Review Article

Epidemiology of youth sports injury: a review of demographic and sports-related risk factors for injury

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Contributions: (I) Conception and design: C Ukogu, D Patterson, AC Colvin; (II) Administrative support: C Ukogu, D Patterson, AC Colvin; (III) Provision of study materials or patients: None; (IV) Collection and assembly of data: None; (V) Data analysis and interpretation: None; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

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Abstract: A growing number of young people are participating in sports leading to an increase in traumatic, overuse, and brain injuries. We reviewed the most updated reports of participation in sports, the prevalence of sports related injuries, and indications for surgery. We concluded that sports related injuries varied by type of sport and gender and thus such demographics should be taken into account when treating injuries and informing patients before surgery.

Keywords: Youth sports; injury; epidemiology

Received: 30 November 2017; Accepted: 11 December 2017; Published: 21 December 2017.
doi: 10.21037/aoj.2017.12.04
View this article at: http://dx.doi.org/10.21037/aoj.2017.12.04

Introduction

An estimated 30 million American youths participate in organized sports, and this number, in part driven by public health initiatives that promote sports participation activity for physical and psychological benefits, is steadily increasing (1-3). Sports participation has been linked to improved self-esteem and school outcomes, as well as decreased alcohol and drug use among youths (4,5). However, sports are also one of the leading causes of injury in adolescents (6,7).

The frequency of surgery for youth sports-related injuries has increased in a pattern consistent with the rise in sports participation (8). There is a wide array of injuries that can occur during play; previous studies have linked certain sports to an increased risk of specific injuries. Sports involving jumping, cutting, or pivoting, like basketball or soccer, are associated with an increased risk of ACL tear, while contact sports increase risk of head injuries (9,10).

With the number of young athletes requiring surgical intervention for their injuries on the rise, it is important to detail the types of injuries common among young athletes looking specifically at demographic and sport specific factors that contribute most (11).

Traumatic injuries

Falls are the most common underlying mechanism for a traumatic sports injury, followed by collision or being struck by or against an object (12). Traumatic injuries are more likely to occur during competition than practice and have been highly correlated with participation in team, not individual, sports (6,13). A large proportion of traumatic injuries sustained during play result in fractures, joint dislocations, muscle strains and ligament strains. Fractures occur most often in the hand/finger, wrist and ankle, while ligament strains are often knee (e.g., MCL and ACL) and shoulder injuries (14). Salter Harris fractures affecting a skeletally immature physis have a particularly deleterious effect (15). Sequelae of traumatic growth plate injury can include deformities, limb length discrepancy, and altered joint mechanics (16).

Males are more likely to experience sports related traumatic injuries than female counterparts (1,14) and the incidence of these injuries is related to type of sport. Men's football and wrestling, and girls' basketball and soccer account for the highest rates of acute, potentially severe, injuries (8,14).

A growing number or traumatic injuries are being treated surgically (11) and studies suggest surgery may provide improved outcomes in this population. Data on anterior cruciate ligament injury in young athletes suggests that early operative treatment reduces instability and long-term sequelae better than delayed surgery or non-operative options (17). Incidence of injury resulting in surgery has also been correlated with gender. Previous studies have shown that among the same sports, males experienced more injuries overall (1,14) but women sustained injuries that resulted in surgery more often (7,8).

Return to play after a traumatic injury is highly variable and depends on many factors, including treatment plan and pain resolution (14,17).

Overuse injuries

Overuse injuries can occur from repeated application of unnatural and/or excessive forces on the soft tissues (18). Almost half of all sports related injuries in adolescents can be attributed to overuse (19). Young athletes may be particularly susceptible to overuse injuries as a result of poor technique, ill-fitting equipment, physical weakness, and muscle imbalances (20). Unlike traumatic injuries, overuse injuries occur over time and mainly affect epiphyseal cartilage (21).

Pain with a prescribed motion is a common sign of overuse injury; the elbows, shoulders, knees, back, and heels are areas frequently affected. Similar to traumatic injuries, the incidence of overuse injuries varies by sport and gender. For example, young athletes participating in baseball, tennis, swimming, gymnastics, and volleyball are highly susceptible to shoulder injuries because of the overhead demands of their sport. An overuse injury of the immature shoulder presents as pain in the shoulder and widening of the proximal humeral physis on imaging (20). Heel pain in athletes 5 to 11 years of age has been most often linked to calcaneal apophysitis (Sever's disease), and affects significantly higher basketball, soccer, and track athletes than sports (22). Gender discrepancies in overuse injuries suggest that female athletes sustain more overuse injuries than their male counterparts; underlying differences in anatomy, flexibility, and strength patterns are thought to contribute to this difference (2,23).

The incidence of overuse injuries has also been studied in the context of early specialization and excess practice hours or multiple team participation. Sports specialization is defined as 8 or more months per year of training in a single sport (24). For young athletes, focusing on one sport may exacerbate the risk of overuse injuries by promoting repetitive training. Additionally, children that focus on only one sport may not fully develop sport-specific neuromuscular patterns that may be protective of injury (25).

Little league baseball and swimming are often implicated in shoulder overuse injuries in youth sports but differ in presentation and underlying etiology. Proximal humeral epiphysiolysis, "little league shoulder", has been increasingly reported in young baseball pitches since 1999 (26). Currently, throwing sports account for 10% of adolescent shoulder pain, and 26% of these shoulder injuries have been associated with overuse (27,28). Repetitive throwing leads to chronic microtraumatic forces, which affect the immature cartilage of the unfused proximal humeral physis, particularly in children 13 or younger (26,29). Studies have blamed this trend on improper throwing technique and underdevelopment of the skeleton (28). Players often present with universal shoulder pain during overhead maneuvers and proximal humerus tenderness upon physical exam; secondary referred elbow pain or other mechanical weaknesses also occur (26). Successful treatment for little league shoulder is almost exclusively nonoperative, consisting of a 3–4 months period of rest, modified activity, and injury prevention education (improved throwing technique) prior to full return to play (26-28).

Many young adolescent swimmers also develop shoulder pain, however the underlying etiology and mechanism of injury, and treatment, is different. The repetitive overhead movements of freestyle, backstroke and butterfly, coupled with a high volume of training are thought to contribute significantly to shoulder pathology in young swimmers. Supraspinatus tendinopathy is the leading cause of shoulder pain and injury in swimmers. Other frequent causes include scapular dyskinesia, multidirectional instability/shoulder laxity and impingement (30,31). Swimmers with a prior history of shoulder injury and an increase or decrease [e.g., glenohumeral internal rotation deficit (GIRD)) in shoulder rotation may have increased risk of developing an overuse shoulder injury, likely due to altered biomechanics or compensatory techniques (30,32). In addition, practice habits and training attitudes of young swimmers have been implicated in shoulder injuries. Hibberd et al showed that many young athletes believe that shoulder pain is a normal byproduct of swimming and should be endured during practice (32). Swimming shoulder injuries are generally managed nonoperatively, similar to little league shoulder (33). However, if pain persists after 3 months of active rest and rehabilitation, arthroscopy may be recommended to repair

labral tears and glenohumeral instability (34,35). Outcomes from such surgical interventions have not been extensively studied in young athletes.

Head injuries

Head injuries sustained while participating in youth sports are extremely dangerous. There is an increasing spotlight on concussions, with ongoing research suggesting there are far more common in adolescent athletes than previously realized. And further, that their accumulative damage and long-term sequelae present devastating consequences in the future.

A "concussion" is defined as traumatic disturbance in brain function (36). Animal models used to elucidate the human brain's pathophysiological response to concussions revealed rapid neuronal depolarization, shifts in ionic membrane potential, alterations in metabolism, and changes in axon function and cranial blood flow following impact (37,38). Athletes ages 15–19 have the highest overall incidence of concussions, followed by those ages 10–14 (39).

Similar to other injury patterns, there are sport- and gender-specific differences in the incidence of concussions. Concussions most often occur in player-to-player collisions, and are thus most common in football, ice hockey, rugby, soccer, cheerleading, and girl's basketball (36). Football and ice hockey have the highest incidence of concussions, and these are most likely to occur during competition (40). A close study of US high school athletes found that boys experienced more concussions than girls (10). Current guidelines suggest one week of lost playing time following injury, but there is a growing corpus of evidence pointing toward increased length of play cessation for recovery (41). One reason for this shift in guidelines stems from work highlighting the cumulative deleterious effects of multiple concussions at a young age leading to mental health concerns in high school and college athletes, or former athletes. Recent work on combined traumatic encephalopathy (CTE) seen in National Football Players found a compounding effect with each subsequent concussion resulting in prolonged loss of playing time, depression, and mental status changes.

Concussions can present with loss of consciousness, and symptoms such as disorientation, confusion, nausea, unsteadiness, headaches, and visual disturbances may last for hours or days after the incident (42). Sports-related concussions are often identified using standardized surveys like the Standardized Assessment of Concussion, which can be administered on the sidelines to help diagnose a concussion (43).

Concussions are managed through interdisciplinary therapies targeting a wide variety of symptoms such as headaches and mood changes. Following injury, young athletes may require a period of absence from school in addition to sport cessation (44). Most concussions resolve a few weeks after impact, but there are many aspects that determine when an athlete can return to regular activity (40,45). In recent years, comparisons of preseason and post-injury neurocognitive testing have been used to identify acute neuropsychological symptoms of a concussion (37,46). Immediate post-concussion Assessment and Cognitive Testing (ImPACT) is one such commercially-available test, which assesses attention span, attention selectivity and specificity, reaction time, and memory (47,48). The presence/absence of a helmet during collision has also been shown to have predictive value for when young athletes can return to play. Concussions occurring during non-helmet sports resulted in longer recovery times and increased risk of loss of consciousness on the field (49). Gender may also play a role in return to play, as studies suggest that female athletes had higher odds of delayed recovery time (42).

The duration of neurocognitive effects of concussions are highly variable. Neuroplasticity in young patients had been thought to be protective against long-term damage from head trauma, but now data suggest that concussions have lasting effects on young athletes (42,50,51). Functional MRI studies have revealed significant alterations in brain activity during working memory tasks, which were related to poorer performance for youths with concussions up to 90 days after injury (45). Other research using functional MRI revealed changes in whole brain activity between concussed and non-concussed youths, but could not replicate poor performance on cognitive tasks (52). Concussions may influence the mental state and health of adolescents. A study of athletes aged 8–18 found that over 50% of them were most distressed by loss of activity as a result of their injury (53), and there is increasing evidence of the effect of a concussion on the development of personality changes, anxiety and depression.

Recurrent concussions also pose a significant threat to young athletes. Contact sports, such as football and hockey, carry increased risk of recurrent concussions. Such injuries in young athletes have been implicated in more severe cognitive neuropathies like chronic traumatic encephalopathy, personality changes, suicide, headaches, and depression, but these claims have been contested (54,55).

Conclusions

Pediatric and adolescent patients are participating in organized sports at increasing rates, which exposes them to the risk of suffering traumatic, overuse, and head injuries. Types of sport, level of intensity, and gender have been shown to contribute to the underlying etiologies of these injuries. This paper provides an up-to-date review of the current epidemiological and demographic characteristics of injuries that occur during youth sport and is important, as more and more young athletes require surgical intervention for such injuries.

Acknowledgments

Funding: None.

Footnote

Provenance and Peer Review: This article was commissioned by the editorial office, *Annals of Joint* for the series "Orthopaedic Sports Injuries in Youth". The article has undergone external peer review.

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/aoj.2017.12.04). The series "Orthopaedic Sports Injuries in Youth" was commissioned by the editorial office without any funding or sponsorship. DP served as the unpaid Guest Editor of the series. ACC served as the unpaid Guest Editor of the series and serves as an unpaid editorial board member of *Annals of Joint* from Jun 2016 to May 2018. The authors have no other conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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doi: 10.21037/aoj.2017.12.04
Cite this article as: Ukogu C, Patterson D, Sarosi A, Colvin AC. Epidemiology of youth sports injury: a review of demographic and sports-related risk factors for injury. Ann Joint 2017;2:79.