and Actiwatch Score (Actiware and Actiware CT; Respironics, Inc, Murrysville, Pennsylvania). All athletes wore the Actiwatch Score during a 5-day period in the competitive season, and students wore the Actiwatch Score during the semester. Both groups completed the sleep diary every night before going to bed and every morning on awakening, recording bed and wake times and subjective sleep information. One-way ANOVAs and paired sample *t* tests were used to analyze sleep efficiency (SE); total sleep time (TST); wake after sleep onset (WASO); and sleep quality, fatigue, and alertness upon awakening ( $\alpha = .05$ ).

**Results:** There was a significant difference between athletes and students for sleep efficiency and WASO (athletes, SE = 79.3% ± 5.9; students, SE = 88.2% ± 3.0;  $P < .001$ ). In addition, athletes had a higher ESS score compared with students, indicating they have more daytime sleepiness. Moreover, there was a significant difference in wake time and wake-time variability between some athletes and students.

**Discussion:** Athletes have poorer sleep compared with students at the same university. For example, football players had a significantly later wake time compared with students (09:18 AM versus 08:00 AM) and varied from 06:36 AM and 11:30 AM, which suggests that the full schedule of the student athlete might compromise his or her ability to get the proper amount of sleep.

**Importance:** Given the amount of resources spent on coaching and conditioning and because sleep affects performance, more studies are needed to study athletes' sleep.

## The Effect of an Intermittent, High-Intensity Exercise Protocol on Drop-Jump Performance

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**Introduction:** It has been observed that bouts of high-intensity, intermittent exercise lead to temporary fatigue. Fatigue has been described as a temporary, multifactorial manifestation of the effects of exercise resulting from a complex interaction between central drive, motor drive, and metabolic factors.

**Rationale:** Elements of sporting performance have been observed to decrease after high intensity, intermittent exercise. However, this decrease is not always evident in short duration, maximal effort activities. It has been suggested that athletes employ compensatory mechanisms to maximize performance. This study aims to determine the effect of a high intensity, intermittent exercise protocol on performance measurements.

**Methods:** Ten healthy, active men (age,  $25.46 \pm 2.73$  years) performed maximal effort drop jumps before and after a high-intensity, intermittent exercise protocol. One lap of the protocol involved a 10-meter forward sprint with a  $90^\circ$  change of direction followed by a backwards sprint for 5 meters (4 times). This was followed by 2-legged jumps (10 times), high-knee side stepping over 50-cm hurdles (10 times), and a lateral 5-meter shuffle (4 times). The participant was given a 30-second break before repeating the course. This was continued until the participant reported 18 on Borg's scale of perceived exertion. Heart rate and lap time were recorded using a heart rate monitor and speed gates, respectively. Drop-jump performance characteristics were measured using Vicon 3-D motion analysis and 2 AMTI force plates (AMTI, Watertown, Massachusetts).

**Results:** Paired samples *t*-test analysis demonstrated an increase in lap time ( $50.3 \pm 4.54$  versus  $55.8 \pm 4.94$  seconds) ( $P = .006$ ) and an increase in absolute ( $58.8 \pm 3.85$  bpm versus  $187 \pm 10.0$  bpm) and percentage ( $30.22\% \pm 1.99\%$  versus  $96.12\% \pm 4.84\%$ ) heart rate measurements after the high-intensity, intermittent exercise protocol ( $P < .001$ ). Repeated measures ANOVA demonstrated no change in jump height ( $23.7 \pm 4.2$  cm versus  $23.0 \pm 3.3$  cm) ( $P = .944$ ); ground contact time; ankle, hip and knee joint excursion; stiffness; and peak concentric and eccentric power ( $P > .05$ ).

**Discussion:** Despite evidence of high levels of perceived exertion, physiological effort, and reduced running performance, there was no difference in drop-jump performance or technique in the variables assessed.

**Importance:** The results of the current study suggest that there is a reserve of neuromuscular power generation for maximal efforts of short duration after high-intensity, intermittent exercise despite the existence of other demonstrations of fatigue.

## Concussion And Concurrent Cognitive and Sport-Specific Task Performance in Youth Ice Hockey Players: A Pilot Study

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**Objective:** To determine the influence of concussion on cognitive performance while completing concurrent sport-specific tasks to further inform return-to-play protocols for youth athletes.

**Design:** This descriptive case pilot study compared the performance of youth ice hockey players who had experienced a concussion in the last ice hockey season to noninjured controls.

**Setting:** Youth athletes were assessed while performing ice hockey skills in an ice hockey arena.

**Participants:** Four male youth ice hockey players who experienced a concussion during the previous ice hockey season (mean age =  $11.7 \pm 0.29$  years; mean time since injury =  $92.5 \pm 49.0$  days) and 9 noninjured control subjects (mean age =  $11.4 \pm 1.0$  years).

**Intervention:** Participants completed a randomized combination of 4 tasks (unobstructed skating, visual interference task, avoiding a fixed obstacle, stickhandling an ice hockey puck).

**Outcome Measures:** Response errors and response reaction time dual-task costs during visual interference task (modified Stroop task).

**Results:** Participants who experienced a concussion within the past ice hockey season and were  $< 58$  days postinjury demonstrated significantly poorer cognitive performance (increased dual task cost) across all conditions when performing concurrent sport-specific skills (based on 95% confidence interval).

**Conclusions:** Youth ice hockey players with a more recent concussion demonstrated greater cognitive deficits compared with controls. This study acts as an initial step toward the development of an ecologically valid, sport-specific assessment of functional performance following concussion in youth ice hockey players.

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