



# Screening For Sudden Cardiac Death In Athletes



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# Korean Heart Rhythm Society

## COI Disclosure

*Name: Tee Joo YEO*

The author has no financial conflicts of interest  
to disclose concerning the presentation



# Outline

- WHY screen?  
→ Rationale
- HOW to screen?  
→ Pre-participation Screening
- WHO to screen?  
→ Guidelines



# Definition of "athlete"

A person who participates in **regular competition**, where emphasis is placed on **excellence** & **achievement**, & **systematic training** is usually intense with a tendency for **exertion to physical limits**



# The first documented sudden cardiac death in an athlete?



Pheidippides - messenger who ran from Marathon to Athens to announce Greek victory

## WHY SCREEN ATHLETES?

Athletes have almost **3x higher risk** of SCD vs. non-athletes

Incidence of SCD in athletes ~  
**1:50,000 to 1:15,000**

*Corrado et al. JACC 2003;42(11):1959-63*

*Harmon et al. Heart 2014;100(16):1227-34*

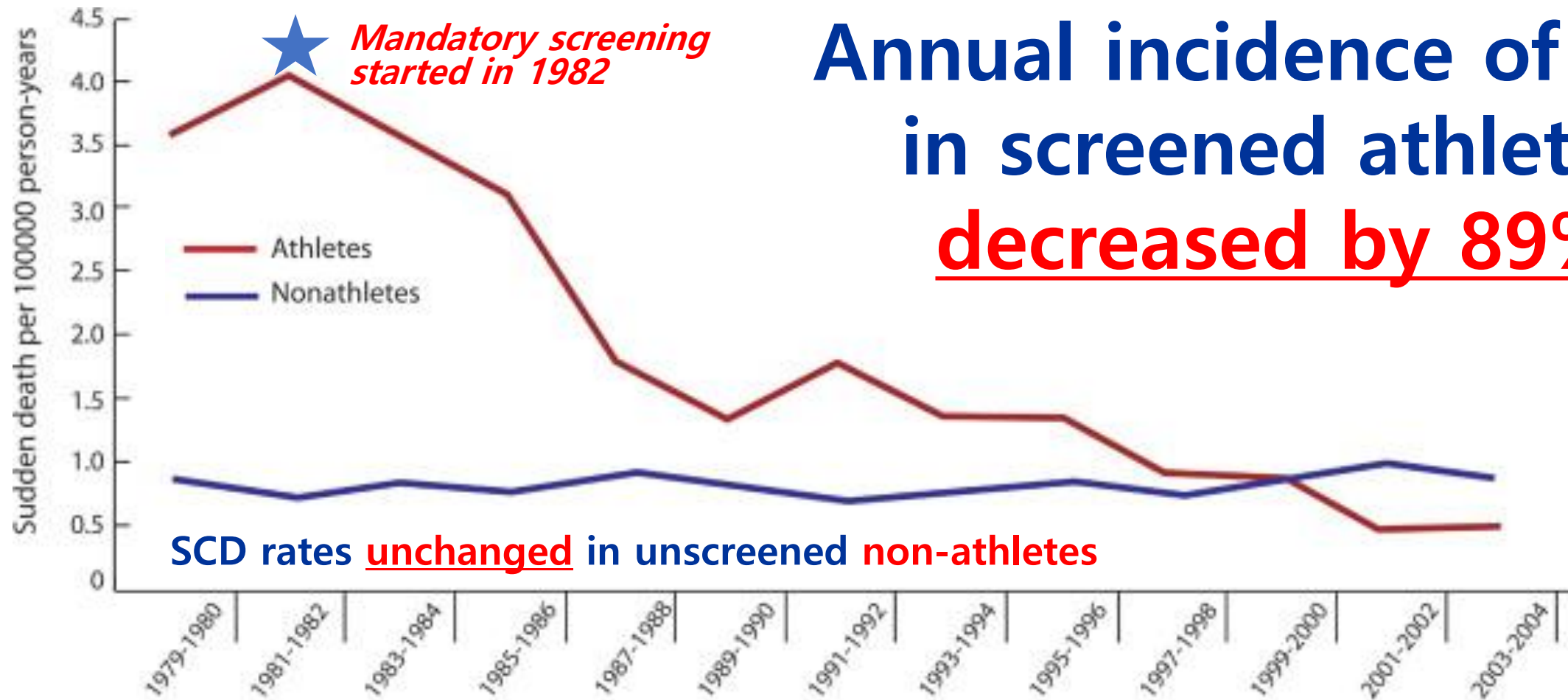
*Malhotra et al. N Engl J Med 2018;379:524-34*

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

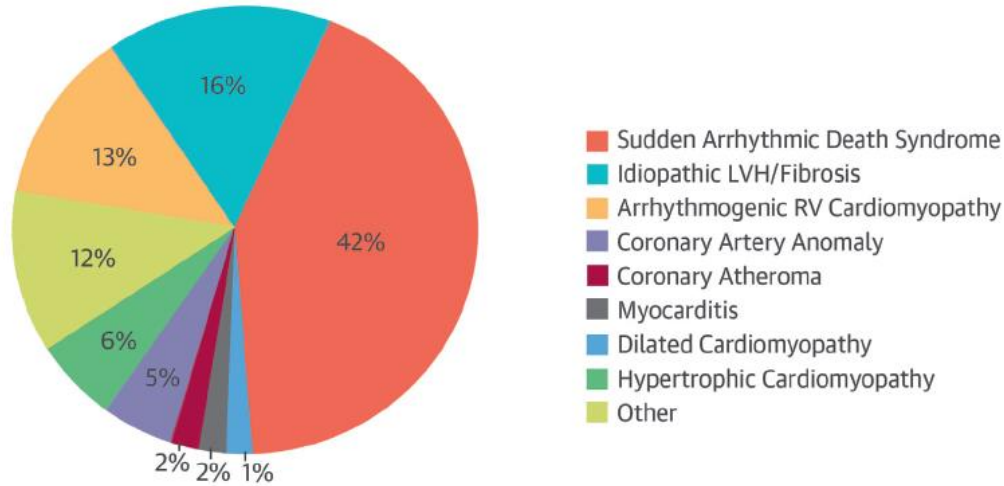
Domenico Corrado, MD, PhD; Cristina Basso, MD, PhD; Andrea Pavei, MD; Pierantonio Michieli, MD, PhD; Maurizio Schiavon, MD; Gaetano Thiene, MD

# Why screen athletes? The Landmark Paper

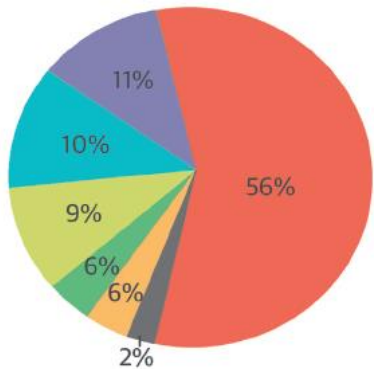
Annual incidence of SCD  
in screened athletes  
decreased by 89%



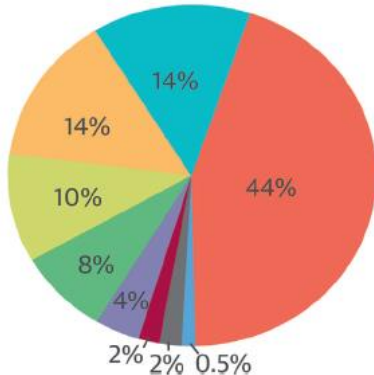
**A. Sudden Death in Overall Population**  
(n = 357)



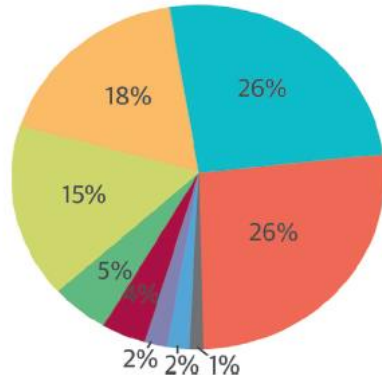
**B. Sudden Death <18 Years**  
(n = 79)



**C. Sudden Death 18-35 Years**  
(n = 179)



**D. Sudden Death >35 Years**  
(n = 99)



Finocchiaro, G. et al. J Am Coll Cardiol. 2016;67(18):2108-15.

Sudden death is shown in the overall population (A), in subjects <18 years of age (B), subjects 18 to 35 years of age (C), and subjects >35 years of age (D). In the overall population, the subgroup classified as "Other" (n = 43) comprised: mitral valve abnormalities/prolapse; n = 7, myocardial infarction with normal coronaries; n = 4, bicuspid aortic valve; n = 3, aortic dissection; n = 3, cocaine/steroid use; n = 2, cardiac sarcoidosis; n = 1, atrium septal defect (ASD). In the remaining 23 cases, the cause of death could not be attributed to a single disease entity or condition and the post-mortem findings were considered of uncertain significance. LVH = left ventricle hypertrophy; RV = right ventricle.

# SCD in athletes

- Causes evolve over time
- Different causes in different age groups
- HCM no longer commonest
- Sudden arrhythmic death syndrome (SADS) most likely cause of SCD

Roh et al. *PLoS One*. 2020; 15(11): e0242799.

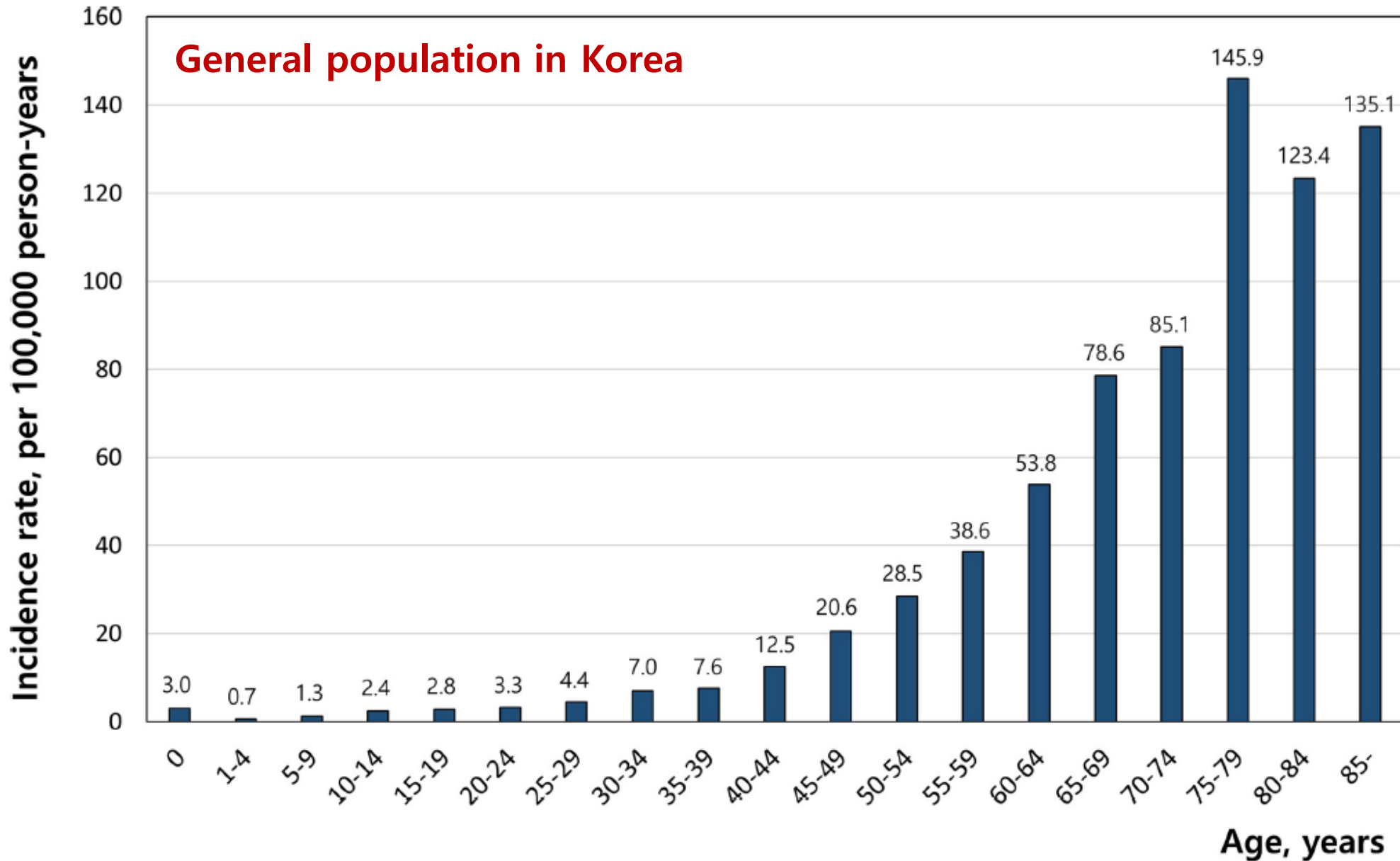
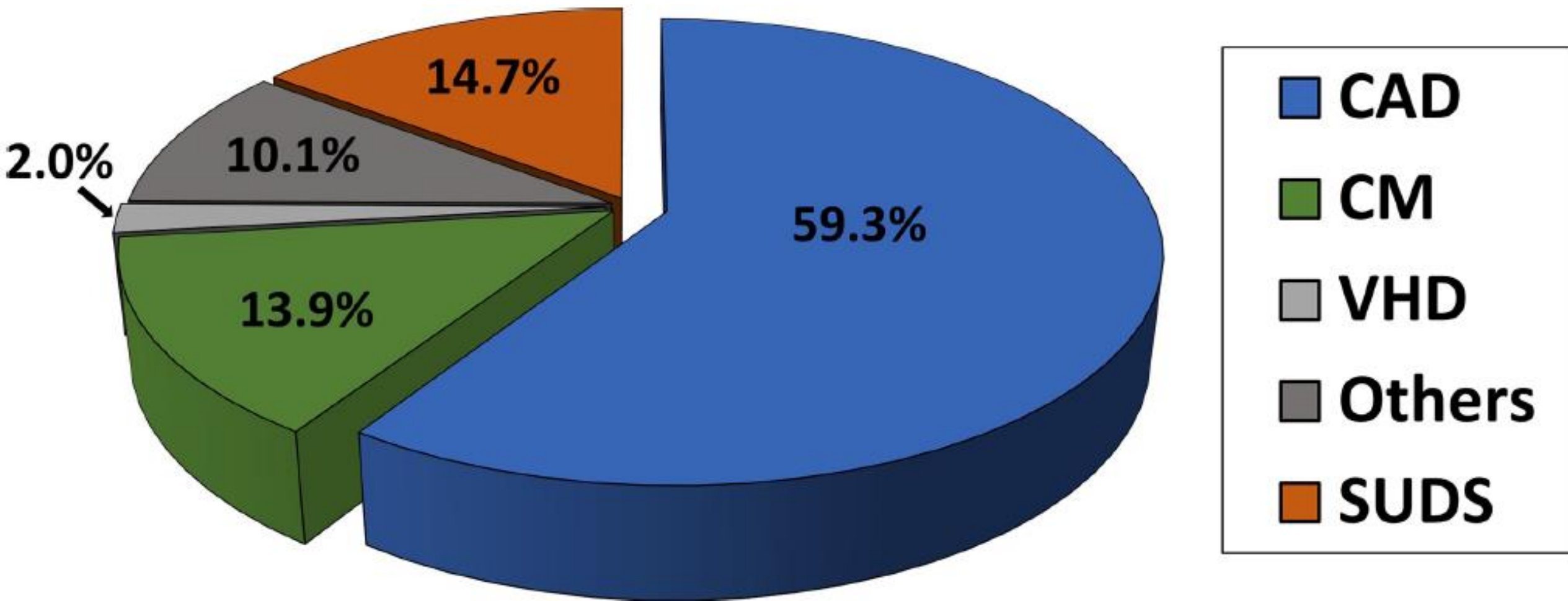


Fig 2. Annual age-related distribution of sudden cardiac arrest incidence per 100,000 person-years.







**Fig 4. Causes of sudden cardiac arrest.** Coronary artery disease was responsible for 59.3% of cases, followed by cardiomyopathy (13.9%), and valvular heart disease (2%). Sudden unexplained death syndrome was 14.7% of total sudden cardiac arrest, CAD. coronary artery disease; CM. cardiomyopathy; VHD. valvular heart disease; SUDS. sudden unexplained death syndrome.

**General population in Korea**

Roh et al. [PLoS One](https://doi.org/10.1371/journal.pone.0242799). 2020; 15(11): e0242799.



# HOW to screen?

- Symptom questionnaire / personal medical history / family history
  - Physical examination
- 14-point AHA recommendations  
→ 5th Pre-participation Evaluation Monograph  
→ ESC questionnaire  
→ International Olympic Committee PPE  
→ FIFA Pre-Competition Medical Assessment
- Resting 12-lead electrocardiogram (selected)



AHA Recommendations (10)*		PPE-4 (21)
Medical History†		
Personal History	Heart Health Questions About You	
1. Chest pain/discomfort/tightness/pressure related to exertion	6. Have you ever had discomfort, pain, tightness, or pressure in your chest during exercise?	
2. Unexplained syncope/near syncope‡	5. Have you ever passed out or nearly passed out <i>during</i> or <i>after</i> exercise?	
3. Excessive and unexplained dyspnea/fatigue or palpitations, associated with exercise	12. Do you get more tired or short of breath more quickly than your friends during exercise?	
	10. Do you get lightheaded or feel more short of breath than expected during exercise?	
	7. Does your heart ever race or skip beats (irregular beats) during exercise?	
4. Prior recognition of a heart murmur	8. Has a doctor ever told you that you have any heart problems? If so, check all that apply:	
5. Elevated systemic blood pressure	<input type="checkbox"/> High blood pressure	
	<input type="checkbox"/> A heart murmur	
	<input type="checkbox"/> High cholesterol	
	<input type="checkbox"/> A heart infection	
	<input type="checkbox"/> Kawasaki disease	
	Other: _____	
6. Prior restriction from sports	1. Has a doctor ever denied or restricted your participation in sports for any reason?	
7. Prior testing for heart disease, ordered by a physician	9. Has a doctor ever ordered a test for your heart? (For example, ECG/EKG, echocardiogram)	
	11. <b>Have you ever had an unexplained seizure?</b>	

# The ECG in PPS

## Strength of Rationale for ECG Screening



5x more sensitive than history & 10x more sensitive than PE  
Diagnostic utility & risk stratification



## Normal ECG Findings

- Increased QRS voltage for LVH or RVH
- Incomplete RBBB
- Early repolarization/ST segment elevation
- ST elevation followed by T wave inversion V1-V4 in black athletes
- T wave inversion V1-V3 age <16 years old
- Sinus bradycardia or arrhythmia
- Ectopic atrial or junctional rhythm
- 1° AV block
- Mobitz Type I 2° AV block

# International Criteria

## Borderline ECG Findings

- Left axis deviation
- Left atrial enlargement
- Right axis deviation
- Right atrial enlargement
- Complete RBBB

## Abnormal ECG Findings

- T wave inversion
- ST segment depression
- Pathologic Q waves
- Complete LBBB
- QRS  $\geq$  140 ms duration
- Epsilon wave
- Ventricular pre-excitation
- Prolonged QT interval
- Brugada Type 1 pattern
- Profound sinus bradycardia < 30 bpm
- PR interval  $\geq$  400 ms
- Mobitz Type II 2° AV block
- 3° AV block
- $\geq$  2 PVCs
- Atrial tachyarrhythmias
- Ventricular arrhythmias

No further evaluation required in asymptomatic athletes with no family history of inherited cardiac disease or SCD

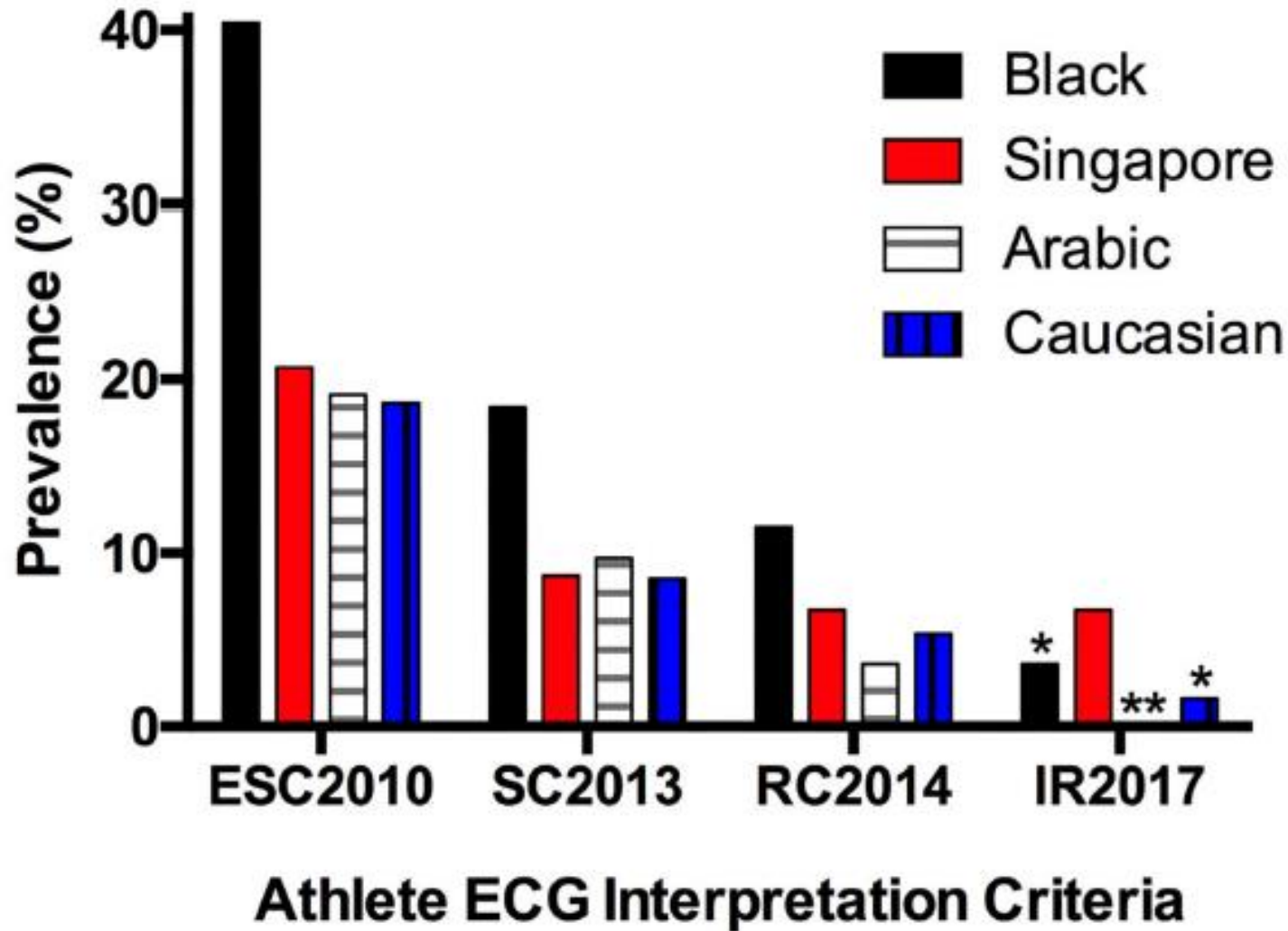
In isolation

2 or more

Further evaluation required to investigate for pathologic cardiovascular disorders associated with SCD in athletes

- Cost-effective
- Reduces false positives
- Preserved sensitivity in disease detection
- Improved inter-observer agreement
- But no Asian data (yet)

# How does the International Criteria fare in Asian athletes?



**FIGURE 2 |** Prevalence of abnormal electrocardiograms in athletes of different ethnicities (10, 15, 16) (\*Adolescent athletes; \*\*Data unavailable; ESC, European Society of Cardiology; SC, Seattle Criteria; RC, Refined Criteria; IR, International Recommendations).



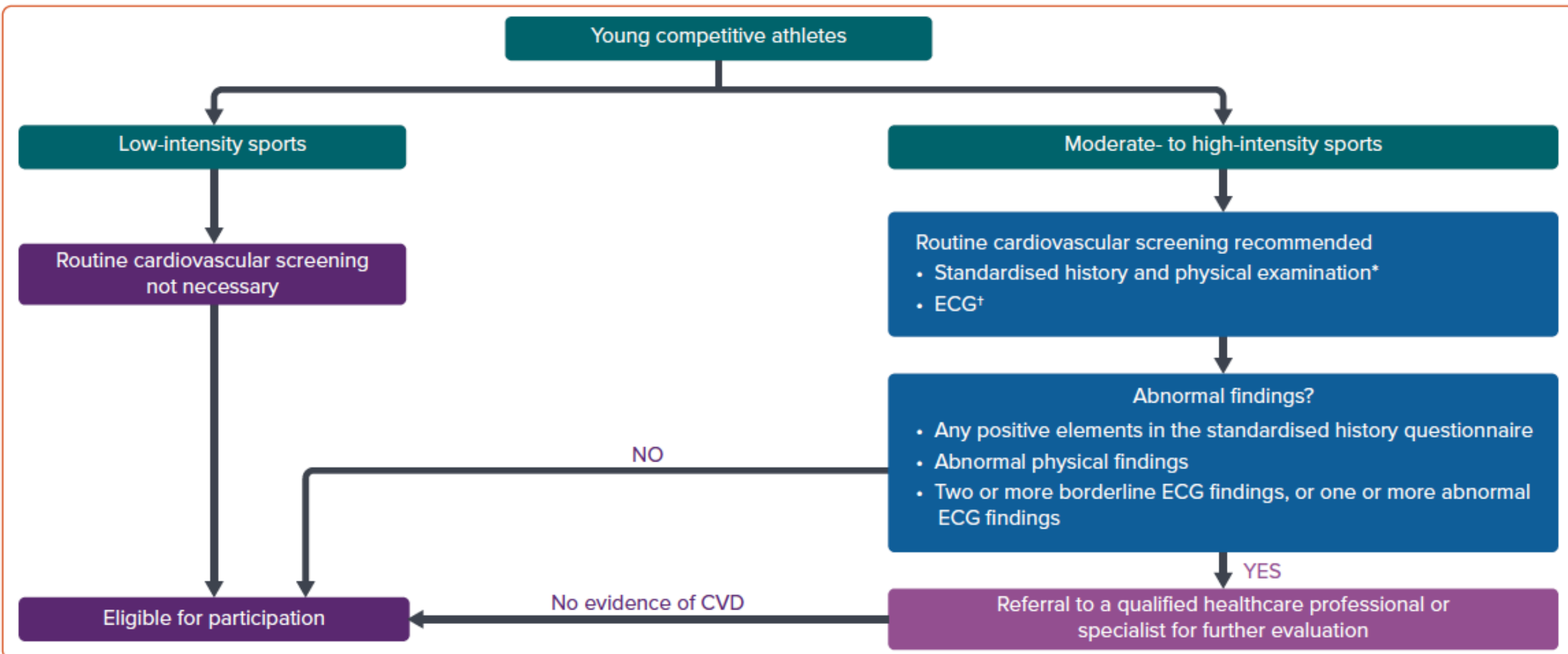
# How does the International Criteria fare in Asian athletes?

Table 5. Sensitivity and specificity using different electrocardiographic criteria to detect cardiac abnormalities in the study population after excluding master athletes (95% confidence interval).

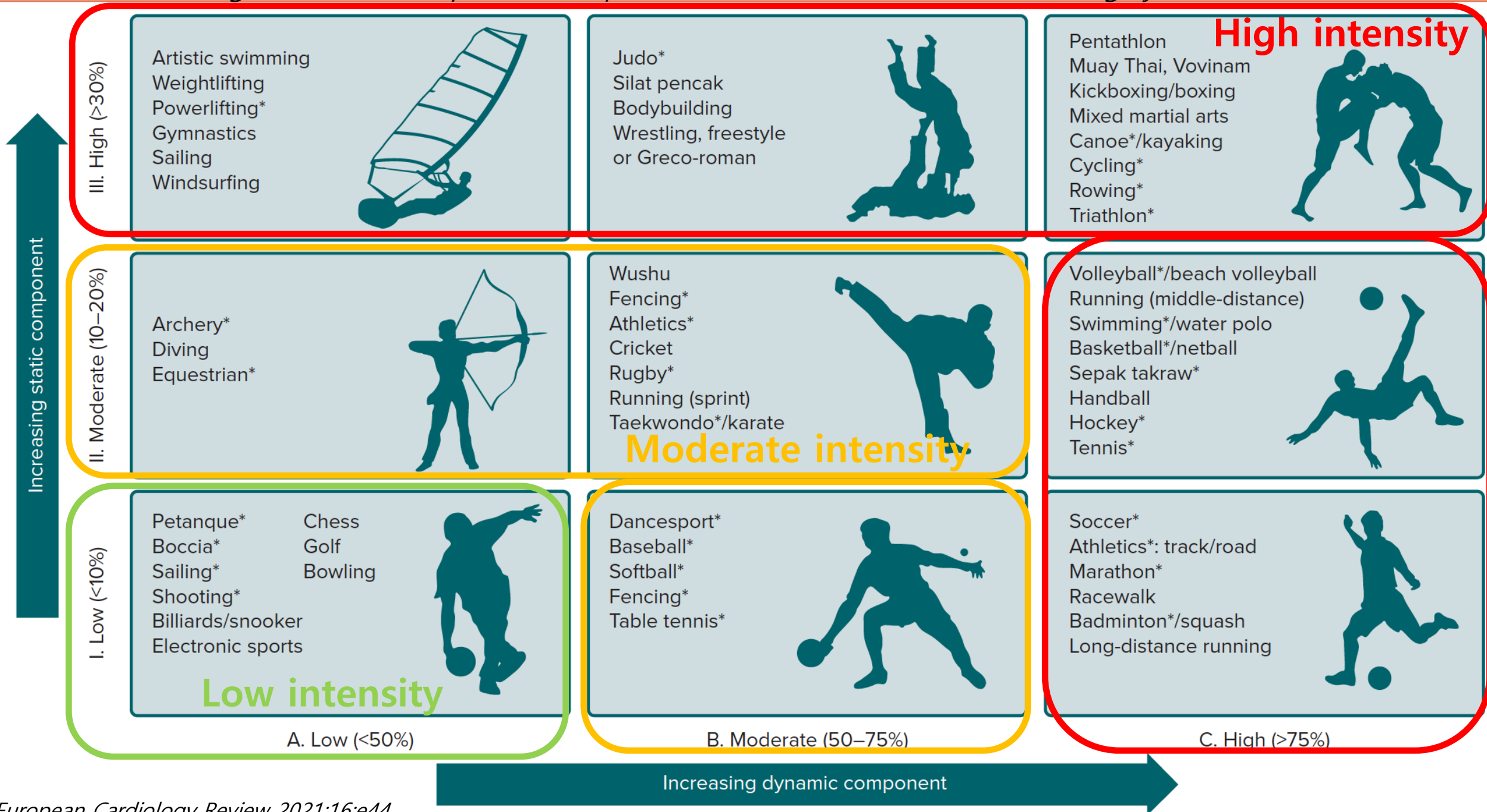
	European Society of Cardiology group 2 Criteria	Seattle Criteria	Refined Criteria	2017 International Criteria
Sensitivity, %	20.0 (4.3–48.1)	0 (0.0–21.8)	13.3 (1.7–40.5)	6.7 (0.2–31.9)
Specificity, %	60.3 (53.3–67.0)	92.8 (88.4–95.9)	81.8 (75.9–86.8)	96.7 (93.2–98.6) ★
Positive predictive value, %	3.5 (0.7–9.9)	0 (0–21.8)	5.0 (0.6–16.9)	12.5 (0.3–52.7) ★
Negative predictive value, %	91.3 (85.3–95.4)	92.8 (88.4–95.9)	92.9 (88.2–96.2)	93.5 (89.4–96.4) ★
False positive rate, %	39.7 (33.0–46.7)	7.2 (4.1–11.6)	18.2 (13.2–24.1)	3.3 (1.4–6.8) ★
False negative rate, %	80.0 (51.9–95.7)	100 (78.2–100)	86.7 (59.5–98.3)	93.3 (68.1–99.8)



Figure 2: Flowchart for Pre-participation Cardiovascular Screening for Young Competitive Athletes



*\*This serves as a guide; real-world practice of sport is fluid and actual intensities are highly variable*





# Screening athletes with pre-existing CV conditions



ESC

European Society  
of Cardiology

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

ESC GUIDELINES

## 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)

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### THE PRESENT AND FUTURE

JACC STATE-OF-THE-ART REVIEW

## Exercise-Induced Cardiovascular Adaptations and Approach to Exercise and Cardiovascular Disease

JACC State-of-the-Art Review



Clinical practice recommendations and position paper



## Italian Cardiological Guidelines (COCIS) for Competitive Sport Eligibility in athletes with heart disease: update 2020

Pietro Delise<sup>a</sup>, Lucio Mos<sup>b</sup>, Luigi Sciarra<sup>c</sup>, Cristina Basso<sup>d</sup>, Alessandro Biffi<sup>e</sup>, Franco Cecchi<sup>f</sup>, Furio Colivicchi<sup>g</sup>, Domenico Corrado<sup>d</sup>, Antonello D'Andrea<sup>h</sup>, Ernesto Di Cesare<sup>i</sup>, Andrea Di Lenarda<sup>j</sup>, Salvatore Gervasi<sup>k</sup>, Franco Giada<sup>l</sup>, Vincenzo Guiducci<sup>m</sup>, Giuseppe Inama<sup>n</sup>, Loira Leoni<sup>d</sup>, Zefferino Palamà<sup>o</sup>, Giampiero Patrizi<sup>p</sup>, Antonio Pelliccia<sup>e</sup>, Maria Penco<sup>q</sup>, Antonio Gianluca Robles<sup>c</sup>, Silvio Romano<sup>q</sup>, Francesco Romeo<sup>r</sup>, Patrizio Sarto<sup>s</sup>, Berardo Sarubbi<sup>t</sup>, Gianfranco Sinagra<sup>u</sup> and Paolo Zeppilli<sup>k</sup>

Since 1989, SIC Sport and a FMSI, in partnership with leading Italian Cardiological Scientific Associations (ANCE, ANMCO and SIC) have produced Cardiological Guidelines for Competitive Sports Eligibility for athletes with heart disease (COCIS – 1989, 1995, 2003, 2009 and 2017).

fitness to participate in competitive sports. In Italy, this certificate is essential for participating in any competition.

J Cardiovasc Med 2021, 22:874–891



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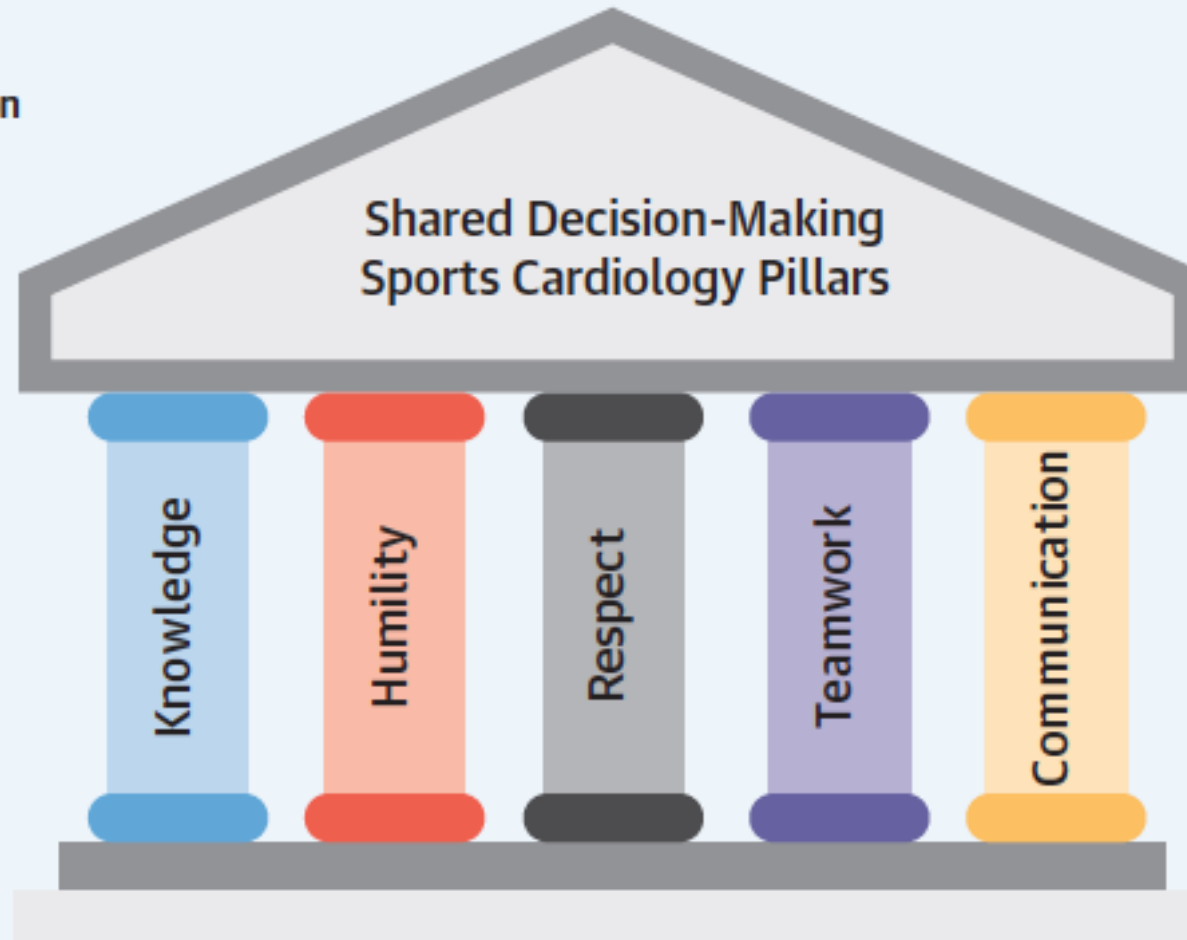
# The Importance of Shared Decision Making

## Knowledge

- Appropriate diagnosis
- Expertise in the cardiac condition
- Expertise in exercise and sport recommendations

## Humility

- Recognize you may not be able to provide expert counsel
- Additional opinions serve both patient and provider
- Recognize that the science can change
- Appreciate that the physician is there to serve the patient



## Respect

- Respect patient priorities
- Recognize the patient's voice and opinion

## Teamwork

- Approach the patient as a teammate and fellow "expert"
- Engage and discuss with patient significant others
- Engage coaches and team medical personnel to optimize the sports environment

## Communication

- Document discussion of risk/ benefits of participation and restriction
- Communicate with all stakeholders

# Conclusion

- Assess athletes objectively based on sport and intensity – many recreational sports require substantial training & exertion
- APSC consensus recommends pre-participation screening in young athletes from moderate to high intensity sports
- History and physical examination are recommended while 12-lead ECG is dependent on available resources
- Shared decision making should be done whenever appropriate



**Thank you  
Save the dates!**



27<sup>TH</sup> ASIAN PACIFIC SOCIETY  
OF CARDIOLOGY CONGRESS



Website: [www.apsc2023singapore.com](http://www.apsc2023singapore.com)



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