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Recommendations for Screening Children for Sudden Cardiac Death Risk with Sports Participation and COVID-19 Infection

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Why Cardiac Screening Matters

The preparticipation physical exam (PPE) and cardiac screening have been recommended for more than a decade to mitigate sudden cardiac arrest (SCA) and sudden cardiac death (SCD) by the American Heart Association (AHA) and American Academy of Pediatrics (AAP).[4,9] The incidence of SCA/SCD is difficult to accurately determine due to rare occurrence, but can be estimated at 1.2 to 1.4 per 100,000 people per year.[8,11] The goal of cardiac screening is ultimately to help identify individuals with risk factors for SCA/SCD, including cardiomyopathy, e.g., hypertrophic cardiomyopathy (HCM), arrhythmogenic cardiomyopathy; channelopathy, e.g., long or short QT syndrome, Brugada syndrome; congenital heart disease, i.e., Wolff-Parkinson-White syndrome; anomalous coronary arteries; aortopathies, e.g., Marfan syndrome; or a family history of thoracic aortic aneurysm. See Table 1, page 5. When determining the cause of sudden death in young athletes, more than one-third of cardiovascular causes have been attributed to HCM, which has an annual mortality rate of about 1%.[9,7]

(continues on page 2)

Recommendations for Screening Children for Sudden Cardiac Death Risk with Sports Participation and COVID-19 Infection

(continued from page 1)

AAP recently published updated cardiac screening guidelines, from their previous 2012 recommendations.[4] Importantly, the 2012 recommendations were primarily focused on screening prior to athletic competition. The updated 2021 policy statement addresses cardiac screening for all pediatric patients, regardless of sport involvement.[4] The AAP 2021 policy statement recommends that primary care providers group their patients into two groups through screening: those without risk factors and those with identifiable risk factors for either SCA or SCD. Screening is accomplished with history and physical examination, detailed below. Patients with identifiable risk factors should be referred to a pediatric cardiologist or electrophysiologist.

The evaluation: history and physical examination

AAP recommends that the following questions be asked of all patients ages 6 to 21 years, at minimum every three years and upon entry into middle school/junior high and high school:

1. Have you ever fainted, passed out, or had an unexplained seizure suddenly and without warning, especially during exercise or in response to sudden loud noises, such as doorbells, alarm clocks, and ringing telephones?

2. Have you ever had exercise-related chest pain or shortness of breath?

3. Has anyone in your immediate family (parents, grandparents, siblings) or other, more distant relatives (aunts, uncles, cousins) died of heart problems or had an unexpected sudden death before age 50? This would include unexpected drownings, unexplained auto crashes in which the relative was driving, or SIDS.

4. Are you related to anyone with HCM, Marfan syndrome, ACM, LQTS, short QT syndrome, BrS, or CPVT, or anyone younger than 50 years with a pacemaker or implantable defibrillator?

Of note, these questions from AAP have been worded so that they can be used within a patient questionnaire, which may be beneficial for practitioners as part of their routine wellness check.

The physical exam is key for: 1) identifying non-innocent heart murmur, 2) evaluating femoral pulses to rule out aortic coarctation, 3) stigmata of Marfan syndrome, and 4) obtaining brachial blood pressure preferably bilaterally.[9] Any patient with abnormal screening should be referred for further cardiac workup. This can include ECG, echocardiogram, Holter monitor, and cardiology referral.

CPR and AED use in cardiac arrest

If an individual suffers cardiac arrest, it is important to initiate high-quality cardiopulmonary resuscitation (CPR) with use of automatic external defibrillator (AED). It is estimated that less than 3% of the general public in the U.S. have received CPR training.[2] Yet, bystander CPR has been shown to almost double survival rates, with bystander recognition of arrest and AED also improving survival rates.[12] We encourage making CPR training readily available to parents, school staff, athletic staff, and event volunteers, which may potentially save a life. Lastly, we recommend ensuring access to AEDs at all times, particularly evenings and weekends when limited access can lead to 50% decreased AED use.[5]

Cardiac screening and COVID-19

Infection with SARS-CoV-2 can have long-term sequelae, including cardiac damage, notably myocarditis. Myocarditis can result in cardiac dysfunction and arrhythmias. A study of NCAA athletes showed a prevalence of 2.3% of college-aged athletes with COVID-19 myocarditis.[3] There are several guidelines for cardiac screening and return to play from the AAP, American Medical Society for Sports Medicine, American College of Cardiology, and peer-reviewed guidelines.[6]

These guidelines are continuously evolving, and the guidelines listed above are, as far as the authors of this article are aware, the most current. In general, patients are grouped into asymptomatic, mild symptoms, moderate symptoms, and severe symptoms or ICU/intubated.

All guidelines recommend that regardless of severity of symptoms, anyone experiencing COVID-19 should refrain from exercise at minimum three to five days (AMSSM/ACC), or more conservatively, 10 days during the isolation period.[6,1] In general, patients who are asymptomatic or experience only mild symptoms can begin the return-to-play progression without specific cardiac screening. Patients who have had moderate or severe symptoms should have high-sensitivity cardiac troponin, ECG, echocardiogram, consideration of cardiac MRI, and cardiology referral. Any patient who has cardiac symptoms, such as chest pain, palpitations, pre/syncope, dyspnea, during their return-to-play progression should also have more extensive cardiac workup. Athletes who are diagnosed with COVID-19 myocarditis should refrain from sports for three to six months and have cardiology referral and evaluation, including troponin, ECG, echocardiogram, and consideration for Holter monitor, prior to return to play. Return to play, regardless of symptom severity, should be monitored by the athletic trainer. We find that the guidelines recommended by AAP and Kim, et al[6] tend to be the most consistent and are summarized in Table 2, page 5.

Summary

All patients, regardless of sports participation, ages 6 to 21 years should have cardiac screening, at minimum every three years and upon entry into middle school/junior high and high school to potentially prevent SCA/SCD. Patients with abnormal screening should have further cardiac evaluation. Athletes who have experienced COVID-19 infection may need cardiac evaluation, depending on severity of symptoms and symptoms experienced during their return-to-play progression.

See page 6 for article references.

(continues on page 5)

Nutrient Requirements in a Young Athlete

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Choosing the right fuel before, during, and after exercise can support training adaptations and enhance sport performance. Without enough fuel, young athletes are at a greater risk for negative health outcomes. In the short term, underfueling can reduce muscular strength and impair performance on the field. In the long term, it can lead to a wide range of negative health outcomes. Inadequate calorie intake in athletic populations is known as Relative Energy Deficiency in Sport, or RED-S. This term has evolved as a broader, more comprehensive replacement for the Female Athlete Triad, which includes disordered eating, irregular menstrual cycles, and impaired bone health.

RED-S is a collection of symptoms that can be observed in athletes of all ages, genders, races, and ethnicities. It can occur in athletes of all shapes and sizes. It's most common in aesthetic sports, like dance, gymnastics, and bodybuilding, as well as weight-class sports, like wrestling and powerlifting. It's also common in sports where lighter bodies are perceived to be advantageous, like running. While the highest rates of RED-S have been observed in these sports, no athlete is immune.

The key concern in RED-S is low energy availability, or LEA. This term indicates that an athlete's calorie expenditure exceeds their calorie intake from food.

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LEA can occur with or without intentional restriction. It often arises when an athlete increases training volume without increasing food intake. This is a common phenomenon in the initial months of an athlete's season. When unaddressed, it can lead to injuries and burnout. Unintentional underfueling can also result from scheduling challenges, when athletes fail to make time for meals and snacks. Food-insecure athletes are also at a greater risk of unintentional underfueling, when they do not have access to the amount of food required to meet their nutritional needs. Athletes with dietary restrictions, like food allergies or a vegan diet, can also fall victim to unintentional underfueling.

LEA can also occur as the result of deliberate food restriction, with the goal of controlling body weight or composition. It may include skipping meals, limiting portions, or avoiding specific foods or food groups. While eating patterns like plant-based, gluten-free, dairy-free, and all-natural can seem health oriented, these restrictions often enable athletes to restrict calories through elimination of entire food groups.

Young athletes are bombarded with nutrition information from social media and advertising. Mainstream media outlets also perpetuate nutrition myths and promote dangerous diets rooted in restriction. Most popular eating plans are designed to promote rapid weight loss through cutting calories and eliminating food groups. These diets are inappropriate for young athletes, who require adequate calorie intake to fuel their sport and support normal growth and development. Restrictive food rules are often disguised as health-promoting behaviors, but can contribute to the development of disordered eating patterns.

When unaddressed, disordered eating behaviors can progress into an eating disorder. The National Eating Disorder Association lists the signs to suspect an eating disorder at **www.nationaleatingdisorders.org/warning-signs-and-symptoms**. Athletes who exhibit these symptoms should be referred to a multidisciplinary treatment team, including a physician, mental health professional, and registered dietitian.

Food is fuel

In order to combat diet misinformation, it's important to understand the facts. Athletes often discover restrictive eating plans when searching for strategies to become healthier or improve athletic performance. Balanced, sustainable eating patterns can be overshadowed by the allure of fad diets. Young athletes have different nutritional needs than older, less-active populations. By educating young athletes about their nutritional needs, healthcare professionals can help stop diet misinformation, and reduce the risk of RED-S and eating disorders.

When it comes to nutrition education, simple messages are the most effective. Teaching athletes how each nutrient fuels the body can reduce the confusion surrounding food. Athletes who understand their food choices are often less likely to seek nutritional advice from inappropriate sources.

Young athletes should understand that all foods are made up of three major macronutrients: carbohydrates, protein, and fat. These nutrients provide calories, which are used to power the brain, heart, lungs, muscles, and other organs. It's important to remember that no foods are inherently bad or harmful. On its own, no single food can cause weight gain or lead to poor health. Instead of fearing food, athletes should think about the nutrients each food provides and its role in health and performance.

Carbohydrates are the preferred fuel source for the muscles, providing energy to support exercise. Carbohydrates are also the main fuel source for the brain, supporting mood, focus, and cognition. Although carbohydrates are often excluded from popular diet plans, they should form the foundation of a young athlete's plate. Athletes who do not eat enough carbohydrates, especially before and after exercise, can feel exhausted on the field and in the classroom. Carbohydrates can be found in grains, fruits, and some vegetables.

Protein is the main building block used to grow, repair, and maintain muscles, tissues, and bones. Athletes who don't get enough protein often struggle to recover from workouts, leading to an increased risk of injuries. Protein also supports the immune system, helping athletes fight off illness. Protein is an essential component of the healing process for injured athletes, since it plays a crucial role in wound healing. Athletes can get protein from a wide range of animal- and plant-based sources, including meat, fish, eggs, beans, nuts, and tofu.

Fat is a concentrated energy source that provides long-term fuel. The body uses fat for energy at rest and during low-intensity exercise. Fat is also required to produce important hormones that support metabolism and regulate the menstrual cycle. Athletes who do not eat enough fat can experience fatigue, frequent injuries and illness, menstrual disturbances, and impaired growth.

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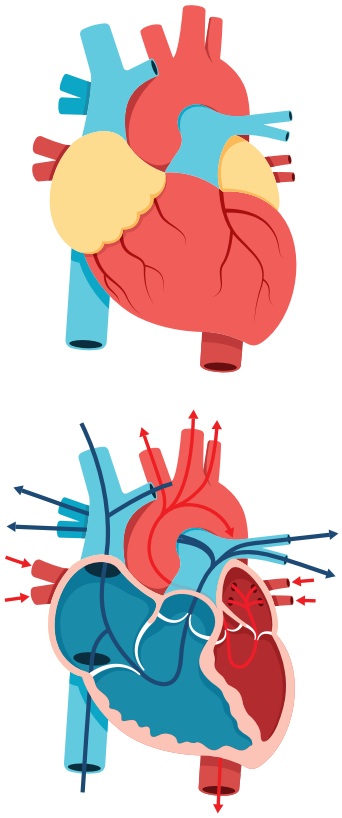

Table 1. Risk factors for sudden cardiac arrest and death

Examples	
Structural	Cardiomyopathy Hypertrophic cardiomyopathy Arrhythmogenic cardiomyopathy Dilated cardiomyopathy Restrictive cardiomyopathy Unclassified cardiomyopathy Aortopathies Marfan syndrome Ehlers-Danlos syndrome Thoracic aortic aneurysm Congenital heart disease Anomalous coronary artery
Structural electrical pathway	Wolff-Parkinson-White syndrome
Channelopathy	Long QT syndrome Short QT syndrome Brugada syndrome Catecholaminergic polymorphic Ventricular tachycardia Idiopathic ventricular fibrillation

Table 2. Cardiac screening and return to play for athletes after COVID-19 infection. AAP uses the term quarantine for the infectious period. CV=cardiovascular; hs-cTN=high sensitivity cardiac troponin-I; CMR=cardiac magnetic resonance imaging.[1,6]

Symptom severity	Exercise	Screening	Return to play
Asymptomatic	No exercise during quarantine	CV screening not necessary	Return to physical activity if asymptomatic
Mild symptoms (<4 days of fever, >100.4F, and <1 week myalgias, chills, lethargy)	No exercise during quarantine	CV screening not necessary	Must have full resolution of symptoms
Moderate symptoms (>/=4 days fever, >/=1 week myalgias, chills, lethargy; non-ICU hospital stay; no evidence MIS-C)	No exercise during quarantine	ECG	Must have full resolution of symptoms
Severe symptoms (ICU-hospitalization or intubation) or MIS-C	No exercise during quarantine	ECG	Must have full resolution of symptoms
Previous infection and already has returned to play prior to evaluation		CV screening not necessary	Continue current activity
Develops symptoms during return to play		ECG	Return to physical activity if asymptomatic

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Food also provides micronutrients, which include vitamins and minerals. These nutrients do not provide calories for energy, but they have essential roles in health and performance. Calcium and vitamin D are the most important nutrients to help young athletes build strong bones. Iron is another critical micronutrient that supports athletic performance, due to its role in transporting oxygen through the bloodstream. Most athletes can achieve appropriate micronutrient intake through a varied, balanced diet. However, restrictive diets and inadequate calorie intake have been linked to micronutrient deficiencies.

In order to get enough calories throughout the day, most young athletes need to eat three meals per day, with multiple snacks. Special focus should be placed on the pre- and post-workout snack, to ensure that the athlete is fueled for exercise. Meals should include a balance of nutrients, and no food group should be excluded. Athletes with food allergies or other dietary restrictions should consider working with a registered dietitian to find appropriate substitutes for avoided foods.

Sports drinks and protein shakes

For most young athletes, water is sufficient to meet hydration needs. However, sports drinks and protein shakes can also be part of a balanced fueling plan, when used for a specific purpose.

Sports drinks provide easily absorbed carbohydrates and electrolytes, to replenish sweat losses and sustain athletic performance. Sports drinks are recommended for exercise lasting more than 60 minutes, or exercise in hot, humid conditions. To prevent excessive consumption of added sugars and sodium, sports drinks are not recommended outside of exercise.

Most young athletes can meet their protein needs without incorporating protein shakes. However, protein shakes can provide a convenient refueling option when a whole-food protein source is not available. This convenience comes at a price, since the cost per gram of protein is often higher than whole-food protein sources. Protein powders, along with other sports nutrition supplements, do not require approval from the Food and Drug Administration, so it's important to choose a trusted brand that undergoes third-party testing, such as USP or NSF.

While sports drinks and protein shakes have evidence-based uses for young athletes, energy drinks are not recommended for children and adolescents. Most energy drinks contain non-nutritive stimulants, such as caffeine and taurine, as well as megadoses of B vitamins. These ingredients can provide a quick jolt, but lack the metabolic fuel to support long-term energy. This is similar to jump-starting a car without putting gas into the tank.

The bottom line? Each macro- and micronutrient plays an essential role in the body. It's important for athletes to consume foods from all food groups to avoid nutrient gaps. Diets that restrict entire food groups can lead to inadequate calorie consumption, as well as nutrient deficiencies that impair health and performance. While fad diets and restrictive eating patterns can be alluring, a balanced diet with carbohydrates, proteins, fats, fruits, and vegetables is the most sustainable path toward long-term wellness.

If parents suspect that a child or adolescent is struggling with an eating disorder, they can call the toll-free, confidential NEDA Helpline at 800-931-2237. Information is also available at **www.nationaleatingdisorders.org**.

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