Pre-participation Cardiovascular Evaluation of Elite Athletes in Hong Kong

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Overview

I. Pre-participation Cardiovascular Evaluation

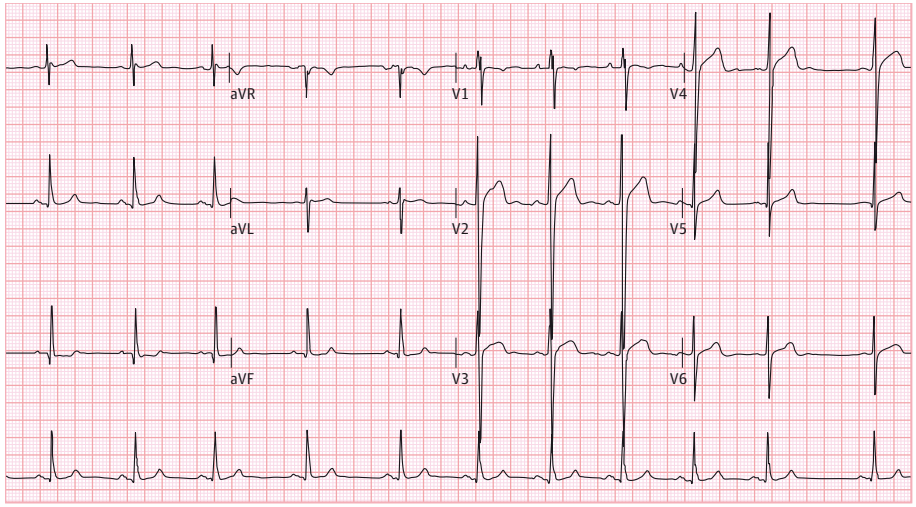
II. Evidence Base

III. Hong Kong data (2020-2022) from screening

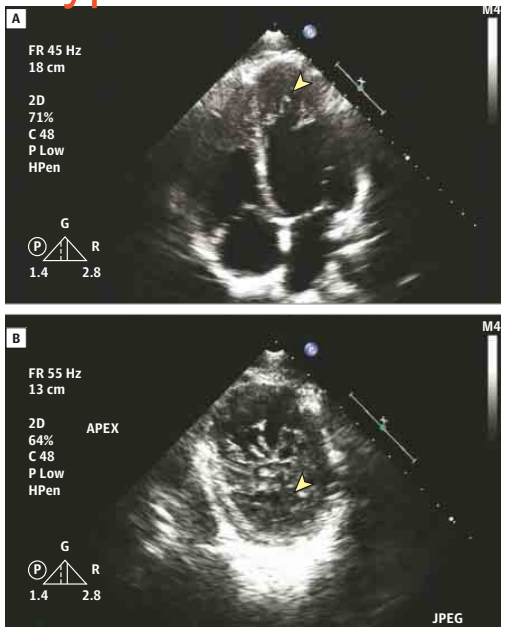
I. Pre-participation Cardiovascular Evaluation

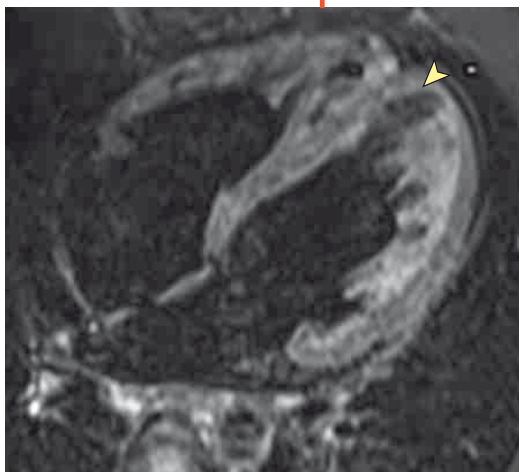
Case 1

18-y.o. football player, no F/Hx CVD or sudden death
Incidental finding of cardiac murmur on PPE



Hypertrabeculation vs. LV noncompaction



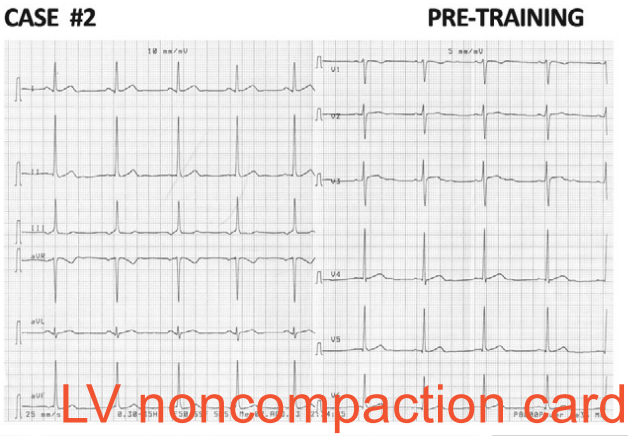


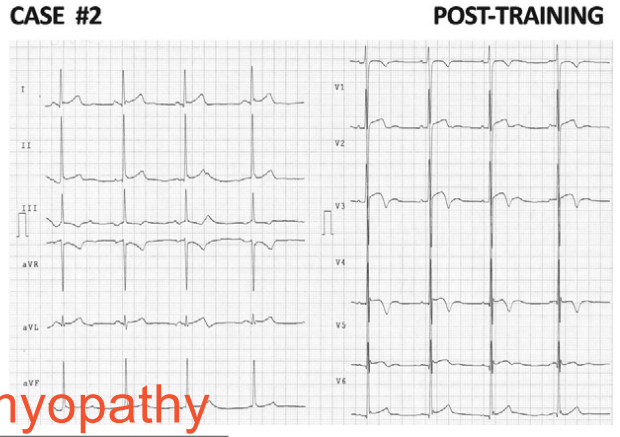
Peritz DC et al. JAMA Intern Med 2014;174:1379

Case 2

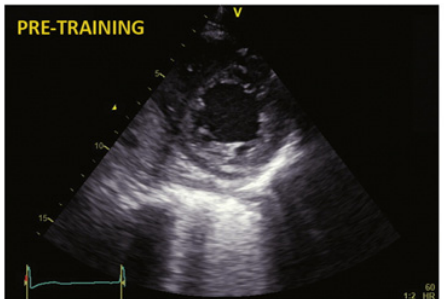
21-y.o. triathlete of African descent, no family history

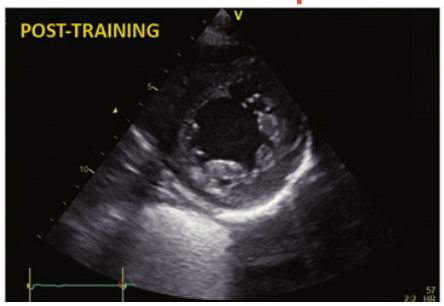
- Previously seen in office for pre-season pre-participation evaluation
- Returns 1 y later
- Change in LV trabeculation

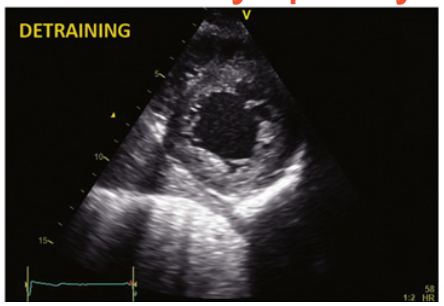




LV noncompaction cardiomyopathy







D'Ascenzi F et al.
Int J Cardiol 2015;181:320

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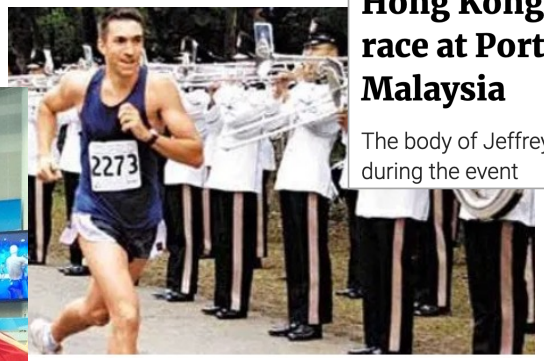
INTERNATIONAL FORUM ON ELITE SPORT HONG KONG 2024

Tribute to fallen competitive & elite athletes of HK



Hong Kong / Society

Hong Kong triathlete found dead after Olympic distance race at Port Dickson International Triathlon in Malaysia

The body of Jeffrey Yuen, 42, was found by local fishermen a day after he went missing during the event

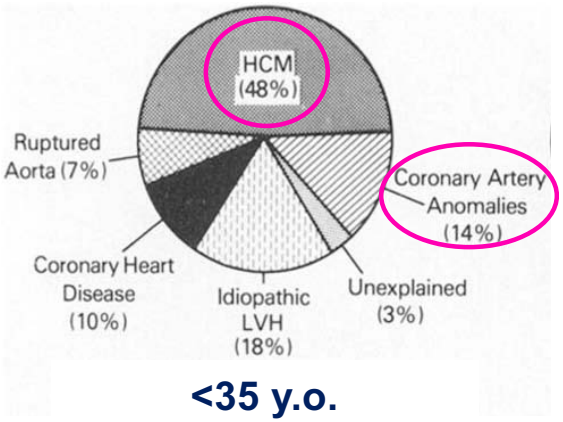
Second Swimmer Dies Following Hong Kong Cross Harbour Open Water Race

October 19, 2016 4486 0

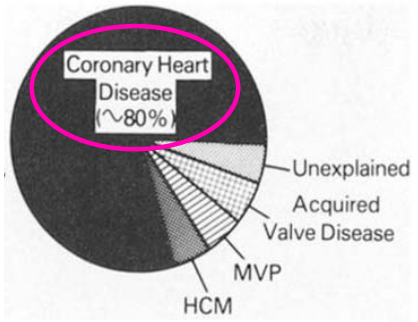
The Hong Kong Cross Harbour open water race. Photo: hkharbourrace.com

Factors that influence risks for SCD

- Important factors
  - **Age**
  - Nature of activity (competitive *vs.* recreational):
    ↑2.5X risk of SCD: **Athletes** > Non-athletes
  - **Intensity** (dynamic vs. static) and **type of sport**
  - Type of underlying heart disease/lesion



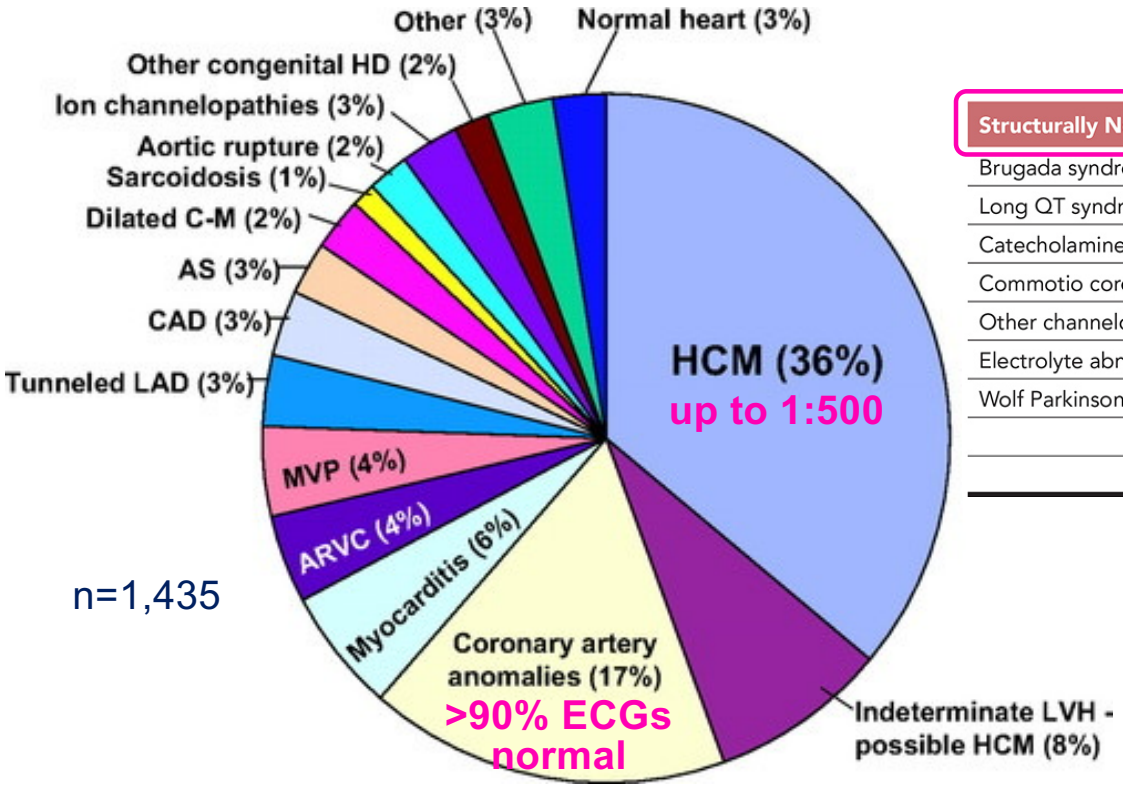
<35 y.o.
(young athletes)



≥35 y.o.
(master athletes)

Maron BJ et al. J Am Coll Cardiol 1986;7:204
Harmon KG et al. Br J Sports Med 2014;48:1185

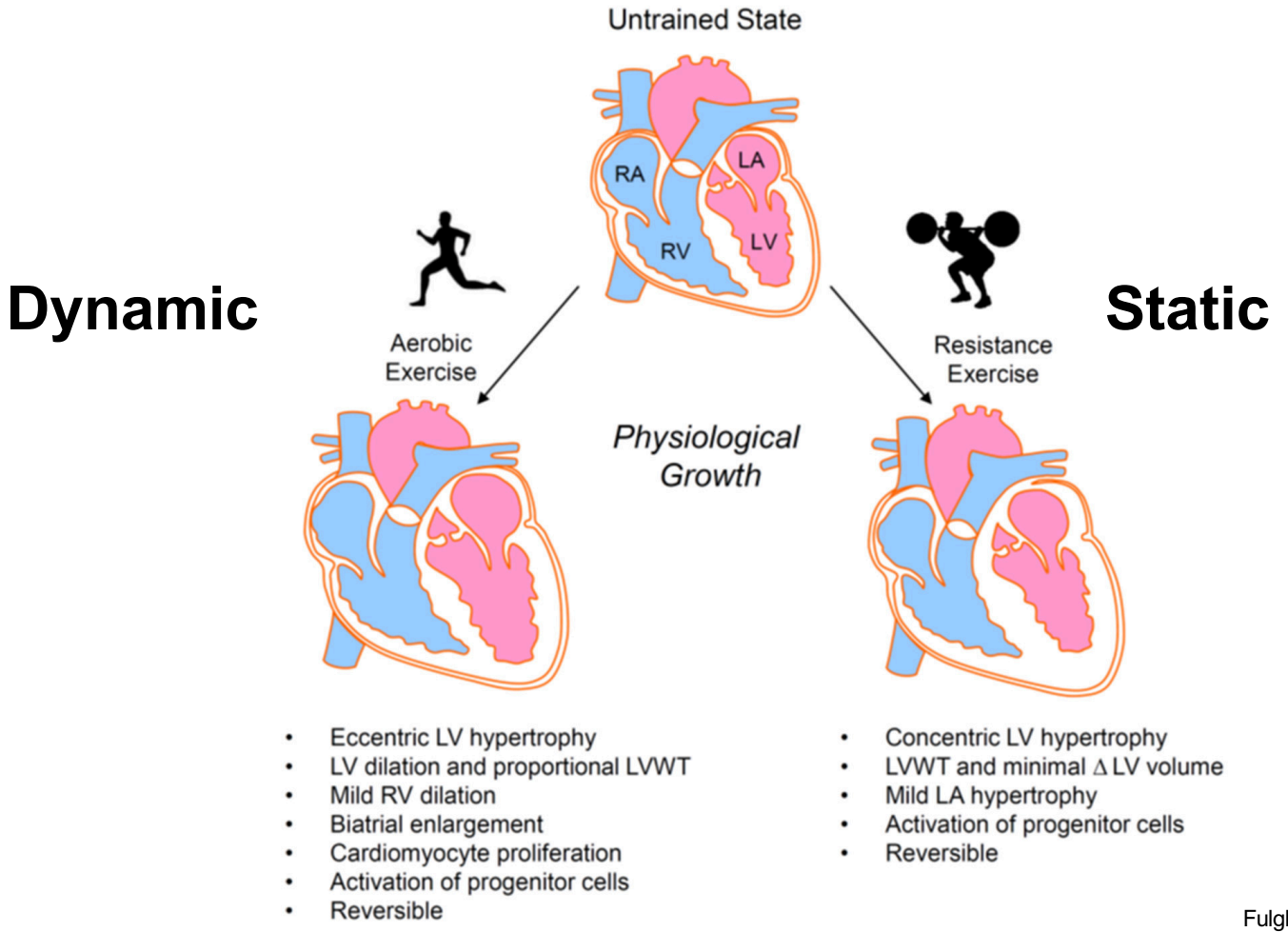
Causes of Sudden Cardiac Death (SCD) in *Young* Competitive Athletes



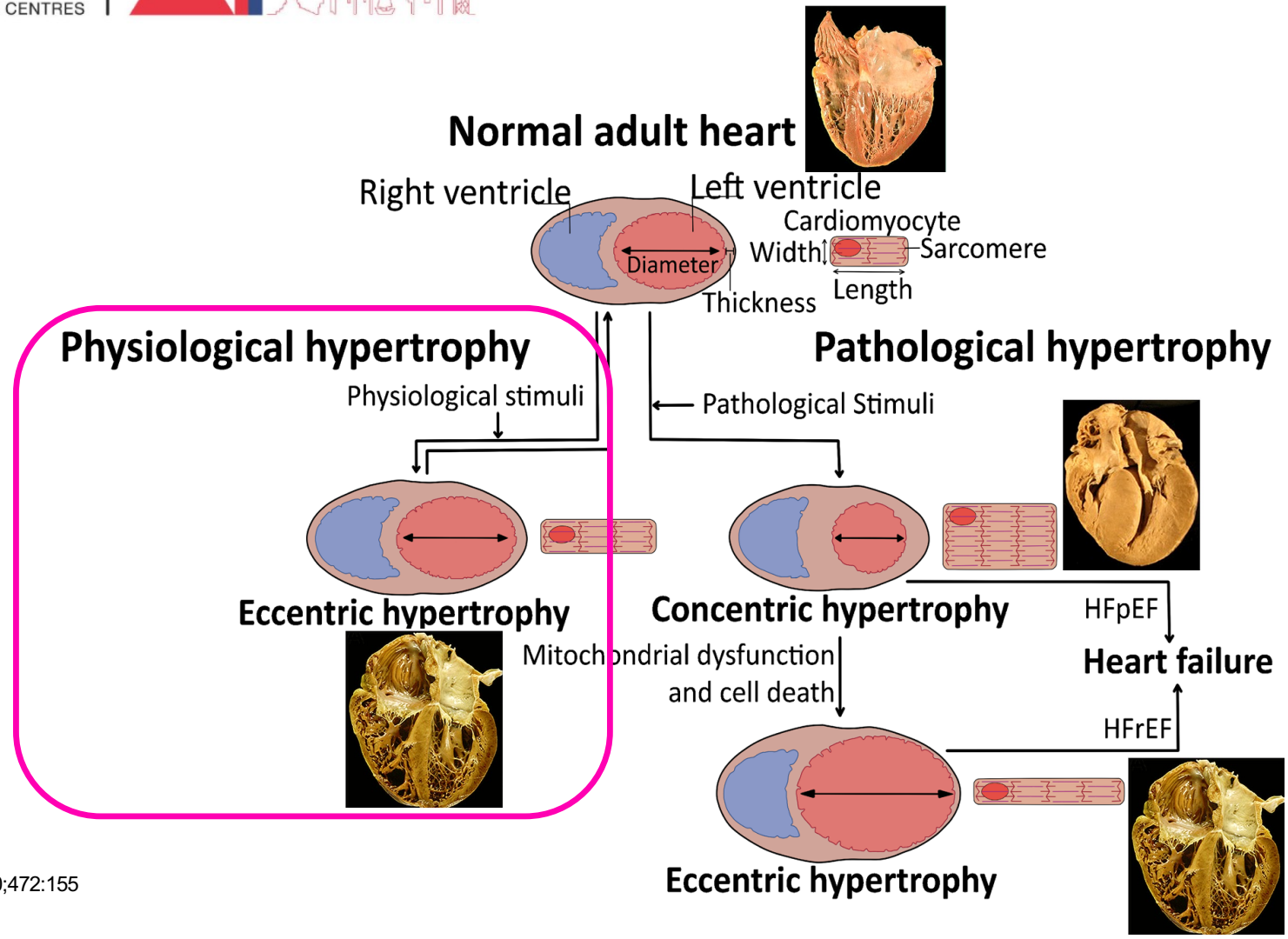
n=1,435

Structurally Normal Heart	Structurally Abnormal Heart
Brugada syndrome	Hypertrophic cardiomyopathy
Long QT syndrome	Arrhythmogenic right ventricular cardiomyopathy
Catecholaminergic polymorphic ventricular tachycardia	Dilated cardiomyopathy
Commotio cordis	Left ventricular noncompaction
Other channelopathies	Congenital abnormalities of the coronary arteries
Electrolyte abnormalities	Marfan syndrome
Wolf Parkinson White syndrome	Valvular heart disease
	Myocarditis
	Coronary artery disease (athletes >35 years old)

Maron BJ et al. J Am Coll Cardiol 1986;7:204
Maron BJ et al. Circulation 2007;115:1643
Mejia-Lopez EI. Focus on Electrophysiology: Sudden Death in Athletes, ACC.org (Dec 20, 2019)



Fulghum K et al. Front Cardiovasc Med 2018;5:127



Seo DY et al. Pflügers Archiv Eur J Physiol 2020;472:155

Alamo L et al. *eLife* 2017;6:e24634

Pre-participation Cardiovascular Evaluation

Aims of cardiac screening in PPE

- To detect as yet *unrecognised* CVD
- Early detection of (potentially) treatable condition (e.g. hypertension)
- Primary prevention of sudden deaths
- Secondary prevention of cardiovascular complications
- Opportunity to promote athlete health and prevent sudden cardiac death (SCD) at any time; maximise safe participation

AAP, AAFP, ACSM. Preparticipation Physical Evaluation, 5th Ed. 2019.
Maron BJ et al. Circulation 2015;132:e267
Harmon KG et al. Br J Sports Med 2014;48:1185
Roberts WO et al. Curr Sports Med Rep 2014;13:395

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2020 ESC Guidelines on sports cardiology and exercise in patients with cardiovascular disease

The Task Force on sports cardiology and exercise in patients with cardiovascular disease of the European Society of Cardiology (ESC)

Authors/Task Force Members: Antonio Pelliccia* (Chairperson) (Italy), Sanjay Sharma* (Chairperson) (United Kingdom), Sabiha Gati (United Kingdom), Maria Bäck (Sweden), Mats Börjesson (Sweden), Stefano Caselli (Switzerland), Jean-Philippe Collet (France), Domenico Corrado (Italy), Jonathan A. Drezner (United States of America), Martin Halle (Germany), Dominique Hansen (Belgium), Hein Heidbuchel (Belgium), Jonathan Myers (United States of America), Josef Niebauer (Austria), Michael Papadakis (United Kingdom), Massimo Francesco Piepoli (Italy), Eva Prescott (Denmark), Jolien W. Roos-Hesselink (Netherlands), A. Graham Stuart (United Kingdom), Rod S. Taylor (United Kingdom), Paul D. Thompson (United States of America), Monica Tiberi (Italy), Luc Vanhees (Belgium), Matthias Wilhelm (Switzerland)

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ESC European Society of Cardiology

European Heart Journal (2021) **42**, 17–96
doi:10.1093/eurheartj/ehaa605

ESC GUIDELINES

6. Key messages

CV screening before participation in recreational and competitive sports is aimed at the detection of disorders associated with SCD and has the potential to lower CV risk through disease-specific and individualized patient management.

CV screening in adult and senior athletes should target the higher prevalence of atherosclerotic CAD including an assessment of CVD risk factors and exercise stress test. CAC scoring may be performed in asymptomatic athletes with a moderate atherosclerotic risk profile.

AHA/ACC Scientific Statement

Eligibility and Disqualification Recommendations for Competitive Athletes With Cardiovascular Abnormalities: Task Force 2: Preparticipation Screening for Cardiovascular Disease in Competitive Athletes

A Scientific Statement From the American Heart Association and American College of Cardiology

Barry J. Maron, MD, FACC, Chair; Benjamin D. Levine, MD, FAHA, FACC; Reginald L. Washington, MD, FAHA; Aaron L. Baggish, MD, FACC;

"The central purpose of preparticipation screening of trained competitive athletes is **to identify or raise suspicion of** those…

- ...cardiovascular abnormalities and diseases that are **potentially** responsible for **sudden unexpected death**..."
- "...**to decrease their personal risk** and generally make the athletic field a **safer environment**…"

Maron BJ et al. Circulation 2015;132:e267

General Approach to Cardiovascular PPE

- **Hx**: detailed personal (clinical, sport, social Hx), effects of exertion, any incidents (palpitations, syncope etc.); family hx
- **PE**
- 12-lead **ECG**
- Ambulatory (ECG) – on-body: Holter, 3d, 7d, 14d, 30d event recorder; implantable monitor
- TMET
- Rest **TTE** +/- stress
- CPET
- CT coronary angiography
- CMR

II. Evidence Base

Does cardiac screening prevent sudden death in young athletes?

- Specificity varies
- Specificity of screening including

  Hx + PE + ECG: 70–95%
- No RCT exists
- Italian population-based (Veneto) study: **90% ↓ sudden death** in young athletes after introduction of mandatory screening over 26 years

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

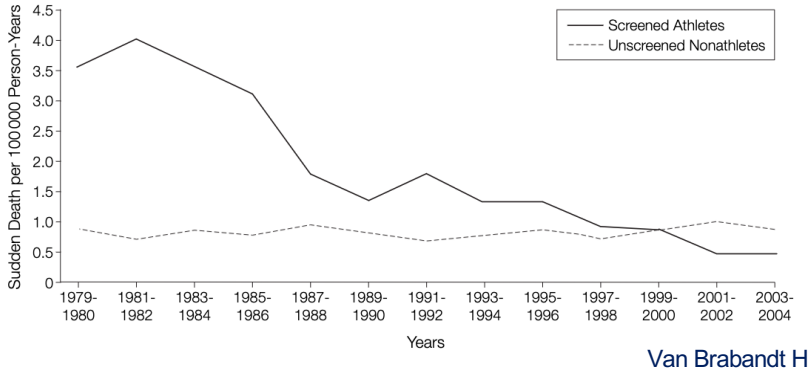
Domenico Corrado, MD, PhD
Cristina Basso, MD, PhD
Andrea Pavei, MD
Pierantonio Michieli, MD, PhD
Maurizio Schiavon, MD
Gaetano Thiene, MD

Context A nationwide systematic preparticipation athletic screening was introduced in Italy in 1982. The impact of such a program on prevention of sudden cardiovascular death in the athlete remains to be determined.

Objective To analyze trends in incidence rates and cardiovascular causes of sudden death in young competitive athletes in relation to preparticipation screening.

Design, Setting, and Participants A population-based study of trends in sudden cardiovascular death in athletic and nonathletic populations aged 12 to 35 years in the Veneto

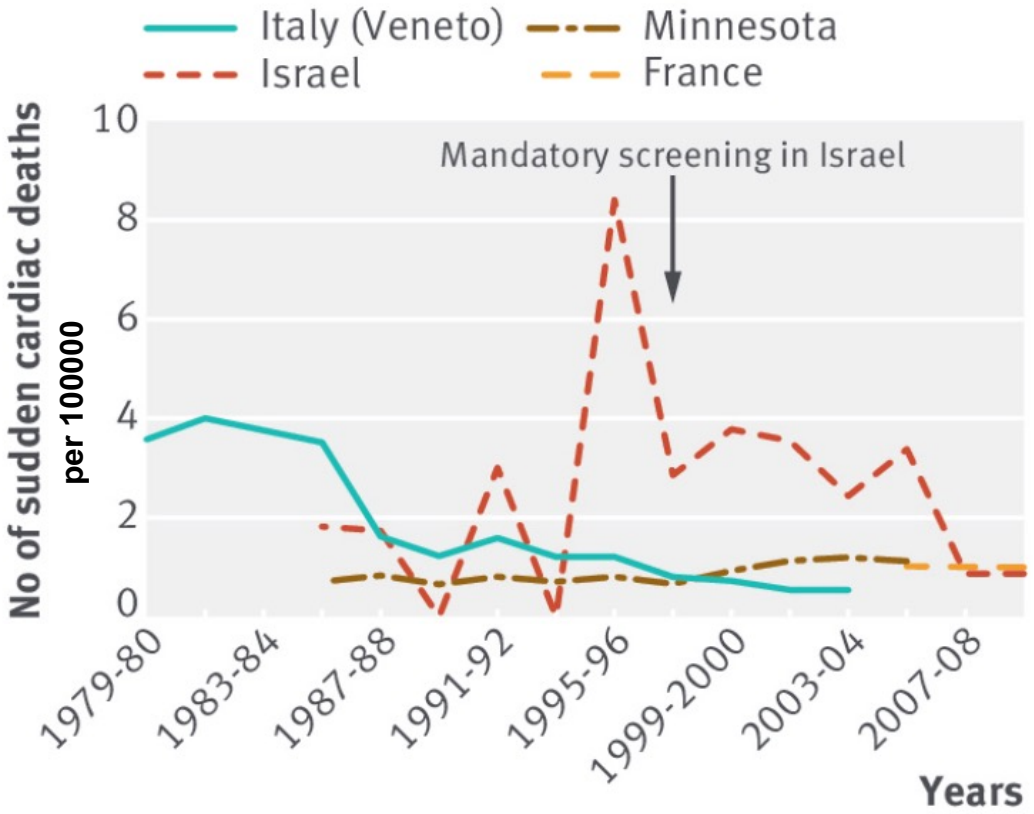
Figure. Annual Incidence Rates of Sudden Cardiovascular Death in Screened Competitive Athletes and Unscreened Nonathletes Aged 12 to 35 Years in the Veneto Region of Italy (1979-2004)



Veneto, Italy (1979–2004)

Van Brabandt H et al. *BMJ* 2016;353:i1156
Corrado D et al. *JAMA* 2006;296:1593

Effects of screening on outcomes by country



Van Brabandt H et al. *BMJ* 2016;353:i1156

Hx: 14-item AHA Cardiovascular Screening Checklist (2014)

The 14-Element AHA Cardiovascular Screening Checklist for Congenital and Genetic Heart Disease

Personal history

Yes	No	
☐	☐	1. Chest pain/discomfort/tightness/pressure related to exertion
☐	☐	2. Unexplained syncope/near-syncope*
☐	☐	3. Excessive exertional and unexplained dyspnea/fatigue or palpitations, associated with exercise
☐	☐	4. Prior recognition of a heart murmur
☐	☐	5. Elevated systemic blood pressure
☐	☐	6. Prior restriction from participation in sports
☐	☐	7. Prior testing for the heart, ordered by a physician

Family history

Yes	No	
☐	☐	8. Premature death (sudden and unexpected, or otherwise) before age 50 attributable to heart disease in ≥1 relative
☐	☐	9. Disability from heart disease in close relative <50 y of age
☐	☐	10. Hypertrophic or dilated cardiomyopathy, long-QT syndrome, or other ion channelopathies, Marfan syndrome, or clinically significant arrhythmias; specific knowledge of certain cardiac conditions in family members

Physical Examination

Yes	No	
☐	☐	11. Heart murmur**
☐	☐	12. Femoral pulses to exclude aortic coarctation
☐	☐	13. Physical stigmata of Marfan syndrome
☐	☐	14. Brachial artery blood pressure (sitting position)***

American Heart Association.

Maron BJ et al. *J Am Coll Cardiol* 2014;64:1479

Limitations of questionnaires

Original article

Efficacy of personal symptom and family history questionnaires when screening for inherited cardiac pathologies: the role of electrocardiography

M G Wilson [1], S Basavarajaiah [2], G P Whyte [3], S Cox [4], M Loosemore [5], S Sharma [6]

Mr M Wilson, Laboratory Director, Research Centre for Sport and Exercise Performance, University of Wolverhampton, Walsall WS1 3BD, UK; mat.wilson@wlv.ac.uk

Abstract

Aims: This study sought to confirm the efficacy of using resting 12-lead ECG alongside personal symptom and family history questionnaires and physical examination when screening for diseases with the potential to cause sudden cardiac death in the young.

Methods and results: 1074 national and international junior athletes (mean age 15.8 (SD 0.7) years, range 10 to 27) and 1646 physically active schoolchildren (16.1 (SD 2.1) years, range 14 to 20) were screened using personal and family history questionnaires, physical examination and resting 12-lead ECG. Nine participants with a positive diagnosis of a disease associated with sudden cardiac death were identified. None of the participants diagnosed with a disease associated with sudden cardiac death were symptomatic or had a family history of note.

Conclusion : Family history and personal symptom questionnaires alone are inadequate to identify people with diseases associated with sudden cardiac death. Use of the 12-lead ECG is essential when screening for cardiac pathology in the young.

- 9 of 1074 had SCD
- None diagnosed as having had a disease associated with SCD were symptomatic or had F/Hx of note.

Wilson MG et al. *Br J Sports Med* 2008;42:157

Limitations of the 14-element CV screening checklist

ORIGINAL RESEARCH

American Heart Association.

Performance of the American Heart Association (AHA) 14-Point Evaluation Versus Electrocardiography for the Cardiovascular Screening of High School Athletes: A Prospective Study

Elizabeth A. Williams, DO; Hank F. Pelto, MD; Brett G. Toresdahl, MD; Jordan M. Prutkin, MD, MHS; David S. Owens, MD, MS; Jack C. Salerno, MD; Kimberly G. Harmon, MD; Jonathan A. Drezner, MD

Conclusions—The AHA 14-point evaluation performs poorly compared with ECG for cardiovascular screening of high school athletes. The use of consensus-derived history questionnaires as the primary tool for cardiovascular screening in athletes should be reevaluated. (***J Am Heart Assoc.*** **2019;8:e012235. DOI: 10.1161/JAHA.119.012235.)**

- N=3620 high school athletes (median age 16 years, 76.8% white, 8.0% black)
- Primary outcome: identification of a CV disorder associated with SCD
- Abnormal P/E: 9.8%
- Abnormal ECG: 2.8%

- 0.4% had conditions associated with SCD
- Sensitivity & specificity: **14-element checklist**, 18.8% & **68%**

  ECG, 87.5% & **97.5%**

Williams EA et al. *JAHA* 2019;8:e012235

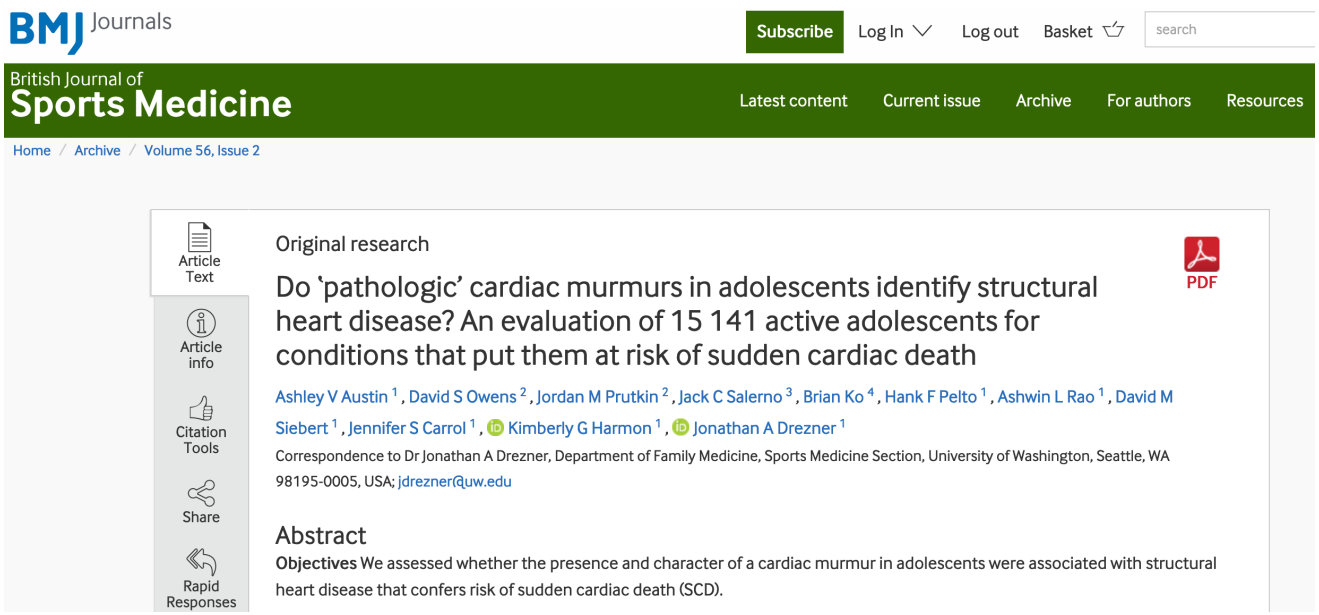
2020 ESC Guidelines on Sports Cardiology: Pearls

Pre-participation CV screening aimed at the detection of disorders associated with SCD is universally supported by major medical societies.[20–22,25,26] However, the best method for CV screening of young competitive athletes (<35 years old) remains controversial, and limited data are available to guide recommendations in master athletes (≥35 years old)

Screening strategies must be tailored to the target population and the specific disorders with highest risk. SCD in young athletes is caused by a variety of structural and electrical disorders of the heart, including cardiomyopathies, ion channel disorders, coronary anomalies, and acquired cardiac conditions.[17,27,28] In adult and senior athletes, atherosclerotic CAD is the primary condition leading to major adverse cardiovascular events (MACE).[28,29]

Pelliccia A et al. Eur Heart J 2020.

How useful is the physical exam?



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British Journal of **Sports Medicine**

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Original research

PDF

Do 'pathologic' cardiac murmurs in adolescents identify structural heart disease? An evaluation of 15 141 active adolescents for conditions that put them at risk of sudden cardiac death

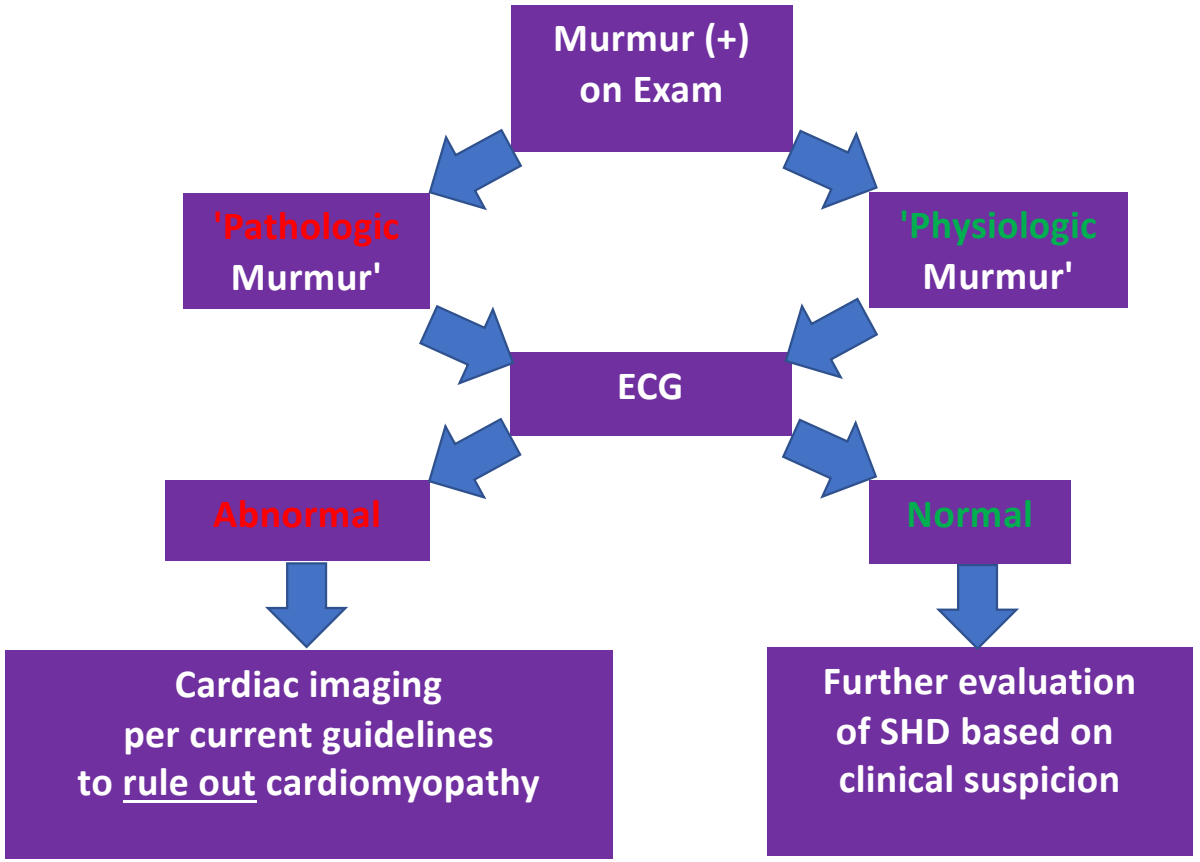
Ashley V Austin [1], David S Owens [2], Jordan M Prutkin [2], Jack C Salerno [3], Brian Ko [4], Hank F Pelto [1], Ashwin L Rao [1], David M Siebert [1], Jennifer S Carrol [1], Kimberly G Harmon [1], Jonathan A Drezner [1]

Correspondence to Dr Jonathan A Drezner, Department of Family Medicine, Sports Medicine Section, University of Washington, Seattle, WA 98195-0005, USA; jdrezner@uw.edu

Abstract

Objectives We assessed whether the presence and character of a cardiac murmur in adolescents were associated with structural heart disease that confers risk of sudden cardiac death (SCD).

- Retrospective analysis
- 15,141 indiv. aged 12–19 y who underwent cardiac screen w/ Hx, P/E and ECG
- Murmurs classified as 'physiologic' or 'pathologic'
- Primary outcome: **echo-detected structural heart disease associated with SCD**



Austin AV et al. *Br J Sports Med* 2022;56:88

Detecting structural HD on P/E

- Findings:

  - 905 participants w/ murmur(+) vs. 4333 murmur(–)

  - 743 (82%) **physiological** | 162 (18%) **pathological** → 25 (**2.8%**) **murmur**(**+**) & 61 (**1.4%**) **murmur**(**–**) had **structural HD**;

  - in the former, 3 (**0.3%**) had **HCM**, the only condition assoc. w/ SCD; among them, 2 had physiologic murmur but **all 3 had abnormal ECGs**

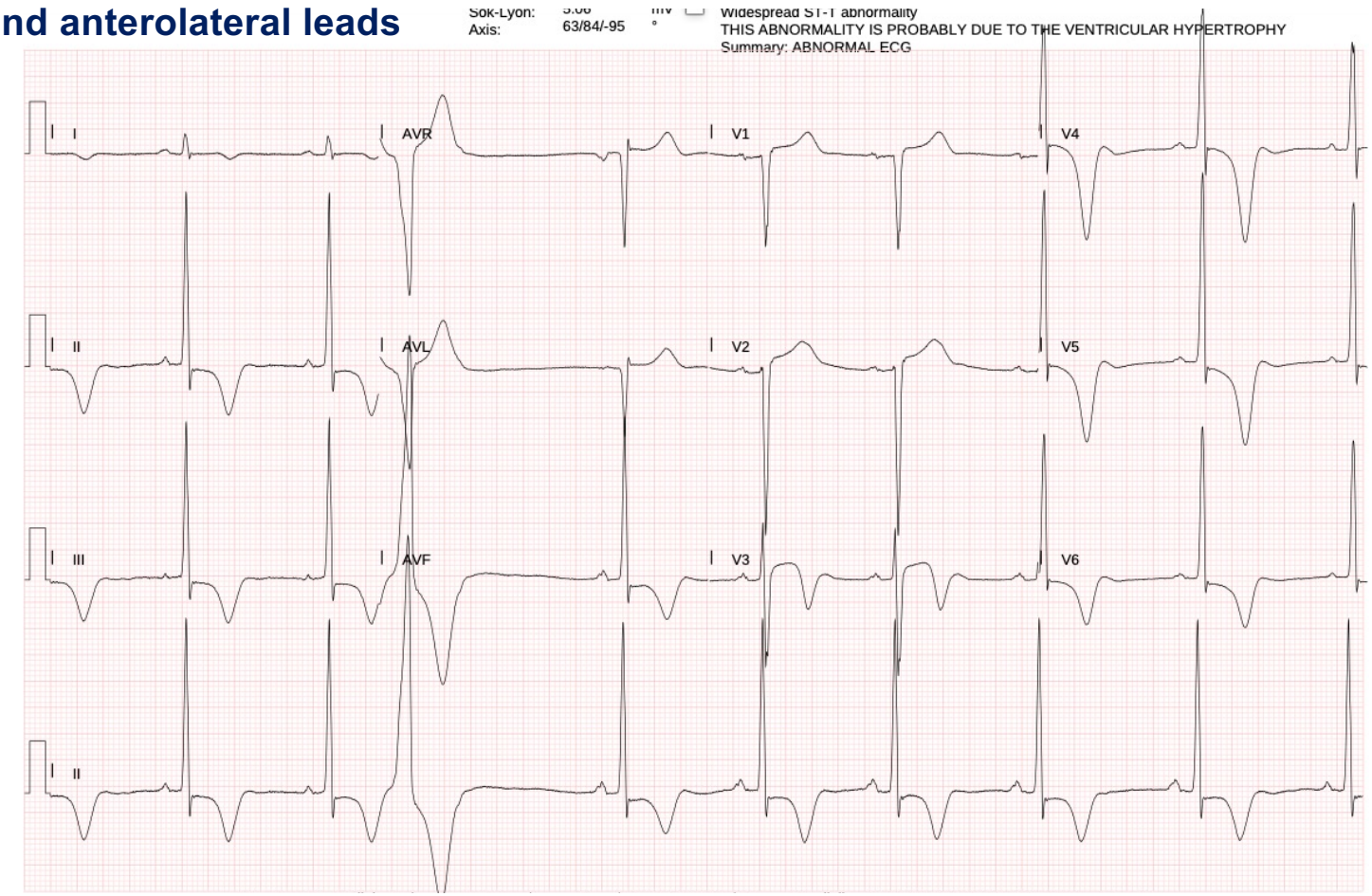
- Conclusion:

  1) **Classifiction of murmurs** as 'physiologic' or 'pathologic' does ***not*** **differentiate** structural HD (a SCD risk)

  2) Perform **ECG if any murmur** to increase detection of HCM.

Austin AV et al. *Br J Sports Med* 2022;56:88

NSR, normal axis, LVH, abnormal repolarization changes, TWI in inferior and anterolateral leads



Professional athlete with HCM

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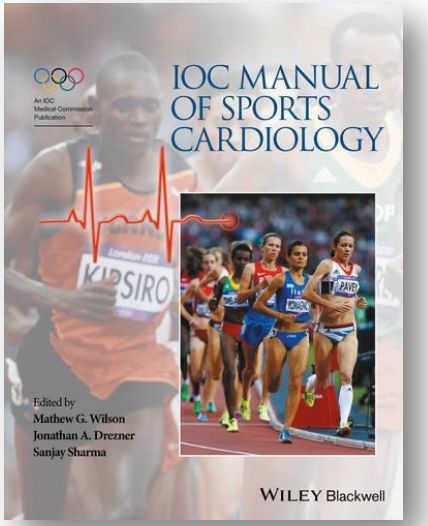
Reason for including ECG in PPE: IOC Manual of Sports Cardiology

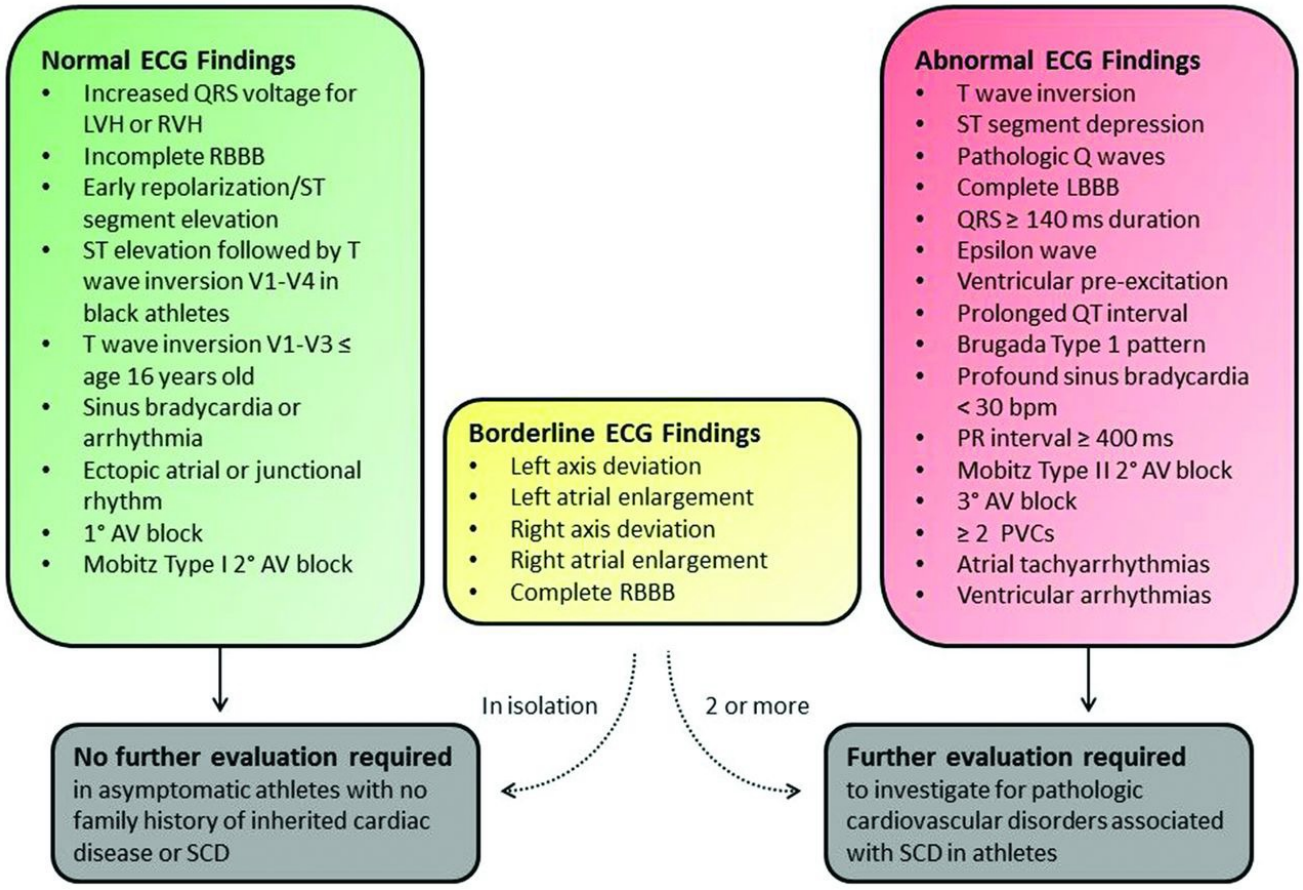


INTERNATIONAL OLYMPIC COMMITTEE

- **Hx & PE have very low sensitivity**
- **Sensitivity of cardiac screening improved with addition of ECG** (↑ **Dx power**): **5X** and **10X** compared to Hx and P/E, respectively
- Majority (but not all) athletes with cardiac abnormalities will have an abnormal ECG:
  - >90% pts with HCM
  - >60% pts with ARVC
  - WPW, LQTS, Brugada syndrome, AV blocks
- In a systematic review/meta-analysis of 15 studies (N=47,137), **sensitivity and specificity = 94% and 93%, respectively.**

Pelliccia A & Corrado D. Ch. 8 in: IOC Manual of Sports Cardiology. Ed: Wilson, Drezner & Sharma (2017).

2017 International Criteria for ECG interpretation in Athletes



- Of note:

  - Endorsed and/or affirmed by 13+ international professional organisations

  - "**Each revision** of the ECG standards **has improved specificity** while **maintaining the sensitivity** for ECG-detectable **pathological conditions associated with SCD**."

  - Total ECG abnormal rate declined – 21.5% (ESC), 9.6% (Seattle) and **6.6% (2017 Int'l)** – while all 3 identified 98.1% of athletes with HCM

Drezner JA et al. *Br J Sports Med* 2017;51:704

2017 International Criteria for ECG interpretation in Athletes

- Limitations:
  - will not detect all conditions predisposing to SCD
  - not detected by ECG: anomalous coronary arteries, premature coronary atherosclerosis, aortopathies
  - possible inter-observer variability
  - possible inaccurate ECG lead placement

Drezner JA et al. *Br J Sports Med* 2017;51:704

Performance of ECGs in Pre-participation CV evaluation

- HCM, **5-10% normal**
- Anomalous coronary artery, >90% normal
- Long QT & heritable arrhythmias, **25% normal**
- CPVT, normal at rest (Hx important)

Mejia-Lopez El. Sudden Death in Athletes | ACC.org (Dec 20, 2019)

2020 ESC Guidelines on Sports Cardiology: Pearls

3.6 Screening modalities for cardiovascular disease in young athletes

Most experts believe that early detection of potentially lethal disorders in athletes can decrease CV morbidity and mortality through risk stratification, disease-specific interventions, and/or exercise modifications.[22,57,58,71] CV screening by history and physical examination or by electrocardiogram (ECG) presents unique challenges and limitations. Several studies have documented the low sensitivity and high positive response rate of pre-participation history questionnaires.[64,65,72–75] In CV screening studies in which experienced clinicians use contemporary ECG interpretation standards, ECG screening outperforms history and physical examination in all statistical measures of performance.[58,59,62,64,65,74,76]

While echocardiography may identify additional structural disorders, there is insufficient evidence to recommend an echocardiogram for routine screening.[77]

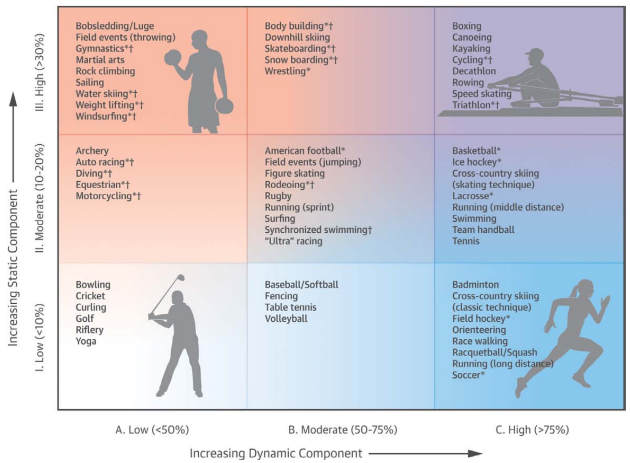
There is insufficient evidence to recommend TTE for routine screening.

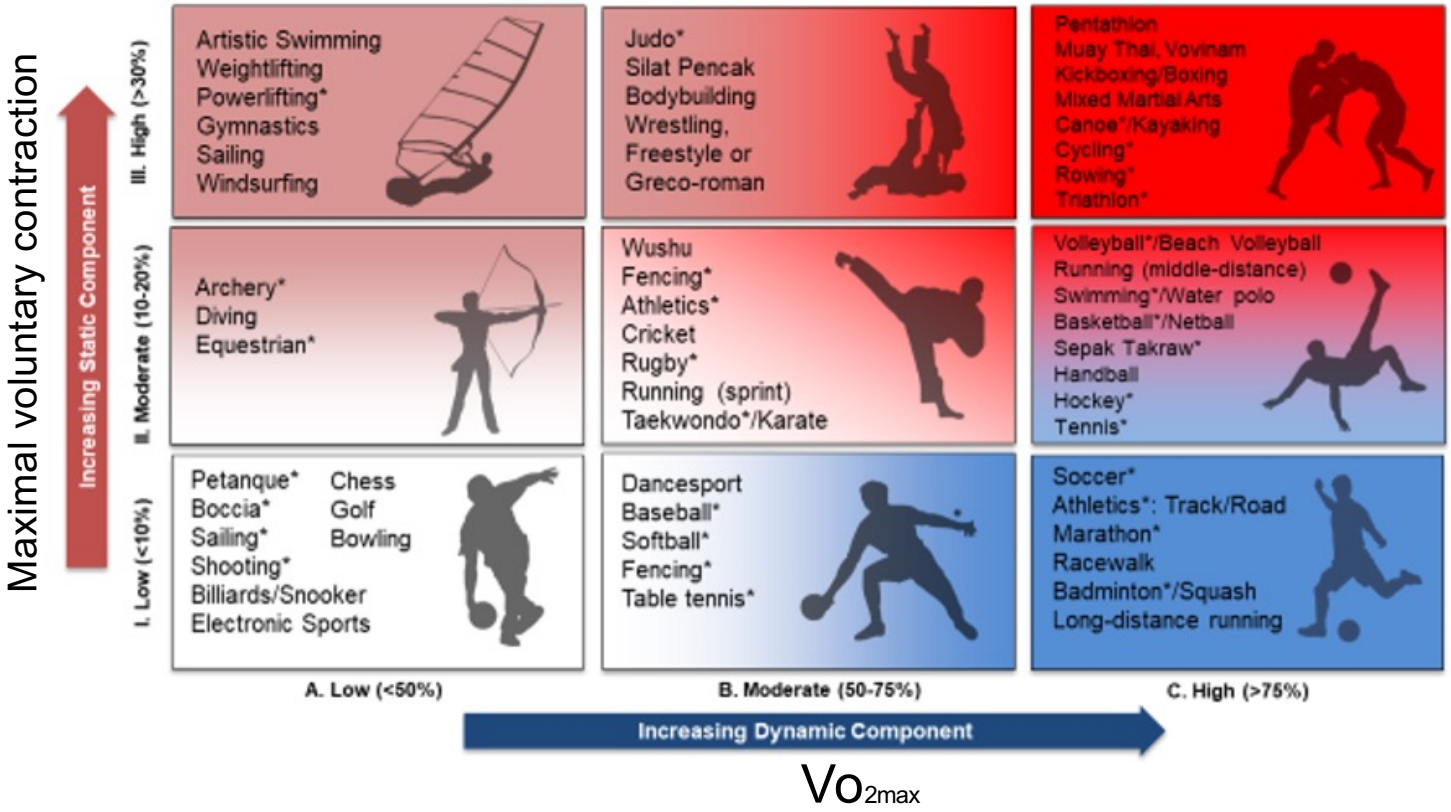
Pelliccia A et al. Eur Heart J 2020.

III. HKSI experience: data from 2020-2022 screening

2021 APSC Consensus Recommendations: Classification of Sports

Modified from ACC/AHA classification:





Wang L et al. *Eur Cardiol*. 2021;16:e44

2021 APSC Classification of Sports: HKSI data from 2020–2022

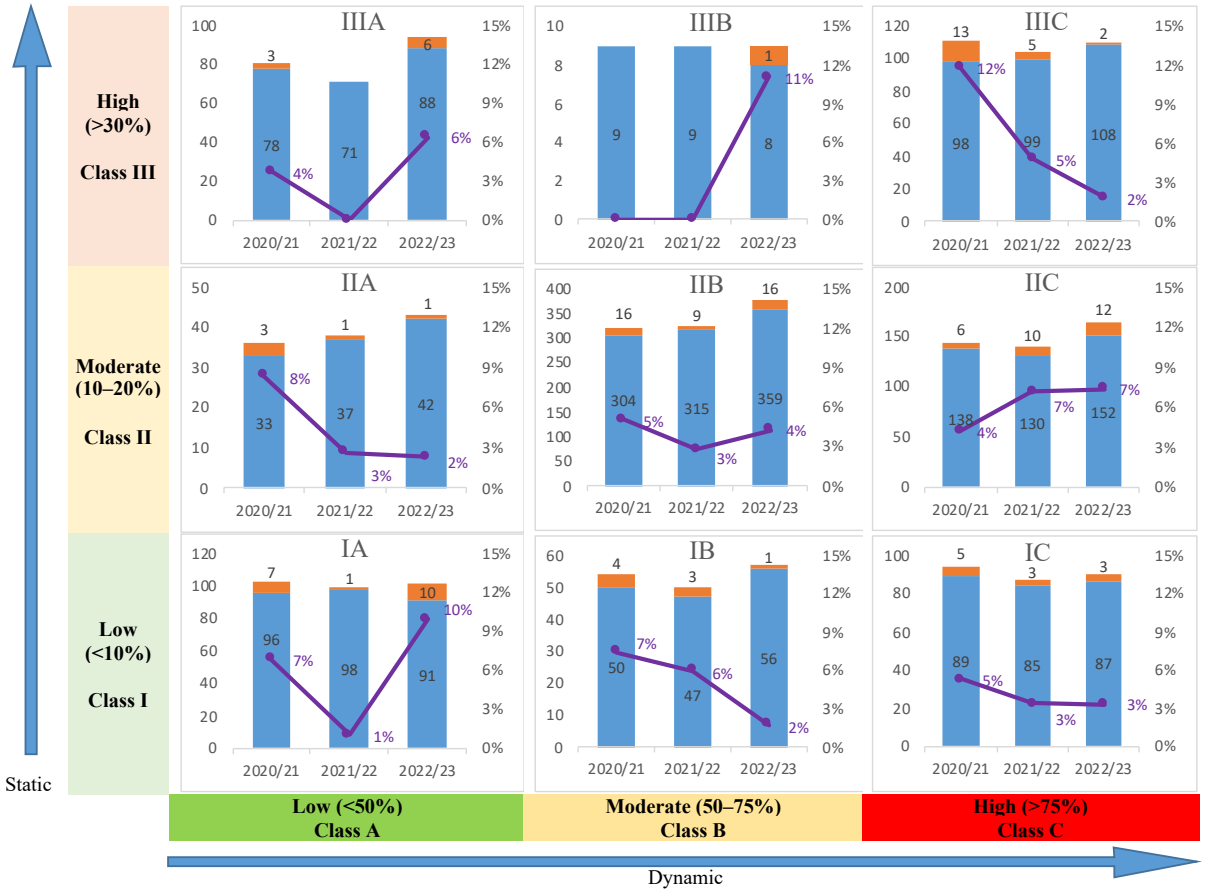
	APSC	HKSI	APSC	HKSI	APSC	HKSI
High (>30%) Class III	Artistic swimming Weightlifting Powerlifting Sailing Windsurfing	Gymnastics Kart Sailing Windsurfing	Judo Silat Pencak Bodybuilding Wrestling, freestyle or Greco-Roman	Judo	Pentathlon Muay Thai, Vovinam Kickboxing/ boxing Mixed martial arts Canoe*/kayaking Cycling* Rowing* Triathlon*	Cycling Rowing Triathlon Para triathlon (physical disability) Mountaineering IASS-boxing IASS-canoe
Moderate (10–20%) Class II	Archery Diving Equestrian	Equestrian IASS-archery Para archery (physical disability)	Wushu Fencing Athletics Cricket Rugby Running (sprint) Taekwondo*/ Karate	Wushu Fencing Wheelchair fencing (physical disability) Rugby Seven Karate Taekwondo Para athletics (physical disability) Para athletics (intellectual disability)	Volleyball*/beach volleyball Running (middle-distance) Swimming*/water polo Basketball*/netball Sepak Takraw* Handball Hockey* Tennis*	Swimming Para swimming (intellectual disability) Tennis Skating Life saving Roller Sports IASS-beach volleyball IASS-handball
Low (<10%) Class I	Petanque* Boccia Sailing* Shooting* Billiards/ snooker Electronic sports Chess Golf Bowling	Billiard sports Tenpin bowling Boccia (physical disability) Lawn bowls Para lawn bowls (Physical disability) Para tenpin bowling (physical disability) Golf IASS-shooting	Dance sport* Baseball* Softball* Fencing* Table tennis*	Table tennis Para table tennis (physical disability) Para table tennis (intellectual disability) Dance sport	Soccer* Athletics*: track/road Marathon* Racewalk Badminton*/squash Long-distance running	Badminton Para badminton (physical disability) Squash Orienteering Shuttlecock
	Low (<50%) Class A		**Moderate (50–75%) Class B**		**High (>75%) Class C**	

Static

Dynamic

Unpublished data

Overview of Cases Identified on PPE at HKSI and Subsequent Determination of Normal or Abnormal Findings by Cardiovascular Specialist



Abnormal

Normal

Unpublished data

	2020/21-2022/23 Season	
ECG abnormalities	Positive diagnosis	Intervention
Preexcitation	10	1
Q wave	5	
LBBB	1	
RBBB with/without axis deviation	5	
RVH with RAD		
Prolonged QT	21	
ST depression	2	
T wave inversion	19	
Frequent atrial ectopic beats		
Frequent ventricular ectopic beats	11	1
Echocardiographic abnormalities		
Hypertrophhic cardiomyopathy	2	
Anomalous coronary artery	2	1
Atrial septal defect	1	1
Ventricular septal defect		
Patent foramen ovale		
Bicuspid aortic valve		
Mitral valve prolapse with moderate MR		
Moderate aortic regurgitation		
Pericardial effusion of unknown aetiology		
LV systolic dysfunction (LVEF <50%)	1	

Unpublished data

Summary (1/2)

- There is an agreement and consensus that athletes should undergo pre-participation CV evaluation.
- Resources may limit the scale and depth of evaluation.
- Higher priority should be given to high-intensity sport (high static and dynamic components).
- No programme can identify all athletes at risk of SCD.
- Knowledge of epidemiology and having local data are important.

Summary (2/2)

- **Hx** is a critical component of pre-participation CV evaluation:
  - Structured forms (efficacy & efficiency?) vs. detailed interview
  - Exertion & red-flag incidents
  - Personal (incl. social, med & drug use) and family history
  - Cardiovascular hx (e.g. previous surgery, procedures, devices)
- **PE**: BP/P, anthropometry, cardiovascular - auscultation, pulses, stigmata & signs
- Ix: resting (**ECG**, TTE, Holter etc.), stress tests, advanced imaging
- Referral to specialist

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Thank you!

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