

ADVANCES IN CARDIAC ARRHYTHMIAS

and

GREAT INNOVATIONS IN CARDIOLOGY

XXVII GIORNATE CARDIOLOGICHE TORINESI

Directors

Fiorenzo Gaita
Sebastiano Marra

Turin

October 23-24, 2015

Centro Congressi
Unione Industriale di Torino

Giuseppe Inama MD FESC
Unità Operativa di Cardiologia
Istituto Clinico F.S.C.
Cremona

**Dipartimento di
Cardiologia
I.F.S.C - Cremona**

**Sudden cardiac
death in sport**

Sudden cardiac death

Sudden cardiac death (SCD) is the death for unexpectedly circulatory arrest, usually due to cardiac arrhythmias, occurring within 1 hour from the onset of symptoms;

Sudden cardiac arrest (SCA) is the unexpectedly circulatory arrest, usually due to cardiac arrhythmias, occurring within 1 hour from the onset of symptoms in whom medical intervention (defibrillation) reverses the event

(ACC/AHA/ESC 2006 Guidelines)

Sudden cardiac death

EXTENT OF THE PROBLEM

**It 'a major cause of mortality
(10% mortality)**

**About 1/1000 inhabitants / year
(MONICA, Project Life Pc, FACS)**

**A "Silent Epidemic"
(In Italy, about 57,000 cases / year, then 156 / day
and therefore one every 9 minutes)**

Sudden cardiac death

General Population

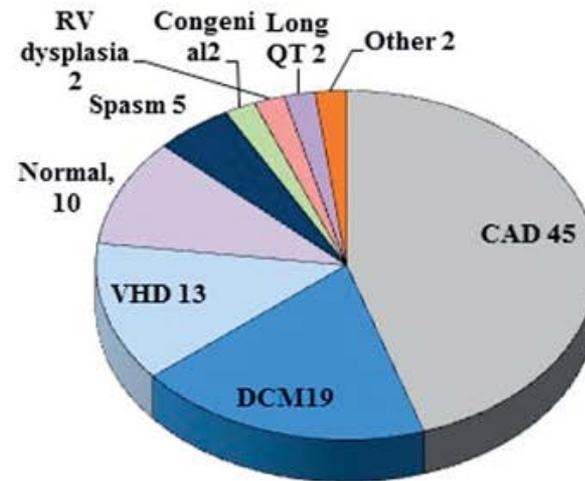
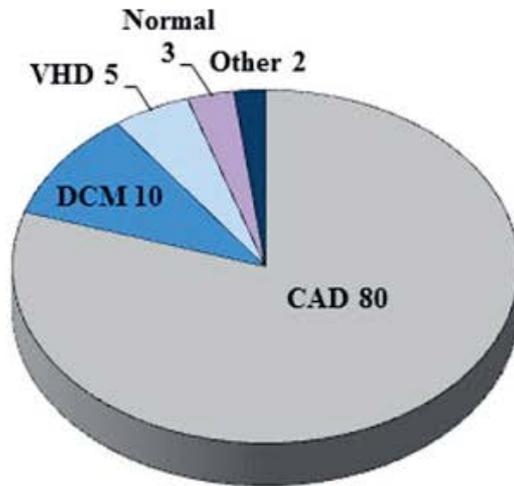


Figure 1. Pie chart illustrating the proportions of various types of underlying structural heart disease in the male and female survivors of cardiac arrest. Abbreviations: CAD, coronary artery disease; DCM, dilated cardiomyopathy; RV, right ventricular; Spasm, coronary vasospasm; VHD, valvular heart disease. Reproduced with permission from Albert et al.²¹

Sudden cardiac death in sport

An unexpected Sudden Cardiac Death (SCD) during sport activity of an adolescent or young adult is always a tragic event for the family, the community, the society, the medical professional and the media. Such events demand an explanation, which is often unsatisfactory.

Sudden cardiac death in sport

Epidemiology and Prevention

Incidence, Cause, and Comparative Frequency of Sudden Cardiac Death in National Collegiate Athletic Association Athletes A Decade in Review

Kimberly G. Harmon, MD; Irfan M. Asif, MD; Joseph J. Maleszewski, MD;
David S. Owens, MD, MS; Jordan M. Prutkin, MD, MHS; Jack C. Salerno, MD;
Monica L. Zigman, MPH; Rachel Ellenbogen, MS; Ashwin L. Rao, MD;
Michael J. Ackerman, MD, PhD; Jonathan A. Drezner, MD

Circulation. 2015;132:10-19

Epidemiology and Prevention

Incidence, Cause, and Comparative Frequency of Sudden Cardiac Death in National Collegiate Athletic Association Athletes

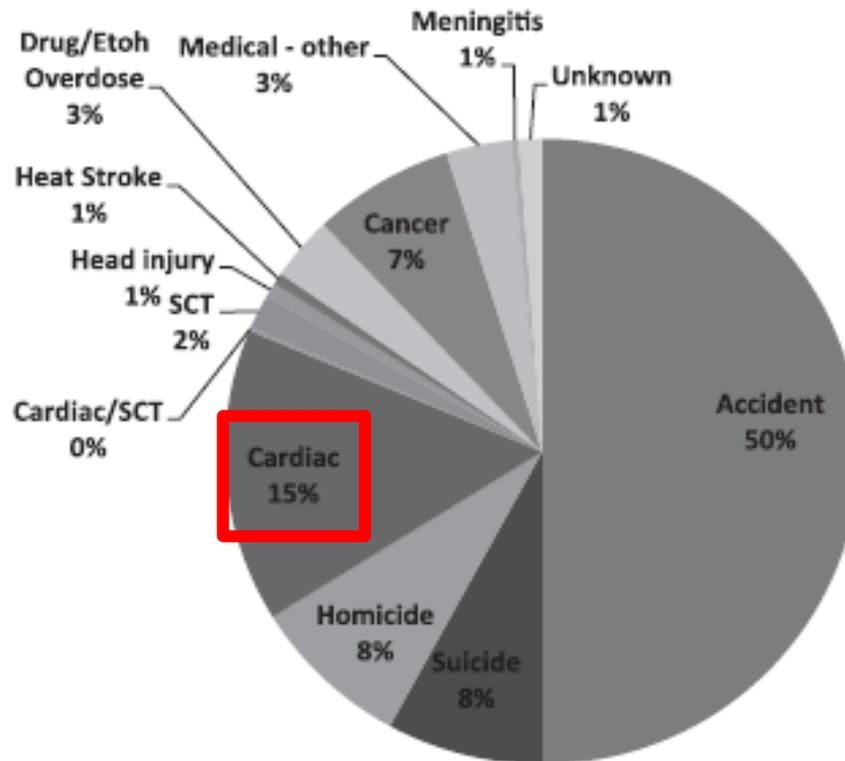
A Decade in Review

Kimberly G. Harmon, MD; Irfan M. Asif, MD; Joseph J. Maleszewski, MD; David S. Owens, MD, MS; Jordan M. Prutkin, MD, MHS; Jack C. Salerno, MD; Monica L. Zigman, MPH; Rachel Ellenbogen, MS; Ashwin L. Rao, MD; Michael J. Ackerman, MD, PhD; Jonathan A. Drezner, MD

Methods and Results—A database of all National Collegiate Athletic Association deaths (2003–2013) was developed. Additional information and autopsy reports were obtained when possible. Cause of death was adjudicated by an expert panel. There were 4 242 519 athlete-years (AY) and 514 total student athlete deaths. Accidents were the most common cause of death (257, 50%, 1:16 505 AY), followed by medical causes (147, 29%, 1:28 001 AY). The most common medical cause of death was SCD (79, 15%, 1:53 703 AY). Males were at higher risk than females 1:37 790 AY versus 1:121 593 AY (incidence rate ratio, 3.2; 95% confidence interval, 1.9–5.5; $P<0.00001$), and black athletes were at higher risk than white athletes 1:21 491 AY versus 1:68 354 AY (incidence rate ratio, 3.2; 95% confidence interval, 1.9–5.2; $P<0.00001$). The incidence of SCD in Division 1 male basketball athletes was 1:5200 AY. The most common findings at autopsy were autopsy-negative sudden unexplained death in 16 (25%), and definitive evidence for hypertrophic cardiomyopathy was seen in 5 (8%). Media reports identified more deaths in higher divisions (87%, 61%, and 44%), whereas the percentages from the internal database did not vary (87%, 83%, and 89%). Insurance claims identified only 11% of SCDs.

Circulation. 2015;132:10-19

Sudden cardiac death in sport



*Harmon et al.
Circulation 2015*

Figure 1. Causes of death in NCAA athletes 2003 to 2013. Etoh indicates ethanol; NCAA, National Collegiate Athletic Association; and SCT, sickle cell trait.

Incidence, Cause, and Comparative Frequency of Sudden Cardiac Death in National Collegiate Athletic Association Athletes

A Decade in Review

Kimberly G. Harmon, MD; Irfan M. Asif, MD; Joseph J. Maleszewski, MD; David S. Owens, MD, MS; Jordan M. Prutkin, MD, MHS; Jack C. Salerno, MD; Monica L. Zigman, MPH; Rachel Ellenbogen, MS; Ashwin L. Rao, MD; Michael J. Ackerman, MD, PhD; Jonathan A. Drezner, MD

Harmon et al.
Circulation
2015

Table 3. Incidence of Sudden Cardiac Death in NCAA Athletes

Characteristic	Athlete-Years	SCD	Incidence per Athlete-Year	IRR	95% CI	PValue
Overall	4 242 519	79	1 in 53 703	—	—	—
Sex						
Male	2 418 563	64	1 in 37 790	3.22	1.9–5.5	>0.0001*
Female	1 823 899	15	1 in 121 593	1.00	Reference	
Division						
Division 1	1 663 441	38	1 in 43 775	1.98	1.1–3.6	0.0131*
Division 2	930 434	22	1 in 42 292	2.05	1.1–4.0	0.0231*
Division 3	1 648 128	19	1 in 86 744	1.00	Reference	
Race						
White	3 075 942	45	1 in 68 354	1.00	Reference	
Black	644 715	30	1 in 21 491	3.18	1.9–5.2	>0.0001*
Hispanic	168 763	3	1 in 56 254	1.22	0.2–3.8	0.6974
Other	353 042	1	1 in 353 042	0.19	0.005–1.1	0.0491*

CI indicates confidence interval; IRR, incidence rate ratio; NCAA National Collegiate Athletic Association; and SCD, sudden cardiac death.

Sudden cardiac death in sport

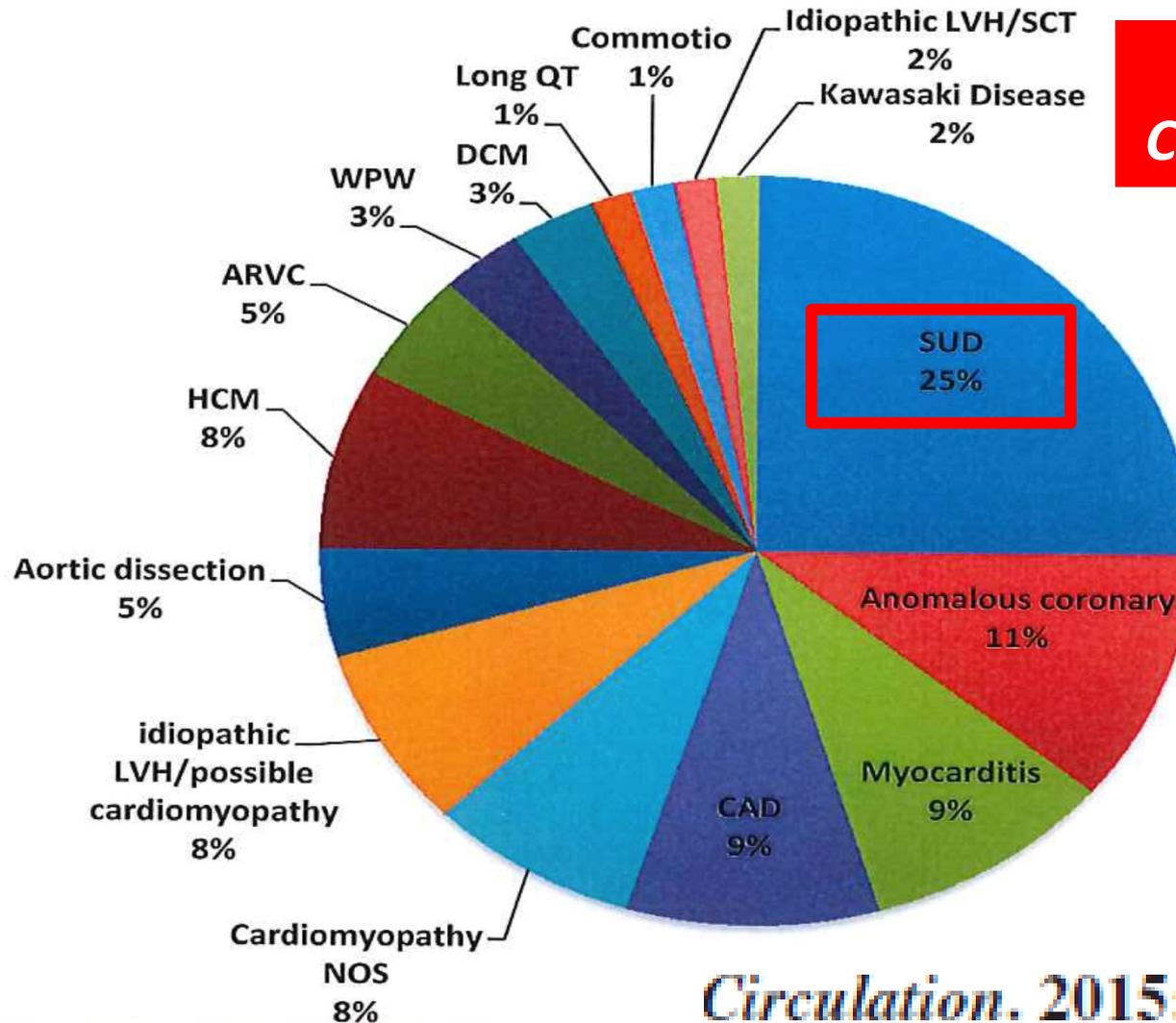
Table 5. Incidence of Sudden Cardiac Death in Sports

Sport	Athlete Deaths	Athlete-Years	Incidence per Athlete-Year	Incidence over 4-y Career
Men's basketball	19	170 590	1 in 8978	1 in 2245
Men's soccer	9	213 205	1 in 23 689	1 in 5922
Men's football	18	647 125	1 in 35 951	1 in 8988
Men's swimming	2	85 568	1 in 42 784	1 in 10 696
Men's cross-country	3	128 570	1 in 42 857	1 in 10 714
Men's lacrosse	2	91 699	1 in 45 850	1 in 11 463
Women's cross-country	3	141 268	1 in 47 089	1 in 11 772
Women's volleyball	3	147 653	1 in 49 217	1 in 12 304
Men's baseball	6	300 137	1 in 50 023	1 in 12 505
NCAA athletes	79	4 242 519	1 in 53 703	1 in 13 426
Women's swimming	2	115 221	1 in 57 611	1 in 14 402
Women's basketball	2	154 121	1 in 77 061	1 in 19 265
Men's track	2	241 041	1 in 120 521	1 in 30 130

The sports with 1 death were men's crew, women's golf, women's softball, women's tennis, men's tennis, women's track, wrestling, and women's lacrosse. Other sports had no identified sudden cardiac deaths.

Harmon et al.
Circulation
2015

Causes of sudden cardiac deaths in NCAA athletes (proven by autopsy in 76% of cases)



Harmon et al.
Circulation 2015

Prevalence
of SCD in
athletes
1.9 x
100,000

Circulation. 2015;132:10-19

Sudden cardiac death in sport

An Autopsy Study of Sudden Cardiac Death in Persons Aged 1-40 Years in Brescia (Italy)

Marzia Vassalini, Andrea Verzeletti, Mario Restori, Francesco De Ferrari

J Cardiovasc Med (2015 Jan 7)

Sudden cardiac death in sport

54 cases of SCD which occurred in pts aged below 40 years during the period **1993-2012** studied at the Institute of Forensic Medicine of Brescia.

Most SCD patients were men (76%), with a mean age of 27 years.

The results of post mortem investigations have identified the following abnormalities:

- **coronary artery disease (18.5%),**
- **arrhythmogenic right ventricular dysplasia (11.1%),**
- **hypertrophic obstructive cardiomyopathy (9.2%),**
- **severe valvular heart disease (7.4%)**
- **myocarditis (7.4%).**

Examination of the cardiac conduction tissue showed abnormalities in 12 cases (22.2%),

Despite all the investigations carried out, any pathogenic substrate that could have justified death was not found in 12 cases (22.2%)

Sudden cardiac death in sport



Blacks 1:20,147

Whites 1:59,143

SCD is more common in African-American than in Caucasian athletes

Males 1:38,390; Females 1:121,593



SCD is rare in female compared to male athletes, e.g., 1.07 in females vs. 2.62 per 100 000/year in males (Corrado et al). Five-fold lower incidence in female compared to male high-school and college athletes (Van Camp et al).

Sudden cardiac death in sport

The practice of sport certainly entails a slightly increased risk, but the side effects are far less than the damage caused by sedentary

Just at the level of the apparatus:

cardiovascular

Breathing apparatus

Apparatus osteo-articular and muscular

Lipid and glucose

Control body weight

Risk of arrhythmias in 52 755 long-distance cross-country skiers: a cohort study

Kasper Andersen^{1*}, Bahman Farahmand^{2,3}, Anders Ahlbom², Claes Held¹, Sverker Ljunghall¹, Karl Michaëlsson⁴, and Johan Sundström¹

Table 1 Baseline characteristics and incidence of any arrhythmias

	<i>n</i> skiers	<i>n</i> cases	PYAR	Incidence rate of any arrhythmias (95% CI) 10 000 PYAR
	52 755	919	513 496	17.9 (16.8–19.1)
Age (years)				
15–24	6258	30	64 867	4.6 (3.2–6.6)
25–34	17 288	106	169 553	6.3 (5.2–7.6)
35–44	12 086	131	119 665	10.9 (9.2–13.0)
45–54	11 328	264	108 401	24.4 (21.6–27.5)
55–64	4546	245	41 101	59.6 (52.6–67.6)
65+	1249	143	10 962	130.4 (110.7–153.7)



EUROPEAN
SOCIETY OF
CARDIOLOGY®

European Heart Journal (2013) 34, 3624–3631
doi:10.1093/eurheartj/eht188

Risk of arrhythmias in 52 755 long-distance cross-country skiers: a cohort study

Kasper Andersen^{1*}, Bahman Farahmand^{2,3}, Anders Ahlbom², Claes Held¹, Sverker Ljunghall¹, Karl Michaëlsson⁴, and Johan Sundström¹

Atrial fibrillation and flutter

The most frequent arrhythmia was atrial fibrillation, which occurred in 681 skiers (13.2; 95% CI 12.3–14.3/10 000 person-years at risk). In

Other arrhythmias

The secondary endpoints of other SVT ($n = 105$) and VT/NF/CA ($n = 90$) were analysed in the same way. No associations of number of completed races or finishing time group with risk of SVT or VT/NF/CA were found (Tables 3 and 4).



CONTROVERSIES IN CARDIOVASCULAR MEDICINE



Can Intensive Exercise Harm the Heart?

The Benefits of Competitive Endurance Training for Cardiovascular Structure and Function

Benjamin D. Levine, MD, FACC, FACSM, FAPS

(Circulation. 2014;130:987-991.)

You Can Get Too Much of a Good Thing

André La Gerche, MBBS, PhD, FRACP, FCSANZ, FESC; Hein Heidbuchel, MD, PhD, FESC

(Circulation. 2014;130:992-1002.)



Can Intensive Exercise Harm the Heart?

The Benefits of Competitive Endurance Training for Cardiovascular Structure and Function

Benjamin D. Levine, MD, FACC, FACSM, FAPS

(Circulation. 2014;130:987-991.)

Can Intensive Exercise Harm the Heart?

The benefit of competitive endurance training for cardiovascular structure and function

When >15 000 Olympic medalists from 9 different country groups were examined over decades after their first medal, there was a progressive increase in conditional survival (compared with age- and sex-matched controls from the general population in those countries) for the Olympic medalists which was greatest in the participants in endurance sports (1).

Recently buttressed by a study of nearly 800 French Tour de France competitors who experienced a substantial reduction in mortality (40%) compared with the French male noncyclist population (2).

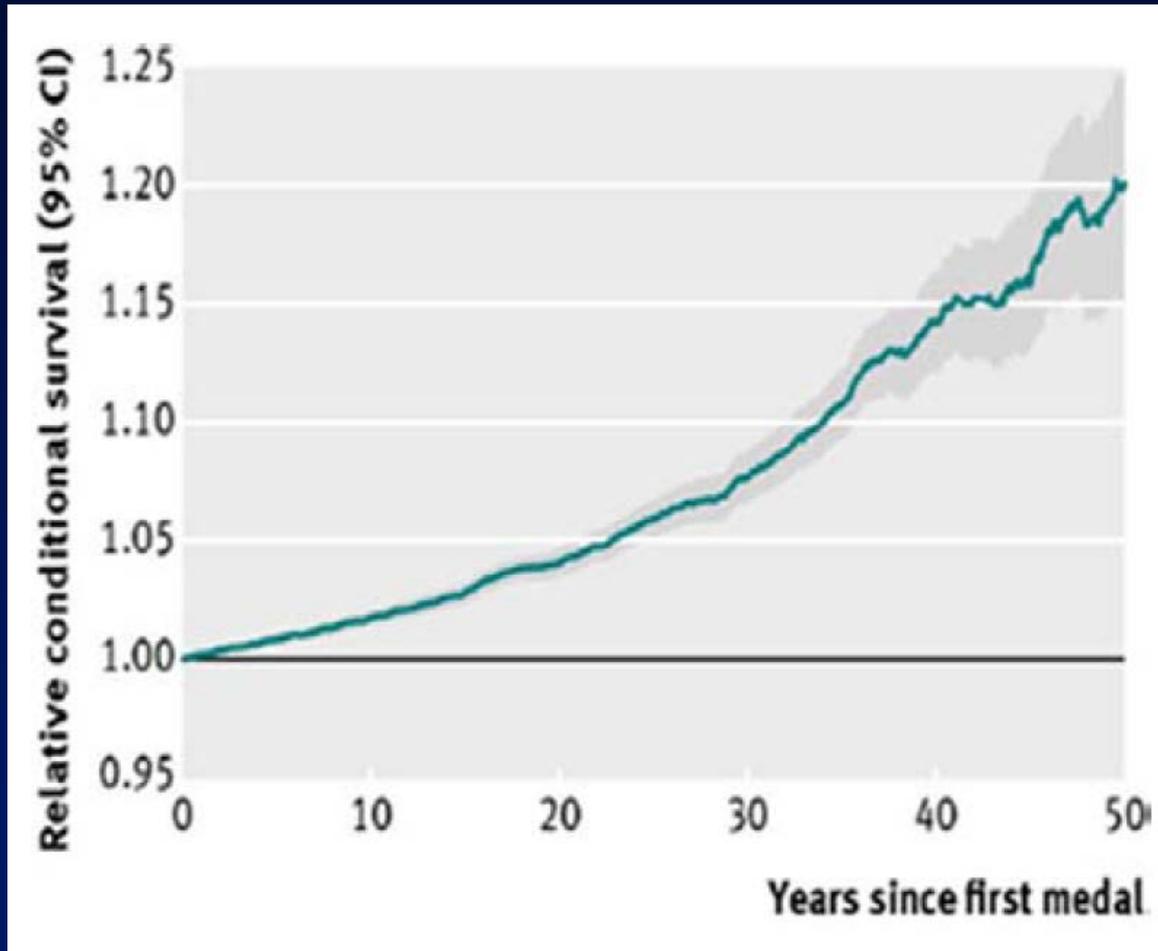
1. Clarke PM, Walter SJ, et al: Survival of the fittest: retrospective cohort study of the longevity of Olympic medalists in the modern era. *BMJ*. 2012;345:e8308.

2. Marijon E. Et al: Mortality of French participants Mortality of French participants in the Tour de France (1947-2012). *Eur Heart J*. 2013;34:3145–3150.

(Circulation. 2014;130:987-991.)

Can Intensive Exercise Harm the Heart?

The benefit of competitive endurance training for cardiovascular structure and function



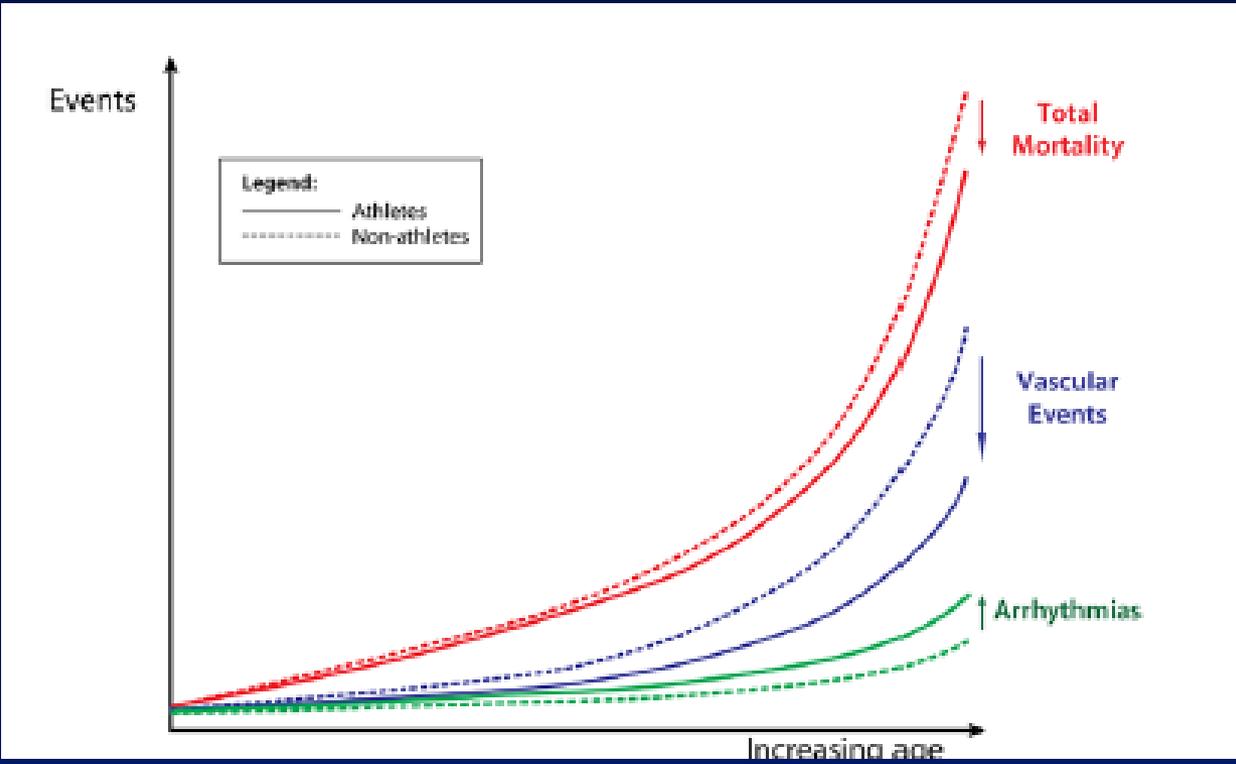
The table showing increase in survival of Olympic medalists compared with controls, which increases with the time since their first medal. CI indicates confidence interval.

(Circulation. 2014;130:987-991.)

Can Intensive Exercise Harm the Heart?

You Can Get Too Much of a Good Thing

André La Gerche, MBBS, PhD, FRACP, FCSANZ, FESC; Hein Heidbuchel, MD, PhD, FESC



Sudden cardiac death in sport

Primary Prevention

Sudden cardiac death in sport

SCREENING IN ITALIA

D.M. 18 febbraio 1982

Norme per la tutela sanitaria dell'attività sportiva agonistica



Esistenza della **Legge** sulla tutela sanitaria delle attività sportive (26/10/1971) e DM 18/2/1982 sulle attività agonistiche

Il giudizio del medico specialista in medicina dello sport rappresenta l'unico elemento per la concessione o meno della idoneità allo sport agonistico

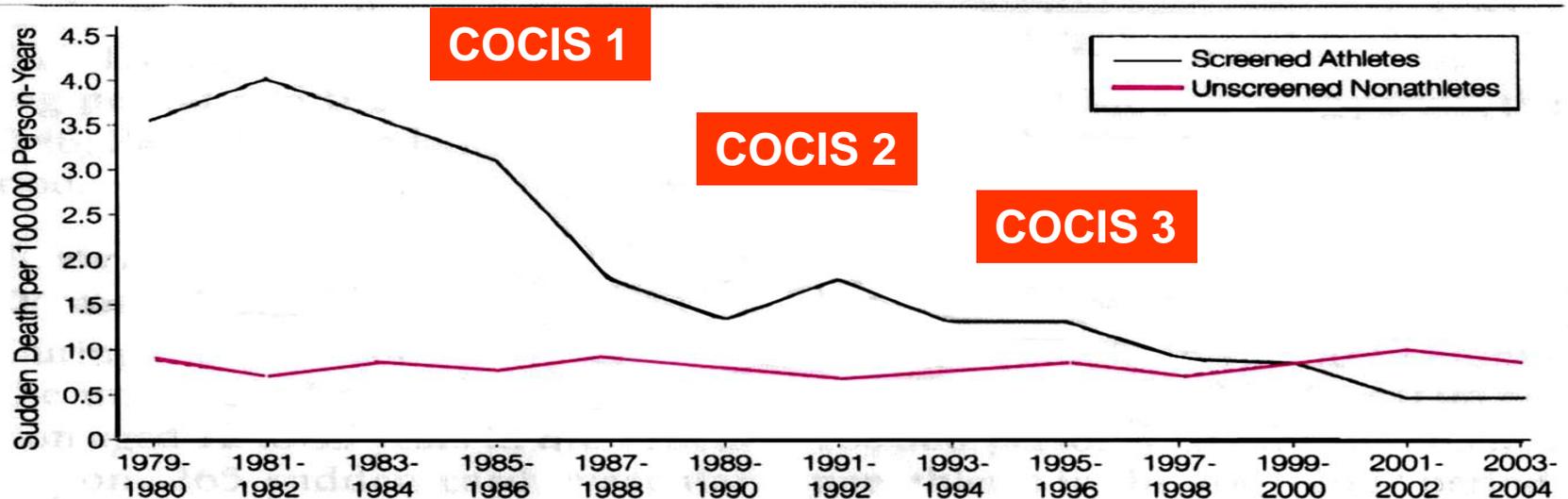
Sudden cardiac death in sport

The Italian pre-participation screening program in preventing sudden death

Trends in Sudden Cardiovascular Death
in Young Competitive Athletes
After Implementation of a
Preparticipation Screening Program

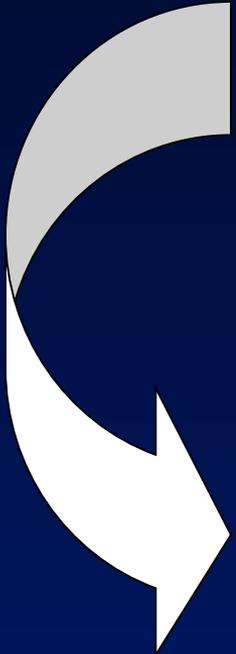
D. Corrado et al.

Figure. Annual Incidence Rates of Sudden Cardiovascular Death in Screened Competitive Athletes and Unscreened Nonathletes Aged 12 to 35 Years in the Veneto Region of Italy (1979-2004)



During the study period, the annual incidence of sudden cardiovascular death decreased by 89% in screened athletes (P for trend $< .001$). In contrast, the incidence rate of sudden cardiovascular death did not demonstrate consistent changes over time in unscreened nonathletes.

Sudden cardiac death in sport



*MASTER and SENIOR
ATHLETES*

Sudden cardiac death in sport

Incidence of SCD is greater in
adult/senior athletes

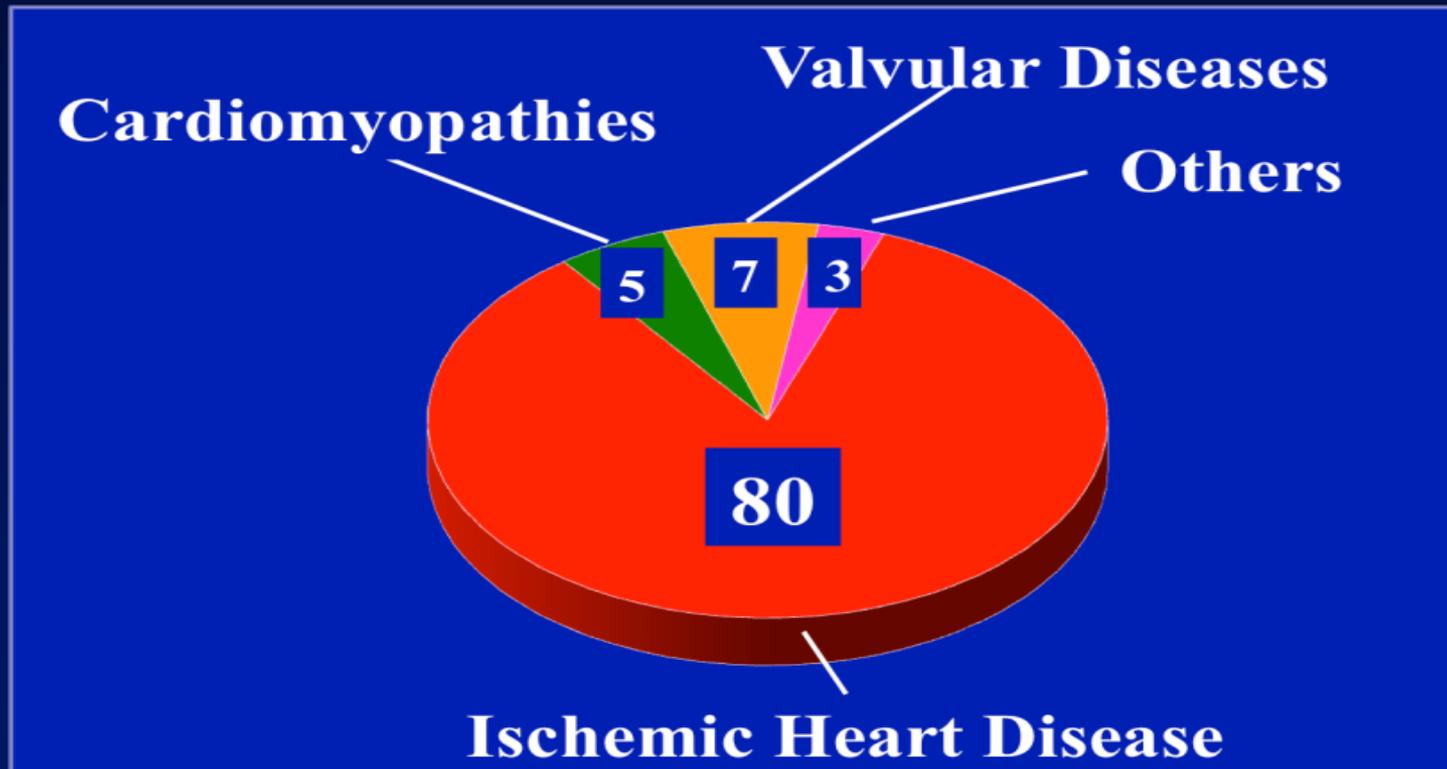


1:15,260 athletes/year (i.e., 7.6 times than sedentary) (Thompson PD JAMA 1982)

1:18,000 men/year (i.e. 25 times than during rest) (Siscovick DS NEJM 1984)

Sudden cardiac death in sport

Incidence of SCD is greater in adult/senior athletes



(Maron BJ et al. Circulation 2007; 15:1643)

Sudden cardiac death in sport

Sudden Cardiac Arrest During Sports Activity in Middle Age

Eloi Marijon, MD, PhD; Audrey Uy-Evanado, MD; Kyndaron Reinier, MPH, PhD; Carmen Teodorescu, MD, PhD; Kumar Narayanan, MD; Xavier Jouven, MD, PhD; Karen Gunson, MD; Jonathan Jui, MD, MPH; Sumeet S. Chugh, MD

Sport
SCA
(n=63)

Non-Sport
SCA
(n=1184)

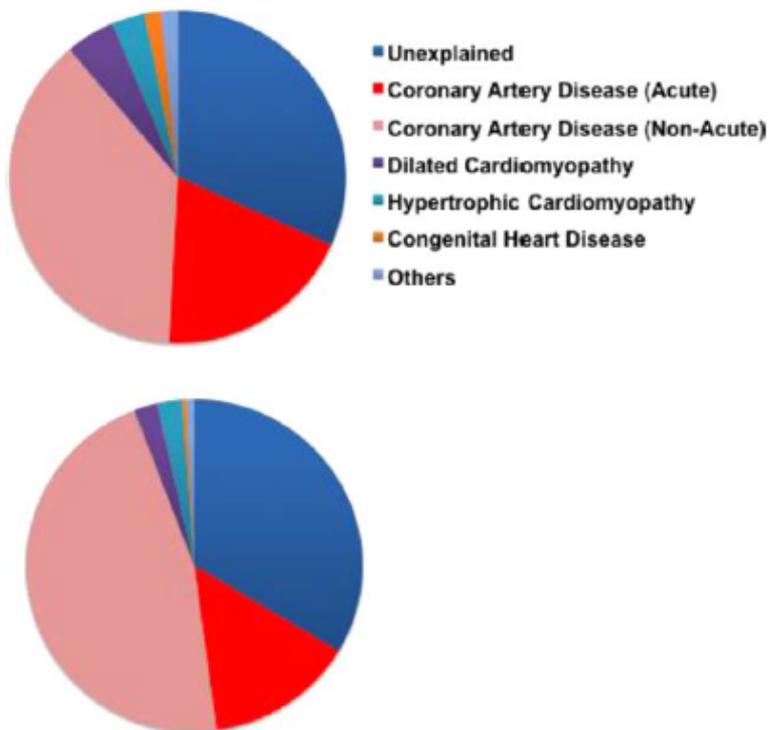


Figure 2. Distribution of cardiovascular abnormalities associated with sudden cardiac arrest (SCA) in the 1247 subjects according to sports SCA (top, n=63) and nonsports SCA (bottom; n=1184).

(*Circulation*. 2015;131:1384-1391)

Sudden cardiac death in sport



European Heart Journal (2013) 34, 3616–3623
doi:10.1093/eurheartj/ehz401

CLINICAL RESEARCH
Sports cardiology

Exercise-related out-of-hospital cardiac arrest in the general population: incidence and prognosis

Jocelyn Berdowski¹, Margriet F. de Beus^{2,3}, Marieke Blom⁴, Abdennasser Bardai⁴, Michiel L. Bots², Pieter A. Doevendans^{3,5}, Diederick E. Grobbee^{2,6}, Hanno L. Tan⁴, Jan G.P. Tijssen¹, Rudolph W. Koster¹, and Arend Mosterd^{2,3,7*}

The incidence of exercise-related OHCA was 2.1 per 100 000 person-years and was more than 10-fold higher in men (4.0) than in women (0.3) (Table 2).

Exercise-related OHCA mainly occurred in men (93 compared with 72% in non-exercise-related OHCA). The male predominance in (exercise related) OHCA is consistent with previous reports.^{6,8} It has been attributed to lower sports participation rates and a later onset of coronary artery disease in women (coronary artery disease being the major cause of death in older athletes),¹ but a

study for the first time establishes the favourable outcome of exercise-related OHCA; 46% of victims survive the event compared with 17% of victims of non-exercise-related OHCA. This benefit remains after adjusting for age and the fact that exercise-related OHCA occurred more frequently in public places, were more frequently bystander witnessed, had higher rates of bystander CPR and AED use, and were more likely to have a shockable initial rhythm.

promote AEDs at sports venues.

Sudden cardiac death in sport

Secondary Prevention



Automated external defibrillators (AEDs)

Effectiveness of Emergency Response Planning for Sudden Cardiac Arrest in United States High Schools With Automated External Defibrillators

Jonathan A. Drezner, MD; Ashwin L. Rao, MD; Justin Heistand, MD;
Megan K. Bloomingdale; Kimberly G. Harmon, MD

- **1.710 scuole negli USA dotate di AED**
- **22 AC in sedentari (età media 57 anni)**
- **14 AC in atleti (età media 16 anni)**

Automated external defibrillators (AEDs)

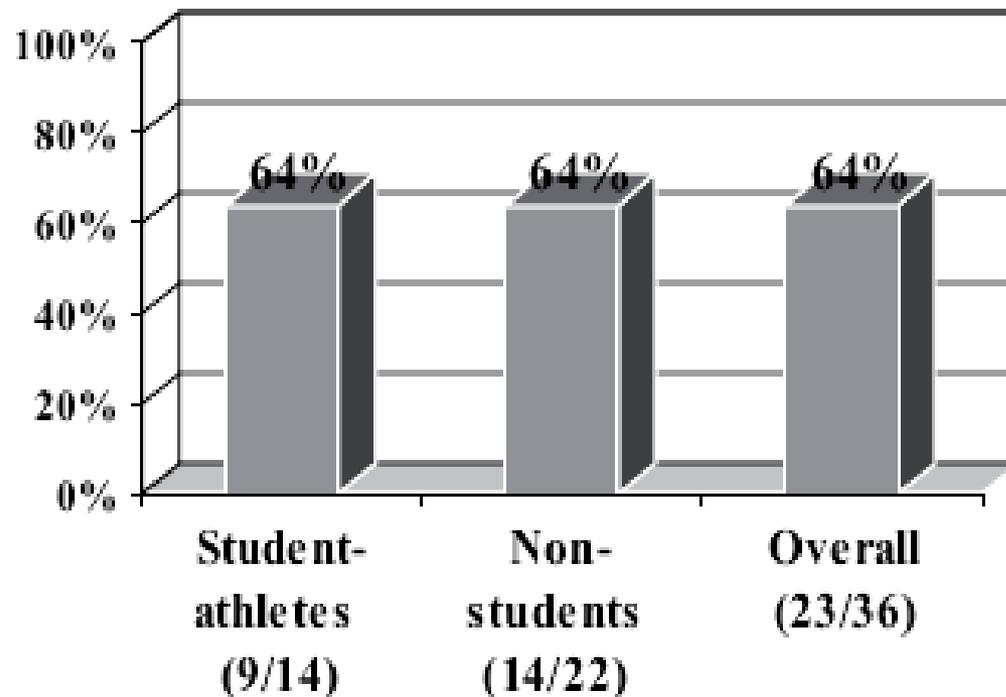


Figure 2. Survival to hospital discharge after SCA in high schools with AEDs.

Automated external defibrillators

Efficacy at sport arenas



European Heart Journal (2011) 32, 2119–2124
doi:10.1093/eurheartj/ehr178

SPECIAL ARTICLE

Consensus document regarding cardiovascular safety at sports arenas

Position stand from the European Association of Cardiovascular Prevention and Rehabilitation (EACPR), section of Sports Cardiology

Mats Borjesson^{1*}, Luis Serratos², Francois Carre³, Domenico Corrado⁴, Jonathan Drezner⁵, Dorian L. Dugmore⁶, Hein H. Heidbuchel⁷, Klaus-Peter Mellwig⁸, Nicole M. Panhuyzen-Goedkoop^{9,10}, Michael Papadakis¹¹, Hanne Rasmusen¹², Sanjay Sharma¹¹, Erik E. Solberg¹³, Frank van Buuren⁸, and Antonio Pelliccia¹⁴, writing group, on behalf of the EACPR section of sports cardiology

¹Department of Acute and Cardiovascular Medicine, Sahlgrenska University Hospital, Göteborg, Sweden; ²Sanitas-Real Madrid FC Sports Medicine Department, Madrid, Spain; ³Unite Biologie et Medecine du Sport, Pontchaillou Hospital, Rennes University, Rennes, France; ⁴Department of Cardiac, Thoracic and Vascular Sciences, University of Padua Medical School, Padua, Italy; ⁵University of Washington, Seattle, WA, USA; ⁶Wellness Medical Center, Stockport, UK; ⁷Cardiovascular Rehabilitation Unit, KU Leuven, Leuven, Belgium; ⁸Heart Center NRW, University Hospital, Bad Oeynhausen, Germany; ⁹Heart Center Radboud University Nijmegen, Nijmegen, The Netherlands; ¹⁰Sports Medical Center Papendal, Arnhem, The Netherlands; ¹¹Kings College Hospital, London, UK; ¹²Department of Cardiology, Bisbebjerg University Hospital, Copenhagen, Denmark; ¹³Department of Medicine, Diakonhjemmet Hospital, Oslo, Norway; and ¹⁴Institute for Sports Medicine and Science, Rome, Italy

Received 5 December 2010; revised 17 March 2011; accepted 13 May 2011; online publish-ahead-of-print 14 June 2011

Automated external defibrillators

Efficacy at sport arenas

Table 1 Check list: written medical action plan of sports arenas with >1000 spectators, should include

Name of medical director at arena
Map of the arena with localization of emergency exits and medical care (for opposing teams and spectators)
Arena and event specific planning
Level of care
Personnel
Medical equipment
Communication
Treatment facilities
Transportation resources
Documentation
Collaboration with local emergency medical system and nearest hospital
Continuous quality improvement
External information

The incidence of SCD in the general population (>35 years) is estimated to be 1 in 1000 persons per year, while in young people (<35 years) the incidence of SCD is 0.3–3.6 per 100.000 persons per year. Intense physical activity, also in athletes, will carry a higher risk for acute cardiac events, especially in subjects with an underlying cardiovascular disease. On the basis of earlier studies, cardiac screening is recommended in competitive athletes. The assistance to players is potentially rapid and readily accessible.

Table 2 Recommendations for minimum level of care at sports arenas/events with >1000 spectators/competitors

Arena size	AEDs no	Physicians	Nurses	MTs	Ambulances
< 10 000	1–2	1	1	2	0–1
10–50 000	4	2	1–5	2–10	1–2
> 50 000	8	2–4	>5	>10	>2

These figures are to be seen as recommendations. As discussed in the consensus document, a specific arena may need a different number of AEDs and personnel, to ensure the chain-of-survival in every case of SCA in the arena, within <5 min.

Automated external defibrillators

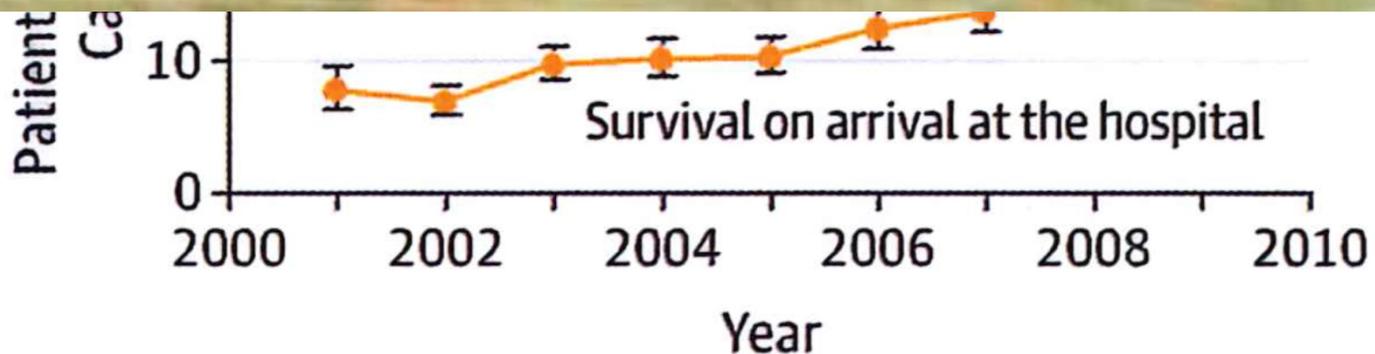
Efficacy at sport arenas

Thirteen witnessed SCAs occurred in the Fritz-Walter Stadium (Keiserlautern - D), capacity of 49.780 spectators, in a 80-month period, all in males with documented VF. Basic life support was usually provided within 2 min and defibrillation and advanced life support within min. Of the victims, *77% regained spontaneous circulation and 62% survived without neurological deficits.*

Another recent retrospective analysis of 36 cases of SCA in US. High Schools with on-site AED programmes showed a survival benefit for young athletes comparable with adult non-athletes (spectators, coaches, officials) *with over 60% of victims surviving.*

Sudden cardiac death in sport

C Bystander resuscitation and survival after



Sudden cardiac death in sport

2015 ESC Guidelines for the management of patients with ventricular arrhythmias and the prevention of sudden cardiac death



12.7 Sudden cardiac death in athletes

The most frequent causes of sudden death in younger athletes are inherited arrhythmogenic disorders (cardiomyopathies and channelopathies) and CAD (both congenital and acquired). In the US, the

It is important that coaches and staff at sporting facilities are trained to face emergency situations, perform cardiopulmonary resuscitation and use automatic external defibrillators. ^{179,786}

Sudden cardiac death in sport

Conclusions

*Harmon et al.
Circulation
2015*

Conclusions

The estimated rate of SCD in NCAA athletes has remained similar over the last 10 years and is $\approx 1:50000$.³ High-risk groups include males, black athletes, and basketball athletes.

The most common finding in this cohort at autopsy after SCD was AN-SUD, and there were fewer cases of definitive HCM than previously described. Media reports are more likely to capture high-profile deaths, and lower divisions may be

underrepresented in this study. Moving toward a standardized autopsy with involvement of a cardiovascular pathologist and the use of molecular diagnostic tests will improve accuracy. Although institutional resources vary and may not

be widely available to institute large-scale advanced cardiovascular screening in all athletes, strong consideration should be given for additional cardiac testing beyond the traditional history and physical in higher-risk groups, in particular, male basketball players.