



33rd Annual Ironman Sports Medicine
Conference
Tuesday October 10th, 2023



Sudden Death in Sports

Professor Gregory P Whyte OBE PhD DSc FBASES FACSM

Research Institute for Sport & Exercise Sciences
FACULTY OF SCIENCE



Sudden Cardiac Death in Athletes



Marc Vivian-Foe

Hank Gathers



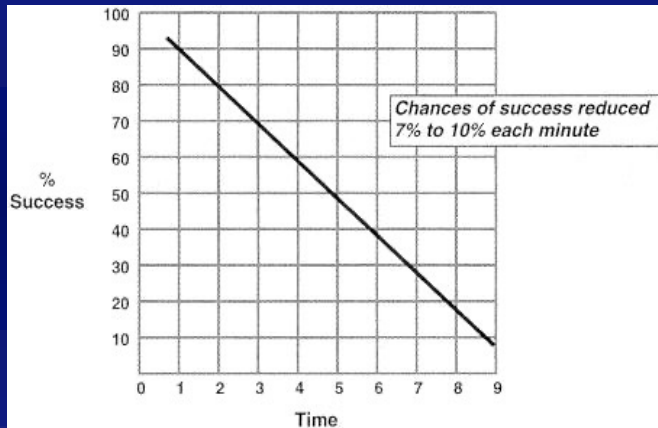
Research Institute for Sport & Exercise Sciences
FACULTY OF SCIENCE



Quality of Medical Care

SCA in athletes is a catastrophic event with a low survival rate (11-16%)

Maron; *JAMA* 2002; Drezner; *Heart Rhythm* 2006; Drezner; *Heart Rhythm* 2008



Larsen *Ann Emerg Med* 1993

Quality Care = Prompt, coordinated and efficient response to a collapsed individual

Early Recognition Call
Emergency Service

+

Early
CPR

+

Early
AED

=

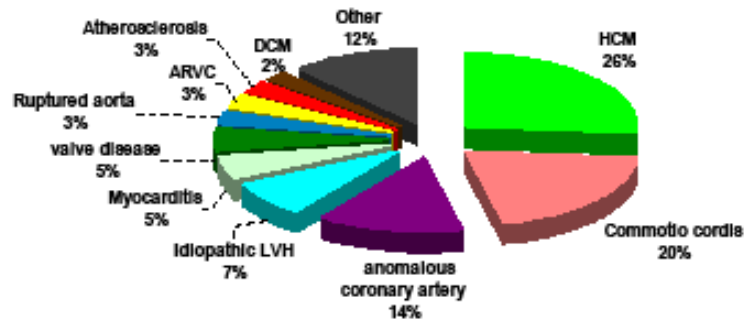
IMPROVED
SURVIVAL

AETIOLOGY & INCIDENCE OF SCD

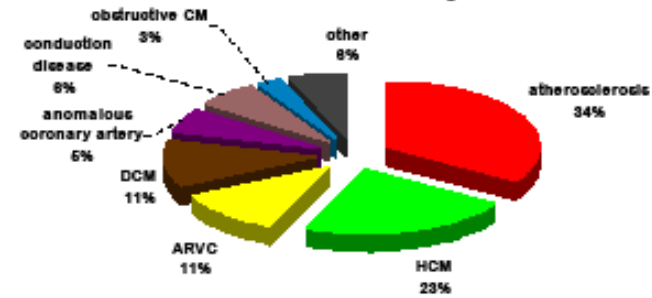
..the global debate has stalled because of a continuing disagreement on the incidence of SCD in young athletes

Drezner et al. *BJSM* 2009;43: 62-626

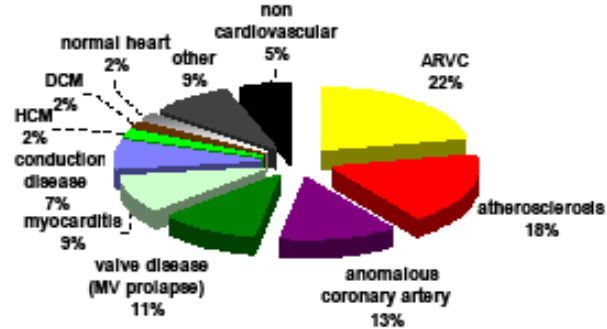
US, 387 cases, 9-40 years



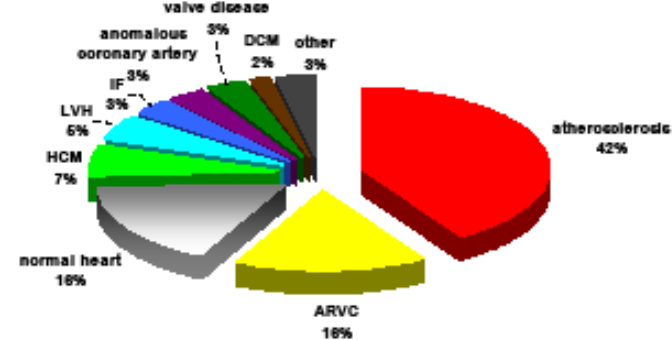
France, 80 cases 2-65 years



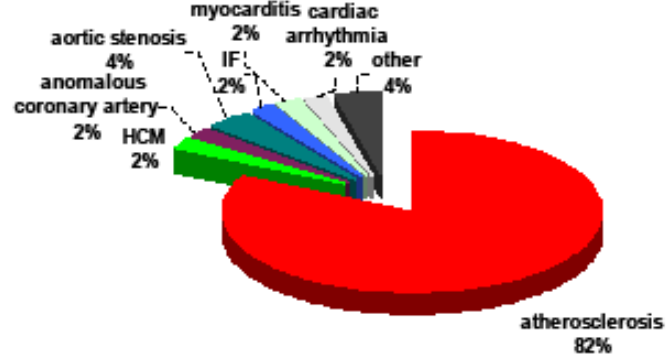
Italy, 55 cases, 12-35 years



Spain, 61 cases, 11-65 years



Ireland, 51 cases, 12-78 years



UK, 118 cases, 7-59 years

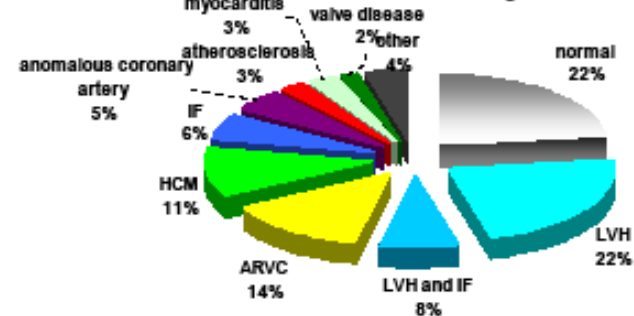
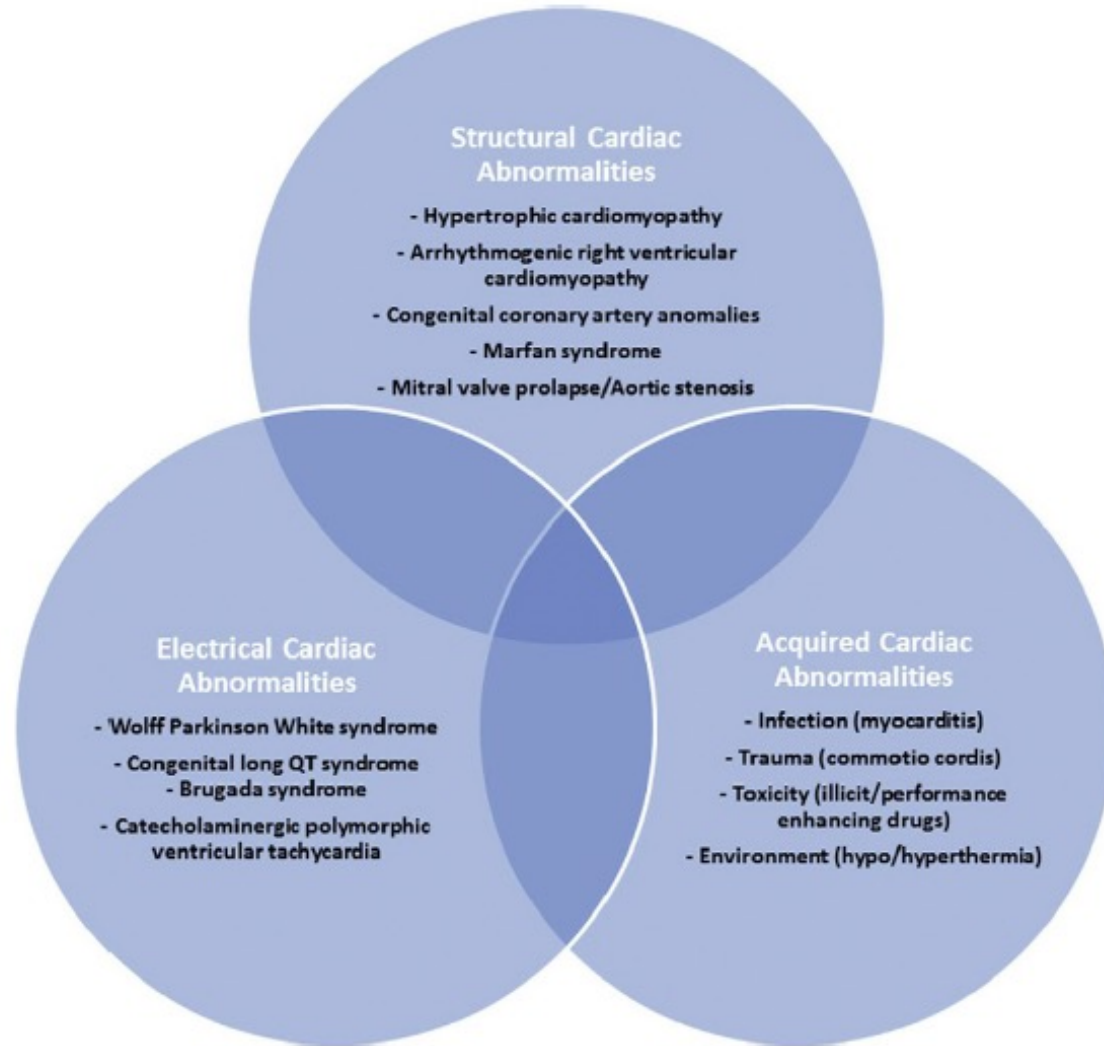
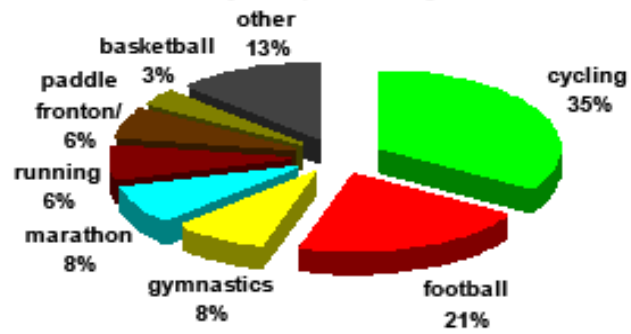


FIGURE 1 Common Causes of Sudden Cardiac Death in Young Athletes

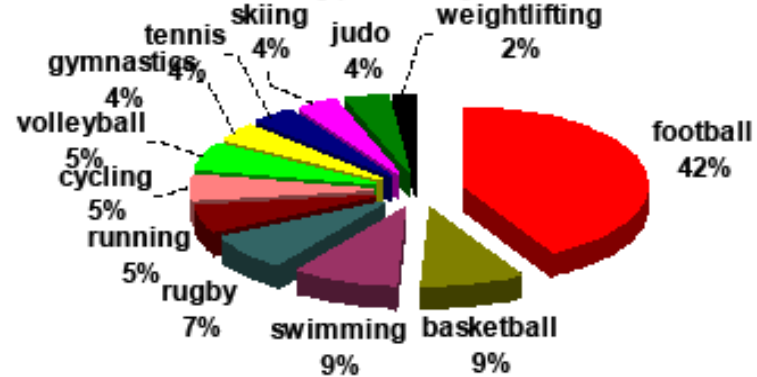


Chandra et al. JACC 2013;61:1027-40

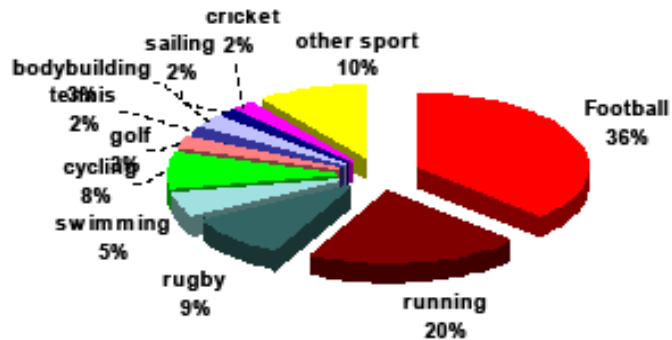
Spain, 11-65 years



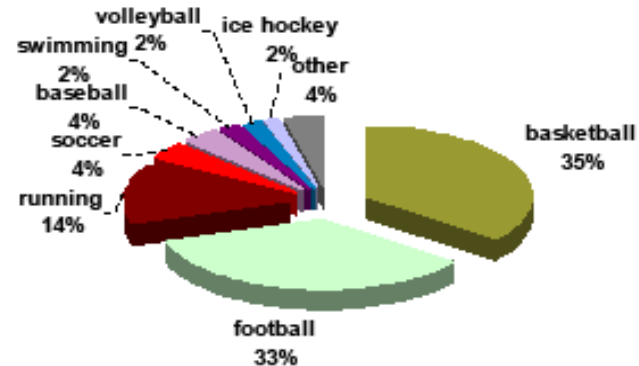
Italy, 12-35 years



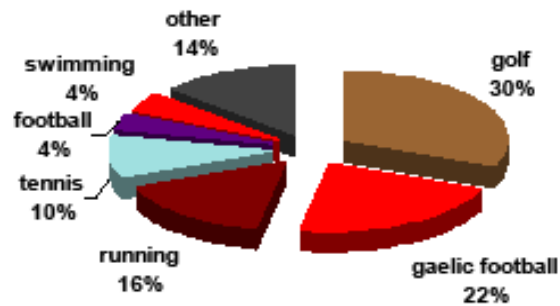
UK, 7-59 years



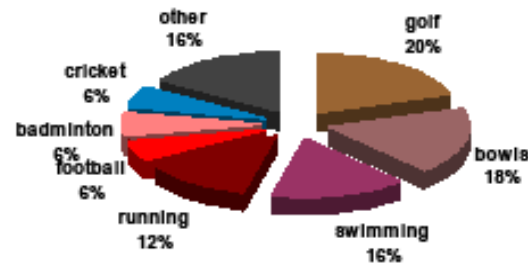
US, 12-40 years



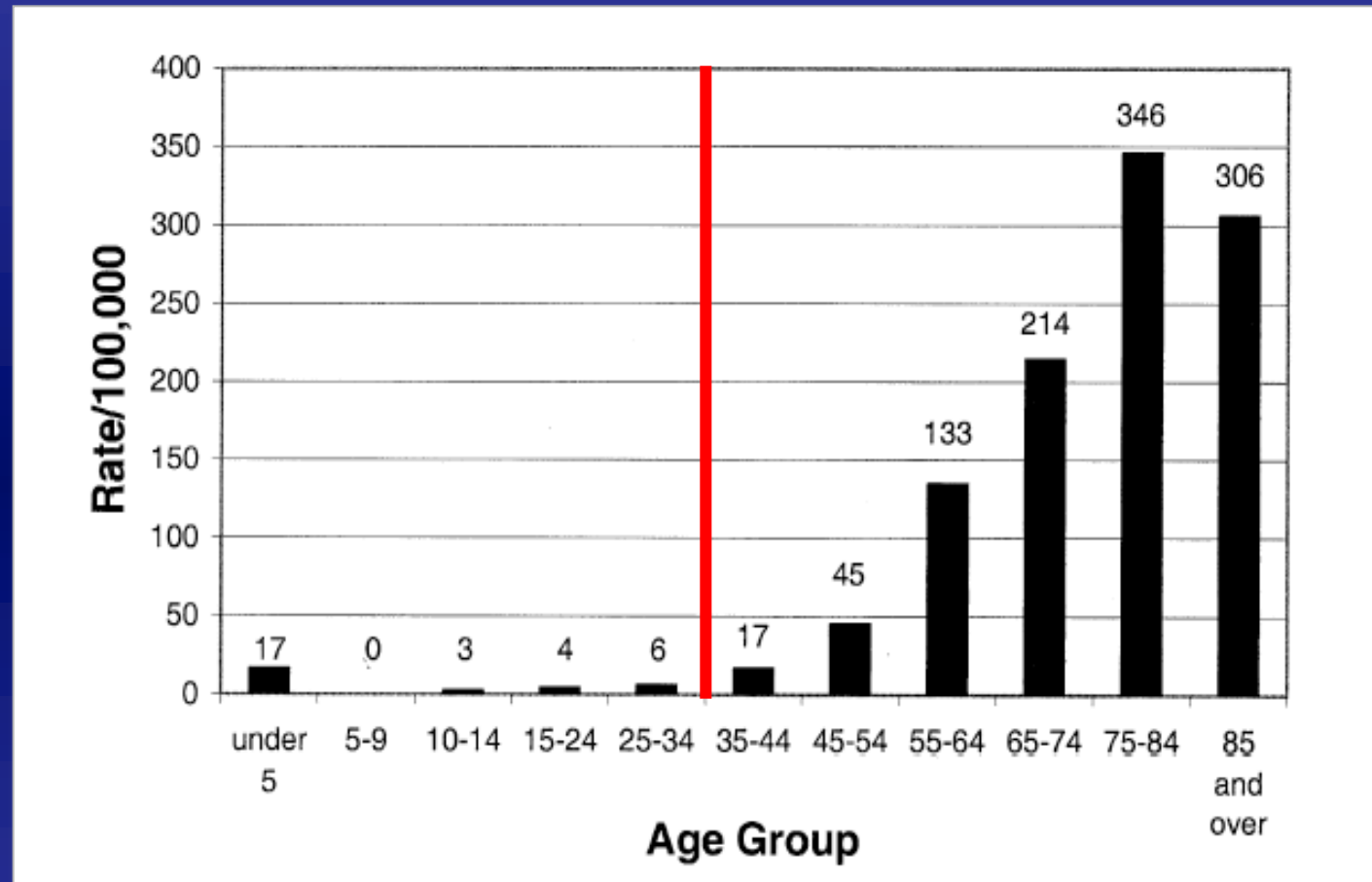
Ireland 12-78 years



Birmingham and Solihull (UK) 8-82 years



Incidence of SCD in the USA



Chugh S et al. J Am Coll Cardiol. 2004;44:1268-75

Incidence of Young (<35 years) SCD

USA:

- ≤ 20 per year [VanCamp et al. *MSSE* 1995;27:641-647; Guidelines for Pediatricians *Sports Shorts* 2002;9]
- 66 per year (average over 6 years) = 0.6 deaths per 100,000 person-years [Maron et al. *Circ* 2009;119:1085-1092].

Lower than cancer, leukaemia, cystic fibrosis, automobile fatalities, and homicides.
[Minimo et al. *National Vital Statistics Report* 2007;55(19)]

Minnesota:

- 0.5 deaths per 100,000/year [Maron et al. *JACC* 1998;32:1881-1884]

Italy:

- 2.1 deaths per 100,000/year [Corrado et al. *JACC* 2003;42:1959-1963]
- 0.87 deaths per 100,000/year [Corrado et al. *JAMA* 2006;296:1593-1601]
- *ca. 0.4 deaths per 100,000/year post-screening

The study population was identified by targeted searches that used a variety of sources at the time each of these strategies became available during the duration of the study: (1) LexisNexis archival informational database with searchable access to authoritative news, business, legal, and public records (n=5 billion searchable documents available from thousands of sources), 2003 to 2006 (457 cases); (2) news media accounts systematically assembled through Burrelle's Information Services (Livingston, NJ), with access to 18 000 US newspapers and international media sources daily, 1990 to 2006 (847 cases); (3) Internet searches, with access to online information via World Wide Web-based search engines (eg, Google, Yahoo), 2003 to 2006 (200 cases); (4) reports from the US Consumer Product Safety Commission (Washington DC), 1988 to 2006 (15 cases); (5) accumulated records of the National Center for Catastrophic Sports Injury Research (University of North Carolina, Chapel Hill), 1985 to 2006 (187 cases); (6) National Heart, Lung, and Blood Institute Pathology Branch archives, 1980 to 1990 (68 cases); and (7) reports submitted directly to the registry and the Minneapolis Heart Institute Foundation Web site (US National Registry of Sudden Death in Athletes, <http://www.suddendeathathletes.org>) or personal reports from physicians, attorneys, coroners/medical examiners, high schools/colleges, and patient advocacy and support organizations, 1980 to 2006 (92 cases).

Background
 physical
Methods
 a large
 died st
 to 200
 (1290
 disease
 cordis
 a singl
 occur
 only 1
 were h
Conclusi
 somew
 releva
 system

act on the
 controversy.
 assembled
 hletes who
 from 1980
 94 to 2006
 liovascular
 commotio
 f events in
 years; 29%
 g, whereas
 ular causes

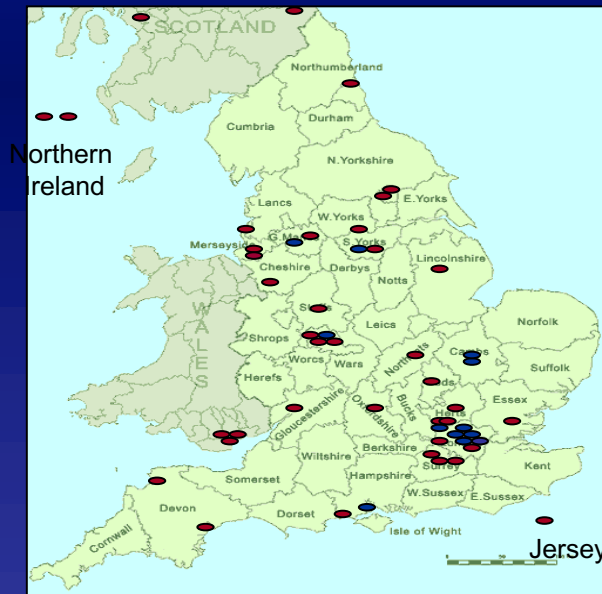
 hletes was
 se data are
 ne need for
 5-1092.)

*Harmon *et al.* *Circ* 2011;19:1594-1600 – NCAA much higher prevalence;
 Only 56% of SCD's identified by public media reports

The True Incidence of SCD

‘Only a national government-subsidized program with mandatory reporting, a centralized database, and dedicated resources would be capable of establishing the precise incidence of sudden death in young athletes in the United States.’

Maron et al. *Circ* 2009;119:1085-1092



UK National network of Cardiac pathologists 2008

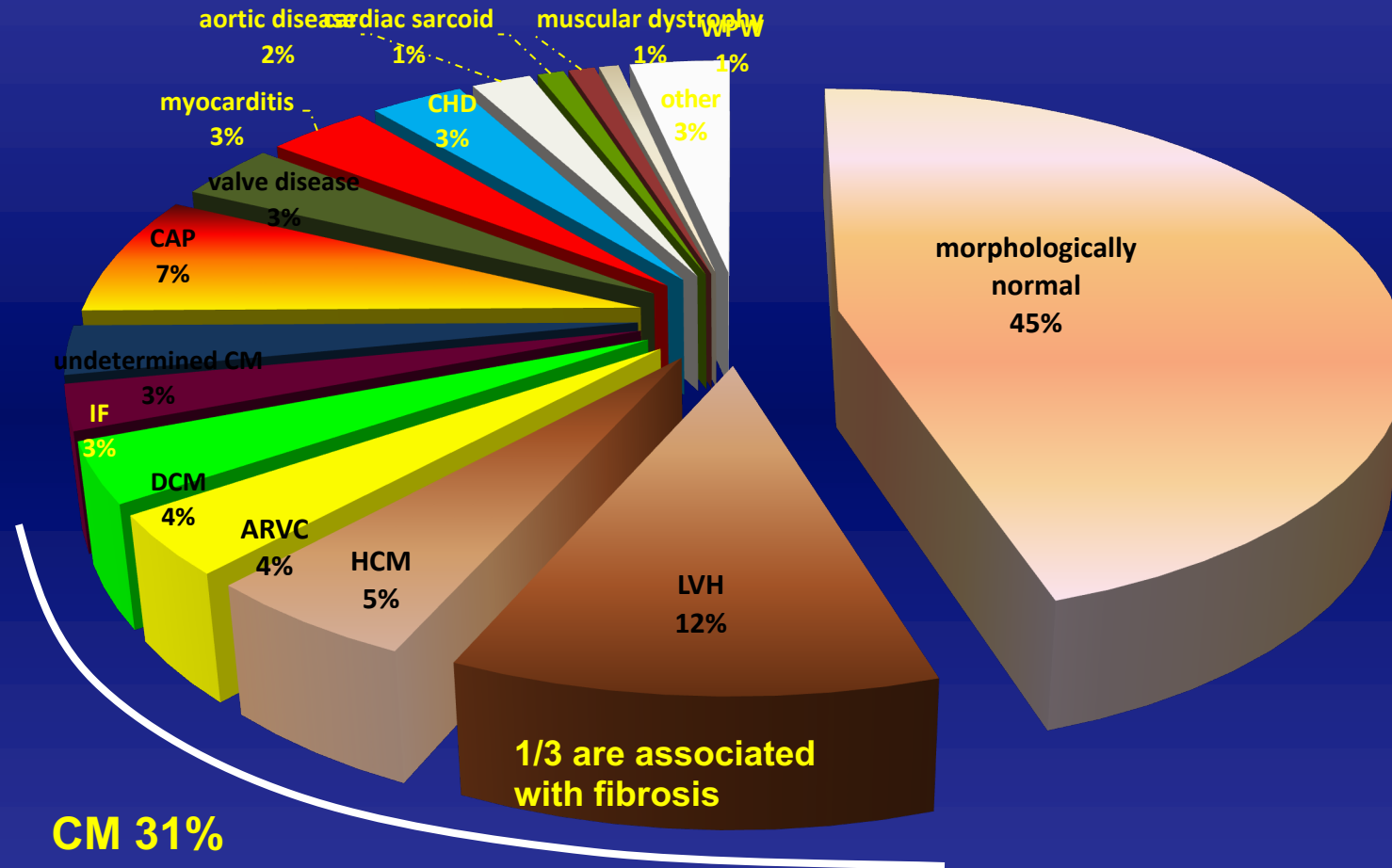
Total members - 53
DGH +/- University – 31
Forensic – 10
Cardiac – 10
Paediatric/Congenital – 2



Exercise Related Sudden Cardiac Death: The Experience of a Tertiary Referral Pathology Centre in the United Kingdom

Sofia de Noronha, Sanjay Sharma, Michael Papadakis, Saral Desai, Gregory Whyte and Mary N. Sheppard

Heart published online 28 May 2009;
doi:10.1136/hrt.2009.168369



RACE SPECIFIC AETIOLOGY



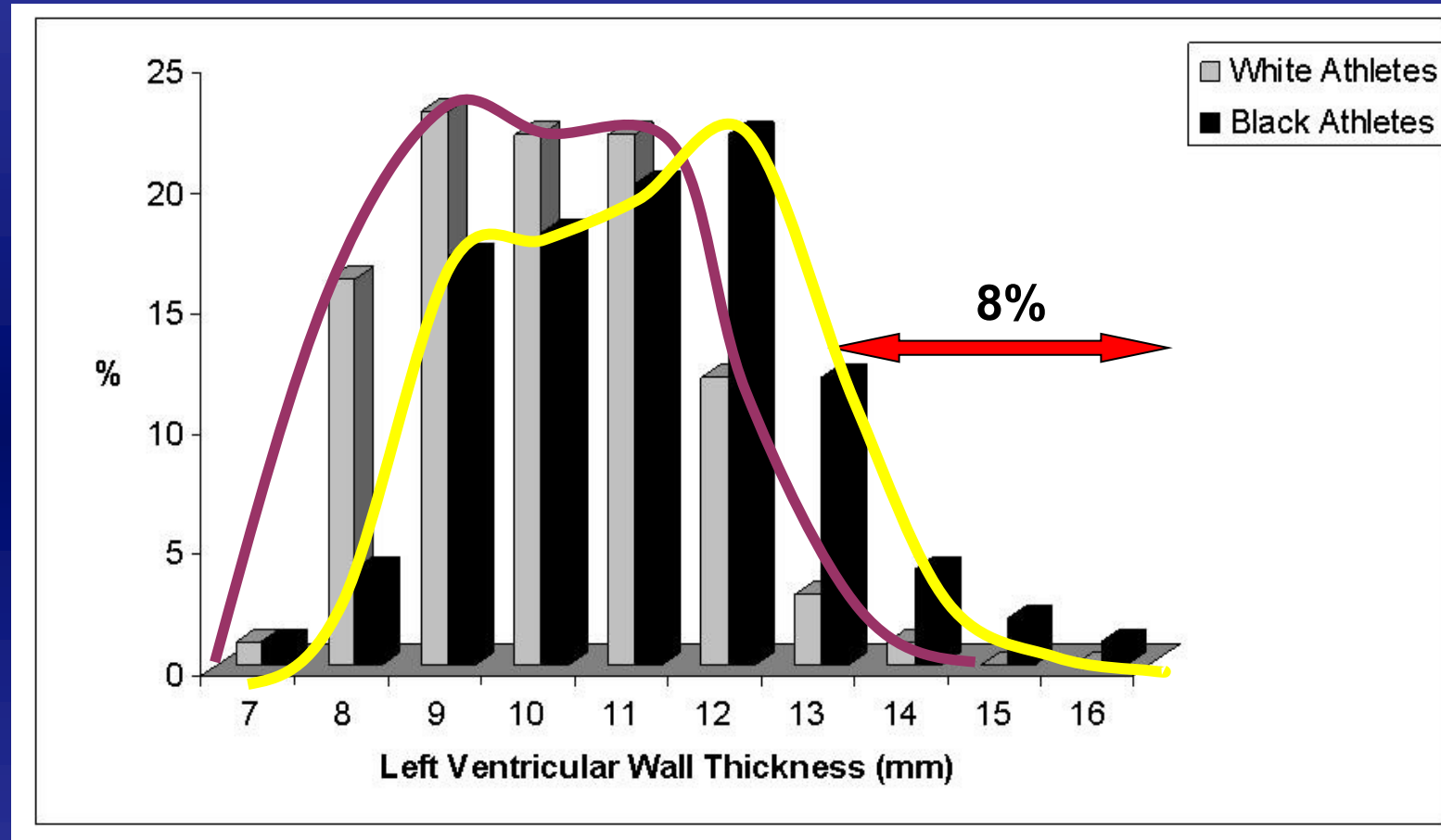
Wilson et al. BJSM 2011

Research Institute for Sport & Exercise Sciences
FACULTY OF SCIENCE

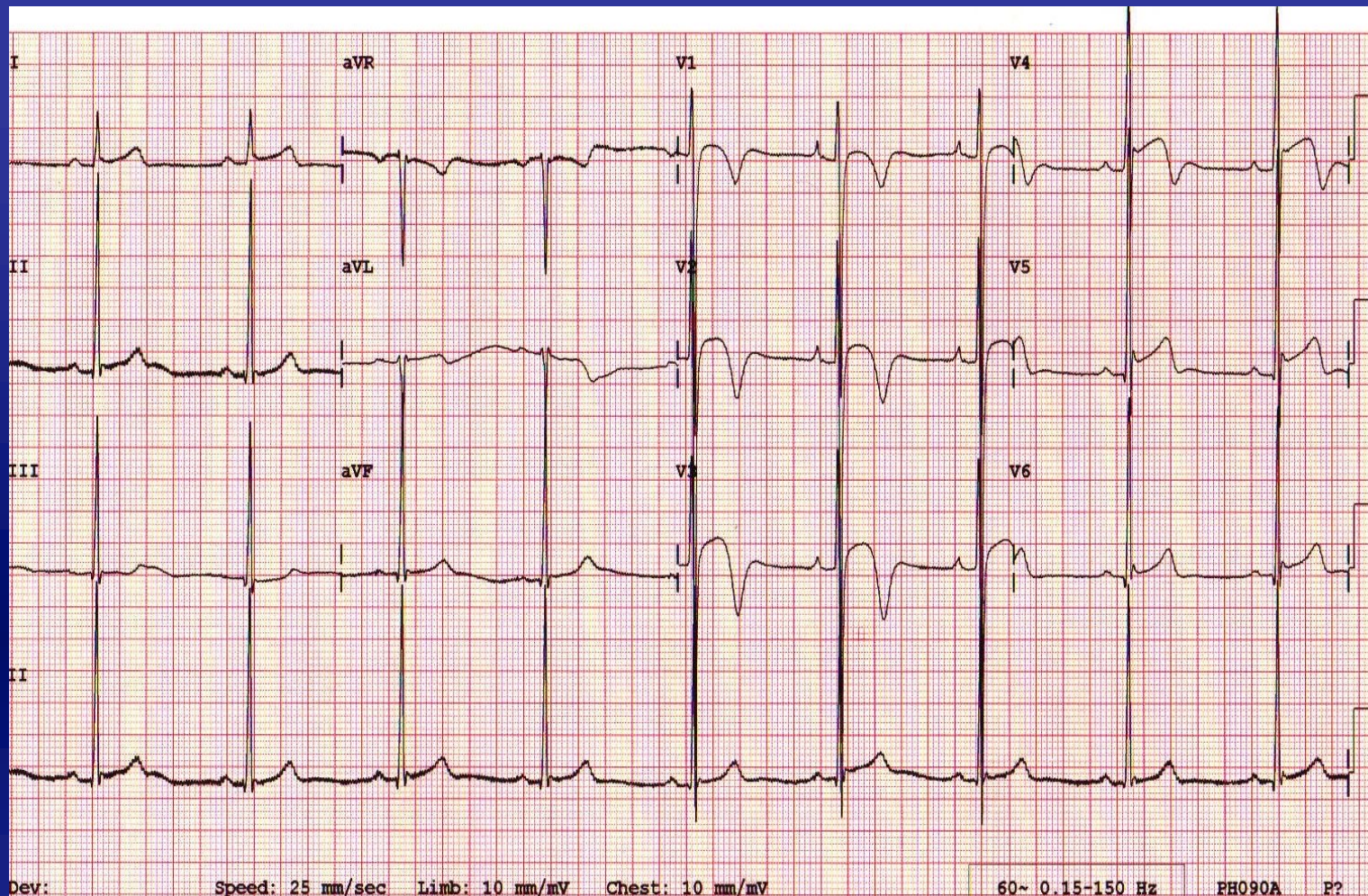


LV Wall Thickness in Male Black vs. White Athletes

Sharma, Whyte et al. *JACC* 2007



Lewis et al., *AJC* 1989; Magalski et al., *JACC* 2008 – similar results



Basavarajaiah et al. JACC 2008

Higher incidence of SCD in Black athletes – NCAA incidence rate ratio of 3.2 compared with white athletes (Div 1 Basketball players = 1:5)

Harmon et al J.Electrocardiol 2015

SCD in Young Athletes

SCD is the leading cause of sudden non-traumatic death
in young athletes (<35 years)

- Incidence: 0.5-2/100,000 athletes/year
- Combined disease prevalence of all disorders that predispose young individuals to SCD: 0.3% [Maron et al. *Circ* 2007;115:1643-1655]
- Relative risk: 2.8X [Corrado et al. *JACC* 2003] 4.5X [Marijon et al. *Circ* 2011]
- Mean age at death in athletes 23 years-old (40% <18 years)
- More common in males than females (9:1)
- 90% deaths during or immediately after exertion
- Population, gender, race specific aetiology

PRE-PARTICIPATION SCREENING

Research Institute for Sport & Exercise Sciences
FACULTY OF SCIENCE



Pre-Participation Screening

AHA/ESC:

**Compelling justification for
screening on medical,
ethical and legal grounds**

Elaborate screening
programmes not cost
effective

Acceptable
interventions to
prevent fatalities

Screening Protocols

USA

History

Physical Exam

Italy

History

Physical Exam

ECG

Corrado et al. Circulation (abstr.) 2004

Identification of Cardiovascular Diseases associated with SCD in the Athlete

(Center for sports Medicine; Padua 1982-1996)

Disease	History, Physical exam, 12-lead ECG (N=43)	History, Physical exam (N=10)*
Hypertrophic CM	22 (51%)	5 (50%)
Arrhythmogenic RV CM	8 (19%)	2 (20%)
Dilated cardiomyopathy	4 (9%)	-
Marfan syndrome	3 (7%)	1 (10%)
Long QT syndrome	2 (5%)	1 (10%)
Obstructive atherosclerotic CAD	2 (5%)	-
Myocarditis	1 (2%)	-
Subvalvular aortic stenosis	1 (2%)	1 (10%)

*Number of athletes that would have been identified on the basis of Hx and physical exam only

Efficacy of Health Questionnaires and Physical Examination versus ECG

Wilson et al., *BJSM* 2007

1074 National and International junior athletes; 15.8 ± 0.7 years (10-27 years); 1646 school children; 16.1 ± 2.1 years (14-20 years)

Patient Number	Gender	Abnormal ECG	Symptomatic	Family History of SCD	Diagnosis
1	Female	Yes	No	No	Long QT syndrome – Type 1
2	Male	Yes	No	No	WPW
3	Male	Yes	No	No	WPW
4	Male	Yes	No	No	Long QT syndrome – Type 1
5	Female	Yes	No	No	RVOT-VT
6	Male	Yes	No	No	WPW
7	Male	Yes	No	No	ARVC
8	Male	Yes	No	No	Long QT syndrome – Type 1
9	Male	Yes	No	No	WPW

Sensitivity of 12-lead ECG in Sudden Death victims of HCM

78

Sudden death victims

53

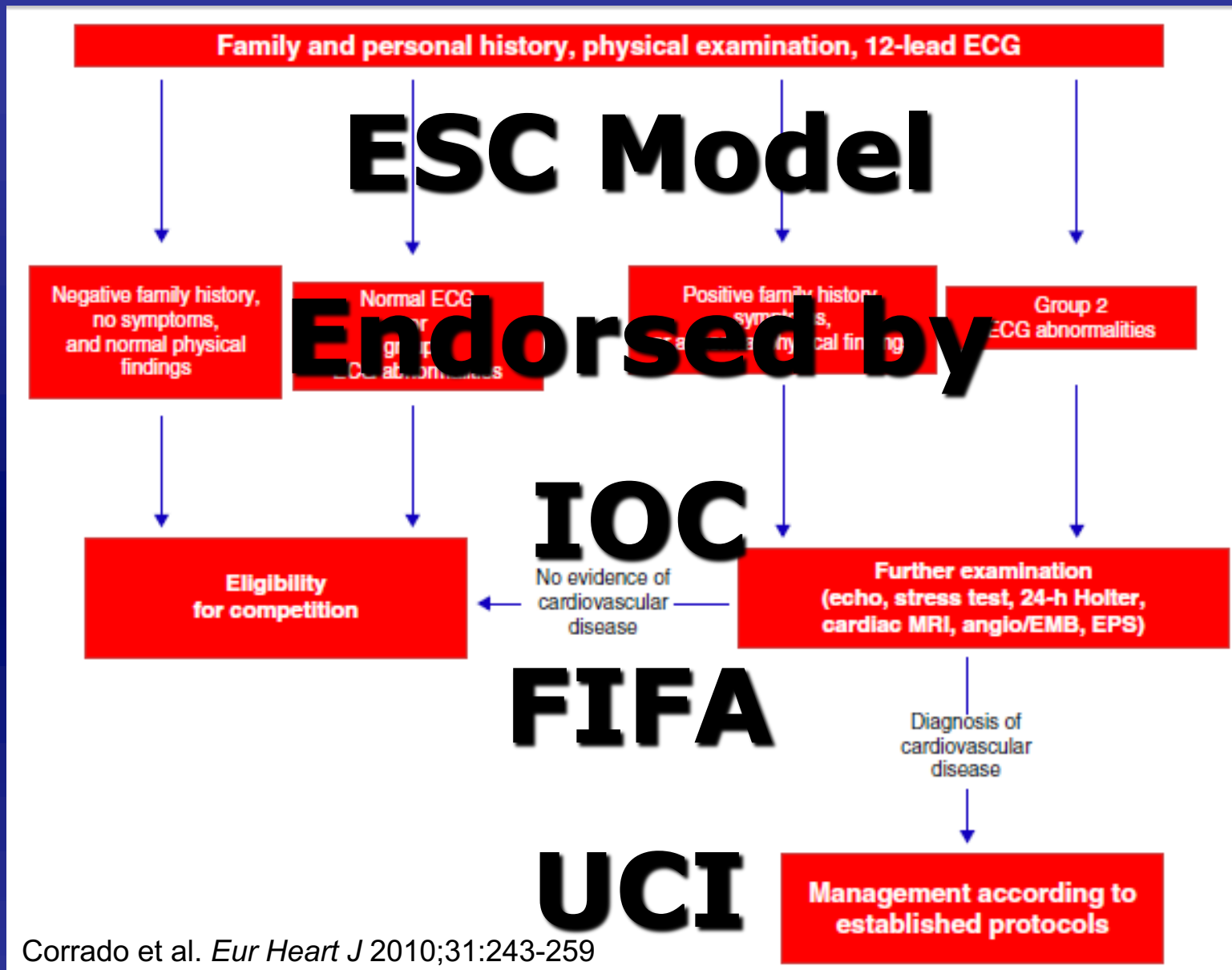
Prior 12-lead ECG

51/53 (96%)

Abnormal ECG

(LVH associated with ST segment depression, q waves)

Maron et al. Circulation 1982; 65: 1388-94



COST EFFECTIVENESS

Research Institute for Sport & Exercise Sciences
FACULTY OF SCIENCE

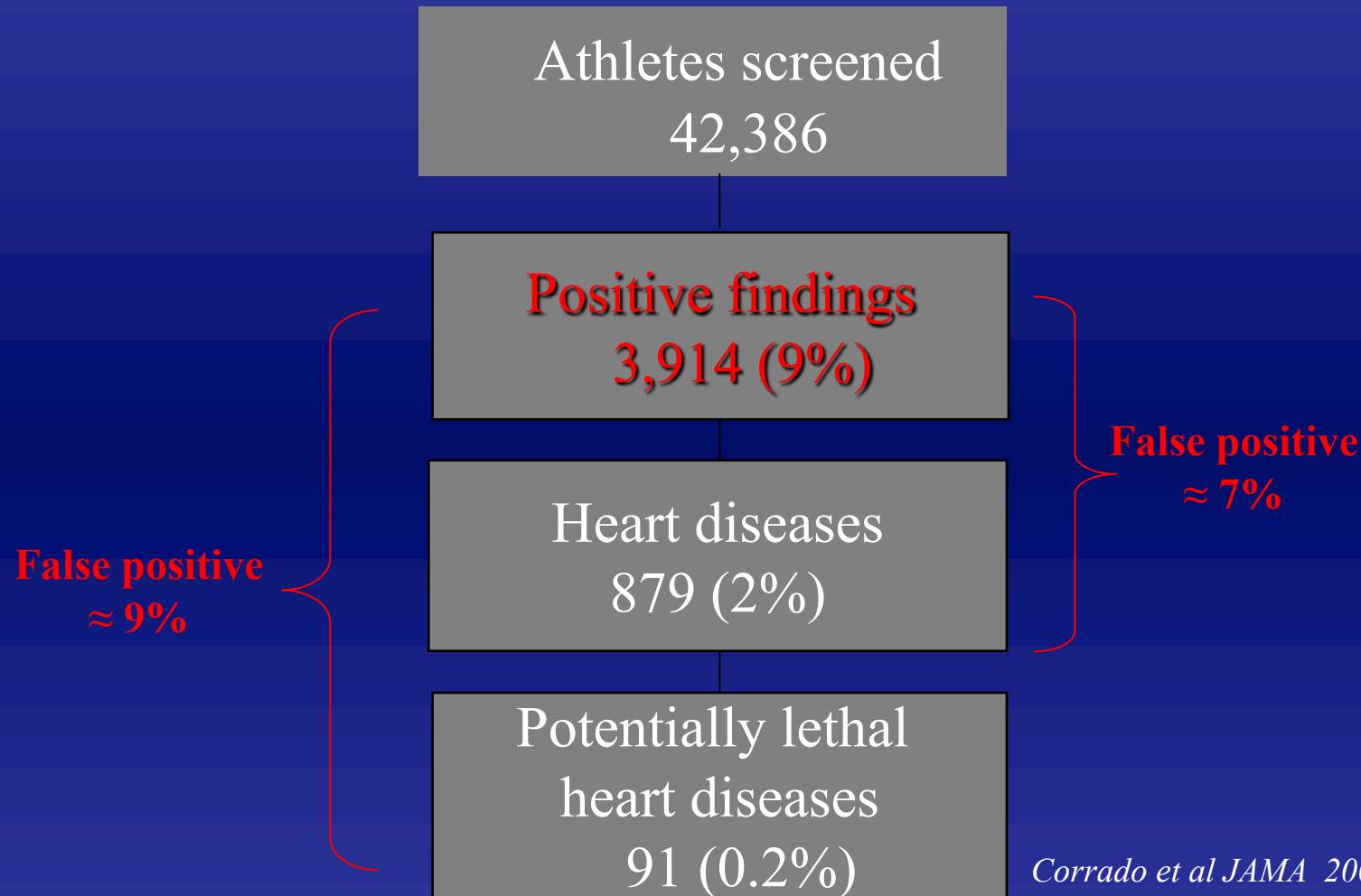


WHICH SCREENING PROTOCOL

Condition	History	Examⁿ	ECG	Echo
HCM	Pos/Neg	Pos in 25%	Positive	Pos
ARVC	Pos/Neg	Negative	Positive	Neg/Pos
WPW	Pos/Neg	Negative	Positive	Neg
LQTS	Pos/Neg	Negative	Positive	Neg
Marfan	Pos/Neg	Positive	Negative	Pos
CAA	Pos/Neg	Negative	Negative	Neg
Myocarditis	Pos/Neg	Pos/Neg	Pos/Neg	Pos

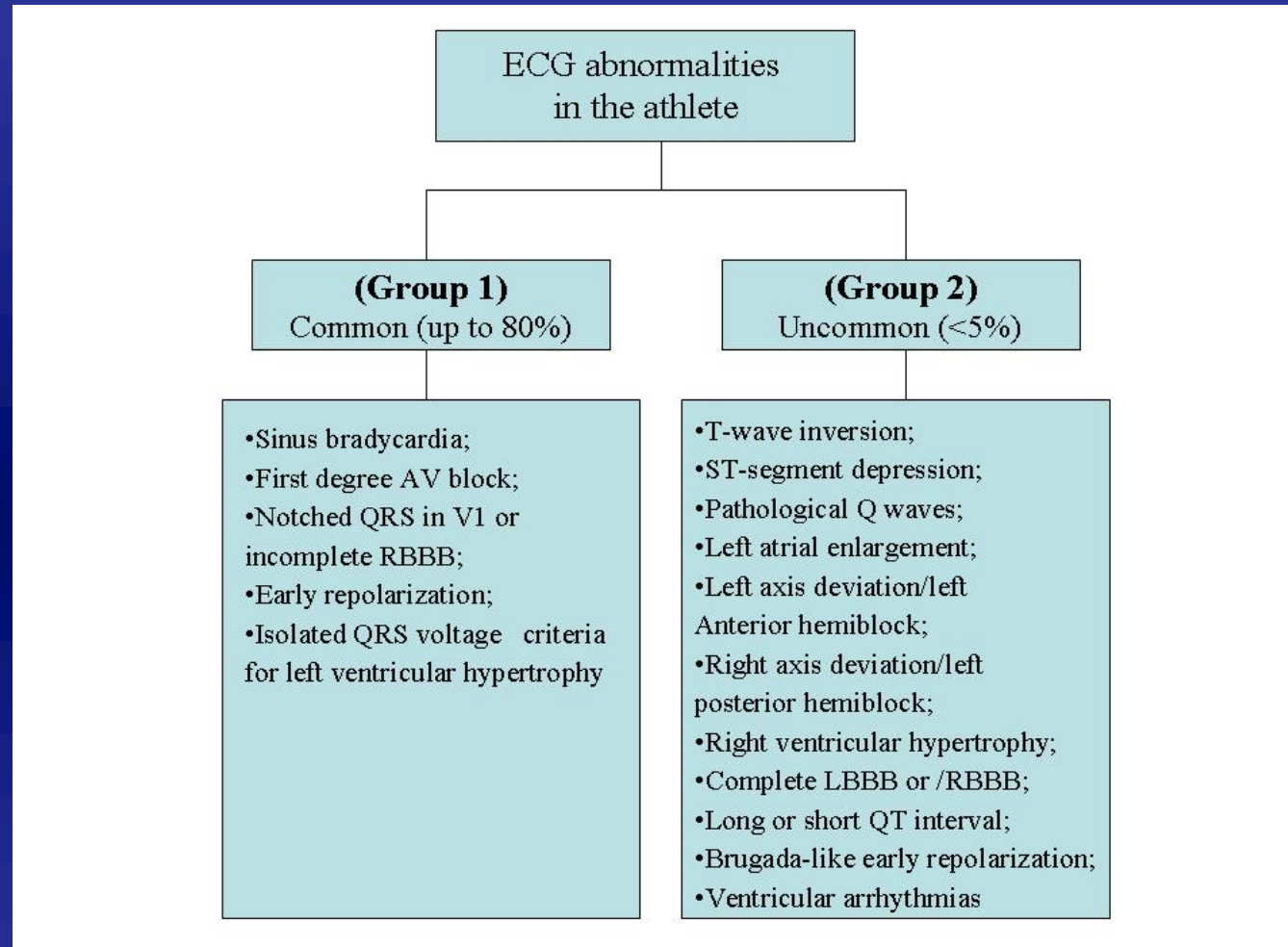

INCREASING COST

Screening of Young Athletes for Cardiovascular Diseases (Center for Sports Medicine, Padua 1979-2004)



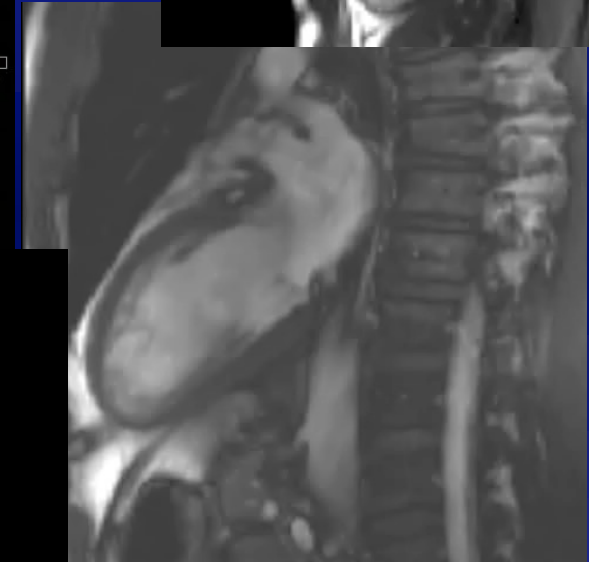
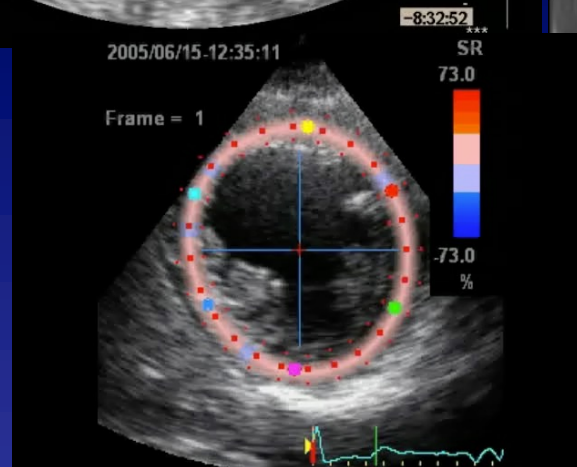
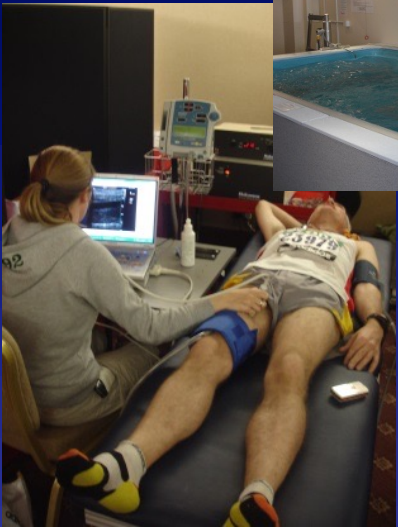
Corrado et al JAMA 2006; 296: 1593-1601

Enhanced Sensitivity of ECG



Corrado D, McKenna WJ: Eur Heart J 2007;28:1920-2

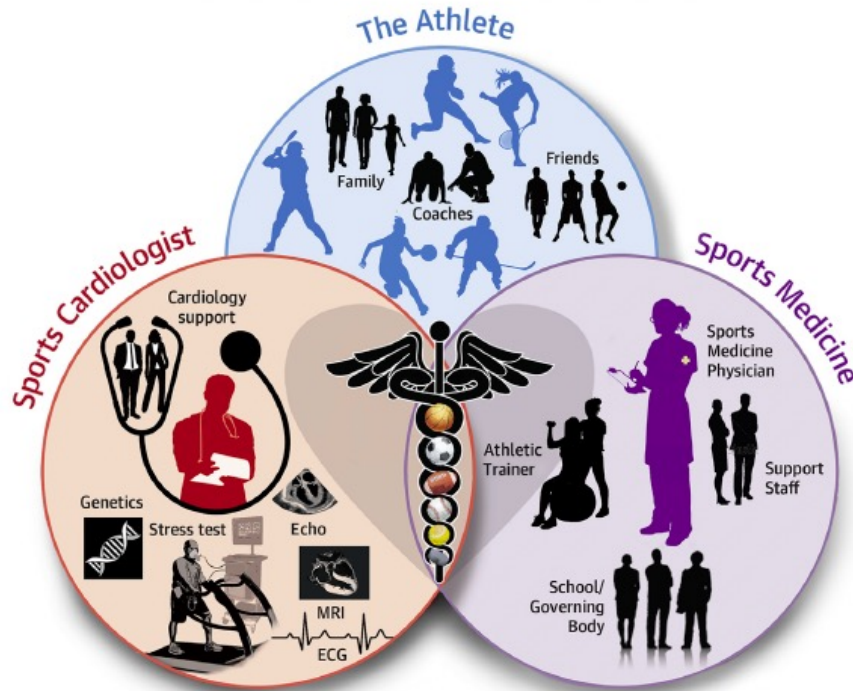
Novel Diagnostic Tools



Research Institute for Sport & Exercise Sciences
FACULTY OF SCIENCE

Multidisciplinary Care of the Athlete

Team-Based Approach to the Cardiovascular Care of Athletes



History, examination and 12-lead ECG

Normal 96%

Abnormal 4%

Continue to play

Suggestive of structural or electrical disorder

99.8%

ETT, Holter, CMR, Tilt

Echo shows congenital anomalies

2%

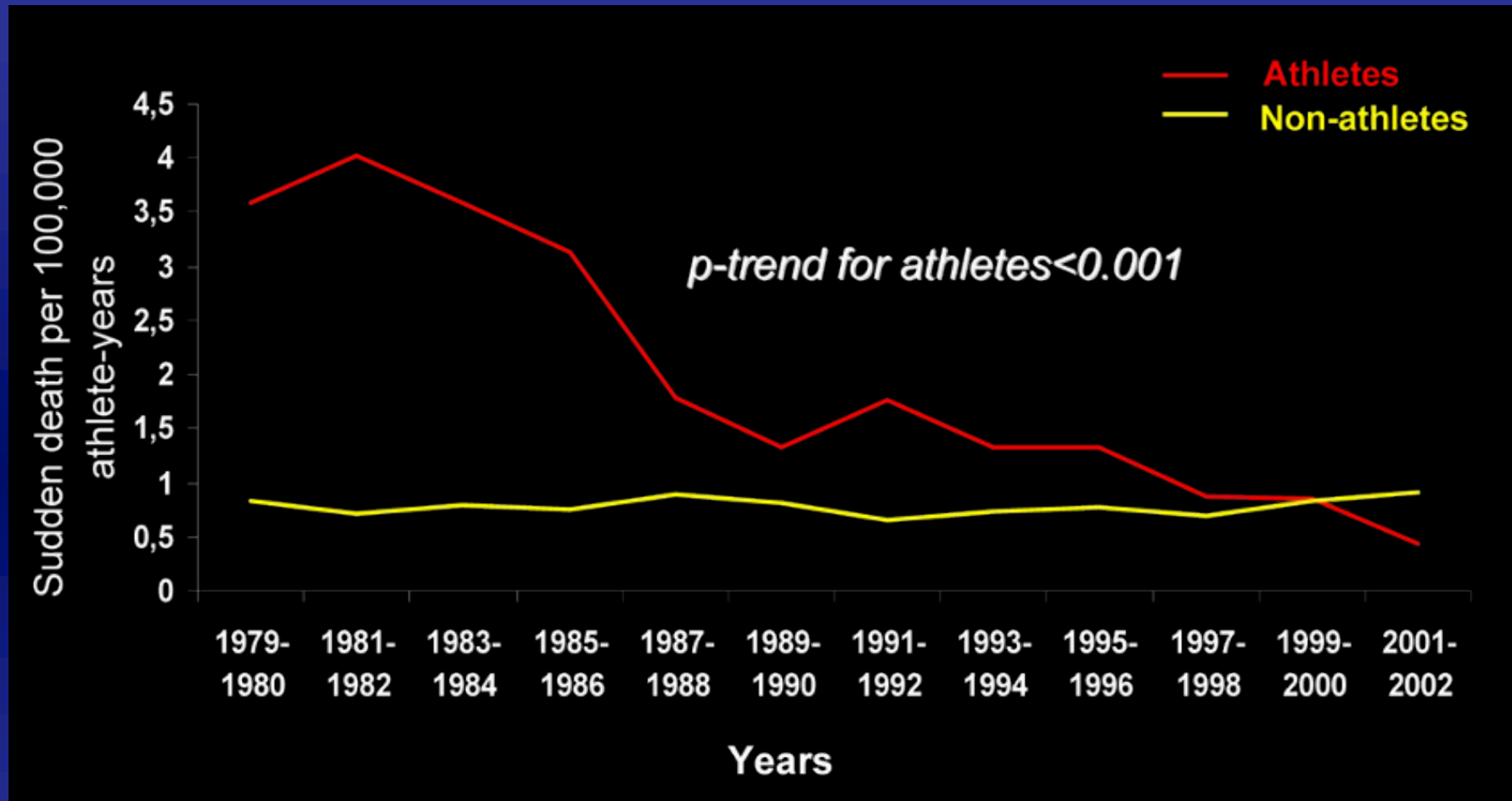
1%

SERIOUS CARDIAC DISORDER 0.2%

Emery et al. JACC 2018;6:30-40

Wilson et al., BJSM 2007

EFFICACY OF PRE-PARTICIPATION SCREENING



Veneto region of Italy.
Corrado et al JAMA 2006;296:1593-1601

THE ROLE OF PRE-PARTICIPATION SCREENING

- (1) Identification and prevention of SCD
- (2) Standards for disqualification
- (3) Reassurance individuals, peers, parents, sports, general population
- (4) Education
- (5) Improved quality of care for the athlete
- (6) Research and development

The EU Screening Protocol

- Meets the WHO criteria for screening
 - Evidenced based
 - Efficacious
 - Low/decreasing false positive
 - Cost effective
 - Evolving
 - Limitations
- * must be conducted in an expert environment



IRONMAN[®]
WORLD CHAMPIONSHIP
MEDICAL SYMPOSIUM

Outrigger Kona Resort – Kailua-Kona, Hawai'i
OCTOBER 8–12, 2023

THANK YOU

Research Institute for Sport & Exercise Sciences
FACULTY OF SCIENCE



Box 2 ECG screening: pros and cons

Arguments in favour of ECG

- ▶ A 12 lead basal ECG is a non-expensive, largely available in practice test for a mass screening of athletes.
- ▶ The ECG screening modality has proven more sensitive than the protocol based on history and physical examination.
- ▶ ECG is abnormal in >80% of individuals with cardiomyopathy (hypertrophic cardiomyopathy and arrhythmogenic right ventricular cardiomyopathy), myocarditis, pre-excitation syndromes, and ion channel disorders which are the leading causes of cardiac arrest in young athletes. Together these conditions account for up to the two-thirds of sudden cardiac death (SCD) in young competitive athletes.
- ▶ Modern diagnostic criteria offer the potential to standardise and simplify the interpretation of ECGs and improve diagnostic accuracy.
- ▶ There has been a notable decline (~90%) of SCD among young competitive athletes after implementation of the nationwide Italian ECG screening programme over 25 years of observation.

Arguments against ECG

- ▶ Highly trained athletes may develop ECG abnormalities that may mimic those seen in the cardiomyopathies causing SCD in the young. Negative T waves are common and not pathological in Afro-Caribbean athletes.
- ▶ Misinterpretation of 12 lead ECG is not uncommon, especially if physicians interpreting the ECG do not have special expertise in sports cardiology. When not in expert hands, athletes may undergo an expensive diagnostic work-up or may be unnecessarily disqualified from competition for ECG abnormalities that fall within the normal range for athletes; conversely, signs of potentially lethal organic heart disease may be misinterpreted as normal variants of the athlete's ECG.
- ▶ Some cardiovascular disorders at risk of sudden death are not associated with ECG changes (Marfan syndrome, premature coronary heart disease, congenital coronary anomaly).
- ▶ As a consequence of the high number of false-positive results, the proportion of unnecessary tests ordered is high and accounts for the high cost and low cost effectiveness of ECG screening programmes.
- ▶ Abnormal ECG screening findings lead to disqualification of up to 2% of athletes from competitive sports.