Female Sexual Dysfunction Following Trauma is Underreported. Many studies reporting sexual dysfunction after pelvic fracture address problems in male patients, particularly impotence; however, sexual dysfunction is reported in female patients as well. Many of the research tools used to assess outcome do not address symptoms of sexual dysfunction specific to women, and women may not feel comfortable reporting symptoms related to sexual function. For this reason, prevalence of the problem may be under-reported. Orthopaedic surgeons commonly counsel patients on sexual activity following total hip arthroplasty, but may not think to address it in post-fracture patients. Traumatic injury involving fracture is known to be disruptive to function of daily activities, but pelvic fracture, in particular, has a higher incidence of sexual dysfunction for both men and women.

Sexual dysfunction can be due to urethral injury, vascular injury, neurologic injury, and psychogenic injury. Disruption of the posterior urethra in association with pelvic fracture in men has been shown to have as high as 40-50% incidence of impotence in numerous studies. Urethral disruption in women is less common in association with pelvic fracture, but has a high incidence of vaginal injury and should raise concern for subsequent sexual dysfunction. Black et al reported on 25 female patients with urethral and bladder neck injury associated with pelvic fracture. All fractures involved the anterior pelvic ring. Twenty three involved the posterior ring as well. They found a 38% incidence of sexual dysfunction, and 43% of patients reported moderate or severe urinary tract symptoms at average follow-up of 7.3 years. Fractures of the sacrum are commonly classified with the Denis classification, and those fractures that involve the spinal canal (zone 3) have a high association with sexual dysfunction due to neurologic injury. Totterman et al. in 2006 found 38% of patients sustaining unstable sacral fractures treated surgically reported sexual impairment at 1 year. Men were more commonly affected than women (46% vs 14%) and complete saddle anesthesia was associated with 100% impairment.

Wright et al also looked at sexual and excretory dysfunction in 1,160 men and women who had sustained blunt pelvic trauma, 292 of whom had pelvic fracture. Twenty-one percent of those with pelvic fracture reported sexual dysfunction versus 14% of those without pelvic fracture. In men, sacroiliac fractures were associated with sexual and excretory dysfunction. In women, symphyseal diastasis was associated with sexual and excretory dysfunction. Baessler et al. assessed pelvic floor dysfunction specifically in women following pelvic fracture. They noted sexual dysfunction in 7 of 17 women who were sexually active at 1 year post-injury. Sixteen of 24 patients reported some symptoms of pelvic floor dysfunction (urinary, fecal, or sexual difficulties), most reporting more than 1 symptom. No patients had sustained direct injury to the bladder, vagina or rectum. Copeland et al. studied trauma and pelvic fracture on female genitourinary, sexual and reproductive function. They found no difference in miscarriage rate between multi-trauma patients with and without pelvic fracture. Cesarean section rate was statistically significantly increased post-injury in subjects compared to controls, particularly those with greater initial fracture displacement (> = 5mm). Dyspareunia also occurred more frequently in subjects with displaced fractures (> = 5mm) compared to non-displaced fractures.

Cannada also looked at pelvic fracture in women of childbearing age. Forty-nine percent (35/71) of their patient population reported genitourinary complaints and 38% noted pain with intercourse. Forty-five percent answered affirmatively to decreased interest in intercourse and decreased orgasm frequency after the injury. The survey used questions specific to female sexual function. Twenty-six patients had children after their pelvic fracture, 38% by vaginal delivery and 62% by cesarean section. Four of ten who delivered vaginally had undergone surgical fixation (symphyseal sparing).

It is important to remember that major trauma of any kind also has a high association of sexual dysfunction. Sorensen et al reported on results from the National Study on Costs and Outcomes of Trauma, looking at patients who sustained moderate to severe trauma. They evaluated sexual function using the Functional Capacity Index at 1 year post-injury and found 30.3% reported some degree of sexual dysfunction, with the majority reporting severe dysfunction. Independent predictors specifically related to the trauma included increasing ISS, pelvic fracture, lower extremity fracture, and spinal cord injury. In this patient cohort, the risk of sexual dysfunction in women was as likely as that in men.

Sexual dysfunction is a common complication of pelvic fracture and lower extremity fracture, in general. Men and women are differently affected by various injury patterns, with anterior pelvic ring injuries posing a greater risk for sexual dysfunction in women. As the treating orthopaedic surgeon, it is important to educate your patient on appropriate timing to return to sexual activity. Once released to full activity, be sure to follow up with both men and women to be certain they have full recovery of their sexual function as well as musculoskeletal function. It’s possible that sexual dysfunction in women sustaining severe trauma is under-reported due to the outcome measures currently used.

A Female Sexual Function Index tool is available at http://www.fsiqquestionnaire.com. It can be self-administered or administered with the assistance of a nurse, with referral to specialist as needed. Most importantly, remember to ask about sexual function in your female trauma patients to ensure their return to the fullest function possible.
There are no published reports associating sexual dimorphism in high-energy skeletal trauma or multiply injured patients who have incurred specifically orthopaedic injuries with outcome. The general trauma and critical care literature, however, has determined differences in outcome following blunt trauma relative to patient sex. Multiple studies have demonstrated an advantage in survival in females following trauma-hemorrhage in animal models. These differences are likely related to hormonal differences and affect immune-modulating mechanism that may play a role in the development of sepsis and/or multi-organ failure following trauma.

Evidence of hormonal response and effect following trauma in humans has been less circumscribed. In a retrospective review of 15,170 trauma patients over a five-year period, although Injury Severity Score (ISS), age, and mechanism were shown by regression analysis to be associated with survival, female sex did not infer advantage to survival.

In a review of complication and mortality rates in 681,730 adults who were the victims of trauma, were recorded in the National Trauma Data Bank, and who were admitted for >3 days, females demonstrated decreased odds of developing pneumonia, acute respiratory distress syndrome, acute renal failure, and pulmonary embolism (OR 0.79, 95% CI 0.76-0.83). When females did develop life-threatening complications, however, they were more likely than males to die from these complications.

Probst et al evaluated outcome 10+ years following trauma in 937 polytrauma patients. Although the same rate of women and men felt rehabilitated physically (75.3% vs 75.4%), women showed higher rates of post-traumatic stress disorder, lower quality of life scores, and longer sick leave time.

Sexual Dysfunction and Polytrauma References:
Sexual Dimorphism in Orthopaedic Oncology

As with many translational and clinical studies, research in orthopaedic oncology is often not stratified by subject sex. Therefore, results on male and female subjects/patients are generally interpreted together, or studies on male populations are extrapolated in practice to females. There are some identified differences in tumor epidemiology and treatment response based on sex; however, the explanation for these differences is not understood. With unknowns such as these present, the management of musculoskeletal tumors is lacking important consideration of sex.

Is there a sex difference in incidence? The Surveillance Epidemiology and End Results database, maintained by the National Cancer Institute, compiles cancer data such as disease incidence, treatment results, and mortality. The incidence of bone and joint cancers is higher in men versus women, as males experience 60% more primary musculoskeletal tumors than females. Mortality also differs in that for all musculoskeletal tumors, mortality is higher in men.[1] A similar trend is present in pediatric orthopaedic tumors. Bone and joint tumors are the sixth most common cancer in children ages 0-14; and boys experience a higher incidence of these cancers than girls.[1]


<table>
<thead>
<tr>
<th>Site</th>
<th>Male</th>
<th>Female</th>
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</thead>
<tbody>
<tr>
<td>All Sites</td>
<td>15.4</td>
<td>13.8</td>
</tr>
<tr>
<td>Leukemia</td>
<td>4.9</td>
<td>4.1</td>
</tr>
<tr>
<td>Brain/Nervous System</td>
<td>3.3</td>
<td>2.9</td>
</tr>
<tr>
<td>Non-Hodgkin Lymphoma</td>
<td>3.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Renal/Pelvis</td>
<td>0.9</td>
<td>1</td>
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<tr>
<td>Soft Tissue</td>
<td>1</td>
<td>1.1</td>
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<tr>
<td>Bone and Joints</td>
<td>0.8</td>
<td>0.5</td>
</tr>
<tr>
<td>Hodgkin Lymphoma</td>
<td>0.6</td>
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What are the exceptions? Desmoid tumors occur at a rate two to three times higher in females versus males.[2] For desmoid tumors of the abdominal wall, the female to male ratio is increased to seven to one. The dramatic difference in abdominal desmoids is due in part, to an association with recent pregnancy: up to 89% of abdominal desmoids present soon after pregnancy.[3] Another hypothesis on why desmoid tumors occur more often in women relates to sex difference in the Wnt/beta-catenin pathway, encoded by genes found to have variations in tumor histopathology.[5]

Increased survival but higher toxicities? Several agents used to treat musculoskeletal tumors have a different toxicity and side effect profile for male and female patients. For example, anhydrous such as doxorubicin exhibit a risk for cardiotoxicity, one risk factor for overt heart failure being female sex.[11] TNF-alpha toxicity, which can include liver toxicity and thrombocytopenia occurs in 22% of isolated limb perfusion female patients versus 7% of male patients.[12] Cessation of methotrexate therapy due to hematologic side effects is highly associated with female sex.[13] Fifty percent of women (versus 40%) of men experience a severe toxicity such as leukopenia and alopecia during cancer treatment with fluorouracil.[14] Females following chemotherapy have higher infertility/amenorrhea rates compared to males.[15] Conversely, one study indicates that women are adversely affected by cancer treatment in other ways. Quality of life parameters indicate that women with malignant tumors report significantly lower emotional life scores, hobby or sport participation/satisfaction, and financial status scores.[17]

How important is metastatic disease? Female cancer patients experience a higher rate of skeletal metastatic disease compared to males.[18] Breast cancer is among the top three cancers which metastasize to bone; and metastatic disease predisposes one to risk of pathologic fracture. The effect of bone architecture in the presence of metastatic cells is currently under study.[19] The morbidity of this is not clearly defined. Furthermore, outcome measures for study of pathologic fracture in female breast cancer patients were designed as study instruments on male primary cancers.

Several findings as outlined above suggest that sexual dimorphism does exist in orthopaedic oncology. Beyond disease incidence, difference in tumor prognosis, treatment efficacy, and systemic toxicity have been demonstrated. Efforts to understand why these differences exist could very well lead to more effective and safer therapies for both male and female patients with certain types of musculoskeletal tumors.

References
Sex Influences Outcomes!
Examining Sexual Dimorphism in Trauma, Tumor, ACL Injuries, Fall Prevention, and Concussion

Jessica Rivera, MD
Brooke Army Medical Center
Fort Sam Houston, TX
WHIAB Resident Member
No reported disclosures.

Elizabeth Arendt, MD
University of Minnesota
Minneapolis, MN
WHIAB Chair

Sheila Algan, MD
University of Oklahoma
Oklahoma City, OK
WHIAB Member
No reported disclosures.

Jennifer Weiss, MD
Children's Hospital Los Angeles
WHIAB Member
No reported disclosures.

Jessica Rivera, MD
Brooke Army Medical Center
Fort Sam Houston, TX
WHIAB Resident Member
No reported disclosures.

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Sexual Dimorphism in Anterior Cruciate Ligament Injury

Many factors have been implicated in the increased recognition of ACL tears among female athletes. Attention to this problem may be attributed to increased participation by females in all levels of sport, higher index of suspicion by the public and the primary care giver, improvement in diagnostic technology (MRI), and improvement in treatment and surgical technique. Neuromuscular factors focusing on body movement patterns remain a high source of interest as a risk factor that can be improved with appropriate training. Recent studies expand upon the role of ACL prevention programs with focus on hip adduction, knee valgus, and foot strike and explores the influence of upper trunk sway and anatomic differences on the increased rate of ACL injury in females.

If females begin with an anatomic risk factor, such as increased posterior lateral tibial slope, then the neuromuscular system must compensate to stabilize the knee with jumping and pivoting sports.

Movement and ACL Injury Prevention: Movement patterns have been studied between male and female athletes in hopes of identifying risk factors for increased incidence of ACL tears among female athletes. Gait patterns and coping strategies of females with ACL deficient knees are different from those of males with ACL deficient knees. In 2011 Roewer et al reported that females without an ACL have been shown to compensate with more hip flexion and less knee flexion than males without an ACL. The implications of these differences on (potential) knee degenerative disease are not yet understood. [1]

Female athletes have been shown to utilize different jump landing strategies than their male counterparts. In 2011 Pappas et al reported that females exhibit greater knee valgus and ankle abduction asymmetry between their limbs than males during drop landings. During forward landings, females show greater hip abduction and knee valgus. Further study of these differences may lead to better understanding of ACL injury prevention in females in the future. [2]

Boden et al studied other risk factors for ACL injury in relation to both foot strike and knee and hip movement. Their study implicates both foot position upon landing and more proximal positioning of the knee and hip. They conclude that athletes who have sustained ACL injuries are more likely to make initial ground contact with the hind-foot or flatfooted and that these athletes exhibit increased knee abduction and hip flexion. [3]

ACL injury prevention programs have been reported to decrease rate of ACL injury among female athletes. [4, 5] Newer contribution to the literature related to this category of research includes a study by Bien et al published in 2011. The authors reviewed components of ACL injury prevention strategies. The strategies that are critical to include are hip and hamstring training, core stabilization, plyometrics, balance, agility, neuromuscular training with video and verbal feedback to modify technique, and stretching. [6]

Upper Trunk Sway: Upper trunk sway has been implicated as an explanation for increased incidence of ACL injury in female athletes. In 2009, Hewett et al performed motion analysis of landing and cutting tasks of ACL-injured males and females and female control subjects. They found greater lateral trunk motion and knee abduction in female ACL-injured patients than the males or female controls. In addition, the female ACL-injured subjects showed less forward trunk lean than male ACL-injured patients or female controls. The authors concluded that trunk sway and knee abduction motion may be more important for females than males in the setting of ACL injury. [6]

Tibial Slope: In 2008 Hashemi et al reported on the anatomy of the tibial plateau in detail. They divided their analysis of the posterior tibial slope into 3 slopes. They reported that females have a greater medial and lateral slope than males and that males have a larger coronal tibial slope. Depth of the tibial plateau was not found to be different between the sexes. [7] In 2010 the authors then went on to examine whether increased posterior tibial slope is a risk factor for ACL injury. They found that increased tibial plateau slope in combination with shallow medial tibial plateau depth of concavity could be a risk factor for ACL injury. They found that females who sustained ACL tears had increased lateral tibial slope and shallower medial tibial depth than control group, and that males had both increased medial AND lateral slope and shallower medial tibial depth than control group. The authors concluded that different ACL injury models are likely appropriate for males and females. [8] A cadaver study performed by McLean et al in 2011 explores the relationship between posterior tibial slope and impact-induced anterior cruciate ligament injury, and their impact on ACL strain. They found that a proportional influence of anterior tibial acceleration and their impact on ACL strain. They found that a proportional influence of impact-induced ACL strain to anterior tibial acceleration, with a moderate dependency on tibial posterior slope. [9]

The difference in ACL injury rates between men and women continues to deserve study. Additional work is necessary to better guide the differences in prevention of the injury and care for the athlete in women versus men.

5. Hewett TE, Yang J, Stecker K, Noyes FR: Quadriceps strength and neuromuscular training are associated with椴åsakmä target=œœ"œà¬ãååãåã¢š"¬ãååãåã¢š"¬ãååãåã¢š"¬ãååãåã¢š"¬ãååãåã¢š"¬ãååãåã¢š"¬ãååãåã¢š"¬ãååãåã¢š"¬ãååãåã¢š"¬ãååãåã¢š"¬ãååãåã¢š"¬ãååãåã¢š"¬ãååãåã¢š"¬ãååãåã¢š"¬ãååãåã¢š"¬ãååãåã¢š"¬ãååãåã¢š"¬ãååãåã¢š"¬ãååãåã¢š"¬ãååãåã¢š"¬ãååãåã¢š"¬ãååãåã¢š"¬ãååãåã¢š"¬ãååãåã¢š"¬ãååãåã¢š"¬ãååãåã¢š"¬ãååãåã¢š"¬ãååãåã¢š"¬ãååãåã¢shaped kinematic strategies continue to improve two years after anterior cruciate ligament reconstruction. Journal of knee surgery 2011, 24(3):200-204.
Falls in the elderly are a particularly difficult problem, especially in the elderly female population, with a high cost to society and the individual. Postural control is a significant component to the initiation and prevention of a fall. A multifactorial approach is necessary to address all components that contribute to impaired postural control in the elderly to develop effective fall prevention strategies.

The risk of falling is increased in children and the elderly. The medical cost to society is high, $19 billion in the U.S. alone, for the elderly population. Fall prevention strategies are most commonly multifactorial, attempting to address intrinsic (environmental) as well as intrinsic (patient-related) factors. Intrinsic fall risk factors include impaired static and dynamic postural control, and deficits in muscle strength, both power and rate of force development. In children, increased postural sway is related to maturation and development of the sensory/motor pathways. In adults, deterioration in postural control begins in middle-aged adults. Cognitive impairment, visual impairment, vestibular impairment, proprioceptive dysfunction, and muscle weakness all contribute. [1]

Grenacher studied the effects of cognitive and motor interference tasks on static and dynamic postural control in both young and elderly subjects. Static control was measured during bipedal stance and dynamic control walking on an instrumented walkway. Dynamic postural control is more challenging in the elderly, as the center of mass rests outside the base of support during single leg stance segments of the gait cycle, and due to deterioration in visual, proprioceptive and vestibular systems requiring increased attentional demand to maintain postural stability. Younger patients showed smaller center of pressure displacements than older patients for all task conditions, and were able to compensate for increased task demands through the application of COP strategies. In contrast, control and task resulted in increased displacement of COP in the elderly subjects.

Elderly subjects showed increased stride variability with respect to stride time, length and velocity, compared to younger subjects, showing both group and task effects as well as group x task interaction. This has implications for functional activities of daily living in the elderly that require either cognitive or motor attention while walking. [1]

Balance confidence has been shown to decline in the elderly population, affecting 20-75% of older community-dwellers. Poor balance confidence is associated with activity avoidance and gait impairment, and may be an independent risk factor for loss of independence and disability. A meta-analysis looking at balance confidence identified 46 RCTs that addressed balance confidence. The types of interventions found to be most successful included some type of exercise component, although several different exercise types were used. The authors were not able to conclude one particular exercise type to be best, though they noted that a combination of strength training and balance exercise was most commonly used. Only 8 studies specifically targeted balance confidence, and 5 of the 8 showed a positive result. Thirty-eight studies indirectly targeted balance confidence but were aimed mainly at fall prevention or gait/balance improvement. Twenty of 38 studies showed improved balance confidence. The concern raised by the authors was that very few studies addressed whether the improved balance confidence translates to a decrease in activity avoidance. In addition, they point out the heterogeneity of the studies, both in population selection as well as interventions used (type, duration, intensity), outcomes measured, making it difficult to draw conclusions. [2]

Fibromyalgia has recently been studied as a risk factor for impaired balance and falling. Jones et al reported on 34 fibromyalgia patients compared to 32 age matched controls and found the fibromyalgia patients performed poorly compared to controls on the Balance Evaluation-Systems Test (BESTest), scored more poorly on balance confidence and reported 37 falls in the 6 month study period compared to 6 falls in healthy controls. The BESTest measures 5 subcomponents of balance. Fibromyalgia patients scored lower in all subcomponents.

Static postural control or stability is defined as maintaining a stable center of mass over a stationary base of support. Ambulation requires dynamic stability, which is defined as controlling the center of mass with a moving base of support. Ambulation requires dynamic stability, which is defined as controlling the center of mass with a moving base of support. Perturbations to balance result in a whole body response to prevent a fall. Responses occur in arm, and leg muscles as well as trunk muscles. Marigold reviews the literature on these linked responses noting that the propotospinal pathway may provide the link between limbocerebral and cervical spinal segments, such that the coupling occurs during locomotion but not other tasks that do not require the coordinated movement. They suggest the use of whole-body coordination training through the use of various agility training techniques to improve the coordination of whole body responses and improve control of center of mass with respect to the moving base of support. [3]

Gravelle et al recently looked at the use of low level electrical noise applied at the knee to improve postural control by increasing sensitivity of the somatosensory system in 13 healthy older adults. They measured displacement of the center of pressure of the subject’s plant foot during single leg stance trials. They noted 6 of 7 sway parameters decreased with the application of electrical noise, 3 of which were statistically significant. The reductions were small however, in the 3.75% range. The authors do not comment on whether these would be clinically significant in preventing a fall. Van den Bogert et al looked at response time and walking velocity for fall prevention in the elderly. Using an inverted pendulum model, they found that tilt angle (body angle at the time the recovery foot is lowered to the ground) was a perfect predictor of successful recovery step, as long as the step occurred before the tilt angle exceeded 23.26 degrees from vertical. Faster response time was more important than slower walking velocity for successful recovery step. This is important in planning fall prevention strategies to initiate recovery step prior to critical tilt angle. [4]

Vitamin D deficiency has been implicated as a risk factor for falls as vitamin D is known to have direct effect on muscle tissue, and likely effects on the CNS as well. Barr et al studied the association between vitamin D receptor gene polymorphisms, falls, balance and muscle power in 2 separate populations of female patients. They found an increased risk for fall in individuals who carried the B allele (Bsm1) of the vitamin D receptor gene. They also found that the BB homozygote versus carriers of the B allele showed significant increase in maximum power. There were significant differences in rise from a chair, with the BB homozygotes performing with ease significantly more often than the BB or BB+BB. Bischof-Herz et al used a trunk angular displacement balance assessment method to predict fall risk with and without calcium and vitamin D supplementation. They found that both postural and dynamic balance predicted the rate of falling. In addition, calcium plus vitamin D supplementation reduced the rate of falling 60% compared to calcium alone. By their analysis, 22% of the treatment effect was attributed to change in postural balance and 14% by dynamic balance.

The Nintendo Wii gaming system is being used in the rehabilitation setting, however, until recently, it has not been well studied as a tool to improve balance and decrease fall risk. Nitz et al [6] performed a pilot program using the Wii Fit on 10 women aged 30-58. Numerous balance measures were studied, as well as strength, proprioception and cardiovascular fitness. They did find significant improvement in unilateral stance balance and lower limb muscle strength, though not the other measures tested. Yamada et al [7] used the Nintendo Wi Fit system to assess fall risk using the “Basic Step” and “Ski Slalom” modules. The Basic Step scores were moderately correlated with those of dual task lag of walking and Timed Up and Go (TUG). In addition, the Basic Step showed a significant difference between participants who reported previous fall in past year compared to non-fallers.

The study of falls and fall prevention is complicated by the specificity of factors involved in the falls and the lack of specificity of exercise programs intended to prevent falls. Fall-related specificity can be broken down by direction-related specificity and disturbance related specificity. Distinguishing the contribution of these factors has implications for designing programs to prevent falls. Grabner et al [8] studied normal healthy older adults ability to avoid a fall when exposed to a large postural disturbance during locomotion. They found older adults who were unable to avoid a fall had 42% higher trunk flexion angle than those that avoided a fall. In addition, older adults had much more difficulty avoiding a fall when subjected to a slip (backward-directed fall). In this situation, trunk angular velocity in the frontal plane was 3 fold higher in the older adults who fell, whereas younger adults were able to flex the trunk. They then went on to test a task specific training protocol in which older adults were subjected to a postural disturbance while standing on a motorized treadmill. Women performed substantially worse than men, however, they were able to “learn” to avoid falling on subsequent trials.

References:
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Sexual Dimorphism in Concussion
Symptoms in Athletes

Sports-related concussions have attracted attention in recent years, with an increased focus on the diagnosis, appropriate treatment, and return to play guidelines. Because symptomatology is critical to the diagnosis of a concussion, knowing if there are age- or sex-specific differences in symptoms would be crucial in determining appropriate treatment of this injury.

Incidence and Definition: An estimated 3 million sports-related concussions occur annually in the United States. After motor vehicle accidents, sports are the second leading cause of traumatic brain injury among people age 15-24 years. A concussion is defined as “a complex pathophysiologic process affecting the brain, induced by traumatic biomechanical forces.” Usually, a short-lived neurologic impairment that spontaneously resolves follows a concussion. Although a concussion may result in neuropathologic (affecting the nervous system) changes, the impairment that may result after a concussion is typically functional rather than structural. Loss of consciousness (LOC) may occur, but this symptom is not determinative of whether or not a person has sustained a concussion and LOC rarely occurs in sports-related concussions. In addition, LOC does not correlate with severity of injury.

Concussion in High School Athletes: Approximately 7.3 million high school students participate in interscholastic athletics each year. About 3 million of these young athletes (~41%) are adolescent girls. The number of female athletes is rising sharply; just a decade ago, only 2.4 million high school athletes were female. An estimated 1.6 million to 3.8 million sports-and recreation-related concussions occur every year. The leading cause of high school sports concussion in males is football, for females, it is soccer. To date, reports of possible differences in concussions between girls and boys have been largely anecdotal. A recent study in the Journal of Athletic Training looked into these questions. The researchers surveyed certified athletic trainers at 100 high schools nationwide concerning the incidence and outcome of concussions sustained by male and female athletes during the 2005–2006 and 2006–2007 school years. They compared symptoms, symptom resolution time, and time to return to play between males and females with sports-related concussions. For each high school, athletes who sustained an acute athletic injury were asked to complete a symptomnaire using an Internet-based injury reporting system. Respondents reported how long it took the symptoms to resolve and how long it took the athlete to return to play. A total of 812 concussions were assessed—610 in boys and 202 in girls—over the 2-year study. Headache was the primary symptom reported for athletes of both sexes in both years of the study. Although no difference in incidence of headache was revealed, other primary symptoms did differ by sex. Amnesia and confusion/disorientation (ie, cognitive symptoms) were reported as primary symptoms for males more frequently than for females, and the difference was statistically significant. During the second year of the study, athletic trainers were asked to report all symptoms, not just the primary symptom. No substantial difference was found in the median number of symptoms reported for girls or boys. Amnesia and confusion/disorientation were reported more frequently for boys than for girls; a statistical significance exists, however, depression (a neurobehavioral symptom) and sensitivity to noise (a somatic symptom) were reported significantly more frequently for girls than for boys. No differences were observed between sexes for symptom resolution time or return-to-play time.

Concussions in Collegiate Athletes: Since 1988, the National Collegiate Athletic Association (NCAA) Injury Surveillance System (ISS) has collected injury and sport exposure data from 16 sport activities: men’s baseball, men’s basketball, women’s basketball, women’s field hockey, men’s fall football, men’s spring football, men’s gymnastics, women’s gymnastics, men’s ice hockey, men’s lacrosse, women’s lacrosse, men’s soccer, women’s soccer, women’s softball, women’s volleyball, and men’s wrestling. Data collection for a 17th sport, women’s ice hockey, began in the 2000–2001 season. Over this 16-year sample period, injury trends may have been influenced by a variety of factors, including increased athletes participation, changes in NCAA rules and policies, and the continued evolution of the practice of sports medicine. Participation has increased among both sexes (80% increase in females and 20% increase in males) in all NCAA championship sports. According to NCAA ISS, the overall concussion rate was 2.8/1000 athletic exposures. Looking specifically at concussions, reports of concussion spanned from a low of 5% (women’s volleyball) to a high of 18% (women’s ice hockey) of reported injuries. Fourteen percent of these injuries restricted participation for 10 days or more (range: 2%). The rate of concussion increased significantly by 7% on average over the 16 years covered in this report, despite sport-specific efforts to address the rising risk in select sports such as ice hockey and men’s lacrosse. This trend may reflect an actual increase in the numbers of concussions per unit of exposure, but it is also attributable, at least in part, to improvements in the identification of concussion (better awareness and diagnosis) in the later years of reporting. The higher reported incidence of concussion in women’s ice hockey may also be due to the fact that it was the only sport where the data collection was only in the latter part of the study period. Promising areas of research include baseline neuropsychological testing for identification and safe return to play decisions. Sex differences in the susceptibility to concussions in sports played similarly among males and females (such as soccer and basketball in this data set) may be another area for future research.

Assessing Concussion: Normative data are useful in assessing concussion, but little normative data exists for high school athletes. Previous studies on college athletes have shown that, in general, female athletes score better on tests of neurocognitive function. Female collegiate athletes were also shown to perform significantly better than male athletes on baseline verbal memory scores, while male athletes performed significantly better than female athletes on baseline visual memory scores. Female athletes also reported a significant number of mild baseline symptoms as compared to male athletes. One way clinicians assess concussions on the sideline is to use a standardized assessment tool that evaluates symptoms, a brief cognitive exam and balance. The Sports Concussion Assessment Tool 2 (SCAT2) is an example of a tool that was developed in 2009 after the Third International Conference on Concussion in Sport held in Prague in 2004. Although neither the SCAT nor the SCAT2 have been validated, several components of the tool (symptom checklist, Standardized Assessment of Concussion (SAC) and modified Balance Error Scoring System) have been, and preliminary data suggests the SCAT2 is useful (Parnian, unpublished). A study of SCAT normative (baseline) data from male and female youth hockey found that ratings varied between age groups and between the sexes; they also varied from previous reports on varsity athletes. Based on symptom-resolution and return-to-play time, little difference is evident in the severity or outcome of concussions sustained by high school athletes of either sex. But recent findings indicate that adolescent female and male athletes may have different types of symptoms after a sports-related concussion and that these symptoms may be interpreted differently by healthcare professionals. Without adequate assessment, the neurobehavioral or somatic symptoms reported by girls may be more easily missed or even attributed to other conditions such as stress or anxiety. In the high school and collegiate age group, female athletes have been found to have greater cognitive impairment than males after concussions. In addition, female athletes have been found to have greater declines in simple and complex reaction time as opposed to males after concussions. More post-concussive symptoms are reported by females than males, as has been found with other injury reporting studies.

Symptom evaluation is only one component of a concussion evaluation, and each symptom should be evaluated and monitored to resolution to baseline before the athlete can return to play. Neurocognitive assessments, balance measurements, symptoms, and the physical examination should be used collectively to evaluate concussions.