Sports Medicine Considerations During the COVID-19 Pandemic

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The outbreak of the novel coronavirus (COVID-19) has resulted in upward of 14 million confirmed cases and >597,000 deaths worldwide as of July 19, 2020. The current disruption in sports activities caused by COVID-19 presents a challenge to physicians, coaches, and trainers in discerning best practices for a safe return to sport. There is a distinct need to develop and adopt consistent measures for resumption of sports activities, including training and competition, in a way that places the health and well-being of athletes at the forefront while also protecting coaches, allied staff, and spectators. This article provides an overview of the effects of COVID-19 in the athletic population and presents considerations for training during the pandemic, as well as guidelines for return to sports as restrictions are lifted.

Keywords: sports; COVID-19; pandemic; athlete

On March 11, 2020, the World Health Organization declared the outbreak of the novel coronavirus (COVID-19) a pandemic. With upward of 14 million confirmed cases and >597,000 deaths worldwide, as of July 19, 2020, COVID-19 has demonstrated its sustainable and relentless transmission across borders and throughout communities.[65] SARS-CoV-2, the virus that causes COVID-19, is transmitted through viral shedding in respiratory droplets as well as transfer from surfaces to mucous membranes through hand contact, highlighting its highly contagious nature.[7] This virus has taken a considerable toll on humanity and caused global economic instability and decline as governments enforce stay-at-home orders to limit viral spread, protect the most vulnerable, and prevent overwhelming the health care system.

Even before the government enacted stay-at-home orders, the sports world began taking steps to protect athletes, coaches, fans, and staff from the virus through cancellations and postponements of virtually every sporting event. Sports at all levels require close contact of athletes, coaches, and fans, thereby making sports an easy vector for community and global spread. The first headline-making cancellation was declared when the National Basketball Association suspended its season on March 11, 2020, after a player tested positive for COVID-19.[12] Then, the National Collegiate Athletics Association canceled all remaining spring championships, including the March Madness tournaments, and the National Hockey League and Major League Baseball postponed the beginning of their seasons. The Boston and London marathons both postponed their races until later in the fall, and the Olympic Games were officially delayed to a tentative date of July 2021.[12,31,43] The latest updates from all of the summer International Federations concerning COVID-19 cancellations, postponements, and recommendations have been compiled on the Olympics website.[30]

Youth athletes have also experienced the termination of their sports seasons after school and facility closures and event cancellations by governing bodies such as the Amateur Athletic Union.[11] The Aspen Institute issued a Return to Play Risk Assessment Tool, encouraging people to maintain daily physical activity while prioritizing low-risk activities such as free play and individual training sessions.[48] The recommendations from sport-specific governing bodies vary widely by the nature of the sport, the jurisdiction of the governing board, and local governmental

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regulations. The US Tennis Association advised for a safe return to tennis in some communities less affected by COVID-19, while USA Gymnastics has urged all clubs to severely limit practice and competition.[11] Comparable guidelines have been issued by other prominent sports organizations in the United States.

The global sporting world was similarly affected in 2003 after severe acute respiratory syndrome (SARS) was declared an epidemic in Hong Kong. This outbreak, caused by a novel coronavirus at the time, led to the cancellation of many international sporting events—the difference being that SARS did not reach pandemic status and the majority of canceled events were isolated to Asia.[52] The Fourth FIFA Women's World Cup was postponed and transferred from China to the United States; the Women's International Ice Hockey World Championships to be held in Beijing was canceled; and in an unprecedented move, Ireland made a decision to ban athletes from Hong Kong and other SARS-infected countries in the 2003 Special Olympics World Summer Games (the decision was later rescinded).[52]

There are limited data available on the specific criteria that were used by the world's governing bodies to determine when it was safe to return to sports after SARS. Furthermore, the current disruption in sports activities caused by COVID-19 is worldwide and much more extensive, making it difficult to discern best practices for a safe return to sport. There is a distinct need to develop and adopt consistent measures for resumption of sports activities, including training and competition, in a way that places the health and well-being of athletes at the forefront while protecting coaches, allied staff, and spectators.

MODE/RISK OF TRANSMISSION IN ATHLETES

Before athletes return to play, the possibility of transmission among them must be addressed and limited. The transmission of the virus is through respiratory droplets and contact routes, with airborne transmission possible in specific circumstances, such as administration of nebulized treatment.[67] Transmission may also occur via contaminated surfaces, such as mats, training room equipment and tables, and surfaces in a locker room, although this is not believed to be the main mode of transmission. It is currently unclear how viable the virus is when deposited onto surfaces.[9] The main risks of transmission in athletes are the close contact nature of sports, the frequency of travel to and from competitions, the dense and humid locker room conditions, and the inability to perform strenuous physical activity while wearing a face mask, as demonstrated through research on the SARS epidemic.[52] Most athletes do not have the luxury of remaining physically distant during practices and competitions, given the nature of contact sports or the space limitations of training facilities, thereby putting them at risk for viral transmission via respiratory droplets. Also, a social distance of 1.5 m was defined for persons who are standing still, and it should be increased with faster walking and running speeds.[4] There is also the potential for virus transfer on shared surfaces (sports equipment, weights, and commonly touched surfaces [eg, doors]) and the possibility that an athlete may then touch his or her face.[9] The Centers for Disease Control and Prevention (CDC) has issued nationwide recommendations to use face coverings whenever possible, as the viral droplets may be able to travel up to 6 ft; however, regular use of face coverings during training or competition is unrealistic in a sports setting, owing to the imposed respiratory limitations of face masks.[8]

There are data suggesting that COVID-19 can be transmitted from individuals who are asymptomatic or presymptomatic carriers.[1,34,63] With many athletes being younger and falling outside the high-risk group for COVID-19 complications, they may be less likely to exhibit symptoms during infection while still being contagious and presenting a risk to those with whom they come into contact. This adds an extra layer of concern for athletes with undiagnosed or underlying conditions, as well as coaches and support staff who may be at a higher risk for complications of COVID-19.

MANAGING ATHLETES WITH COVID-19

Cases of COVID-19 have been generally stratified from asymptomatic to critical, with different treatment indications at each phase.[42] An asymptomatic athlete who tests positive for COVID-19 should immediately self-isolate and be monitored for the development of symptoms. An effort should also be made to trace all close contacts of the infected individual. The percentage of patients who remain asymptomatic throughout the course of their illness is currently unknown. An athlete with mild symptoms (ie, fever, cough, sore throat, fatigue, muscle pain) should self-isolate and be closely monitored for worsening symptoms, which may be indicative of decreased oxygen saturation, in which case hospitalization may be recommended for clinical observation. Throughout March 2020, only 2.5 per 100,000 patients aged 18 to 49 years in the United States who were infected with COVID-19 required hospitalization.[15] However, clinical data suggest that some patients with COVID-19 rapidly progress in the severity of their illness, making clear the need for close monitoring of any symptomatic athlete.[16,19] To date, definitive treatment for COVID-19 has yet to be established. Fever in mild cases can be safely managed with antipyretics such as acetaminophen/paracetamol.[50,53] Although several clinical trials are under way to test the efficacy of antiviral agents, treatment strategies are constantly evolving; therefore, further controlled evidence is needed.

SEQUELAE OF COVID-19 IN THE ATHLETIC POPULATION

On the basis of the limited available data, athletes—who tend to be younger with no comorbidities—are less likely to develop moderate to critical symptoms from COVID-19 and may instead be asymptomatic or experience a mild, flulike illness.[56] Currently, the long-term effects of this virus are unclear; therefore, it is important to understand how the potential sequelae of COVID-19 infection may

affect the athletic population and what considerations need to be made in return-to-play preparticipation examinations. It is important to note that the understanding of COVID-19 is continually changing. The goal of this review is to summarize general principles for consideration in developing return-to-play protocols with the awareness that specific guidelines will undoubtedly evolve over time.

The majority of patients with COVID-19 who underwent chest imaging have shown lung abnormalities, with 75% exhibiting bilateral involvement.[25] Visible abnormalities on chest computed tomography have been estimated to peak at 10 days after symptom onset, with lesion resolution occurring at 14 days to beyond 26 days.[46] Based on a review comparing COVID-19 with the respiratory effects seen after SARS and Middle East respiratory syndrome (MERS) infection, long-term follow-up chest imaging may be warranted, as fibrosis was a common finding in patients who experienced persistent respiratory symptoms.[25] Hui et al[27] followed patients who recovered from SARS to assess long-term functional capabilities. They noted that at 6 months, there was well-preserved lung function, although exercise capabilities measured with the 6-minute walk distance test, a cardiopulmonary exercise test, were significantly reduced at 3 and 6 months. For athletes exhibiting pulmonary complications of COVID-19, special attention should be given to long-term monitoring of radiographic lung findings as well as to allocating sufficient recovery time (6 months to 1 year) to regain preinfection respiratory capacity.

Acute and chronic cardiovascular complications commonly occur with viral infections such as influenza, the related SARS and MERS viruses, and concomitant pneumonias.[2,69] Documented cardiovascular manifestations include hypotension, arrhythmias, acute cardiac injury, myocarditis, acute myocardial infarction, and exacerbation of heart failure.[69] Acute cardiac injury has been reported in 8% to 12% of patients with COVID-19 and was likewise seen as a common complication of MERS infection.[2,72] Long-term data on patients with SARS demonstrated that up to 40% of patients exhibited cardiovascular abnormalities at 12 years.[68] Although this is not a predictive element to COVID-19, it highlights the necessity of long-term monitoring for cardiovascular sequelae in patients who have recovered from COVID-19. Recent data suggesting the presence of myocarditis in patients with COVID-19 positivity, with and without respiratory symptoms, indicate the importance of cardiovascular monitoring for recovered athletes before returning to play.[29,71] We recommend the following as a baseline plan in monitoring the cardiovascular health of athletes as they transition back to regular physical activity. At this time, there are no guidelines for how long someone should be monitored for cardiovascular sequelae, but implementing long-term cardiac screening may be a vital component in assessing the health of athletes after COVID-19 infection. Because of the cost of cardiac screening and the distinct risk of false-positive findings that necessitate further evaluation, with its financial and emotional implications for athletes and their families, a careful risk stratification approach should be followed. Consultation with a sports cardiologist is recommended. For those individuals who are thought to be at higher risk of cardiovascular sequelae, consideration should be given to performing electrocardiography and echocardiography and to measuring cardiac biomarkers (serum troponin levels). Evaluation with cardiac magnetic resonance imaging, exercise testing, or ambulatory rhythm monitoring should be based on the clinical course and initial testing. Furthermore, although COVID-19 presents a lower risk in generally healthy young athletes, the procoagulant state induced by systemic inflammation may increase a patient's susceptibility to deep venous thrombosis and even pulmonary embolism.[69] It was hypothesized that recovered patients with SARS would need a prescribed exercise program targeted at improving cardiorespiratory function, an important consideration to make in addition to the aforementioned thoughts on return-to-play training protocols.[52]

There is noted central and peripheral nervous system involvement with COVID-19 infection. Mao et al[36] demonstrated that 36.4% of their cohort of patients in Wuhan, China, exhibited central nervous system (CNS) symptoms of dizziness, headache, stroke, seizure, and altered sensorium.[3] In addition, 8.9% of this cohort exhibited peripheral nervous system symptoms of taste and smell abnormalities and nerve pain.[36] A multicenter European study by Lechien et al[33] identified 85.6% of patients with smell abnormalities, some of whom had no other COVID-19 symptoms. Although there is no clinical reason that an athlete who is anosmic or hyposmic would not be cleared for return to play, the presence of these symptoms could help identify otherwise healthy athletes who are infected with COVID-19. There is currently no evidence of viral entry into motor neurons and peripheral nerves.[20] Laboratory testing in patients with neurological symptoms has demonstrated elevated levels of C-reactive protein, increased D-dimer levels, reduced lymphocyte counts, lower platelet counts, and higher blood urea nitrogen levels.[3,36] Although much of these data were collected from patients with severe CNS symptoms, the use of these laboratory tests may elucidate potential CNS involvement in affected patients. Serious CNS complications (eg, critical illness polyneuropathy or myopathy) were exhibited in patients with SARS, indicating that severe long-term effects may be present only in patients who experience critical illness with extended brain hypoxia.[57] For the average athlete, CNS complications may be minimal, but the potential for subtle abnormalities in proprioception, balance, or coordination that can affect athletic performance should be considered.

Myalgia has been commonly documented in individuals with COVID-19 infection, as is common with other viral illnesses. Wang et al[61] reported 34.8% of patients in their cohort from Wuhan, China, presenting with myalgia. Similarly, Mao et al[36] reported muscle pain with elevated creatine kinase levels in 10.7% of their cohort. Long-term musculoskeletal effects seen in patients with SARS included chronic arthralgia with unremarkable imaging and otherwise diffuse chronic joint pain.[18,40] There was a high prevalence of osteonecrosis associated with SARS recovery that was linked to the use of corticosteroid treatment.[18] Dexamethasone has been used to treat severely ill patients with COVID-19, with favorable outcomes.[55] However, the possibility of subsequent osteonecrosis should not be ruled out in these patients. Athletes with symptomatic

COVID-19 are likely to have diffuse myalgia, but unless their illness is critical, long-term effects appear to be unlikely.

Systemic inflammation and immune dysregulation have also been reported in COVID-19. A so-called cytokine storm has been reported in critically ill patients with COVID-19, which is manifested as persistently elevated systemic inflammation, with concomitant abnormalities in inflammatory cytokines such as interleukins 1 and 6, and which is associated with a high rate of mortality.[39,70] Although this cytokine storm is seen only in critically ill patients, lesser degrees of inflammatory dysregulation may be present in an athlete after COVID-19 infection and may affect the individual's response to the stresses associated with training, competition, and travel. Measurement of serum levels of ferritin and C-reactive protein has been suggested as biomarkers of systemic inflammation.[39,70]

COVID-19 PREVENTIVE MEASURES IN ATHLETES

Although athletes are generally younger with fewer medical comorbidities and therefore may be at a lower risk of severe symptoms or death from COVID-19, preventing transmission is important to slow the pandemic and limit the number of individuals affected. In addition, team physicians, coaches, and athletes should focus on preventive measures to allow for safe return to athletic participation, minimize the number of COVID-19–related interruptions in training, and reduce adverse physiologic affects that may impair an athlete's ability to return at pre–COVID-19 levels in the short and long term.[56]

Social distancing and physical avoidance of athletes who have tested positive for COVID-19 or had exposure to a person with COVID-19 are ultimately the most effective ways to prevent spread of infection. Avoidance of mass gatherings while following the CDC's recommendation of staying 6 ft apart from others is advocated within the athletic community.[6] Additionally, personal hygiene through frequent hand washing and avoidance of touching the nose, mouth, or eyes may help diminish the spread of infection. Showering before and after athletic activity, as well as sanitizing all sporting equipment and clothing used during practice daily, may limit transmission of the disease.[26] Although utilization of a face mask in high-risk situations may be beneficial, previous studies have demonstrated that this does not reduce the risk of infection in the community setting and is not advised in the athletic population at this time.[8,56] Monitoring for fever has been an alternative strategy to help identify potentially infected athletes, and it is recommended that athletes who exhibit fever should be socially isolated, discontinue training, and seek immediate medical attention.[52] Travel bans, with cancellations of sports leagues and tournaments, have been instituted to limit transmission of COVID-19 among athletes. During the time of the pandemic, it has been recommended that athletes travel to and from only their location of local training.[56] Last, proper educational resources should be easily accessible to familiarize athletes with the symptoms and sequelae of COVID-19 to appropriately manage and treat the disease as well as prevent transmission.

Testing for COVID-19 as a preventive measure continues to be controversial. At this time, it is recommended that only individuals who have symptoms, including fever, cough, or shortness of breath, be tested for the virus with a nasopharyngeal swab using an RNA detection polymerase chain reaction (PCR) test.[56] Chest radiographs and chest computed tomography are also considered in more severe cases that require hospital evaluation or admission. Measurement of oxygen saturation using pulse oximetry may also be considered. A consideration in testing is the sensitivity and specificity of the test. Further data are required to define these important metrics for currently available tests. We also need data to understand the duration that an individual remains contagious after a positive test result. Data from the CDC suggest that by 10 days after symptom onset, the statistically estimated likelihood of recovering replication-competent virus approaches zero (ie, not infectious) despite a PCR test finding that may remain positive for 5 to 6 weeks after symptom onset.[7]

In addition to testing for viral nucleic acid with PCR to establish active infection, serologic testing for the presence of immunoglobulins may be considered. Immunoglobulin M may be seen in the acute phase of illness, followed by development of immunoglobulin G.[17] At this time, the implications of positive serology (ie, the presence of antibodies) is unclear, with questions about the degree and duration of immunity conferred. Similar to PCR testing, questions remain regarding sensitivity and specificity of serologic testing, with the possibility of a false-positive result from previous exposure to a different coronavirus strain. As more tests are developed and refined, the indication of whom and when to test will also evolve and will aid in providing a more accurate assessment of an athlete's exposure to or severity of COVID-19 infection.

THE DECONDITIONED ATHLETE AND RETURN TO PLAY

The spread of COVID-19 has led to a halt in professional and recreational sporting activities. Athletes have been forced to rely on individualized training at home. Although many teams have implemented a home-based training program with online training sessions or video conferences, the level of training is unfortunately not comparable with the typical practice and game setting.[32] The current literature has yet to establish a protocol for return to sport during a pandemic situation, including the current pandemic. Therefore, considerations must rely on previous disuse-based studies demonstrating the results of returning to physical activity after periods of detraining and deconditioning. Detraining, which is a loss of fitness when athletes stop working out, negatively affects neuromuscular, cardiovascular, respiratory, and musculoskeletal systems, which should all be taken into consideration when developing a return-to-sports protocol (Table 1).

The cessation of routine physical activity at any level can have detrimental effects on an athlete's ability to maintain aerobic power and muscle strength. Varandas et al[59] reported an overall loss of up to 10% of fitness for

TABLE 1
Physiologic Effects of Detraining[14,32,44,59]

Cardiovascular/ respiratory	↓ VO_2 max
	↓ Aerobic capacity/endurance
	↓ Blood volume
	↓ Stroke volume
	↓ Cardiac output
	↓ Hemoglobin content
	Impaired ventilatory efficiency
	↓ Cardiac dimensions
Musculoskeletal	↓ Strength endurance
	↓ Muscle mass
	↓ Muscle strength
	↓ Flexibility
	↓ Skeletal muscle capillarization
	↓ Arteriovenous O_2 difference
	↓ Oxidative enzyme activity
	Type II fast twitch → type I slow twitch
	Altered tendon/muscle architecture
Miscellaneous	Altered temperature regulation
	↑ Percentage of body fat mass
	↑ Reliance on carbohydrate metabolism
	↓ Insulin sensitivity

each week of total inactivity. In addition, it has been demonstrated that the rate of loss for aerobic endurance and strength endurance is higher than that for speed and maximum strength, which is important when organizing a protocol for an athlete's return to physical activity.[14] The reversibility principle refers to a compromise in athletic performance attributed to a partial or complete reversal of training-induced adaptations.[24,32] This principle is often associated with the deconditioning that is prevalent after the "transition" or "off-season" periods commonly utilized during sports, which consist of rest and a reduction in the normal day-to-day physical activity levels of the athlete. Previous studies demonstrated that this period of rest is associated with a decrease in muscle strength and mass, a reduction in VO_2 max, and an increased risk of injury.[13,14] Neufer et al[44] attributed detraining effects to an initial rapid decline in VO_2 max; a decrease in blood volume, total hemoglobin content, skeletal muscle, and capillarization; a change in cardiac hypertrophy; and a disruption of temperature regulation.[32] Muscle disuse atrophy occurs in lower limb muscles even after short periods of unloading, and these losses in muscle size and architecture, as well as in tendon mechanical properties, are accelerated in elite athletes who have greater initial muscle mass.[32] This is often accompanied by a decrease in flexibility, limiting an athlete's range of motion and ultimately leading to an increased risk of injury.[32] Caldwell and Peters[5] reported a decrease in flexibility after 8 weeks of detraining. Therefore, athletes are encouraged to participate in activities including tai chi and yoga, which can help improve dynamic balance control and flexibility during periods of isolation.[32,35] Last, detraining can affect the strength and size of type II fast-twitch and type I slow-twitch muscle fibers. Previous studies demonstrated a transition of fast-twitch fibers into slow-twitch fibers after 4 weeks of inactivity, with a decrease in the transverse fibrillar area of approximately 0.6% per day.[32,47,62] In addition, prolonged physical inactivity can result in (1) muscle shortening and/or hypertonia in type I slow-twitch muscle fibers or (2) laxity and/or hypotonia in type II fast-twitch muscles.[32] These changes can result in suboptimal athletic performance and increased risk of injury and should be a concern for athletes after release from COVID-19 home confinement.

It is critical for return-to-sport protocols to take into account the deconditioning of athletes during the first few weeks when returning to high training volume and intensity. Eirale et al[14] described 3 factors to consider when evaluating an athlete's return to training: (1) whether the player had contracted COVID-19 and if there are any associated sequelae, (2) the duration of the detraining period, and (3) the level of physical activity that the player maintained during the detraining period. In a pandemic situation, the process of how sporting events will reopen has yet to be established. If progression is slow with reintroduction of an athlete back into the sporting environment over the course of several months or if it occurs during an athlete's off-season, the athlete will have the ability to increase his or her training in a stepwise fashion with a lower risk of injury. Alternatively, athletes who return in the peak of season may be required to enter directly into high-level competition with a condensed season and therefore may be unprepared for the requisite elevated training and physical demands.[32] A sport-specific reconditioning period is important to allow for recovery of the neuromuscular and cardiorespiratory functions to return to sport without an increased risk of injury.[14] Sport governing bodies should also offer appropriate time for high-level athletes to return to sport and competition safely.

The literature has demonstrated an association between physical activity and immune system effectiveness, with moderate activity enhancing the immune system response against viral respiratory infections.[37] Previous studies have shown that there is an increase in B and T lymphocytes and neutrophils with an increase in leukocytosis during moderate endurance sports activities and that overall inflammation is reduced because of an increase in stress hormones.[60] Harris[23] reported a 30% reduction of upper respiratory tract infections in individuals performing moderate daily activity. However, it should be noted that more prolonged periods of high-intensity training or overtraining can lead to suppression of immune function and an increased susceptibility to infection. This may be especially relevant if there is persistently elevated inflammation as a sequela of COVID-19, as discussed earlier. Such immune dysfunction may be attributed to an induced oxidative state with accelerated neutrophil apoptosis and a consequent effect on innate immunity.[14,54,60] The period after intense bouts of exercise has been considered an "open window" leading to increased inflammation, muscle damage, and an overall risk of infection.[51] For example, Niemen[45] conducted an epidemiologic study evaluating the risk of developing an infectious episode before and after running a marathon. The authors found that runners training >97 km/wk had a higher risk of developing an upper respiratory illness as compared with runners training <37 km/wk.

In a 1994 literature review evaluating upper respiratory illness in sports and exercise, Weidner[64] demonstrated that athletes who exceed their physiologic exercise limit may be at increased risk for developing an upper respiratory infection. This concept is important, as athletes may be at increased risk for contracting COVID-19 if they participate in excessively demanding physical training. Therefore, careful monitoring for respiratory symptoms with athletic training during the COVID-19 pandemic is important to help reduce the severity and spread of the virus. In addition, the potential need for cardiac screening may be considered before participation in the rehabilitation protocol when increasing an athlete's activity levels after periods of confinement.

RETURN TO ACTIVITY AFTER COVID-19 INFECTION

Unfortunately, there are no data available assessing the appropriate guidelines for an athlete to return to sport after COVID-19 infection. Although the majority of athletes are young and healthy and appear to contract mild disease, previous studies demonstrated a heightened risk of deterioration with lower respiratory tract infection.[28] In addition, there is concern for increased risk of complications after return to sport in athletes who have had COVID-19, including the development of myocarditis or myocardial damage.[29,71] Hull et al[28] suggested that athletes wait to return to activity after a minimum of 10 days from onset of symptoms plus a minimum of 7 days from symptom resolution after a respiratory illness that occurred as a result of COVID-19. The "neck check rule," which has been implemented by many physicians, involves determining whether the symptoms of upper respiratory tract infection are limited to above-neck symptoms, including coughing, sneezing, or a sore throat.[21] Halabchi et al[21] recommend evaluating an individual's ability to jog for 10 minutes. If an athlete's condition does not change during the 10-minute interval, then the athlete may be allowed to return to low to moderate physical activity <80% VO_2 max.[21] Athletes who have any symptoms below the neck, including tight chest, persistent cough, nausea, vomiting, or muscle aches, should be prohibited from sports participation until symptoms resolve.

PHASES FOR RETURN TO ATHLETIC ACTIVITY

As a result of the strict guidelines enforced to limit exposure and transmission of the COVID-19 virus, athletes are limited in the type of training in which they can participate. The US Olympic and Paralympic Committee organized a generic return-to-play protocol during different phases of the pandemic, which is based on the rules and regulations set by public health authorities.[58] Table 2 summarizes the proposed guidelines and offers activity recommendations based on the level of social and physical interaction permitted.

During the "confinement" or "shelter in place" phase, athletes are required to stay at home, where they are able to participate in activities using their own equipment. It is recommended at this time that coaches and athletic trainers implement an individualized training program that athletes are instructed to follow utilizing the space available in their homes. During the second phase, when the "shelter in place" rule is lifted, athletes are encouraged to continue their training regimen within the confines of their home or backyard. There is controversy of whether one-on-one, coach-athlete interaction should be permitted at this time, but athletes still are able to maintain physical fitness through use of their equipment and individualized training regimen.[58] Training during these initial phases should focus on maintenance of cardiovascular and strength endurance, as well as incorporation of exercises to improve stretching and flexibility.[32,58] Cardiovascular training is important when developing a return-to-play protocol for athletes. Previous studies recommended 3 or 4 cardio sessions per week, not exceeding 60 minutes per day, with intensities limited to 80% of the maximum heart rate.[22,38] In addition, biweekly strength training sessions should be incorporated but not exceed 60 minutes. Additionally, exercises with maximum loads at full muscle exhaustion should be avoided.[14] These recommendations can be incorporated into an individual's training program. Phase 3 during the pandemic allows for social gatherings consisting of <10 individuals at a time.[58] Teammates are still restricted from direct and indirect contact, but small groups are permitted to train together while practicing social distancing. It is important that athletes self-monitor for symptoms. This remains true during the fourth phase, when public facilities open and there is no limitation on social gathering. Regulations are constantly evolving; however, it is possible that programs will implement regular temperature checks before practice and competition for their athletes and that 2 negative COVID-19 test results may become mandatory for sports participation. Last, once a vaccine is developed, vaccination will likely become standard of care for all participating athletes, coaches, and athletic trainers.

PSYCHOLOGICAL ASPECTS OF RETURN TO SPORT AFTER COVID-19

The cessation of sporting events has disrupted individual and team training, which can negatively affect the mental health of athletes during quarantine and as they transition to returning to play. An editorial by Schinke et al[49] reported that athletes are now faced with issues of social isolation, career disruption, and limited access to training environments and training partners, which can negatively affect their overall sense of well-being and lead to suboptimal performance. On an international level, differences in the level of confinement throughout the world has created concern that some athletes may have a training advantage or disadvantage depending on the region. During periods of confinement, athletes should have access to support groups and be encouraged to speak with health care professionals. Uncertainty regarding when athletes will be able to return to practice, as well as competition, can provoke stress, anxiety, and depression. Previous studies demonstrated that at baseline,

TABLE 2
US Olympic and Paralympic Committee: Return-to-Training Phases With Activity and Regulation Recommendations[58]

Phase	Individual or Team Training	Training Environment	Recommended Activity	Regulations
Confinement, shelter in place	Individual	Home, virtual coaching, own equipment	Treadmill, bicycle, rowing ergometer, resistance training equipment, body mass resistance circuit-based training, sports skills training (video analysis, virtual reality), personalized strength and conditioning training, plyometrics, nutritional education, mental fatigue monitoring	
Prohibition of group activities, public facilities closed	Individual (1 or 2 people)	Home/outside, social distancing, virtual coaching, own equipment	Treadmill, bicycle, rowing ergometer, resistance training equipment, body mass resistance circuit-based training, sports skills training (video analysis, virtual reality), personalized strength and conditioning training, plyometrics, nutritional education, mental fatigue monitoring	No symptoms of COVID-19 in 14 d, clearance note required if previously infected
Small group activities, public facilities closed	Individual or <10 people	Outside with maintenance of social distancing, own equipment if possible, no direct or indirect contact with teammate		No symptoms of COVID-19 in 14 d, clearance note required if previously infected, minimize change in group, temperature checks, possible COVID-19 testing
Open public facilities, no group size restrictions	Individual or team	Social distancing no longer required, resumption of contact activities		No symptoms of COVID-19 in 14 d, clearance note required if previously infected, minimize change in group, temperature checks, possible COVID-19 testing
Vaccine administration				

elite athletes experience depression at a similar rate to the general population.[49] Cohen et al[10] investigated the effect of social bonding during exercise and showed that when compared with training alone, group training significantly increased pain threshold and potentially heightened opioidergic activity. The National Alliance on Mental Illness created the following general recommendations as a strategy for athletes' self-care during the pandemic[41]:

Space: structured work environment
Routine: normal daily routine, including attire and structured breaks
Activity: regular physical activity as well as "mindfulness" activities with quiet time and deep breathing
Time and energy management: awareness of self-talk, communication with others, nutrition, and structuring daily activity to mirror the normal workday
Accessibility: accessibility to friends, family, and colleagues
Face time and connectivity: utilization of video tools to connect visually
Support: the National Alliance on Mental Health Illness website as a resource and guide

The strategies provided by the National Alliance on Mental Health organization can serve as a guide for programs and teams to promote mental health and well-being during periods of confinement and restricted team physical activity.

SAFETY FOR FANS

To date, there have been no previous data addressing the appropriate time frame of when fans will be allowed to attend sporting events in a public setting. The World Health Organization outlined considerations for organizers of mass gatherings in the context of COVID-19 and included 3 phases to aid in the preparation for mass events:

Planning phase: liaison with local and national public health authorities, risk assessment, action plan for COVID-19, capacity and resource assessment, risk communication, and community engagement plan

Operational phase: risk communication, surveillance of participants, testing/diagnostic arrangements, treatment facilities, decision making, operational practices to reduce event-related transmission of COVID-19

Postevent phase: risk communication, lessons identified, legacy[66]

Targeted screening with rapid testing of individuals is a potential alternative to allow fans who have proven negative test results into public sporting events.[56] Although feasible, a vaccination that has been proven effective will likely be required to offer a safe environment that fans will be comfortable attending. Until then, leagues may have to expand television coverage of games when reinitiated and may also consider developing alternatives to broaden the stadium experience through virtual reality streams until the physical presence of fans returns to normal.[32]

CONCLUSION

The spread of COVID-19 has led to a halt in sporting activities. Unfortunately, there are limited data available discerning best practices for a safe return to sport after COVID-19. Although the majority of athletes are young and healthy and appear to contract mild disease, there is concern for increased risk of complications after return to sport in athletes who have had COVID-19. Strict guidelines have been enforced to reduce exposure and transmission of the COVID-19 virus, thereby limiting athletes in the type of training in which they can participate. This reduction in normal physical activity can result in deconditioning, which can negatively affect the neuromuscular, cardiovascular, respiratory, and musculoskeletal systems—all of which should be considered when developing a return-to-sports rehabilitation protocol. In addition, careful monitoring for respiratory and cardiovascular symptoms during the COVID-19 pandemic is even more critical to help reduce the severity and spread of the virus, as well as to ensure a safe return to play when increasing an athlete's activity levels after periods of confinement.

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