Sudden Cardiac Death During Exercise

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Cardiac Risk in the Young

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Declaration for [Sanjay Sharma]

I have the following financial interest or relationship/s to disclose with regard to the subject matter of this presentation:

- Consulting fees: English Football League Clubs, Rugby Union Clubs, Lawn Tennis Association, English Cricket Board, Team GB Rowing.

- Research contracts: Grants from British Heart Foundation and Cardiac Risk in the Young

Benefits of Formal Exercise Training Programmes on Risk Factors for Atherosclerotic CVD

- Systolic blood pressure -5 mm Hg
- Diastolic blood pressure -3 mm Hg
- Total cholesterol -5%
- LDL cholesterol -2%
- Body mass index -1.5%

Benefits of Exercise

- ↓ Body mass index
- ↑ Insulin sensitivity
- ↓ Metabolic syndrome
- ↓ Type II diabetes mellitus

- ↑ cardiac size
- ↑ cardiac filling in diastole
- ↑ stroke volume

- ↑ HDL
- ↓ LDL
- ↓ Triglycerides

- ↓ aortic stiffness
- ↓ systemic vascular resistance
- ↑ left ventricular compliance
- ↑ plaque stability

- ↑ myokine release
- ↓ C-reactive protein
- ↑ IL-6 from muscle

- ↓ heart rate
- ↑ ion channel expression
- ↑ electrical stability

- ↑ capillary conductance
- ↑ endothelial function
- ↓ oxidative stress
- ↓ thrombogenicity

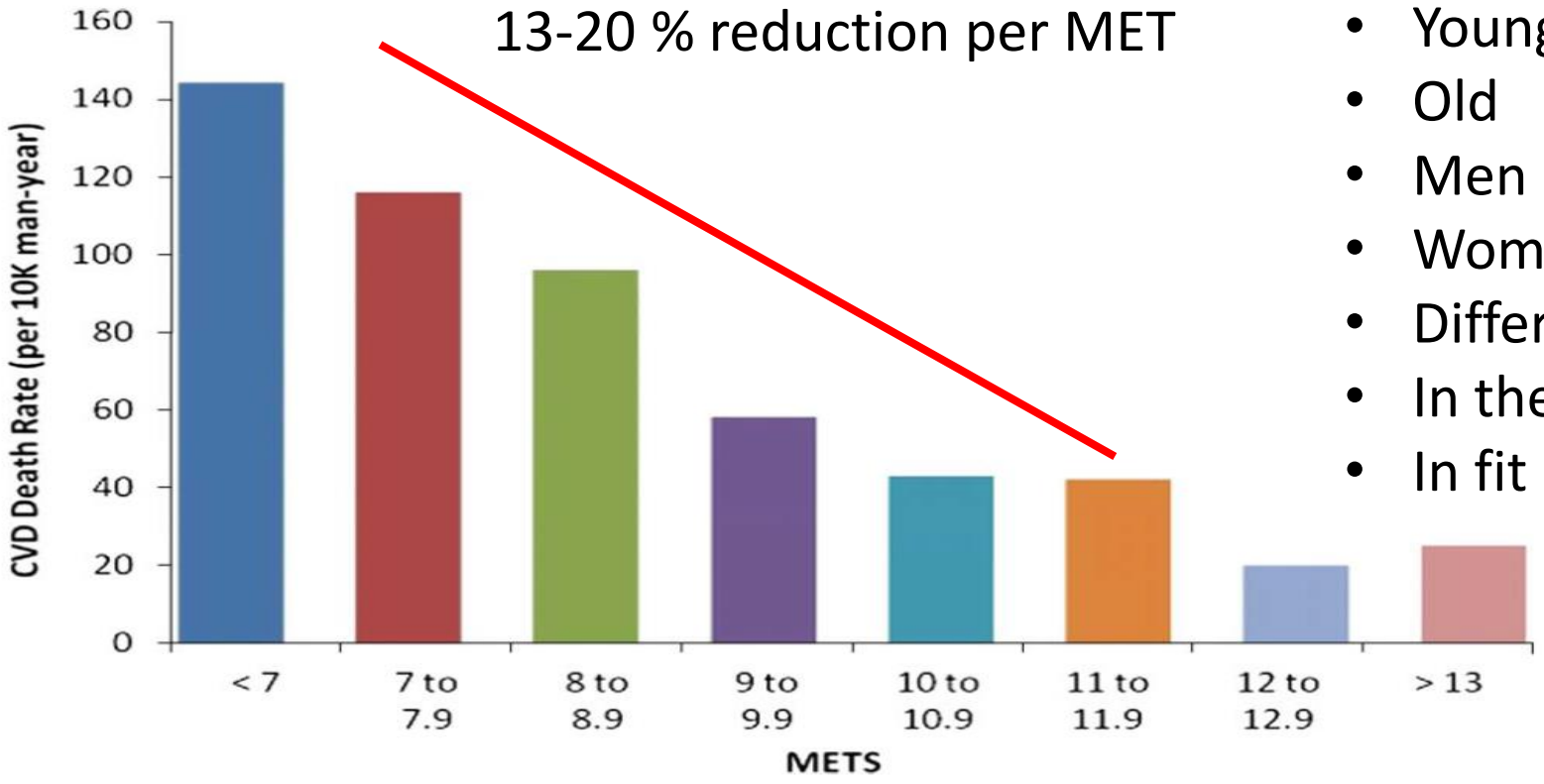
1, Fuiza-Luces et al Nat Rev Cardiol. 2018 Dec;15(12):731-743. 2. Lavie CJ et al. Circ Res. 2015; 117: 207-2019

The Exercise Paradox

Can trigger myocardial infarction and promote fatal arrhythmias in predisposed individual

May worsen arrhythmic substrates

Relationship Between Cardiovascular Fitness, Cardiovascular Disease and All Cause Mortality



- Young
- Old
- Men
- Women
- Different ethnicities
- In the presence of comorbidities
- In fit and ostensibly healthy people

Church TS. Arch Int Med 2005
Kokkinos P et al Circulation 2008

Eriksen: European Championships 2020

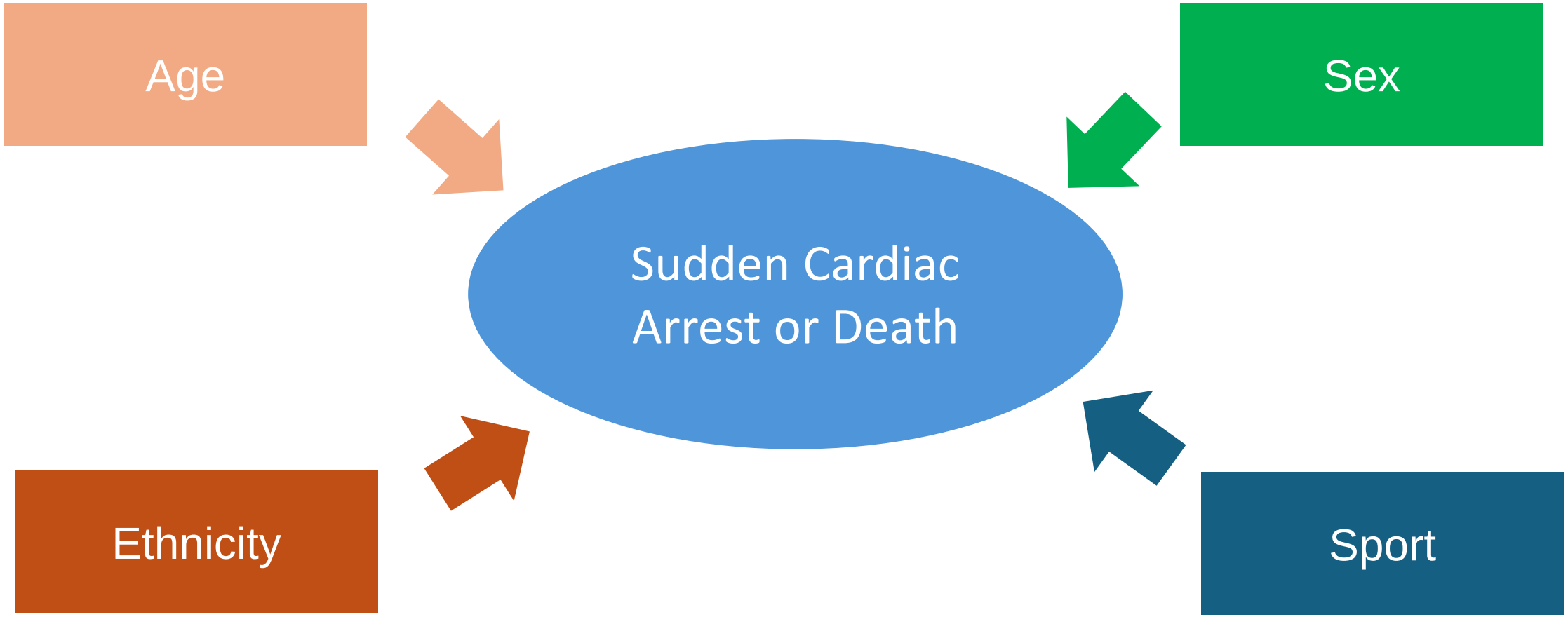
Tom Lockyer: December 2023

Sudden death in Young Athletes

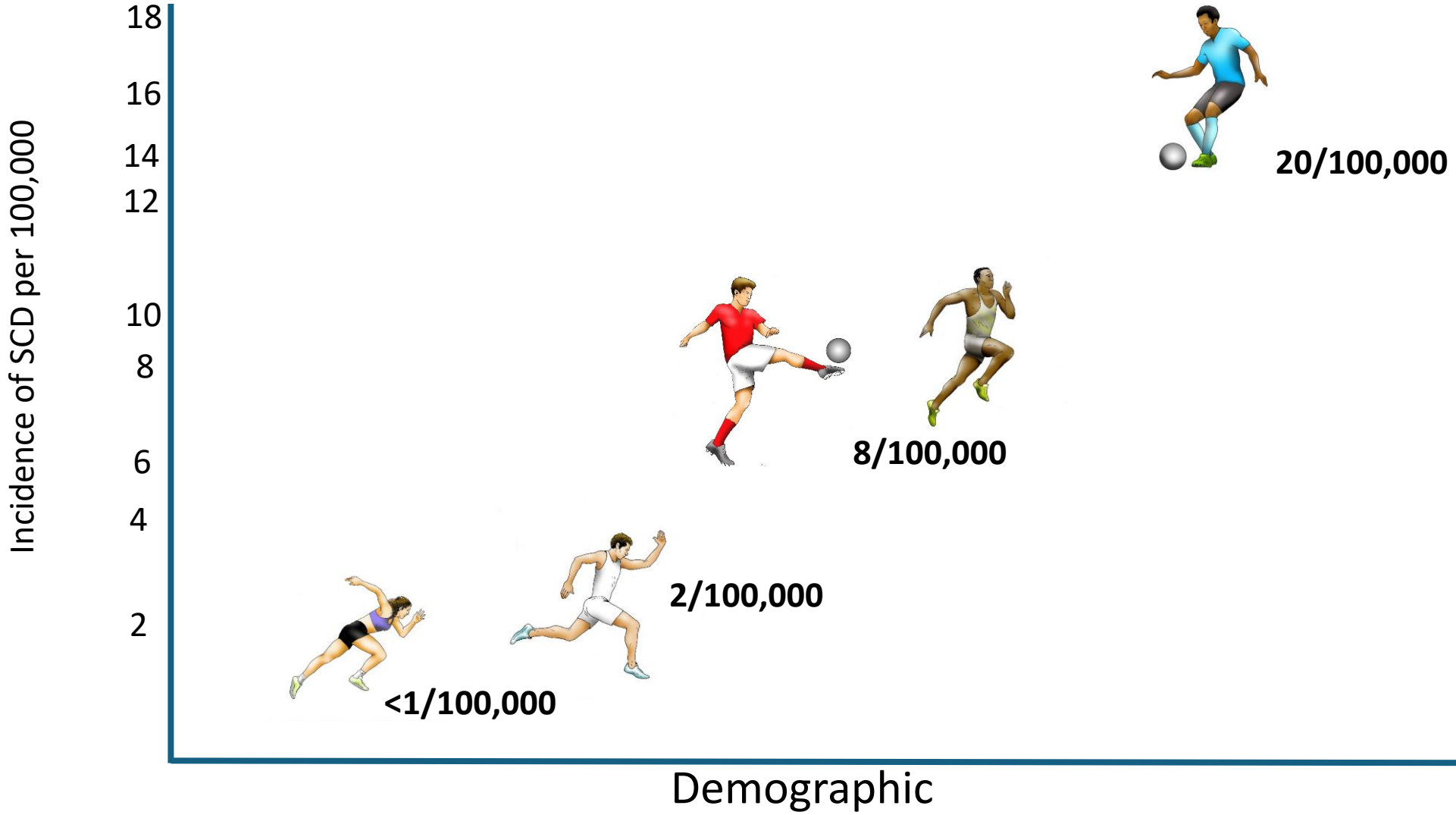
- Mean age of death: 18 years old
- Male to female ratio 9:1
- Greater risk in black athletes
- Some sports afford greater risk
- (soccer and basketball).
- Over 80% during exertion.
- **Over 80% have no prior warning symptoms**

1. Maron BJ et al. Circulation. 2009; 119: 1085-1092;
2. Harmon K et al Circulation 2015 Jul 7;132(1):10-9

Determinants of Exercise Related Sudden Cardiac Arrest

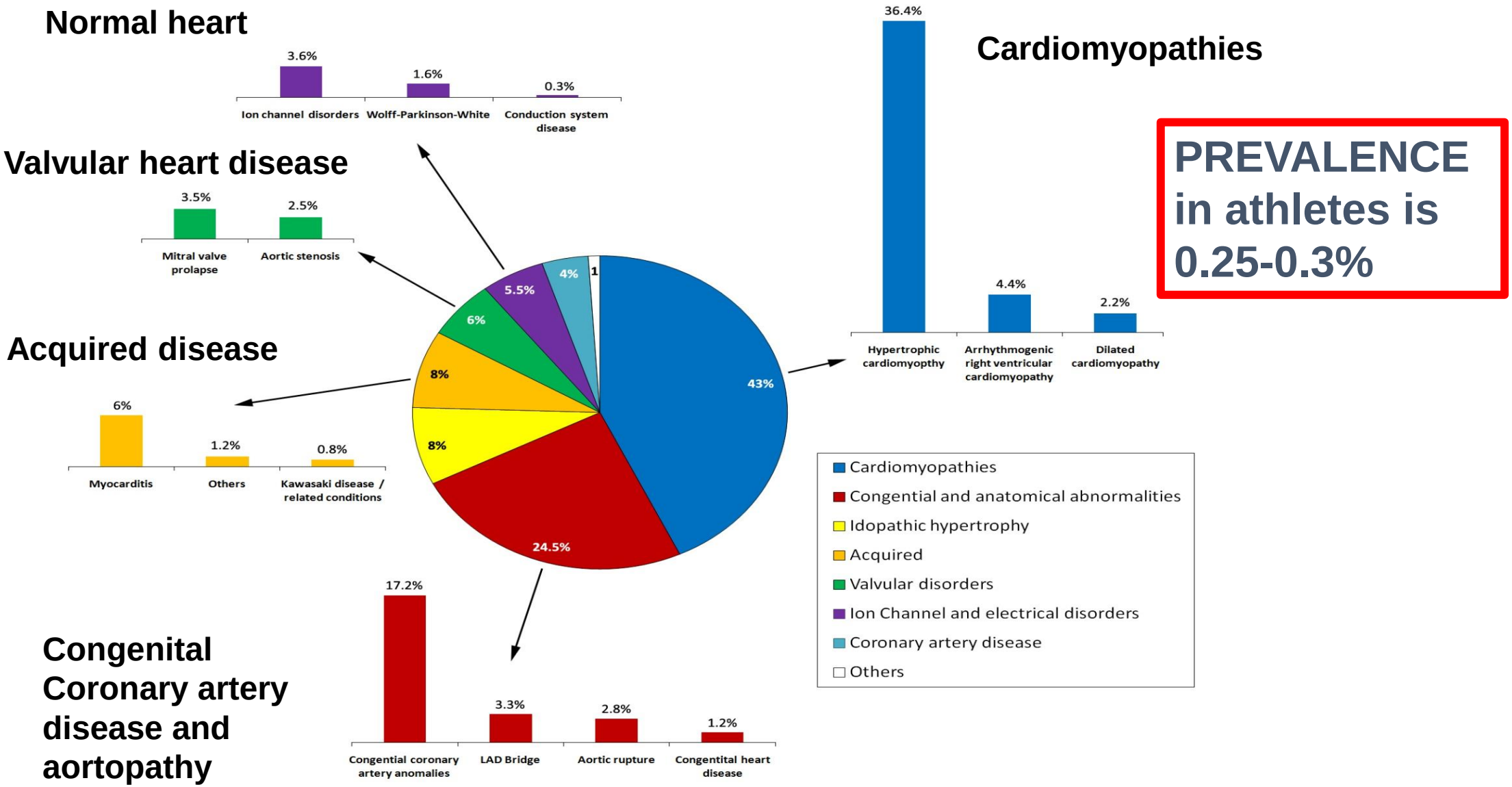


Incidence of SCD in Athletes in Relation to Sex and Race



Adapted from Maclachlan H and Drezner. Clin Cardiol. 2020;43:906

Causes of SCD During Sport in the Young



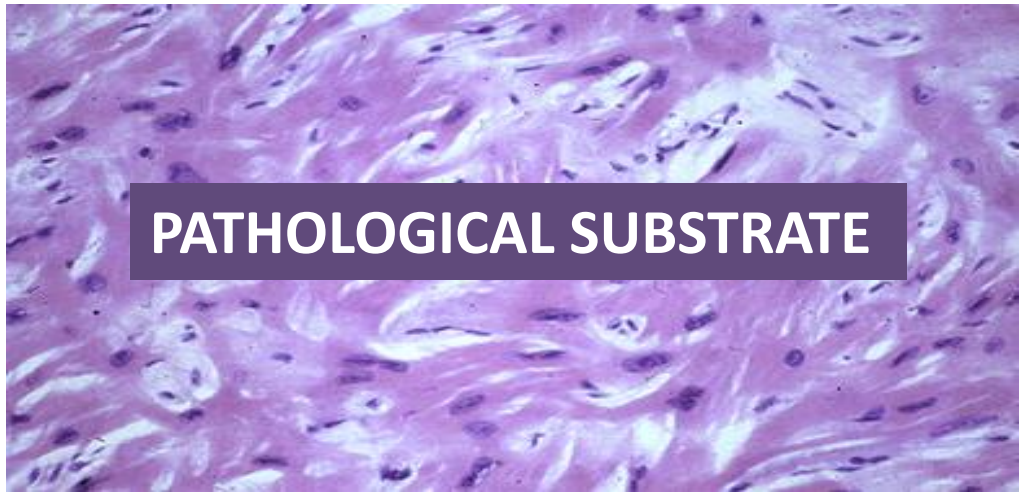
PREVALENCE in athletes is 0.25-0.3%

Maron BJ et al. Circulation. 2009; 119: 1085-1092

Triggers for Sudden Cardiac Death

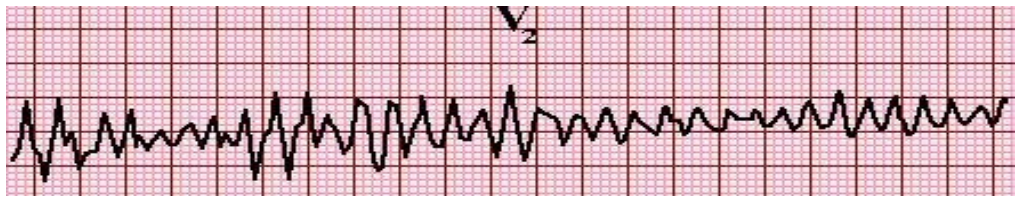
Dehydration

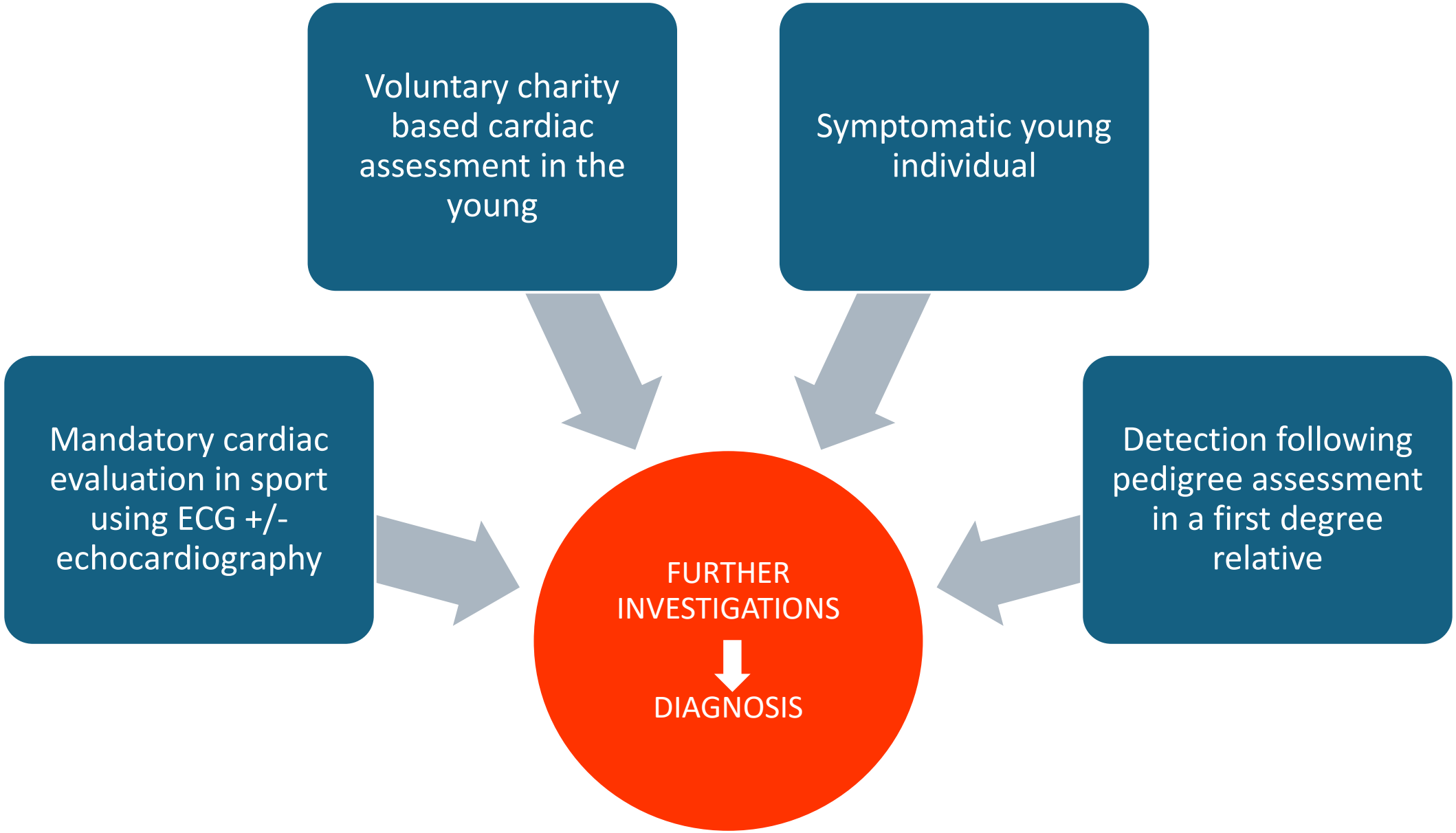
Adrenergic surges



Electrolyte imbalance

Acid/base disturbance



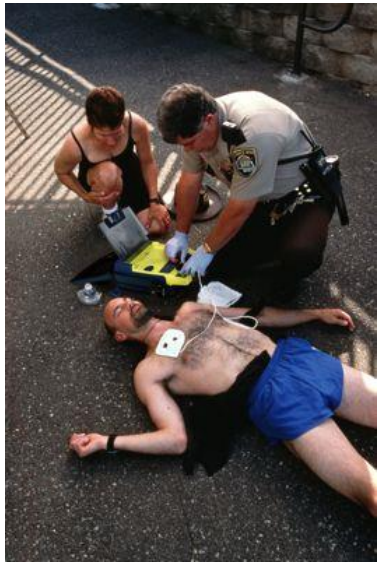

Voluntary charity based cardiac assessment in the young
Symptomatic young individual
Mandatory cardiac evaluation in sport using ECG +/- echocardiography
Detection following pedigree assessment in a first degree relative
FURTHER INVESTIGATIONS
DIAGNOSIS

Preventive Strategies

Athlete Education

Active Screening

Provision of Automated external defibrillators

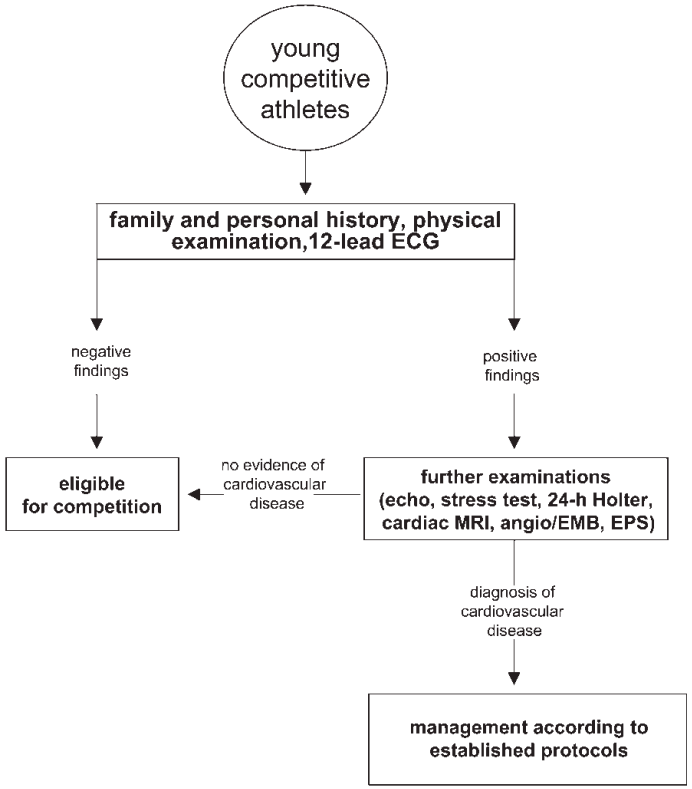


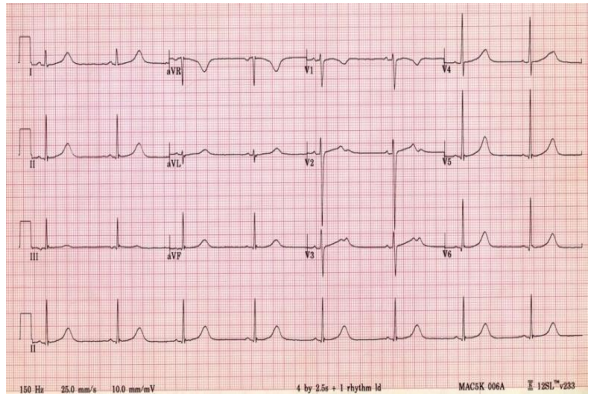
Screening Athletes

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

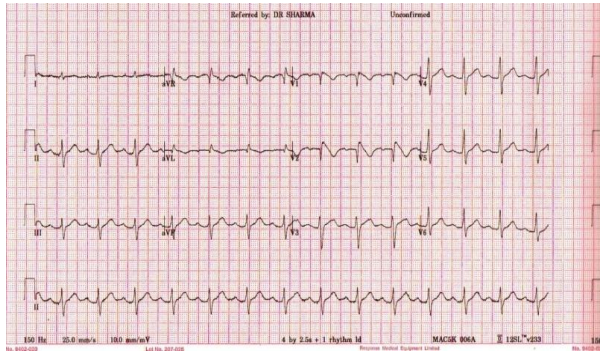
INCREASING COST

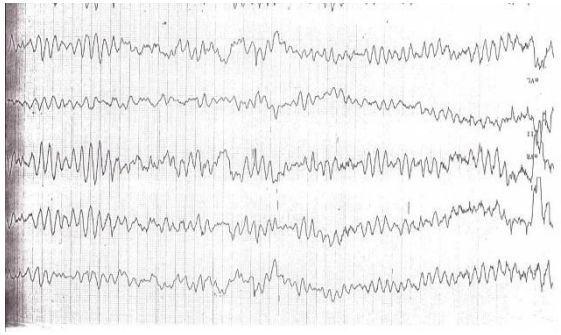
EUROPEAN SOCIETY OF CARDIOLOGY®



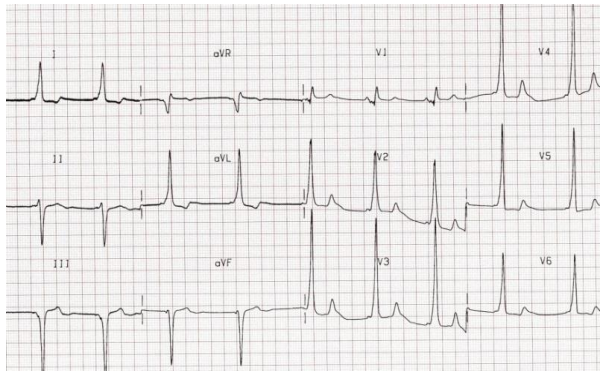


LQTS





Brugada



WPW

Aetiology of Sudden Cardiac Death in Sports: Insights from a UK Regional Registry

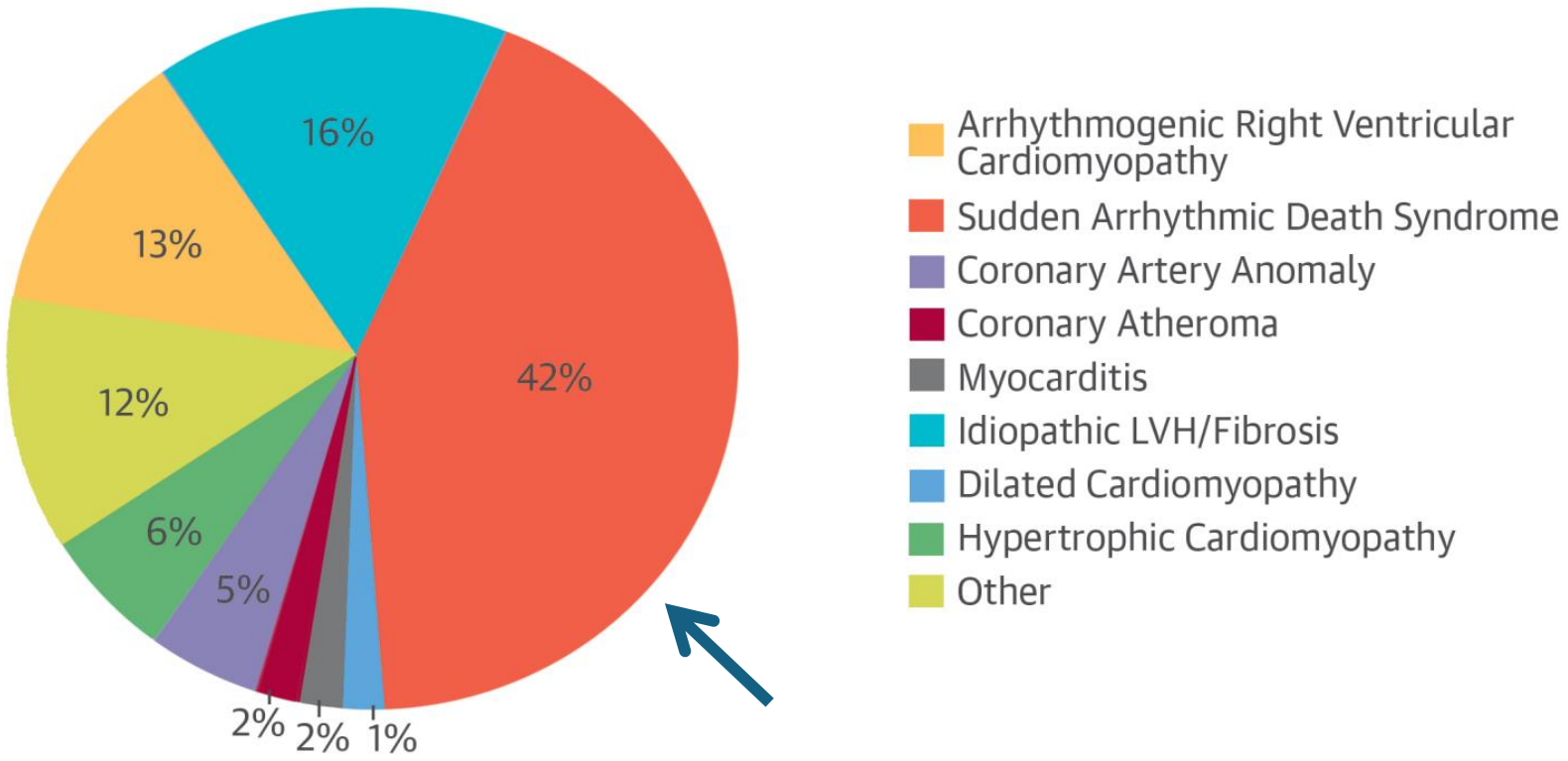
357 consecutive athletes.

Mean age 29 ±11 years old.

92% Male.

69% competitive.

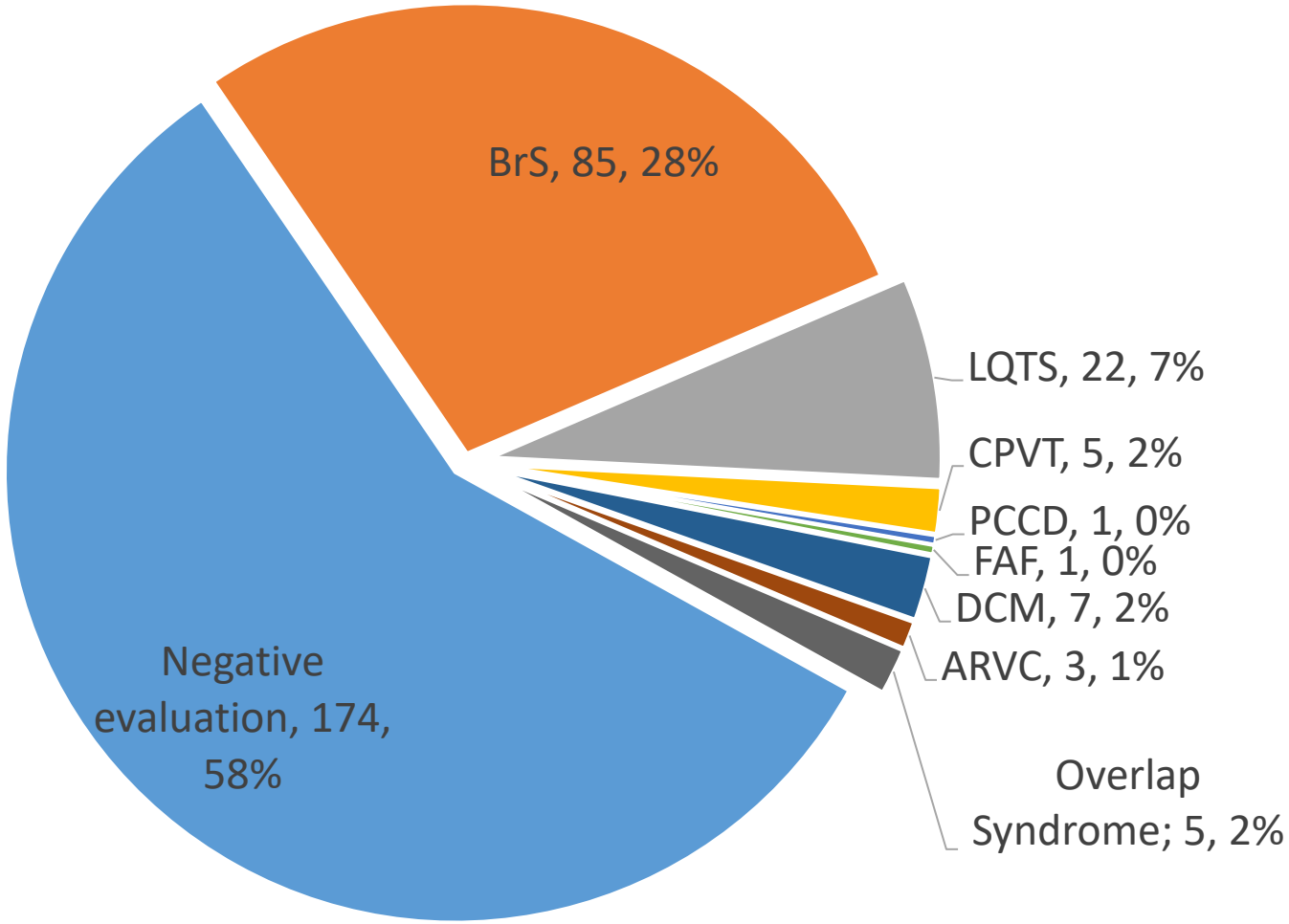
40% died at rest



Finnochiaro G, Sharma J Am Coll Cardiol. 2016;67(18):2108-2115

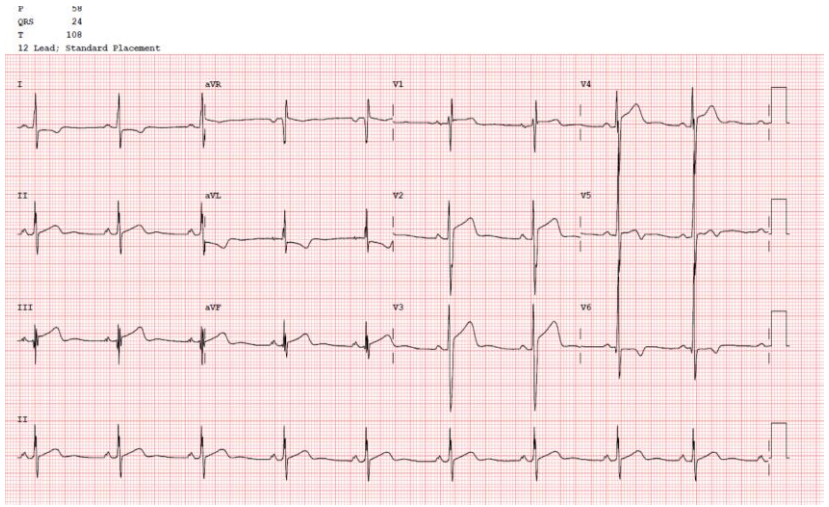
Diagnostic Yield in Families of Victims of Sudden Arrhythmic Death Syndrome: 300 Families (911 members)

Underlying ion channel disorder in 40% of families



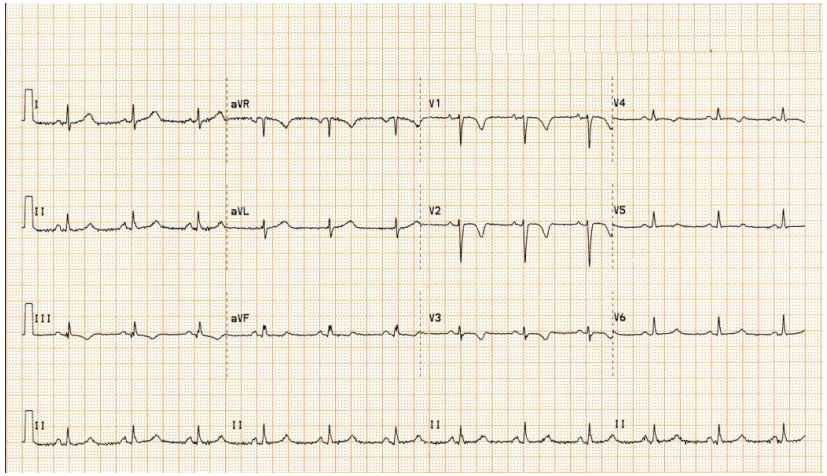
Papadakis M et al. JACC.2018; 71: 1204-1214

ECG is Frequently Abnormal in Individuals with Cardiomyopathy



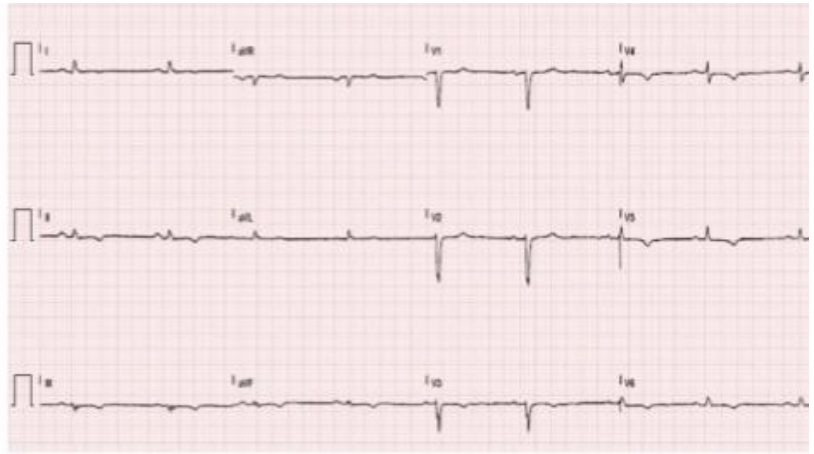
HCM 95%

Corrado et al NEJM, 1998; 339(6):364-369



ARVC 80%

Finocchiaro G. Europace. 2018; 332-338



DCM 75%

Zaffalon D Eur J Clin Invest. 2022 doi: 10.1111/eci.13837

European Heart Journal (2017) **00**, 1–19
doi:10.1093/eurheartj/ehw631

CURRENT OPINION

International recommendations for electrocardiographic interpretation in athletes

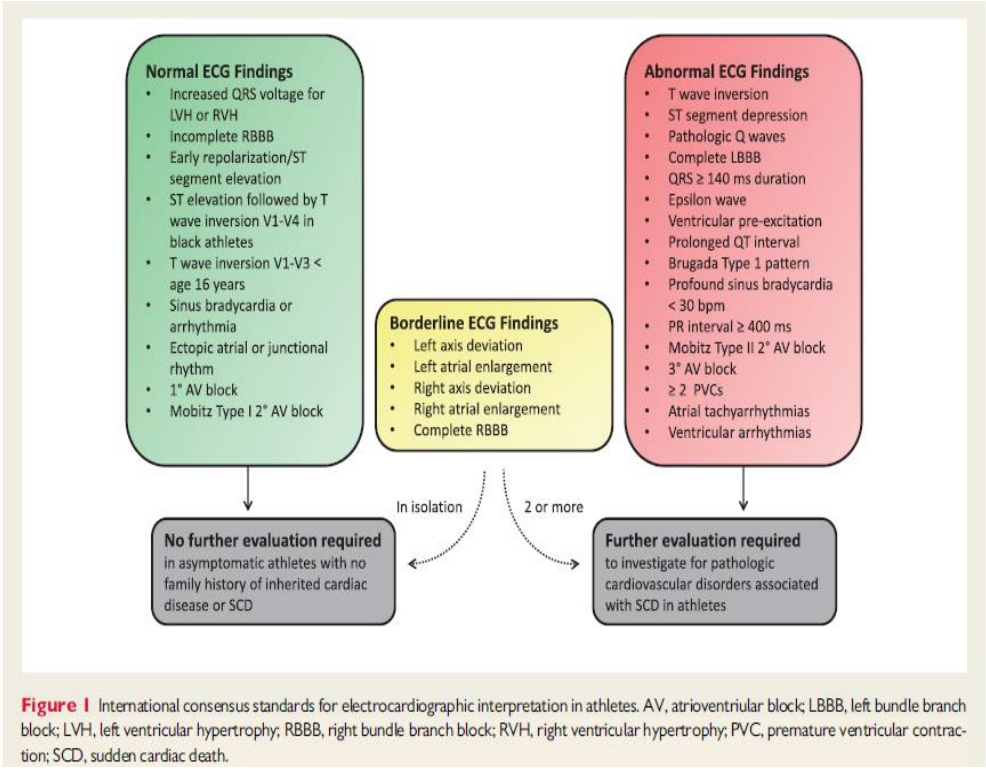


Figure 1 International consensus standards for electrocardiographic interpretation in athletes. AV, atrioventriular block; LBBB, left bundle branch block; LVH, left ventricular hypertrophy; RBBB, right bundle branch block; RVH, right ventricular hypertrophy; PVC, premature ventricular contraction; SCD, sudden cardiac death.

Positive ECG number reduced to 2.5% in white athletes.

Maintained sensitivity for diagnosing serious disease at 92%.

Improved specificity for diagnosing serious disease from 87% to 97%.

Positive predictive value of ECG 17%.

Deaths Despite Screening with ECG

False Negatives

Anomalous coronary arteries

Adrenergically driven ion channel disorders

Incomplete expressions of cardiomyopathy

Acquired conditions

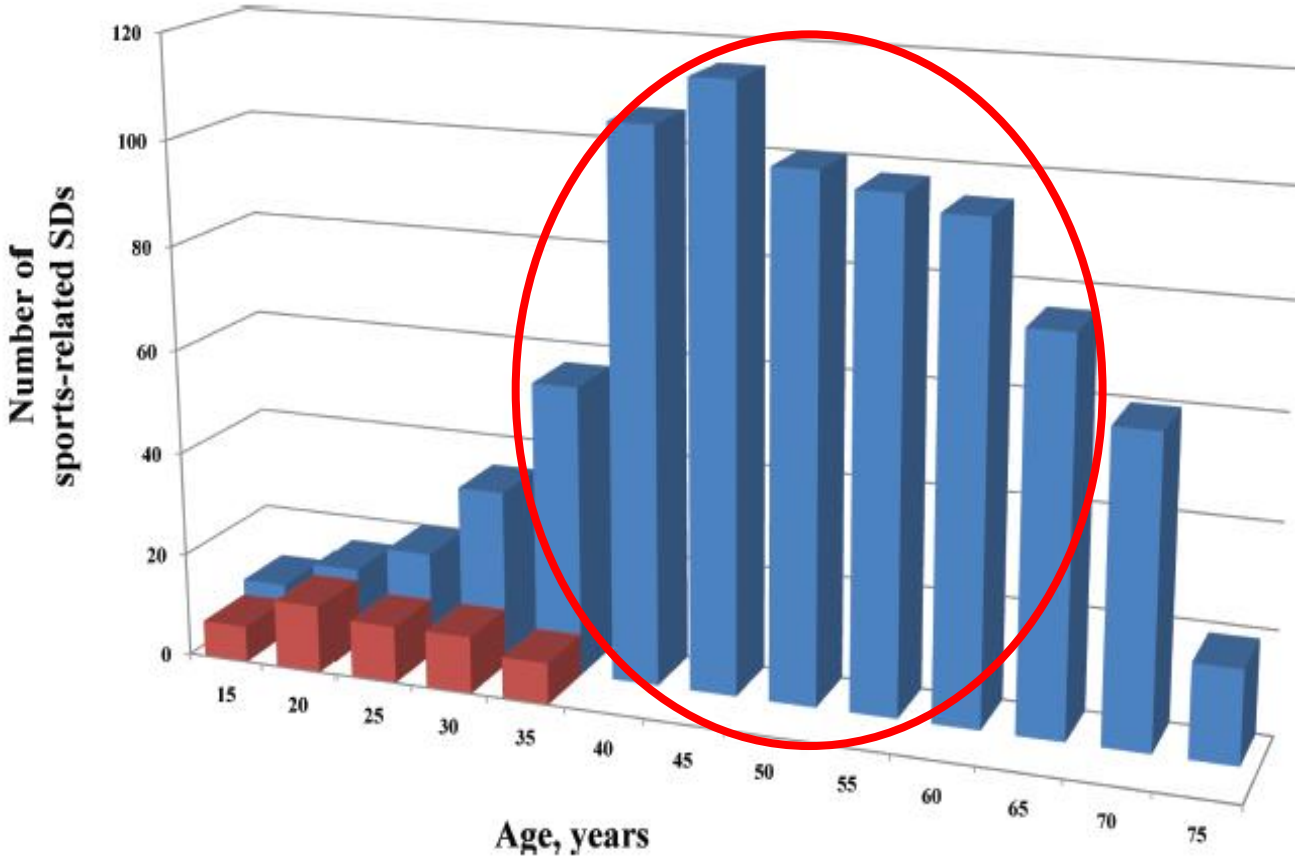
Atherosclerotic coronary artery disease

Commotio cordis

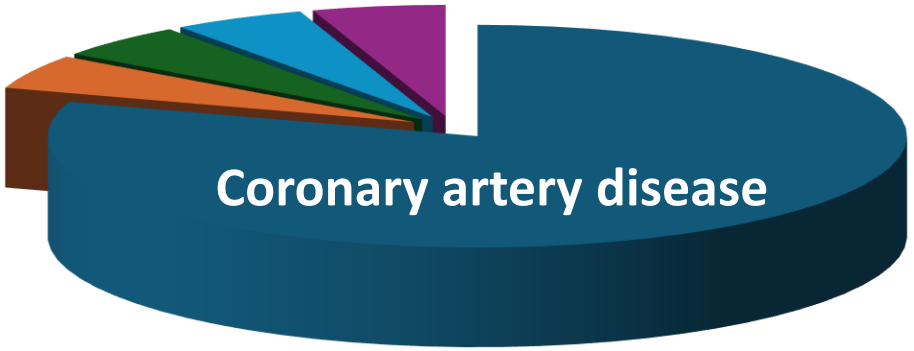
Myocarditis

Electrolyte disorders

Sport Related Sudden Cardiac Death in the General Population



Causes of Sudden Death in Middle Aged and Older Athletes

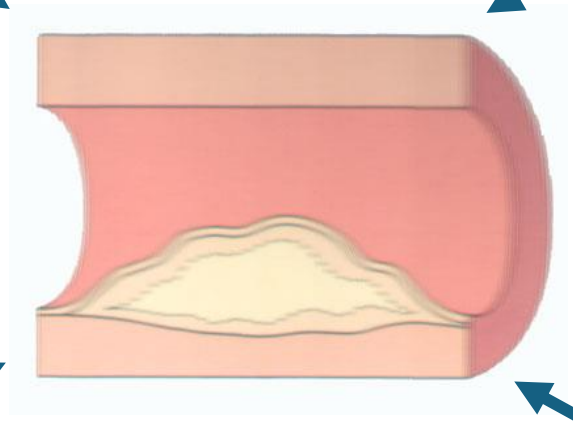


Marijion E. Circulation 2011;124:672-681

Mechanisms for Acute Myocardial Infarction and SCD

Metabolic factors

Shearing forces

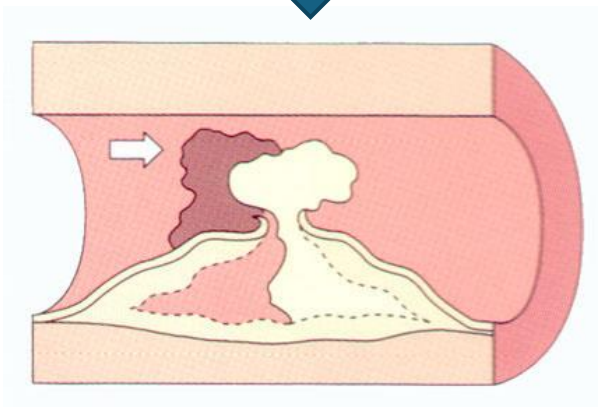


Oxygen Supply

Oxygen Demand

Activation of the haemostatic system

High catecholamines



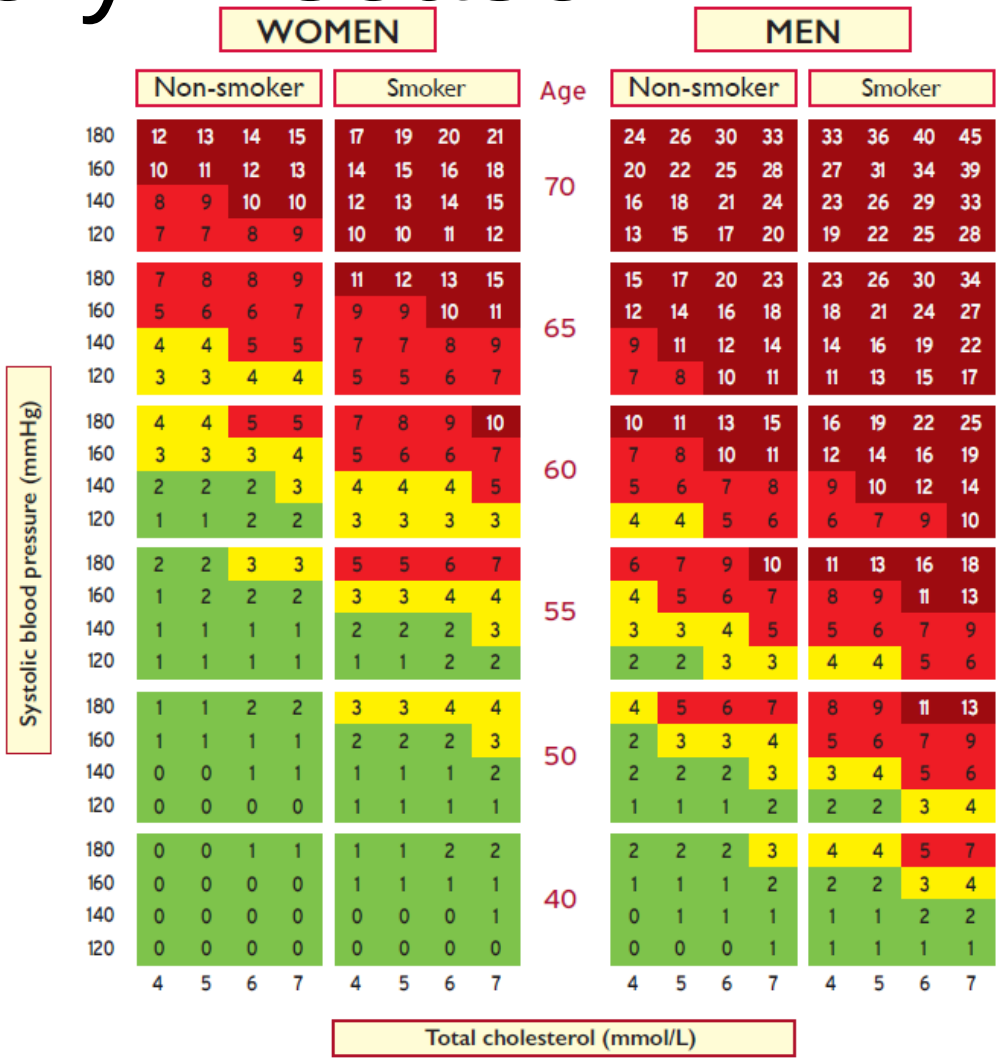
Identifying Individuals at High Risk of Coronary Artery Disease

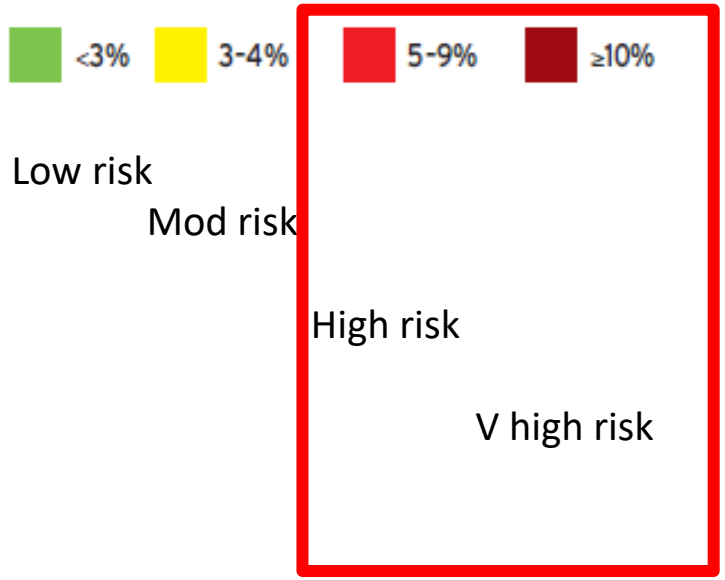
Symptoms

Habitual activity level

10-year risk based on the SCORE chart

High level of established risk factors





High Risk Profile for Coronary Artery Disease

Health Questionnaire

Symptoms

Previous cardiac history

High risk factor profile

10-year risk of adverse cardiac event > 5%

History of diabetes mellitus

BP > 180/110 mm Hg

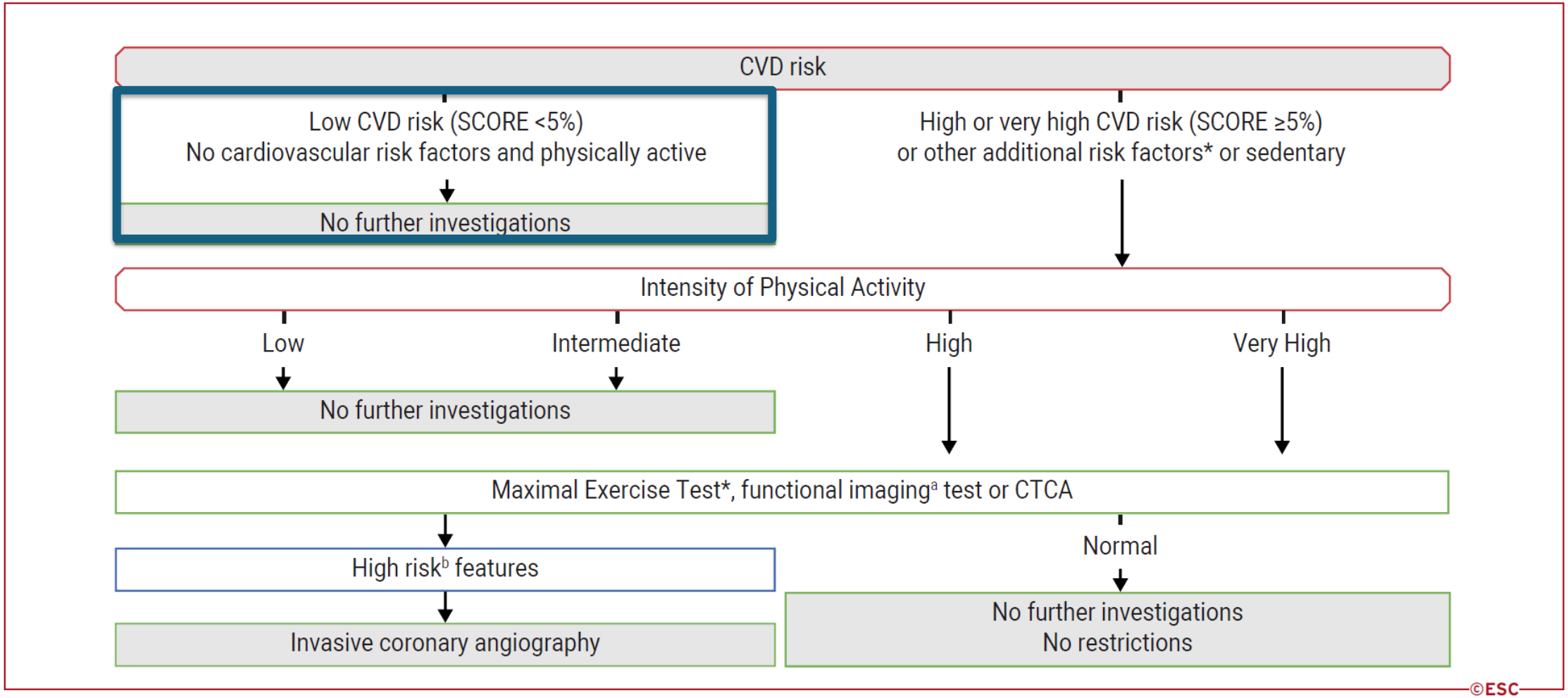
Total cholesterol > 8 mmol/L or LDL > 6 mmol/L

Family history of premature CVD in first degree relative

BMI > 28

Recommendations for CV screening at health fitness facilities. Balady G et al. Circulation. 1998; 97:2283

Proposed algorithm for pre-participation cardiovascular assessment in individuals aged >35 years



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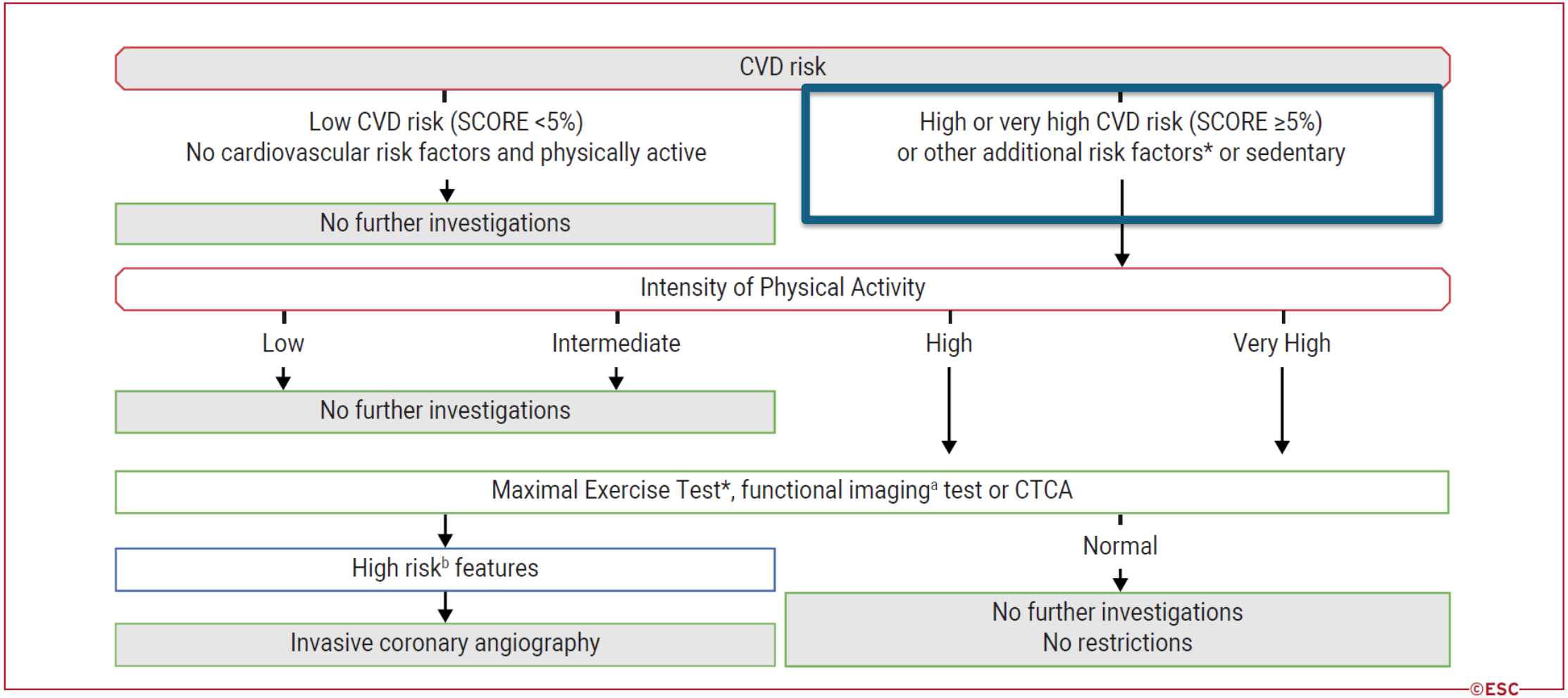

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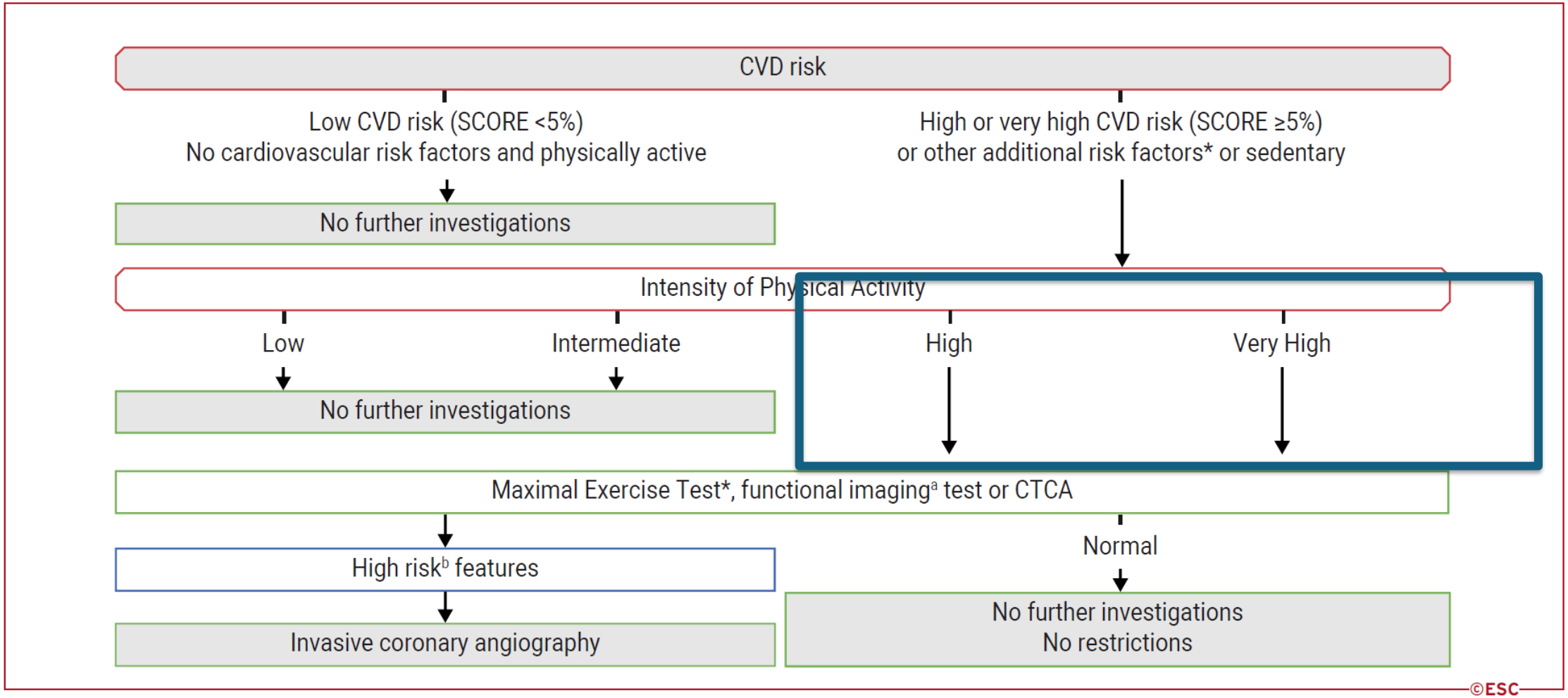

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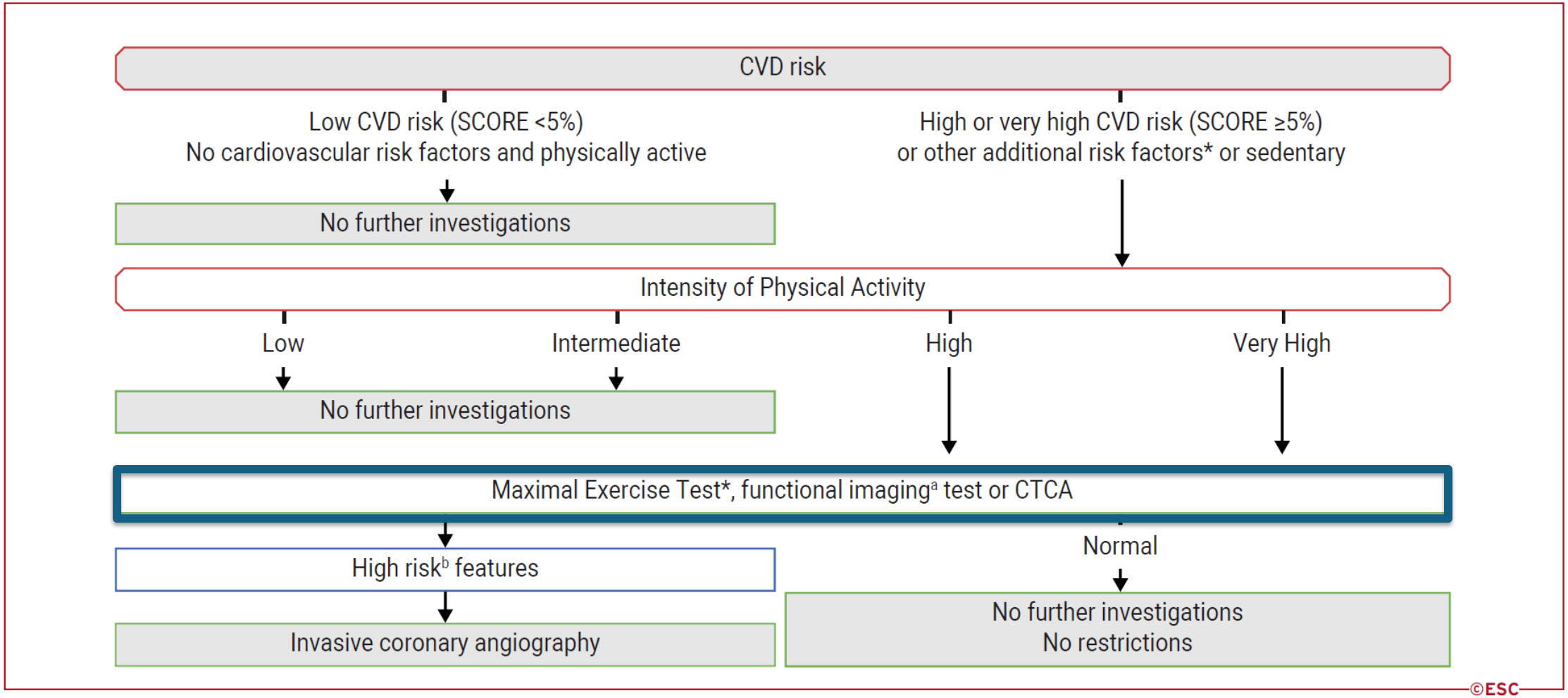

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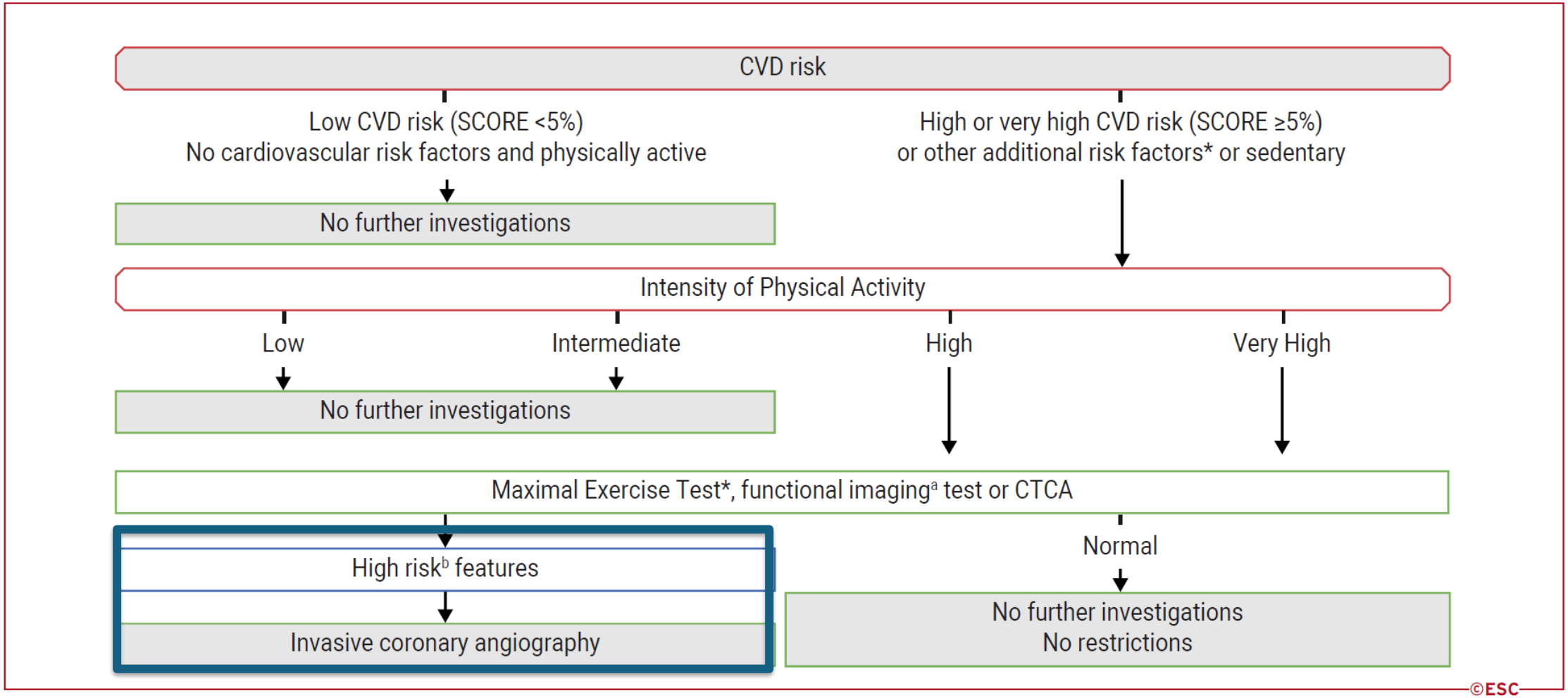

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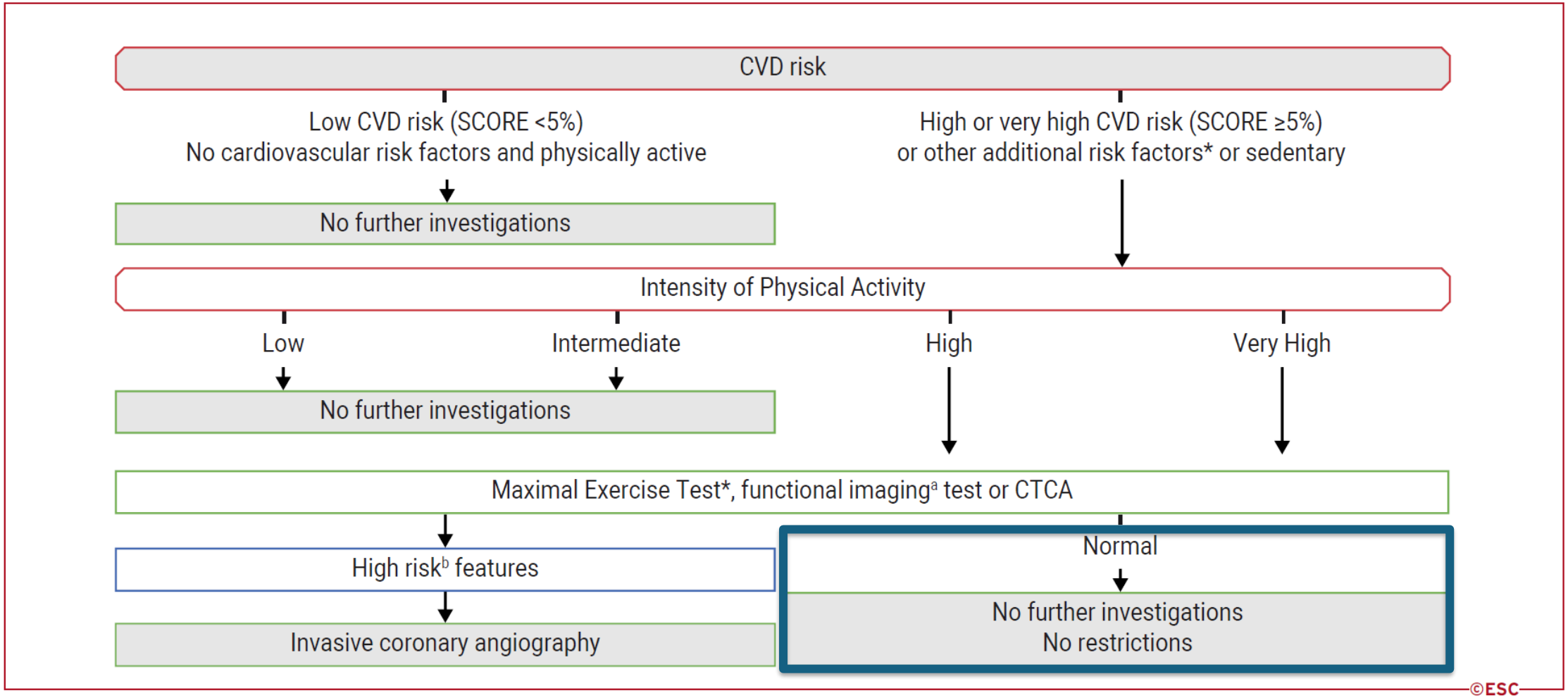
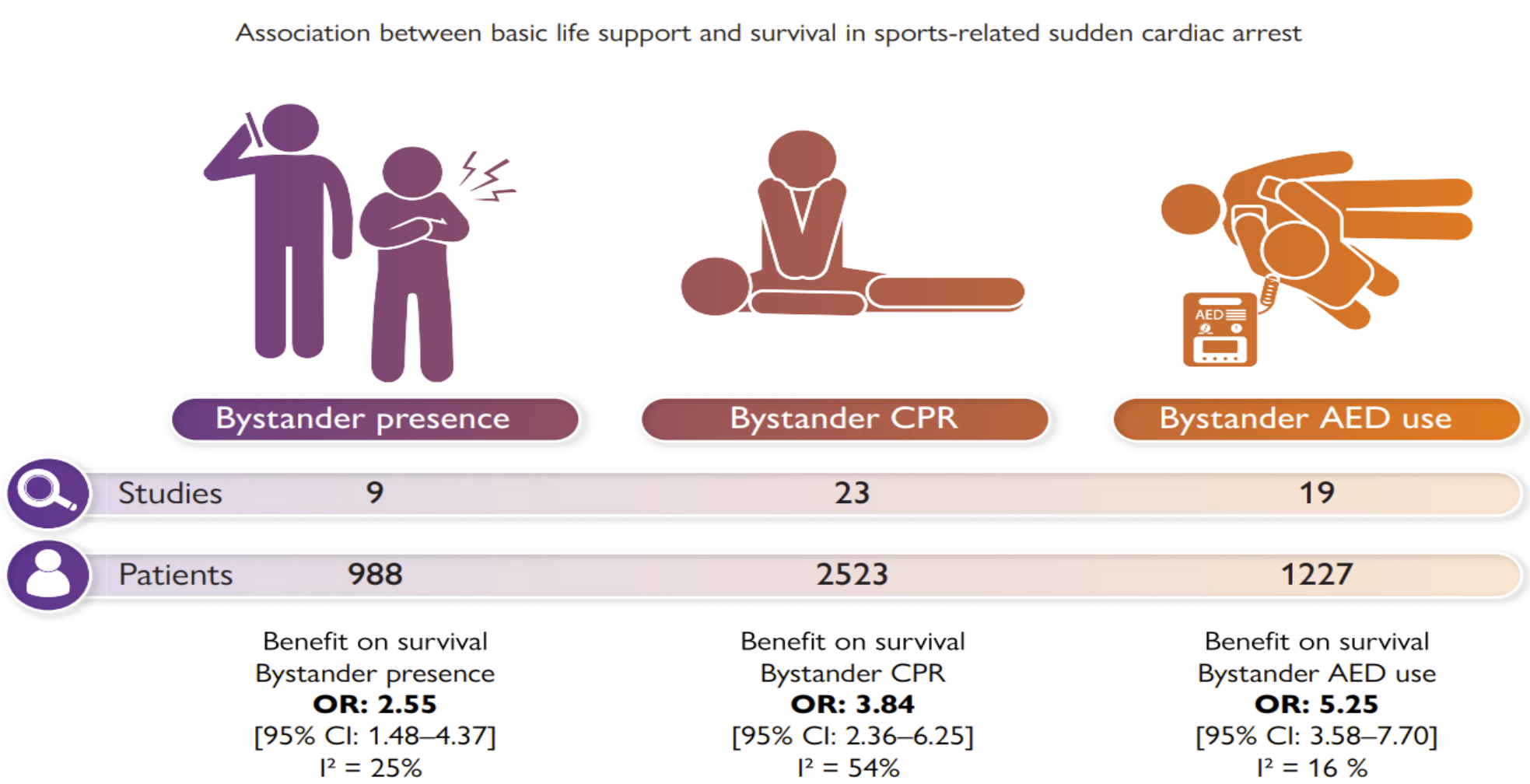


Association Between Basic Life Support and Sports-Related Sudden Cardiac Arrest

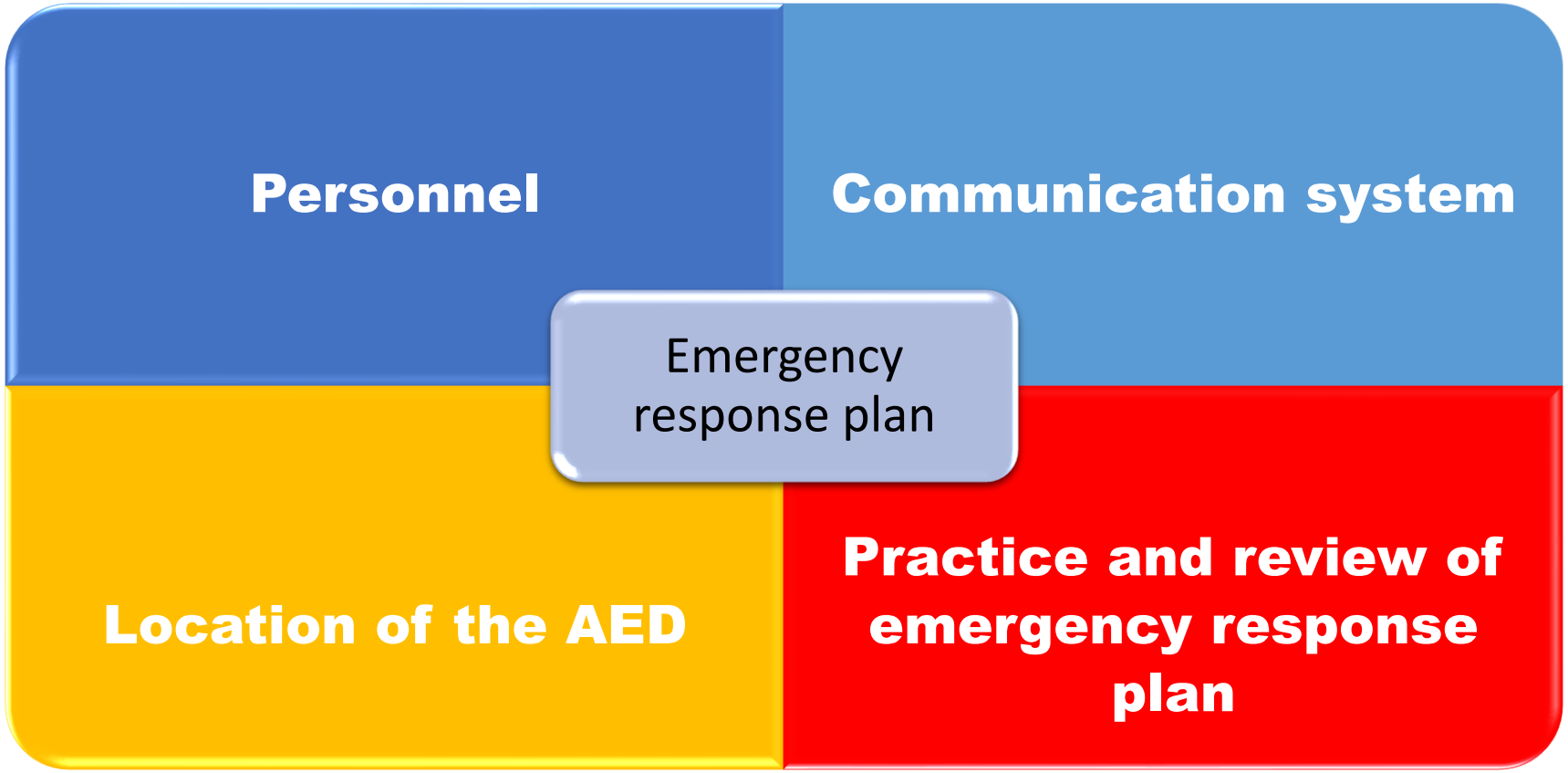


www

ease

(European Heart Journal 2020 - doi/10.1093/eurheartj/ ehaa605)

The Emergency Response Plan in US Schools



- Mean time from collapse to CPR

1.5 Minutes

- Mean time from SCA to first shock

3.6 Minutes

Drezner. Circulation. 2009

Report of 1710 US high schools with an on-site AED program.
Survey relating to sudden cardiac arrest (SCA) between Jan 2006-July 2007

36 cases of SCA

Prompt CPR 94%
AED shock 83%

14 (high school)
Mean age 16

22 older non students
Mean age 57

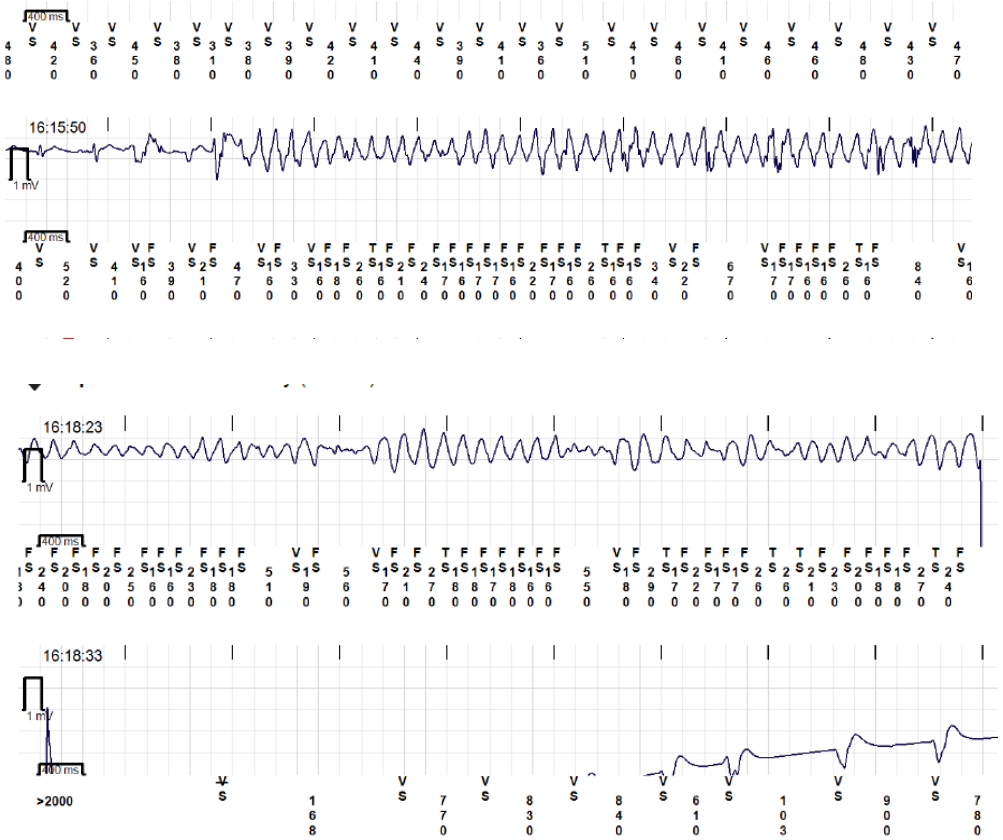
64% survived to hospital discharge in each group
Higher survival rates may have been to the onsite AED (79%) and smaller number of cases of hypertrophic cardiomyopathy (21%)

Drezner et al. Circulation 2009

Survival After SCA During Exercise

Author	Study	Survival
Kinoshi	Road races in Japan	93%
Drezner	Schools with AED	64%
Berdowsky	Gen Pop Amsterdam	46%
Sharma	London Marathon	43%
Kim	Marathon runners	29%
Marion (US)	Gen Pop Oregon	23%

Prepared for an Emergency



16.15:50

16.18:23

2020 ESC Guidelines on sports cardiology and exercise in patients with cardiovascular disease
(European Heart Journal 2020 - doi/10.1093/eurheartj/ ehaa605)

Education

Exercise	• Exercise within limits that do not produce cardiac symptoms.
Avoid	• Avoid exercising during febrile episodes, lower respiratory tract symptoms or gastroenteritis
Abstain	• Abstain from performance enhancing agents
Avoid	• Avoid specific medications (Long QT syndrome)
Attention	• Among individuals with atherosclerosis, pay particular attention to risk factor control

Sudden Cardiac Arrest During Sports Activity in Middle Age

SCA 35-65 years old → 5% occurred during exercise → Mean age 51.1 ± 8.8 yrs

M:F 19.1

16% had pre-existing heart disease
56% had ≥ 1 risk factor for CAD
36% had typical symptoms of cardiovascular disease in the prior week.

Marijion et al. Circulation. 2015;131: 1384-1391

Conclusions

Exercise is a risk factor for myocardial infarction and sudden cardiac arrest

A large proportion of adolescent and adult athletes with serious cardiac diseases can be identified by relatively simple screening methods.

Sudden death during sport is most common in middle aged and older male athletes and is most frequently due to coronary artery disease.

The identification of high risk individuals requires a pragmatic approach checking for symptoms and risk factors for atherosclerosis.

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