

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

Sudden Cardiac Death in Young Athletes, What to Consider?

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Etiology of SCD in Athletes

- ▶ In athletes **older than 35** years of age, 80% of SCD is frequently due to atherosclerotic coronary artery disease
- ▶ Inherited and other acquired cardiovascular abnormalities are usually responsible for SCD in **younger athletes**

Navin Chandra et al. *J Am Coll Cardiol* 2013; 61:1027-1040

Epidemiology of SCD in Athletes

- ▶ High school and college athletes reported a **5-fold higher** incidence of SCD in **male** compared with female athletes (1)
- ▶ Death rates from **hypertrophic cardiomyopathy (HCM)** are **higher** in **black** compared with white athletes (20% vs. 10%, respectively) (2)

(1) Van Camp SP, et al. Med Sci Sports Exerc 1995;27:641-7

(2) Maron BJ, et al. Circulation 2009;119:1085-92

Common Causes of SCD in Young Athletes

- ▶ I– Structural Cardiac Abnormalities
- ▶ II– Electrical Cardiac Abnormalities
- ▶ III– Acquired Cardiac Abnormalities

A- Hypertrophic Cardiomyopathy (HCM)

- ▶ HCM is the **most common** condition responsible for SCD in **young athletes**
- ▶ Deaths caused by HCM are **common** in start-stop sports as football and basketball كرة سلة
- ▶ Sudden death due to ventricular tachycardia (VT)/ventricular fibrillation (VF) is often the first clinical manifestation

Maron BJ. JAMA 2002;287:1308-20

Diagnosis of Hypertrophic Cardiomyopathy

- ▶ More than 90% of affected individuals have an abnormal **resting ECG** (LA enlargement & LVH, left axis deviation, ST-depression, T-wave inversion, pathological Q waves)
- ▶ **Echocardiography** is gold standard investigation in HCM: significant asymmetrical septal hypertrophy
- ▶ Previous cardiac arrest or sustained VT are at **high risk of SCD** and require **treatment with (ICD)**
ICD: implantable cardioverter-defibrillator

B- Arrhythmogenic Right Ventricular Cardiomyopathy (ARVC)

- ▶ Is the **SECOND** most common cause of unexpected SCD in **young athletes**
- ▶ **During exercise** myocardial stretch and myocyte detachment result in ventricular arrhythmia and SCD
- ▶ **5-fold higher** risk of SCD in ARVC has been demonstrated during competitive sports (Cricket & Diving)

J Am Coll Cardiol. 2018;72(7):784-804

Basso C, et al. Lancet 2009;373:1289-300

Corrado D, et al. J Am Coll Cardiol 1997;30:1512-20

Diagnosis of: Arrhythmogenic Right Ventricular Cardiomyopathy (ARVC)

- ▶ **12-LEAD ECG:** More than 70% of affected individuals have **T-wave inversion** in right precordial leads
- ▶ Cardio Magnetic Resonance scan showing ARVC with **right ventricular dilation** and wall fibrosis
- ▶ Previous cardiac arrest, unexplained syncope, and extensive structural disease including LV are **risk factors for SCD** and need rapid ICD implantation

C– Congenital Coronary Artery Anomalies (CCAAs)

- ▶ Although rare, CCAAs confer a **high risk** of myocardial ischemia and SCD, especially in **young** during exercise
- ▶ Cardiac magnetic resonance angiography is the **gold standard** imaging modalities
- ▶ The recommended **therapy** for CCAAs is surgical correction

Schiavone M, et al. *Pediatr Cardiol.* 2021 ec;42(8):1676–1687

Angelini P. *Circulation* 2007;115:1296–305

Prakken N, et al. *Int J Cardiovasc Imaging* 2010;26:701–10

Other Structural Cardiac Abnormalities

- ▶ Marfan syndrome, mitral valve prolapse (MVP), and aortic stenosis may include aortic dissection/rupture and can be associated with SCD

Marfan Syndrome

- ▶ Is a collagen disorder caused by mutations in the gene encoding fibrillin
- ▶ It accounts for 3% of exercise-related SCD in **young athletes**
- ▶ Marfan patients should be **prohibited** from exercise of moderate to high intensity
- ▶ Individuals with an enlarged aortic root (>40 mm) should receive a **beta-blocker** to help retard aortic dilation

Yetman AT, et al, J Am Coll Cardiol 2003;41:329-32
Maron BJ, Zipes DP. J Am Coll Cardiol 2005; 45:1312-75
Maron BJ, et al. J Am Coll Cardiol 2005;45:1340-5

Mitral Valve Prolapse (MVP)

- ▶ MVP is an under-estimated cause of arrhythmic SCD, mostly in **young** women during physical exertion
- ▶ Competitive sport is **prohibited** when MVP is **associated with** moderate to severe mitral regurgitation, severe chest pain, exertional syncope, long QT interval, or Marfan syndrome

Basso C, et al. Circulation. 2015; Vol 132, Issue 7
Maron BJ, et al. J Am Coll Cardiol 2005;45:1340-5

Aortic Stenosis

- ▶ Aortic stenosis due to a congenital bicuspid aortic valve is **rare** but a documented cause of SCD in **young athletes**
- ▶ Athletes with **mild** aortic stenosis may compete in **low- to moderate-intensity** sports **provided that** they are asymptomatic and free of familiar arrhythmia, with normal LV function

Maron BJ, et al. J Am Coll Cardiol 2005;45:1340-5

Common Causes of SCD in Young Athletes

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A– Wolff Parkinson White (WPW) Syndrome

- ▶ The electrical properties of the **accessory pathway** is crucial for establishing the risk of SCD
- ▶ WPW syndrome **revealed by** a delta wave, short PR interval, and prolonged QRS duration on the ECG
- ▶ The risk of fatal arrhythmia appears to be higher in asymptomatic **children** than in adults, and **SCD** frequently occurs
- ▶ In **adolescents**, high-risk pathways require **catheter ablation**

Heidbuchel H, et al., Eur J Cardiovasc Prev Rehab 2006;13:475–84
Timmermans C, et al. Am J Cardiol 1995;76:492–4
Cohen MI, et al. Heart Rhythm 2012;9:1006–24

B- Congenital Long QT Syndromes (LQTS)

- ▶ LQTS considered when the **QTc interval exceeds 440 ms** in males or **460 ms** in females

QTc estimates the QT interval at a standard heart rate of 60 bpm
Bazett formula: $QTc = QT / \sqrt{RR}$

- ▶ **High-risk** features include a QTc interval >500 ms in **adolescents** associated with **LQT2 genotype**
- ▶ Despite medical therapy with beta-blockers; **ICD** is an option to revert ventricular fibrillation to sinus rhythm

Maron BJ, et al. Circulation 2009;119:1085-92
Schwartz PJ, et al. Circulation 2001;103:89-95
Corrado D, et al. Eur Heart J 2010;31:243-59
Longo, UG et al. BR MED BULL 2018 Sep 1;127(1):43-53

C– Brugada Syndrome

- ▶ Is an autosomal dominant sodium channelopathy associated with ventricular arrhythmias and SCD
- ▶ **Increased vagal tone** induced by chronic athletic training at rest and **exercise-induced hyperthermia** may enhance the tendency to SCD
- ▶ The only established treatment is **ICD insertion**

Heidbuchel H, et al., Eur J Cardiovasc Prev Rehab 2006;13:676–86
Antzelevitch C, et al. Circulation 2005;111:659–70

Common Causes of SCD in Young Athletes

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A– Trauma “Commotio Cordis”

- ▶ **Blunt trauma** to the chest can trigger VF and SCD
- ▶ Commotio cordis **occurs** in sports as ice hockey and baseball
- ▶ High–risk contact sports such as **soccer** have also been implicated
- ▶ Commotio cordis is more common in **children and adolescents** due to a thin and compliant thoracic cage

B- Infection “Myocarditis”

- ▶ Myocarditis, caused by viral infections (e.g., Coxsackie B) accounts for **7% of SCD** in athletes
- ▶ Myocarditis is considered in any **healthy young individual** with new exercise intolerance, and **ECG repolarization abnormalities**
- ▶ Active myocarditis can be **identified** on cardiac MRI
- ▶ Myocarditis can lead to **DCM** and increased risk of **SCD**
- ▶ Athletes diagnosed with myocarditis should **stop sports activity for 6-month**

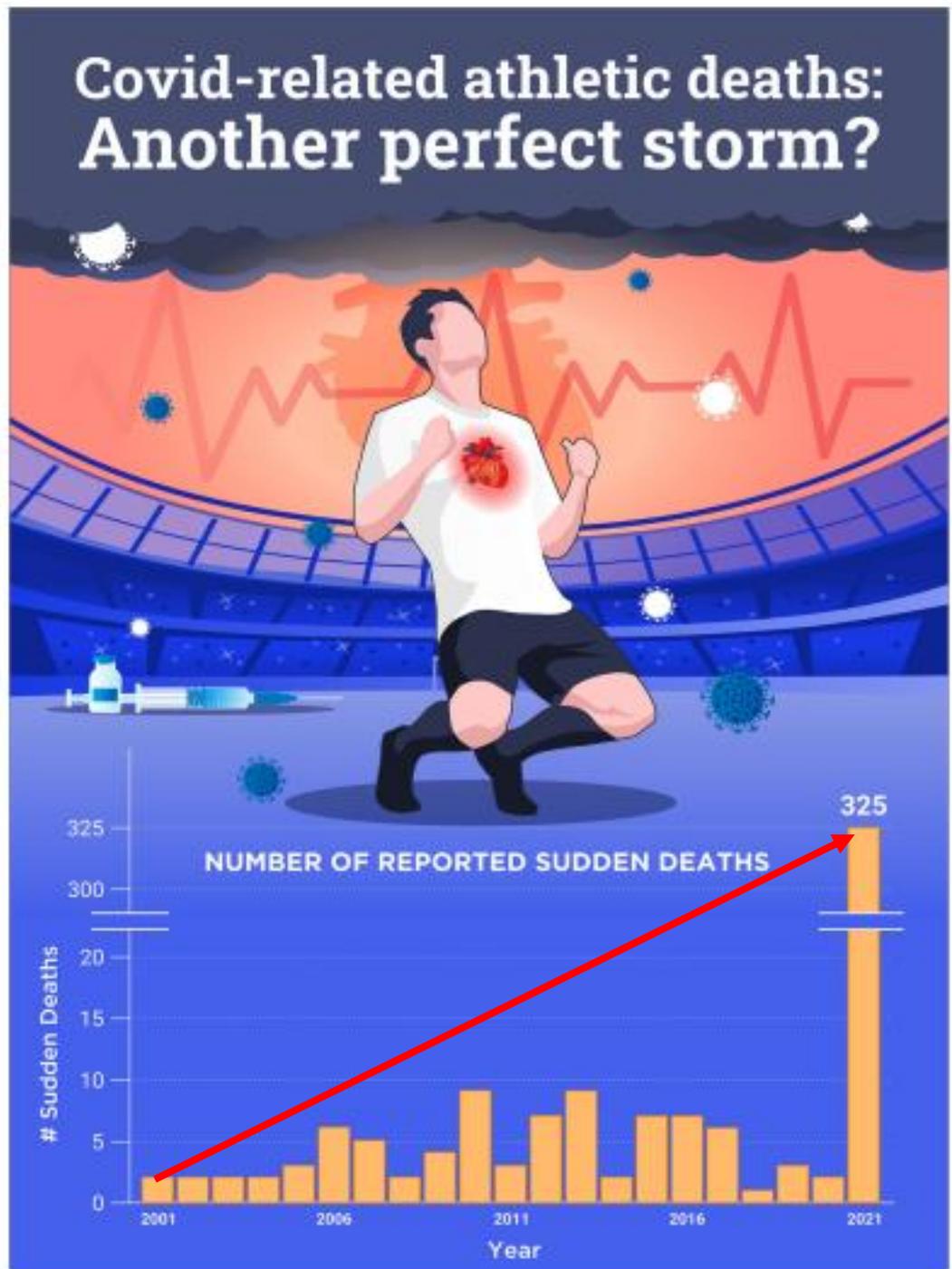
In the US From December 2020 to August 2021

- ▶ The risk of **myocarditis** after receiving **mRNA-based COVID-19 vaccines** was increased across multiple age and was highest after the second vaccination dose in **adolescent males and young men**

Oster, M. E., et al. (2022). *JAMA*. 327, (4) 331–340

Number of reported SCDs post-COVID-19 and/or vaccination worldwide in 2021 compared to 2001-2020

Philip B. et al. *Front. Sports Act. Living*, 12 April 2022



C– Toxicity “Performance–Enhancing Drugs”

- ▶ **In athletes:** Anabolic–androgenic steroids, stimulants such as ephedrine, and nonsteroidal agents have been associated with SCD
- ▶ Anabolic androgenic steroids have been shown to change lipoprotein metabolism leading to premature ASO and MI
- ▶ **Toxicological** investigation is recommended after SCD event in an athlete

Conclusions

- ▶ SCD in the sports field is rare but highly destructive
 - ▶ Pre-participation screening of **young athletes** to prevent SCD of competitive athletes and increasing availability of automated external defibrillators are challenges
 - ▶ Victims of SCD are often entirely asymptomatic before their initial presentation
 - ▶ Cardiac evaluation of an athlete is performed by trained cardiologists and sports physicians aware with the conditions causing SCD
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Thank You

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