



SUDDEN CARDIAC DEATH RISK ASSESSMENT AND SPORTS INVOLVEMENT AMONG ATHLETES: A COMPREHENSIVE REVIEW

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ABSTRACT

In the realm of sports cardiology, definitions are pivotal in evaluating sudden cardiac death (SCD) risk. Athlete categories young, masters, competitive, and recreational- provide contextual frameworks. Optimizing participation necessitates balancing the intricacies of cardiovascular conditions. Structural anomalies like hypertrophic cardiomyopathy and arrhythmogenic right ventricular cardiomyopathy mandate judicious approaches. The enigmatic interplay of exercise and inherited arrhythmia syndromes necessitates cautious engagement. Amidst these complexities, the symphony of cardiac health and athletic pursuit unfolds, with each note representing a nuanced facet of prevention and well-being.

KEYWORDS : Sudden Cardiac Death, Athletic Heart Syndrome, Inherited Arrhythmia Syndromes, Hypertrophic Cardiomyopathy, Sports Cardiology.

INTRODUCTION

In the vast and pulsating stage of life, a rare and enigmatic phenomenon takes center stage: sudden cardiac death (SCD) intertwined with athletic activity. A devastating mystery that casts its shadow over seemingly healthy youths, snatching them away without warning. While often devoid of explanation, a considerable proportion remains veiled beneath the cloak of undetected cardiovascular diseases (1).

METHODS

In conducting a comprehensive review of the topic "Sudden Cardiac Death Risk Assessment and Sports Involvement Among Athletes," a systematic search strategy was employed to identify relevant literature. The search was executed using medical subject headings (MeSH) and descriptor terms (DeCS) related to sudden cardiac death, risk assessment, sports involvement, and athletes. PubMed and SCOPUS, two prominent databases renowned for their expansive coverage of biomedical literature, were meticulously queried. The search strategy was designed to ensure a comprehensive synthesis of the current understanding of the intricate relationship between sudden cardiac death, risk evaluation, and engagement in sports activities among athletes.

Athlete Category	Definition	Associated Risk Factors
Young Athletes	Typically refers to high school and college students, or individuals under age 35. SCD in this group is often linked to various congenital heart diseases.	Congenital heart diseases
Masters Athletes	Adults aged ≥35. SCD is commonly associated with coronary heart disease in this group.	Coronary heart disease
Competitive/Elite Athletes	Engaged in organized sports with regular competition, prioritizing achievement. May lack restraint in activity.	High-level training and competition
Recreational Athletes	Participate for health and enjoyment, with less pressure to excel. Activity levels can still be vigorous.	Less emphasis on competition

Optimizing Athletic Participation: A Comprehensive Approach

The realm of sudden cardiac death (SCD) during physical exertion has predominantly been examined in competitive athletes. Yet, it is essential to acknowledge the comparable intensity of certain recreational activities, especially for those with cardiovascular disorders linked to SCD. Although SCD incidents are often higher in competitive athletes, the sheer volume of recreational enthusiasts leads to a greater overall number of SCD cases. The equilibrium between the risks and benefits of athletic activity depends on various factors, including baseline fitness, activity intensity, cardiac condition, and the psychological and physiological advantages of sports (3,4).

Our approach to sport participation aligns with principles set forth by the American Heart Association (5,6):

- Asymptomatic individuals with no cardiovascular disease may pursue their regular exercise regimen, progressing gradually.
- Asymptomatic individuals with known cardiovascular disease, evaluated within a year, may engage in a moderate-intensity routine, halting in case of symptoms for medical reassessment.
- Inactive individuals without cardiovascular issues can initiate light to moderate exercise without medical consultation, adhering to prevailing American College of

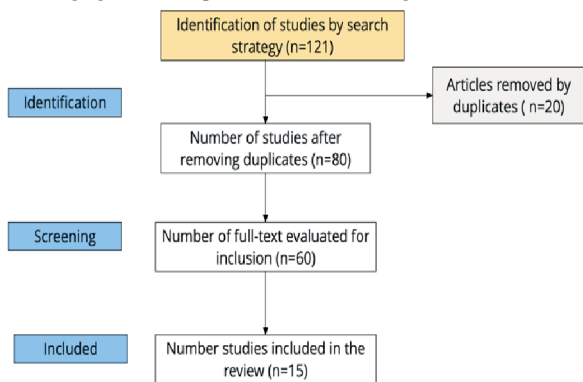


Figure 1. PRISMA.

Definitions

Within the intricate realm of athletic populations, diverse contours of definition converge, serving as crucial beacons to illuminate the landscape of sudden cardiac death (SCD) risk assessment. Each definition, though distinct, threads a common theme, a tapestry woven from the threads of age, ambition, and heart health (Table 1) (2).

Table 1. Definitions.

Sports Medicine (ACSM) guidelines.

- Physically inactive individuals with cardiovascular disease indicators should seek medical guidance before beginning exercise, regardless of intensity.

Epidemiology

Sudden cardiac death (SCD) is a grave concern among athletes, but its true incidence remains contentious. Available evidence, scrutinizing reporting methods and population definitions, estimates an incidence of 1:50,000 to 1:100,000 per year in young athletes. Notably, older adults face higher risk, about 1:7,000 healthy adult athletes yearly. Incidence fluctuates based on exercise intensity, population, observation period, and SCD scope. Media-based identification underestimates SCD risk by 50%. Male African American athletes exhibit disproportional risk. A study of competitive athletes aged 12 to 45 revealed a 0.76 per 100,000 athlete-year SCA rate, with 44% survival. Challenges persist in screening, evident in arrhythmic events during endurance events. SCD risks vary across exercises, emphasizing the imperative of tailored prevention strategies (7,8).

Etiology of Sudden Death in Athletes

The intricate spectrum of sudden death etiology among athletes underscores the multifaceted interplay of structural heart disease, primary electrical disturbances, and precipitating factors (Table 2) (9).

Table 2. Etiology and mechanisms.

Etiology of Sudden Death in Athletes	Mechanisms and Conditions
Structural Heart Disease	<ul style="list-style-type: none"> • Ventricular tachyarrhythmias due to reentrant arrhythmias in abnormal myocardium or fibrotic regions. • Bradycardia, asystole, or syncope involving conduction system. • Outflow tract obstruction and cyanosis. • Dissection of great vessels (Marfan syndrome).
Athletes <35 Years	<ul style="list-style-type: none"> • Hypertrophic cardiomyopathy (HCM). • Anomalous coronary origin. • Arrhythmogenic right ventricular cardiomyopathy (ARVC). • Myocarditis. • Coronary atherosclerosis.
Athletes ≥35 Years	<ul style="list-style-type: none"> • Coronary artery disease (predominant cause among masters athletes).
Primary Electrical Disease	<ul style="list-style-type: none"> • Long QT syndrome • Brugada syndrome. • Catecholaminergic polymorphic ventricular tachycardia. • Short QT syndrome. • Early repolarization syndrome.
Other Considerations	<ul style="list-style-type: none"> • Trauma-induced arrhythmic events (commotio cordis). • Androgen use for performance enhancement and associated cardiac findings.

Structural abnormalities associated with sudden cardiac death in athletes

Sudden Cardiac Death (SCD) is an ominous threat, lurking within the realm of sports, and often finds its roots intertwined with structural abnormalities of the heart. The stories of young athletes collapsing mid-game have spurred investigations into the underlying causes of these tragic events. Hypertrophic Cardiomyopathy (HCM), a condition characterized by abnormal thickening of the heart muscle, has been a prominent player in this tragic symphony. Over the years, the advice for athletes with HCM has been cautious, urging

avoidance of competitive sports. But as knowledge advances, a new melody emerges. Recent European guidelines have harmonized a more flexible approach, permitting recreational and even selective competitive engagement for individuals with HCM deemed to be at low risk of sudden arrhythmic events (10).

The 2020 American Heart Association (AHA) guidelines echo this harmony, inviting shared discussions between athletes and clinicians regarding the delicate dance of exercise in the context of HCM. Meanwhile, athletes with congenital coronary artery abnormalities are confronted with unique challenges. Unveiling an anomalous coronary artery origin, a hidden peril, can send athletes down a divergent path. Those with uncorrected anomalies are often advised against the competitive arena, their hearts vulnerable to the twists and turns of exertion (11).

Myocarditis, a swift and unpredictable interlude, throws athletes into disarray. Those struck by this inflammatory intruder must seek a period of convalescence before rejoining the symphony of sports. This forced hiatus is dictated by the heart's rhythm, its recovery monitored closely by echocardiography and MRI. And in the midst of it all, congenital heart diseases silently underscore the fragility of the athlete's heart. Pulmonary hypertension, cyanosis, arrhythmias, and ventricular dysfunction cast a shadow, tempering the athlete's zeal (12).

Navigating inherited arrhythmia syndromes in athletes

The realm of inherited arrhythmia syndromes casts a shadow of uncertainty over athletes, posing intricate questions about their participation in competitive sports. The spotlight falls on Long QT Syndrome (LQTS), an enigmatic condition that triggers partial divergence of opinions. While American guidelines extend an olive branch to asymptomatic LQTS athletes equipped with on-site automated external defibrillators, European counterparts exercise caution, casting a restrictive veil (12,13).

Brugada Syndrome, a lurking mystery, unravels with unique dynamics. Engaging in a symphony of shared decision-making, low-risk Brugada patients find solace in low-impact activities. However, the looming specter of trauma-induced harm and syncope-induced mishaps restricts certain ventures (13,14).

The melodic rhythm of exercise intertwines with Catecholaminergic Polymorphic Ventricular Tachycardia (CPVT), weaving a complex tapestry. Those symptomatic or treading on the precipice of ventricular arrhythmias stand on the fringes of competitive sports. Uncertainty shrouds the asymptomatic genotype-positive, phenotype-negative patients, prompting a harmonious yet cautious approach. In this dance of cardiac harmony, Short QT Syndrome introduces a rare and cryptic character. With limited knowledge about exercise's orchestration, a cautious tempo guides management, akin to other arrhythmia syndromes. As the symphony swells, Early Repolarization Syndrome emerges, a composition of ventricular arrhythmias and early repolarization patterns. Yet, the score remains incomplete, leaving exercise's impact uncertain and demanding precautionary restraint (14,15).

Turning the spotlight to Coronary Artery Disease (CAD), athletes with a history of this condition engage in a nuanced choreography. Risk stratification guides their steps, with factors like left ventricular function, exercise tolerance, ischemic response, and arrhythmias conducting the rhythm. Athletes' hearts become a canvas for individualized evaluation, with CAD's melody blending with the tempo of exercise. In this symphony of inherited arrhythmia syndromes,

athletes navigate a complex interplay between heartbeats and sports fields, guided by guidelines that intertwine caution and passion. Each note, each rhythm, plays a part in the grand composition of health and performance (15).

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