

# Pediatric orthopedic injury prevention for team sports post COVID-19

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## ABSTRACT

Queries of youth orthopedic sports injuries from the U.S. National Electronic Surveillance System, a database from the Consumer Product Safety Commission, demonstrate decreased orthopedic injuries related to team sports during the COVID-19 pandemic, indicative of reduced sports participation. Multiple articles have shown that COVID-19 had a marked effect on the physical and psychological wellbeing of the youth. The lockdown resulted in a cessation in school attendance and sports activities, especially team sports. Though increased emphasis has been placed on children infected by COVID-19, less attention has been given to healthy children. Numerous articles discussed the physical and psychological benefits for the youth returning to physical activity and sports; however, few have addressed detraining and deconditioning concerns postpandemic. This article discusses a safe return to team sports for the youth experiencing physical and psychological changes related to the pandemic. Orthopedic injuries are anticipated to increase as restrictions are relaxed. A multidisciplinary team presents a review of common youth sports orthopedic injuries, a discussion of psychological issues youths have experienced during COVID and why sports participation is beneficial for youth, and a risk assessment for pain and limited range of motion for youth returning to sports. The intent of this article is to increase awareness of the physical and psychological changes experienced by youth due to their inability to participate in team sports during the pandemic. Family medicine and primary care providers need to recognize the increased risks for injury and proactively encourage the youth to return to sports in a safe manner.

**Keywords:** COVID, injury prevention, orthopedic, pediatric, psychological, rehabilitation, sports

## Overview

Family medicine and primary care play a key role in the identification and treatment of pediatric sports injuries. Anticipating that practitioners may see a marked increase of sports injuries after COVID-19, a multi-disciplinary team presents a review of common youth sports orthopedic injuries, a discussion of psychological issues youths have experienced during COVID and why sports participation is beneficial for

youth, and a risk assessment for pain and limited range of motion for youth returning to sports.

## Introduction

Family medicine and primary care physicians are frequently the first lines of treatment for pediatric sports injuries, especially in rural communities. COVID led to an unprecedented long period without training or sports participation, which may lead to deconditioning and increased risk of injuries.<sup>[1,2]</sup> Several articles<sup>[3,4]</sup> showed the decreased number of fractures and sports-related injuries during the COVID pandemic. Given limited exposure to musculoskeletal problems during training,<sup>[5]</sup> family medicine and primary care physicians may benefit from additional knowledge

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about pediatric orthopedic injury prevention for team sports in the aftermath of COVID-19.

Pediatric orthopedic sports injuries are very common in the United States (U.S.), which is not surprising given that 35–45 million youths between the ages of 6 and 18 years participate in some form of athletic activities.<sup>[6]</sup> Team sports result in an alarming number of injuries in children. The Consumer Product Safety Commission’s National Electronic Injury Surveillance System (NEISS)<sup>[7]</sup> is a probability sample of hospitals (including children’s hospitals) in the U.S. with at least six beds and an emergency department. The participating NEISS hospitals are hand-selected to provide a statistical representation of hospitals of similar size and characteristics.<sup>[7]</sup> The findings of numerous articles published during the COVID pandemic were based on injury trends seen at the individual institutions.<sup>[3,4,8]</sup> In contrast, the NEISS database allows us to assess the number of injuries reflected for the entire country of the U.S., which is more representative than data from individual institutions.

Based on NEISS data in the 5 years prepandemic (2015–2019), an estimated 2,883,759 children in the U.S. have been treated for orthopedic injuries including strains, sprains, dislocations, fractures, and avulsion injuries [Table 1]. In March of 2020, a novel coronavirus (SARS-CoV-2) COVID-19 triggered a global pandemic that resulted in widespread closures of schools and organized sports in order to slow transmissions. NEISS illustrates a dramatic decrease in team sports injuries in 2020 during COVID-19 compared to 2018, a year unaffected by COVID-19, indicating reduced participation in sports during COVID [Table 2].

A study published by the Centers for Disease Control and Preventions Morbidity and Mortality Weekly Report in March, 2021 found the transition to virtual education led to decreased physical activity and worsening mental health for children.<sup>[9]</sup> The report found the difference in physical activity to be of concern, as regular physical activity is associated with improved cardio-respiratory fitness as well as bone and muscle strength.<sup>[9]</sup> Additionally, multiple articles from Italy, China, and the United States discuss increased body mass index as well as decreased physical activity of youth during the COVID-19 lockdown.<sup>[10-12]</sup>

A step count study showed significantly reduced physical activity levels in children during COVID-19 stay-at-home orders

compared to a pre-pandemic age-matched cohort. Differences in physical activity typically seen between weekdays and weekends prepandemic were not present during stay-at-home orders.<sup>[13]</sup>

The American Academy of Pediatrics released a *COVID-19 Interim Guidance: Return to Sports and Physical Activity*<sup>[6]</sup> updated in March, 2021. The guidance discussed transmission mitigation risk for individuals and their families as children return to sports and physical activity. The guidance also recommended that any child who tested positive for SARS-CoV-2 should not exercise until cleared by a physician with an emphasis on cardiac and respiratory screening.<sup>[6]</sup> Though increased emphasis has been placed on children who had been infected by COVID-19, less attention has been given to healthy children. While the guidance discussed physical and psychological benefits for children and adolescents returning to physical activity and sports, it did not address detraining and deconditioning concerns post COVID-19.

Numerous articles published in the past year discuss elite, professional athletes being more at risk for injuries after modifying training and competition during COVID-19.<sup>[14-17]</sup> The term “detraining” is used in athletics to describe the loss of endurance, muscle mass, and strength resulting from an interruption in training.<sup>[2,14-16]</sup> Detraining negatively affects physical qualities such as strength and power as well as abilities to accelerate, decelerate, and change direction. In addition to the physiological impacts, game-specific contact skills (such as tackling or blocking) and decision-making skills have been hard to maintain due to the physical distancing measures because of COVID-19. Teams have been unable to train together or have routine access to coaching and training facilities during the lockdown. Athletes may have continued to train on their own, but socio-economic issues and limitations of equipment and space are factors that affect their readiness and increase the risk of injuries as they resume team sports.<sup>[15]</sup> The same principles and concerns of detraining exist for student-athletes; therefore, they also face an increased risk of orthopedic injuries as they return to team sports.

This article provides an overview of common orthopedic injuries associated with team sports and psychological importance of sports to children. As society reopens and life returns to a semblance of normal, we need to prepare for an increase in pediatric sports injuries. Prevention of injury is preferable to treatment of injury, so we provide a screening assessment for young athletes returning to sports.

**Psychological impact and benefits of return to sports**

Restrictions designed to reduce the spread of COVID-19, including online education and social distancing, have profoundly altered the daily life of youth. COVID-19 restrictions have interrupted daily routines and social rites of passage (outdoor activities, sporting events, and graduation). Rates of depression and anxiety have increased in school-aged children, with some research revealing significant increases in mood disorders after

**Table 1: U.S. national estimate of pediatric orthopedic team sports injuries by diagnosis<sup>[7]</sup> during 2015-2019. See query selections in Table 2**

	Male	Female	Total
Dislocation	121,579	42,553	164,132
Fracture	744,705	233,814	978,520
Strain, Sprain	1,100,657	632,705	1,733,362
Avulsion	4,853	2,892	7,745
Total	1,971,794	911,964	2,883,759

**Table 2: Comparison of U.S. national estimates of pediatric orthopedic sports injuries<sup>[7]</sup> in 2018 and 2020**

	2018			2020			Decrease
	Male	Female	Total	Male	Female	Total	
<b>By Sport</b>							
Baseball/softball	18,641	17,287	35,929	8,911	5,370	14,281	60.3%
Basketball	126,520	37,062	163,582	56,868	16,829	73,697	54.9%
Football	110,296	7,936	118,232	49,709	2,528	52,237	55.8%
Hockey	5,555	1,093	6,648	3,441	712	4,153	37.5%
Lacrosse, rugby, etc.	14,817	8,579	23,396	4,077	1,567	5,644	75.9%
Miscellaneous sports	35,693	59,223	94,916	15,316	24,045	39,361	58.5%
Soccer	46,118	24,743	70,861	20,407	11,136	31,543	55.5%
Volleyball	4,394	16,733	21,127	1,914	6,671	8,585	59.4%
<b>By Diagnosis</b>							
Dislocation	22,909	7,283	30,599	14,665	3,578	18,242	40.4%
Fracture	135,447	42,689	180,183	67,781	22,263	90,044	50.0%
Strain, sprain	201,862	112,469	320,433	79,363	43,210	122,573	61.7%
Avulsion	<1200	<1200	1,636	<1200	<1200	<1200	>26.6%
<b>By Body Part</b>							
Shoulder	34,030	7,690	41,720	18,490	3,364	21,855	47.6%
Upper arm	4,642	2,369	7,011	1,774	1,197	2,971	57.6%
Elbow	9,094	7,148	16,242	4,963	2,805	7,768	52.2%
Lower arm	20,134	6,711	26,844	12,562	4,903	17,465	34.9%
Wrist	39,943	16,804	56,747	17,490	7,223	24,713	56.5%
Hand	10,013	4,232	14,245	4,647	1,114	5,761	59.6%
Finger	62,929	27,676	90,605	25,819	10,982	36,801	59.4%
Lower trunk	13,107	5,768	18,875	5,421	2,414	7,835	58.5%
Upper leg	3,979	2,820	6,799	1,999	780	2,779	59.1%
Knee	41,867	22,240	64,107	18,013	8,882	26,896	58.0%
Lower leg	11,892	4,182	16,074	7,327	1,896	9,223	42.6%
Ankle	91,091	52,032	143,123	37,969	20,192	58,161	59.4%
Foot	13,732	9,113	22,846	7,456	4,198	11,654	49.0%
Toe	4,533	3,070	7,603	2,900	870	3,770	50.4%

Query selections: Age range: 0-19 years. Sport: baseball/softball, basketball, football, hockey (all kinds), lacrosse, rugby, miscellaneous ball games, miscellaneous sports (e.g., cheerleading, gymnastics and wrestling), soccer, volleyball. Diagnosis: avulsion, dislocation, fracture, strain, sprain. Body part: upper extremities, lower extremities, lower trunk/public region

only a month of home restrictions.<sup>[18]</sup> During this uniquely stressful period of time, parents report significant sleep-disruption in their children along with associated psychological difficulties, such as increases in disruptive behavior and emotional dysregulation.<sup>[19]</sup> Opportunities for extra-family socialization have been restricted, further reducing the peer-to-peer in-person interactions and social skills development.<sup>[20]</sup>

Returning to sports may offer an antidote to many of the mental health sequelae of COVID-19 restrictions. Active participation in sports improves youth mental health and provides opportunities for socialization, identity development, and physiological regulation.<sup>[21]</sup> Physical activity and sports appear to serve a protective role in youth mental health<sup>[22,23]</sup> and have been shown to influence feelings of self-worth and physical self-perceptions.<sup>[24]</sup> Team sports, as an example, provides long-term mental health “protection” for the youth who experienced adverse childhood experiences including physical, sexual, and emotional abuse, parental incarceration, and substance abuse.<sup>[25]</sup> Longitudinal research demonstrates that school sports involvement significantly correlates with lower depression, lower perceived stress, and higher self-rated mental health in young adults.<sup>[26]</sup>

Importantly, youth who have been heavily involved in sports pre-COVID-19 may face unique challenges in their return to sport. Physical deconditioning associated with reduced physical activity<sup>[8]</sup> may increase feelings of performance anxiety in athletic youth. Youth with social phobia and shyness are at particular risk of experiencing heightened symptomatology as they return to sports.<sup>[27]</sup>

The implications of COVID-19 are concerning; however, there is reason to believe that returning to sports can attenuate the impact of social distancing on the psychological and physical functioning of the youth. Taking an educated, graduated, and supported approach to returning to sport is optimal.<sup>[15,28]</sup> Setting realistic performance expectations for youth who are deconditioned may reduce distress and anxiety in youth who are returning to sports. Providing opportunities to rebuild sports team relationships can help to re-establish team bonds and the capacity to tolerate distress. When possible, coaches and teachers can consider sharing and rehearsing basic stress-management techniques with their athletes and students, including progressive muscle relaxation and deep breathing to help normalize stressors and provide opportunities for skills development.

It is difficult to calculate the psychological impact on children who return to sports and sustain an injury that prevents participation in that sport. Therefore, injury prevention is important from not only the physical but also the psychological standpoint.

### Physical impact and potential for increased orthopedic injuries

During the COVID-19 pandemic, it is clear that children have had decreased participation in sports and other recreational activities. Furthermore, most children were not going to school in person or participating in physical education classes. It is not surprising that there has been an increase in obesity and overall musculoskeletal deconditioning during the COVID pandemic.<sup>[10]</sup> Childhood obesity is thought to increase the risk of fractures due to decreased bone mineral density, the increased force generated during an injury (such as a fall), impaired balance, and other biomechanical factors.<sup>[29]</sup> For example, obese children with fractures in the supracondylar humerus region of the elbow are more likely to have complex fractures requiring open surgical treatment.<sup>[30]</sup>

As children start to return to sports and other pre-pandemic activities, it is likely that we will see an increase in musculoskeletal pain, overuse, and traumatic injuries. Common overuse injuries in the upper extremity include shoulder and elbow conditions in throwing athletes (Little League shoulder and Little League elbow). In the lower extremity, stress fractures can arise in several locations including the femoral neck, tibial shaft, or metatarsals. Apophyseal or traction injuries include Osgood Schlatter disease and Sever's calcaneal apophysitis. These injuries may require advanced diagnostic imaging such as magnetic resonance imaging. Most of these conditions are initially treated with rest and symptomatic treatments (e.g., ice and anti-inflammatories), followed by physical therapy for a more measured return to activity. Injuries not responding to conservative therapy may require surgical management by an orthopedic specialist.<sup>[31]</sup>

Compounding the risk of deconditioning is the increased risk of injury in adolescents who are experiencing a growth spurt. During the rapid phase of growth, also known as peak height velocity, the growing bones go through a period of relatively decreased bone mineral density. This phase is associated with a higher rate of fractures,<sup>[32]</sup> and providers and caregivers should be aware of the increased risk.

Table 3 lists common traumatic orthopedic injuries of the upper and lower extremities in pediatric patients.<sup>[33,34]</sup> As a general principle, a thorough assessment of all extremities should be performed. Most of these injuries require radiographs for diagnosis, including the joints above and below the area of concern. For example, a mid-shaft forearm fracture may have an associated radial head dislocation (Monteggia fracture); a complaint of knee pain may be associated with hip pathology (such as slipped capital femoral, epiphysis). Providers must also be cognizant of the patient's age and familiar with the

**Table 3: Common pediatric upper and lower extremity injuries<sup>[33,34]</sup>**

	Upper extremity	Lower extremity
Dislocation	Shoulder Elbow	Patella
Fracture	Distal radius Midshaft forearm Distal humerus (supracondylar, lateral condyle) Clavicle Hand/fingers	Ankle Tibial shaft Foot/toes
Sprain/ strain	Fingers Wrist	Ankle Knee (anterior cruciate and medial collateral ligaments)
Avulsion	Elbow (medial epicondyle)	Pelvis (anterior superior and inferior iliac spine) Tibial tubercle 5th metatarsal base

variations in radiographic findings as children mature. Fractures involving the physis (growth plate) should be followed by an orthopedic specialist, as there can be long-term implications such as growth arrest, limb length inequality, and angular deformity.

### Return to sports assessment and risk factors

After the pause in sports and general activity that resulted from the pandemic, athletes may require more time and attention to rebuild their strength and endurance. Physiological changes caused by inactivity begin within 2–4 weeks of detraining.<sup>[16]</sup> Players also quickly become less agile. Many children need physical reconditioning before they return to individual and team sports. The pediatric population is more susceptible to injury due to an immature musculoskeletal system.<sup>[31]</sup> It is important to have a gradual progression to build up their strength and endurance as they resume their previous level of activity.

Though the literature is replete with evidence for return to sports after specific injuries,<sup>[35-37]</sup> there is little guidance for return to sports after a prolonged absence. Most protocols initially focus on strengthening, range of motion, and aerobic capacity, followed by agility and neuromuscular control. An example is squatting and hopping initially with both legs and progressing to a single leg. After general conditioning, the focus should be on demands specific to each sport.

Each sport has unique physical demands and risk factors for injury. When returning to a sport, it is important to factor in the duration of a game and the physical demands placed on the young athletes. This requires an evaluation of a child's strength, speed, flexibility, neuromuscular control, and cardiovascular endurance.

The lower extremities and core muscles are typically the weakest due to deconditioning. With inactivity and increased sitting, large muscle groups have likely become weak, and athletes of all ages and competition levels would benefit from strengthening. The focus of strengthening should be on core and proximal hip



**Table 4: Return to sports quick assessment for pain and limited range of motion**

Movement	The expected range of motion	Risk factors with pain or limited range of motion
Reach behind head and back	Able to touch top and bottom of shoulder blades	Neck, upper thoracic spine, or scapular pain
Extend arms in front and raise arms overhead	Able to reach forward and raise arms overhead	Shoulder pain Compensation leading to overuse injuries (Little League shoulder)
Raise arms out to side and overhead	Able to reach forward and extend arms up overhead	Shoulder pain Compensation leading to overuse injuries (Little League shoulder)
Wall push-up	Shoulder blades are symmetrical Shoulder blades do not raise or pop off the ribs	Mid back pain Overuse injury (Little League shoulder, Little League elbow)
Squat	Able to squat as low as if sitting on a chair	Hip or knee injuries
Sidestep	Able to keep toes pointing forward while sidestepping	Iliotibial band overuse injury Knee injuries (anterior cruciate ligament or medial patellofemoral ligament tears) Low back pain
Walk on heels	Able to walk 10 steps up on heels	Shin splints Achilles tendon injury
Walk on toes	Able to walk 10 steps up on toes	Gastroc tightness Achilles tendonitis Plantar fasciitis
Straight leg raise from the supine position	Able to achieve 90° of hip flexion	Low back pain Hamstring injuries

muscles, including hip flexors, especially gluteus medius and gluteus maximus.

The upper extremity joints (neck, shoulder, elbow, and wrist) all play a role in overhead throwing, racket/bat swinging, and swimming, resulting in increased susceptibility to overused injuries. It is essential to consider general strengthening for each joint, while also including stretching for flexibility and range of motion.

Acceleration, deceleration, and change of direction are all important aspects of many sports, especially team sports.<sup>[16]</sup> With each of these components, it is critical to have the strength and coordination needed to prevent injury, especially anterior cruciate ligament tears. Strengthening prevents injury and improves muscle coordination. Ideally, a balance should be established between the pace of reconditioning and the prevention of injury.

Table 4 is a quick assessment for pain and limited range of motion before youth return to sports. If the assessment identifies pain or limitations in the range of motion, a referral to a pediatric physical or occupational therapist may be beneficial. Young athletes, depending on their current strengths and weaknesses, may need an individual approach for a safe return to sports.

## Conclusion

The NEISS database demonstrated the dramatic decrease in pediatric orthopedic sports injuries during the COVID pandemic in 2020. Given the prolongation of the COVID pandemic, as mutations have resulted in continued restrictions, the authors will reassess the database in 2021 and 2022 to monitor changes in pediatric sports injury trends. As discussed in the article, team sports are important to the physical and psychological well-being of children, with prevention preferable to treatment

of the injury. With COVID-influenced factors such as obesity and/or decreased conditioning, musculoskeletal pain, overuse, and traumatic injuries are likely to increase. Family medicine and primary care physicians play a key role in the prevention, identification, and treatment of pediatric sports injuries.

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## Abbreviations

National Electronic Injury Surveillance System (NEISS), United States (U.S.)

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## Conflicts of interest

There are no conflicts of interest.

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