SCREENING AND PREVENTING SUDDEN CARDIAC DEATH IN EXERCISE

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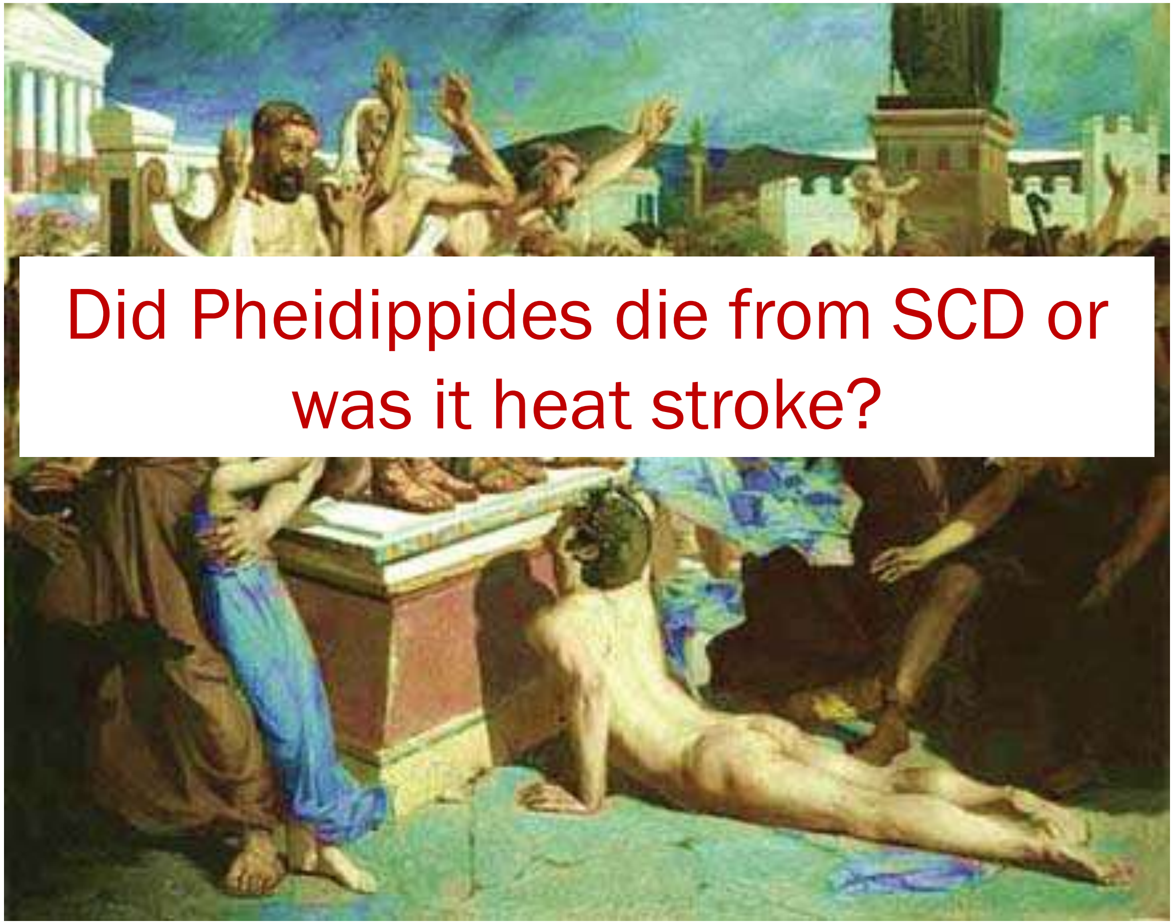
My Disclosures

When I was still young….

No Money

Did Pheidippides die from SCD or was it heat stroke?



Pheidippides, a running courier, ran the 40 km (25 miles) from Marathon to Athens to announce the Greek victory (490BC), and then collapsed and died of sudden death.

SAF officer dies in 10km race

By

Road marshals alerted the medical team on

defibrillator. A
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was pronounced
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Singapore Biath
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The assistant
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run when he co

On Feb 27, Kishon Ng, 10, a Primary 4 pupil at St
Ling
playi
died less than two hours later.

A day later, Anglo-Chinese Junior College student Jonathon Teo, 18, died after collapsing during a run at his condominium's gym.

Modern day Pheidippides

RCH 13 2012 PAGE B5

hairil, who was said to be very fit, collapsed without varning and later died from heart failure. PHOTO: COURTESY F THE FAMILY OF MUHAMMAD KHAIRIL MUHAMAD NIZAM

Definition of Sudden Cardiac Death

Death from cardiac causes, heralded by abrupt loss of consciousness, within 1 hour of the onset of acute symptoms

Epidemiology of SD on athletes

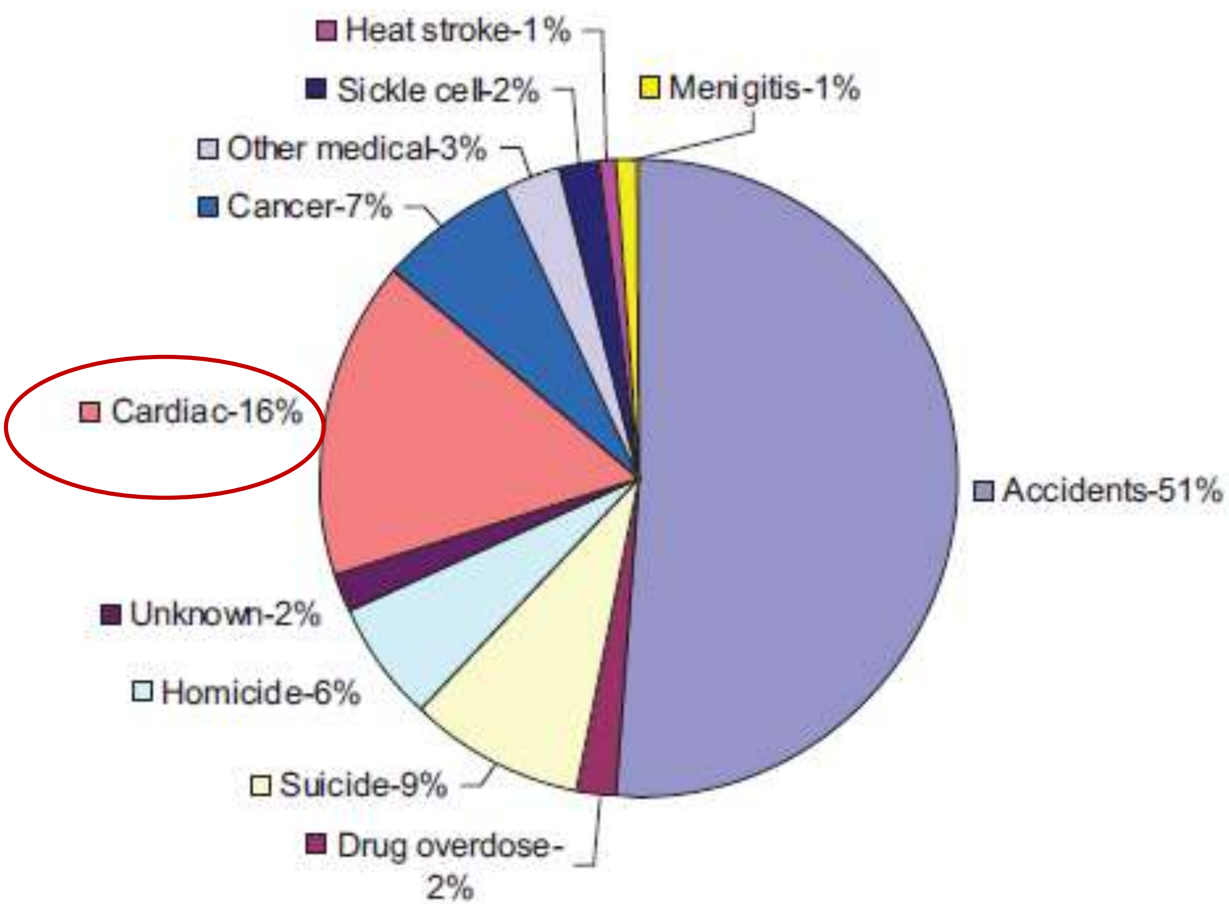

Figure 2. Causes of death in National Collegiate Athletic Association athletes (from Harmon et al[11]).

- 90% of SD in athletes are SCD, without prior warning
- Only minority (11%) survive a SCA despite witnessed collapse and prompt resus

Risk of SCD during exercise

TRIGGERING OF SUDDEN DEATH FROM CARDIAC CAUSES BY VIGOROUS EXERTION

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I.-MIN LEE, M.B., B.S., SC.D., CHARLES H. HENNEKENS, M.D., DR.P.H., AND JOANN E. MANSON,

ABSTRACT

Background Retrospective and cross-sectional data suggest that vigorous exertion can trigger cardiac arrest or sudden death and that habitual exercise may diminish this risk. However, the role of physical activity in precipitating or preventing sudden death from cardiac causes has not been assessed prospectively in a large number of subjects.

Methods We used
over design within
compare the risk o
30 minutes after an
that during periods
then evaluated wh
modified the risk of sudden death that was associated with vigorous exertion. In addition, the relation of vigorous exercise to the overall risk of sudden death and nonsudden death from coronary heart disease was assessed.

Results During 12 years of follow-up, 122 sudden deaths were confirmed among the 21,481 male physicians who were initially free of self-reported cardiovascular disease and who provided information on their habitual level of exercise at base line. The relative risk of sudden death during and up to 30 minutes after vigorous exertion was 16.9 (95 percent confidence interval, 10.5 to 27.0; P<0.001). However, the absolute risk of sudden death during any particular episode of vigorous exertion was extremely low (1 sudden death per 1.51 million episodes of exertion). Habitual vigorous exercise attenuated the relative risk of sudden death that was associated with an episode of vigorous exertion (P value for trend=0.006). The base-line level of exercise was not associated with the overall risk of subsequent sudden death.

Conclusions These prospective data from a study of U.S. male physicians suggest that habitual vigorous exercise diminishes the risk of sudden death during vigorous exertion. (N Engl J Med 2000;343:1355-61.)

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ly triggers and protects against sudd
ever, the role of vigorous exertion in
preventing sudden death has not be
spectively in a large number of subje
tive data compiled in the Physicians' H
sented a unique opportunity to de
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s exercise dimini

Physician Health Study
12 yrs, 21 481 male physicians
40 to 84 yrs old

METHODS

Physicians' Health S
scribed in detail elsewhere.[12] Briefly, 22,071
were from 40 to 84 years of age in 1982 an
myocardial infarction, stroke, transient ischem
were assigned to receive aspirin, beta caroten
to a randomized, placebo-controlled, two-
sign. At base line, the physicians complete
their cardiovascular risk factors, intake of sel
quency of vigorous exercise. In this investi
590 men who reported having angina or ha
onary revascularization, or for whom data
were missing, at base line, leaving 21,481 pa
population for the analysis.

Study Design

We used a nested case–crossover design to quantify the relative
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Frequency

Frequency of Vigorous Exertion at Base Line

At base line, the subjects were asked, "How often do you ex-

TABLE 2. EFFECT OF HABITUAL VIGOROUS EXERCISE ON THE RISK OF SUDDEN DEATH DURING VIGOROUS EXERTION.

FREQUENCY OF HABITUAL VIGOROUS EXERCISE	SUDDEN DEATHS		RELATIVE RISK (95% CI)*
	TOTAL	RELATED TO VIGOROUS EXERTION	
	no.		
<1 time/wk	32	3	74.1 (22.0–249)
1–4 times/wk	67	13	18.9 (10.2–35.1)
≥5 times/wk	23	7	10.9 (4.5–26.2)

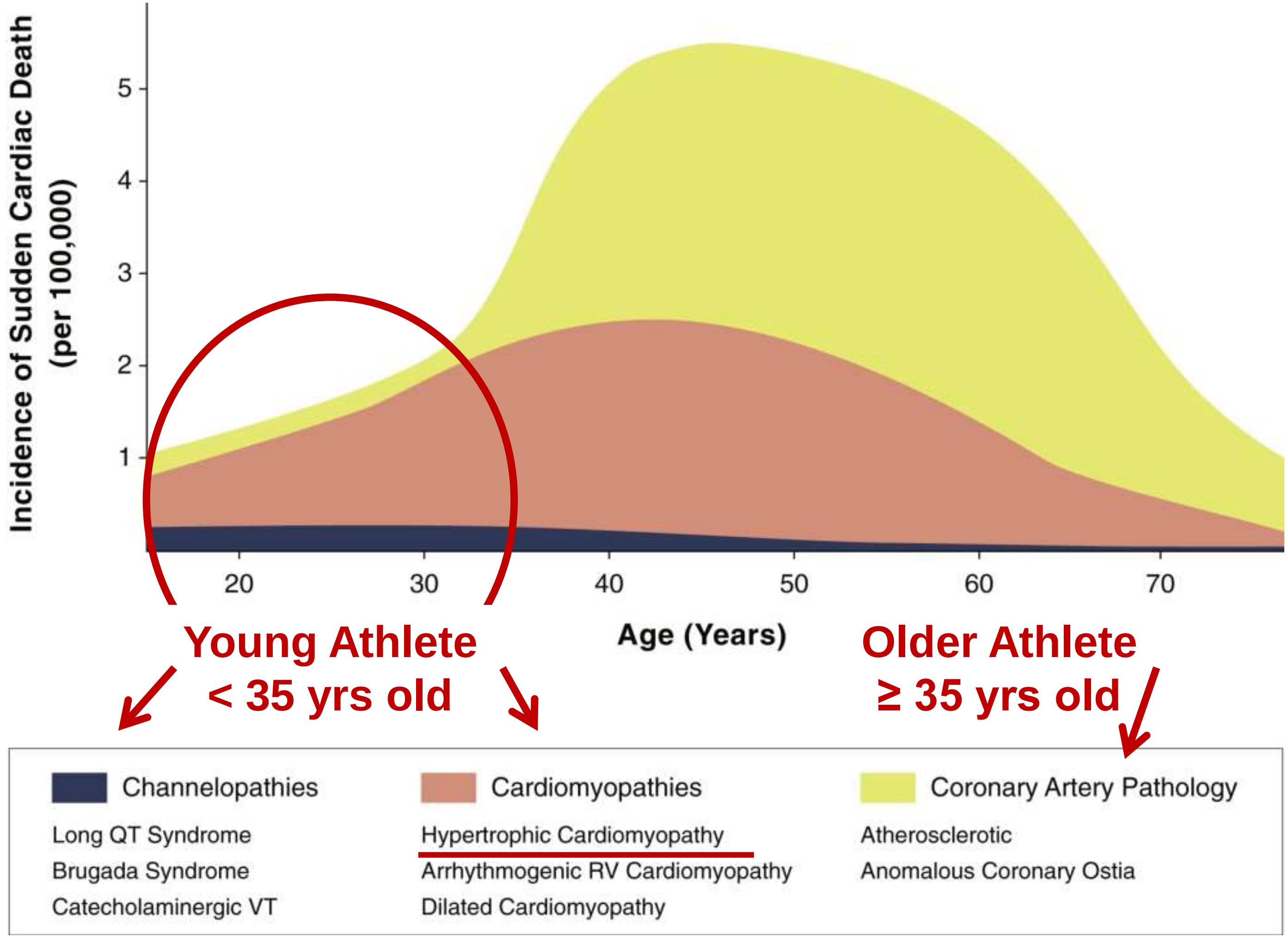
*The relative risk is the risk of sudden death during and 30 minutes after an episode of vigorous exertion, as compared with the risk during periods of lighter exertion or none. CI denotes confidence interval.

1. Relative risk of SD after vigorous exertion was 16.9
2. Absolute risk is v low 1 per 1.51 million

   - Sports Paradox
3. Habitual vigorous exercise attenuate the risk of SD

Absolute Risk of Acute Vigorous Intensity Exercise is Low

Study / Population	Prevalence of SCD and/or MI
Physicians' Health Study (men)	1 in every 1.5 million episodes of vigorous activity
Nurses' Health Study (women)	1 in every 36.5 million hours of moderate or vigorous exercise
Joggers in RI	1 death per 396,000 hours of jogging
YMCA participants	1 death per 2,897,057 person-hours of exercise
Marathon and half-marathon runners	0.20 cardiac arrests and 0.14 SCD per 100,00 runner-hours
Supervised Cardiac Rehabilitation Programs	1 cardiac arrest per 116,906 patient-hr, 1 fatality per 752,365 patient-hr, and 1 major complication per 81,670 patient-hr of exercise participation

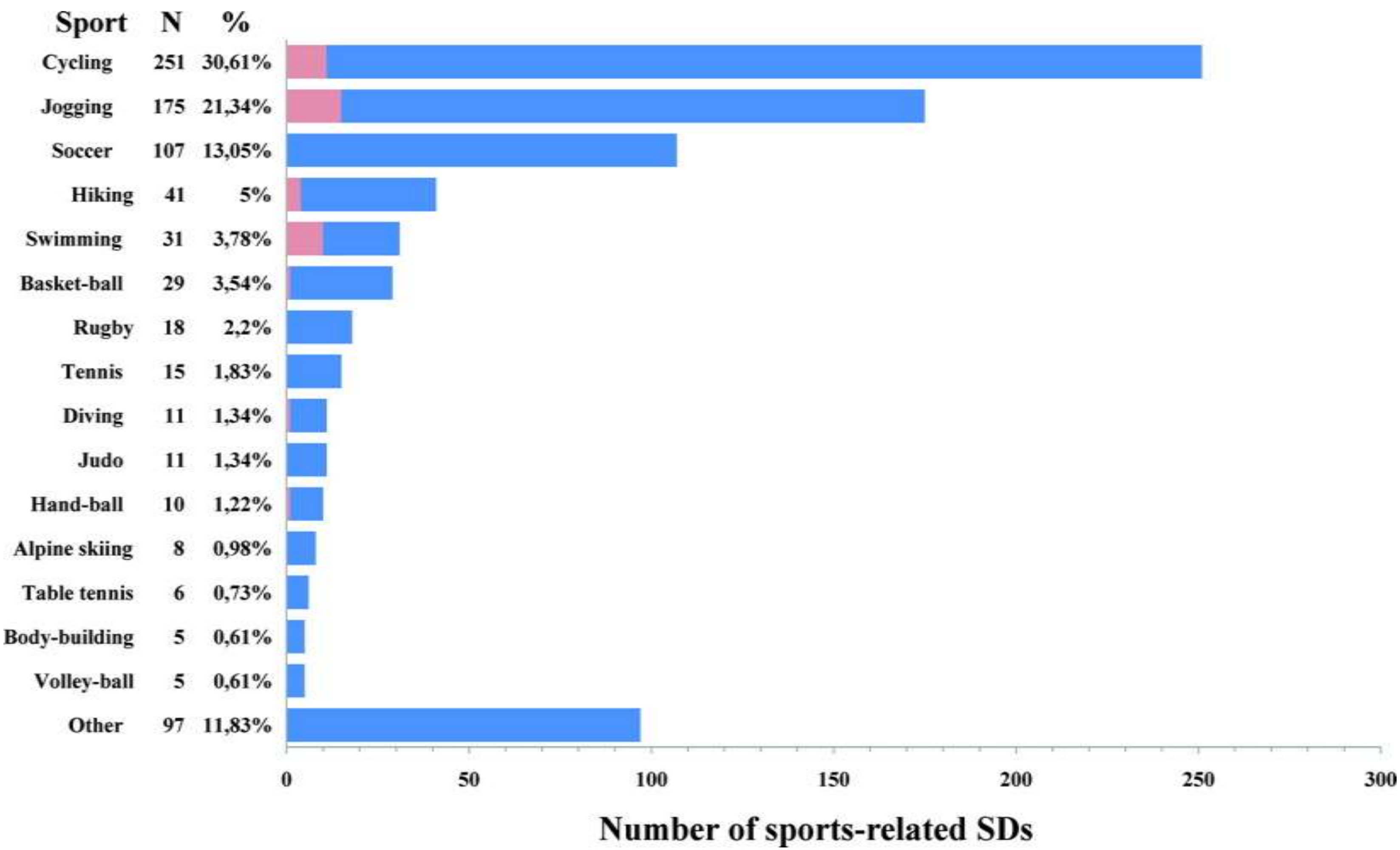


Hereditary causes of SCD occurs mainly in the young athletes, acquired CAD mainly in older athletes, but there is no absolute cut-offs.

Thus, athletes in their thirties and forties are at greatest risk of sudden cardiac death caused by both inherited and acquired causes.

J Am Coll Cardiol Img. 2013;6(9):993-1007. doi:10.1016/j.jcmg.2013.06.003

Sports engaged in at the time of sudden death (SD) in 820 sports participants.



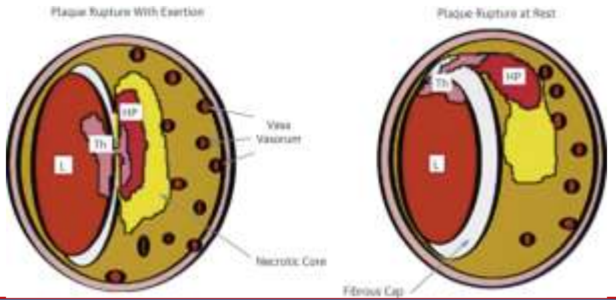
Eloi Marijon et al. Circulation. 2011;124:672-681

"Correct. And in the case of a cardiac arrest, every second counts. Who can tell me why? Anyone? Clock's ticking."

VT/VF is the final common pathway (so, exercise with AED nearby, within 3 mins ☺)

Possible triggers include:

1. Sympathetic activation
2. Electrolytes abnormalities
3. Haemostasis
4. Haemodynamic factors



Individualised Risk of SCD =

1. Desired exercise intensity **x**

	Subjective measures	Physiological measures	Absolute
Intensity	Talk Test	Maximal HR%	METs
Light	Talk and sing	<64	<3
Moderate	Talk but can't sing	64-76	3-6
Vigorous	Difficult talking	>76	>6

Predicted max HR = 220 - age

2. Number of CAD risk factors / underlying CVS disease/CAD equivalents (DM, PVD, Symptomatic carotid disease, Framingham risk score ≥20%) x
3. Male:female = 9:1 x
4. Age

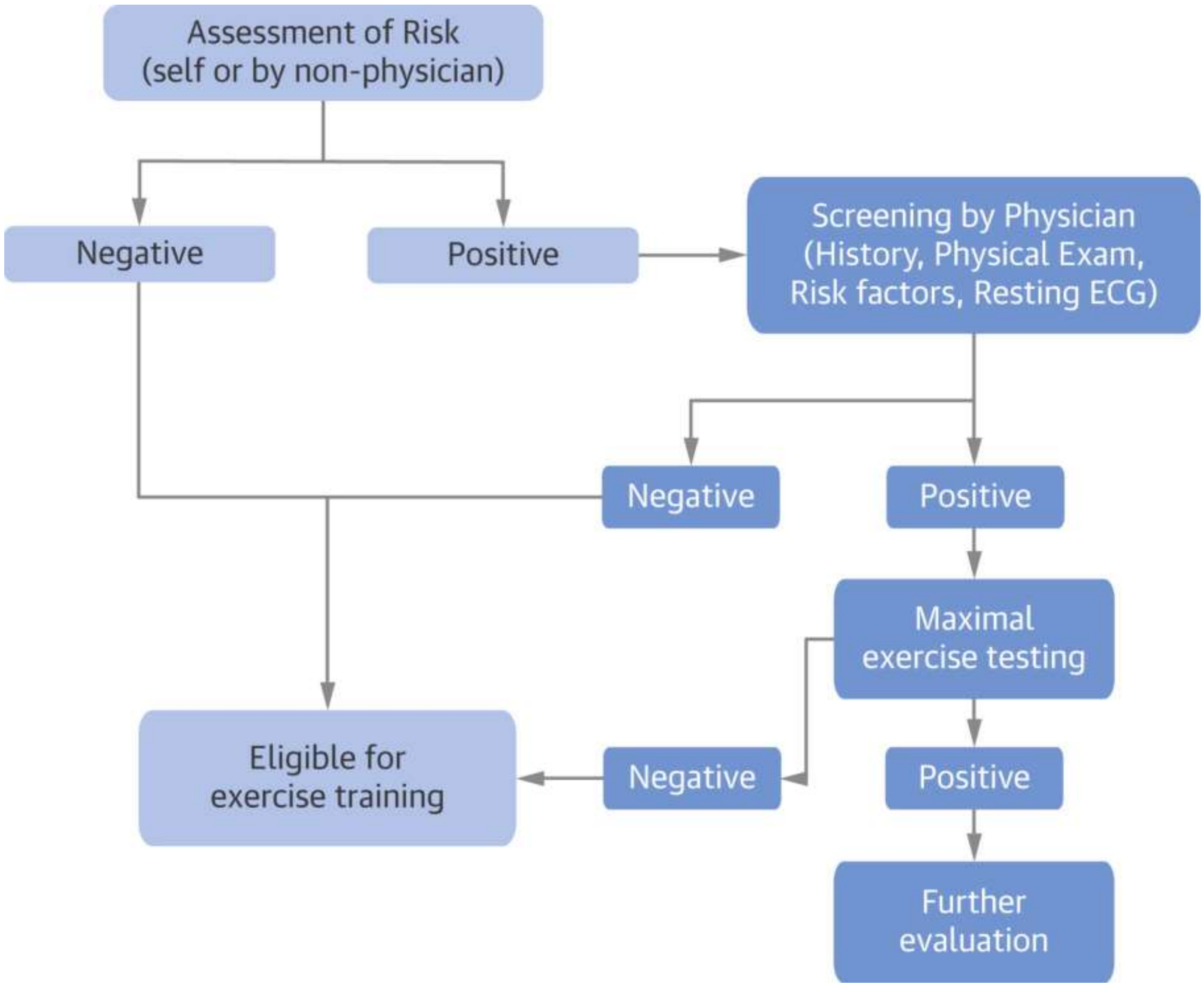
How can we prevent SCD during exercise?

1. Preparticipaton Screening
2. Eligibility for competition per established guidelines
3. Educating doctors
4. Educating athletes, laymen (bystander CPR)
5. Resus personel and equipments

ACSM /AHA : Exercuse and Acute Cardiovascular events: placing the risks into perspective. Med Sci Sports Exerc. 2007;39(5):886-97

Objective of Preparticipation Screening

- T*o identify and withdraw from intense exercise (eg weight loss program, loss to win) and competition* those perceived to be at risk in an effort to reduce likelihood of SCD and to allow preventive interventions.
- *.. Predicated on the likelihood that intense exercise increases risk of SCD…*
- Universal consensus that some kind of PPS is necessary, question is what?



Clinical approach to PPS and CVS risk reduction in exercise: Greatest utility in the previously sedentary individual

PAR-Q

TABLE 1. Revised Physical Activity Readiness Questionnaire (PAR-Q)

Yes	No	
______	______	1. Has a doctor ever said that you have a heart condition and recommended only medically supervised activity?
______	______	2. Do you have chest pain brought on by physical activity?
______	______	3. Have you developed chest pain in the past month?
______	______	4. Have you on 1 or more occasions lost consciousness or fallen over as a result of dizziness?
______	______	5. Do you have a bone or joint problem that could be aggravated by the proposed physical activity?
______	______	6. Has a doctor ever recommended medication for your blood pressure or a heart condition?
______	______	7. Are you aware, through your own experience or a doctor's advice, of any other physical reason that would prohibit you from exercising without medical supervision?

If you answered "yes" to any of these questions, call your personal physician or healthcare provider before increasing your physical activity.

Adapted from Shephard et al[26] and Thomas et al.[28]

Step 1. Self Assessment of Risk

Balady et al Circulation 1998;97:2283-93

TABLE 2. AHA/ACSM Health/Fitness Facility Preparticipation Screening Questionnaire

Assess your health needs by marking all *true* statements.

History

You have had:

____ a heart attack
____ heart surgery
____ cardiac catheterization
____ coronary angioplasty (PTCA)
____ pacemaker/implantable cardiac defibrillator/rhythm disturbance
____ heart valve disease
____ heart failure
____ heart transplantation
____ congenital heart disease

If you marked any of the statements in this section, consult your healthcare provider before engaging in exercise. You may need to use a facility with a medically qualified staff.

Symptoms

____ You experience chest discomfort with exertion.
____ You experience unreasonable breathlessness.
____ You experience dizziness, fainting, blackouts.
____ You take heart medications.

Other health issues:

____ You have musculoskeletal problems.
____ You have concerns about the safety of exercise.
____ You take prescription medication(s).
____ You are pregnant.

Cardiovascular risk factors

____ You are a man older than 45 years.
____ You are a woman older than 55 years or you have had a hysterectomy or you are postmenopausal.
____ You smoke.
____ Your blood pressure is >140/90.
____ You don't know your blood pressure.
____ You take blood pressure medication.
____ Your blood cholesterol level is >240 mg/dL.
____ You don't know your cholesterol level.
____ You have a close blood relative who had a heart attack before age 55 (father or brother) or age 65 (mother or sister).
____ You are diabetic or take medicine to control your blood sugar.
____ You are physically inactive (ie, you get <30 minutes of physical activity on at least 3 days per week).
____ You are >20 pounds overweight.

If you marked 2 or more of the statements in this section, consult your healthcare provider before engaging in exercise. You might benefit by using a facility with a professionally qualified exercise staff to guide your exercise program.

____ None of the above is true.

You should be able to exercise safely without consulting your healthcare provider in almost any facility that meets your exercise program needs.

AHA/ACSM indicates American Heart Association/American College of Sports Medicine.

AHA recommends
- Hx
- PE

(1996, 2007, 2014)

American Heart Association
Learn and Live

Basic Hx and PE are still key

Table 1. The 14-Element AHA Recommendations for Preparticipation Cardiovascular Screening of Competitive Athletes

Medical history*

Personal history

1. Chest pain/discomfort/tightness/pressure related to exertion
2. Unexplained syncope/near-syncope†
3. Excessive 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

8. Premature death (sudden and unexpected, or otherwise) before 50 y of age 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 genetic cardiac conditions in family members

Physical examination

11. Heart murmur‡
12. Femoral pulses to exclude aortic coarctation
13. Physical stigmata of Marfan syndrome
14. Brachial artery blood pressure (sitting position)§

Table 2. Preparticipation Athletic Screening and Athletic Restriction in Italy, the United States, and Israel

Country	Years	Screening	Initial	Examiners	Sudden Death
Italy[6]	1981–2008	Mandatory	History, PE, ECG, ETT	Sports medicine MD	Decrease
United States[30]	1985–2006	Recommended	History, PE	MD and non-MD	No decrease
Israel[26]	1985 to 2009	Mandatory	History, PE, ECG, ETT	Certified MD	No decrease

PE indicates physical examination; ETT, exercise tolerance test.

No Consensus on the screening ECG
- To mandate or not to mandate?

Values of ECG

- Gold standard for detection of WPW, ion-channelopathies eg long and short QT syndrome, Brugada syndrome
- True positives – 95% of HCM, 80% ARVD, 85% Long QT syndrome, Brugada syndrome.
- High negative predictive value (99%) in excluding cardiomyopathy
- Increase the sensitivity of detection of lethal CVS conditions

Limitations of ECG

- False negatives
  - Miss congenital coronary anomalies and premature CAD
  - Miss intermittent QT prolongation, concealed WPW, some HCM / ARVDs
- High false positives (20%) in athletes
  - Training-related physiological ECG changes mimic pathological changes
  - Leads to more unneccessary investigations and more costs
  - Recent Guidelines on ECG interpretations in Athletes (Seattle and Refined Criterias in Athlete) reduces false positives to <6% (http://learning.bmj.com/ECGathlete)

FOC!! ☺

Population wide screening ECG is not cost effective due to low prevalence rate of SCD

- Italy state sponsored, 30 euros pp
  - Screen 1 million young athletes to save 36 lives
  - **1 million euros to save 1 life**
- USA (assuming 10 million athletes, prevelence 1.8/10000)
  - **USD $3.4 million to prevent 1 death**
- Independent self financed sports organisations
  - eg. NBA, singapore sports school, FAS

Interassociation Consensus Statement on Cardiovascular Care of College Student-Athletes

NCAA guidelines 18 April 2016

Brian Hainline, MD,[a] Jc ... n, MD,[b]
Michael S. Emery, MD,[d] Robert J. Myerburg, MD,[e] Eduardo Sanchez, MD, MPH,[f] Silvana Molossi, MD, PhD,[g]
John T. Parsons, PhD, ATC,[a] Paul D. Thompson, MD[h]

ABSTRACT

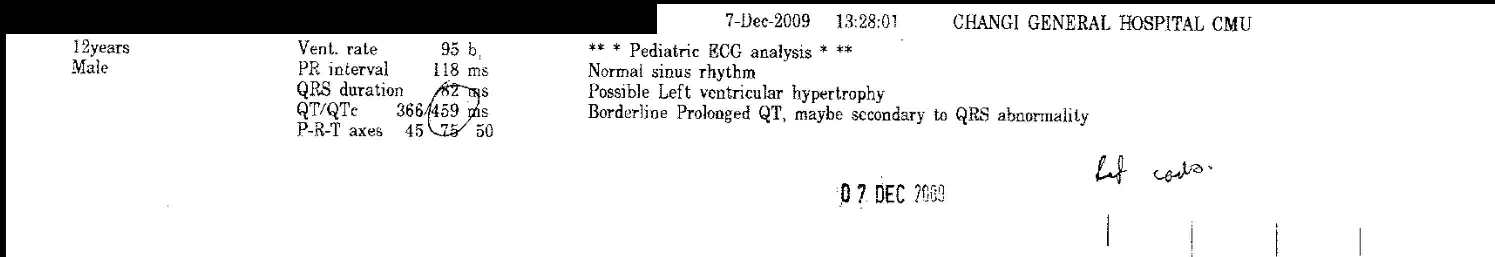
Cardiovascular evaluation and care of college student-
medical communities. Emerging strategies include scre
permissible levels of participation by athletes with iden
unanticipated cardiac events in athletic venues. The p
screening with or without advanced cardiac screening.
disciplinary task force to address cardiovascular concer
interassociation statement. This document summarizes
includes available evidence on cardiovascular risk, pre-
cardiac arrest. Future recommendations for cardiac res
provided. (J Am Coll Cardiol 2016;■:■-■) © 2016 by

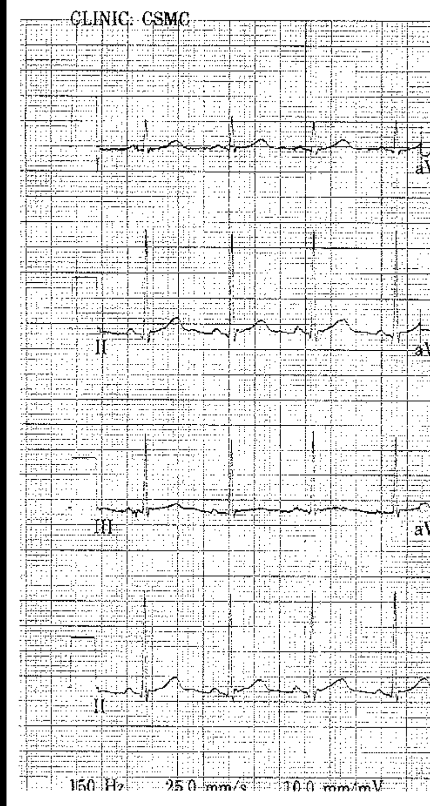
1. All NCAA member schools must have and practice **a response plan** to aid a victim of cardiac arrest in both competition and practice settings.

2. The team physician should review or conduct the sports physical.

3. Said sports physical should include the AHA's 14-point cardiac health questionnaire and a physical exam.

4. **If the screening ECG is used, it should be interpreted with modern standards.**





Sokolow Criterias for LVH

-> 35 mm if > 40 yrs

-> 40 mm if 30 -40 yrs

-> 60 mm if 16 -30 yrs

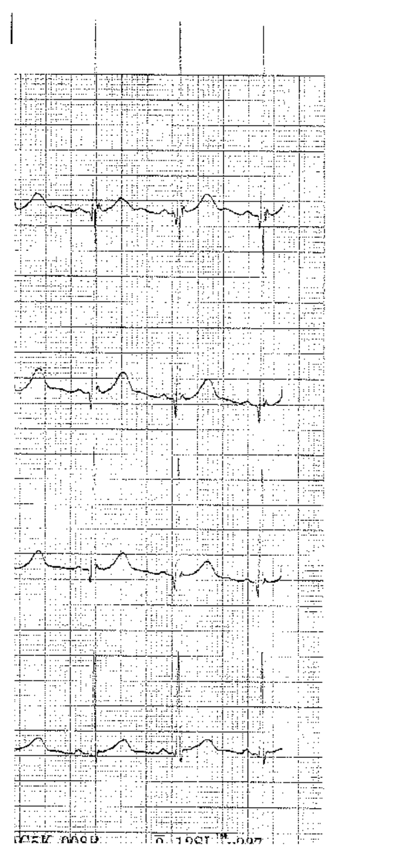
Cornell Criteria (most accurate)

-R aVL + S V3

->28 in males

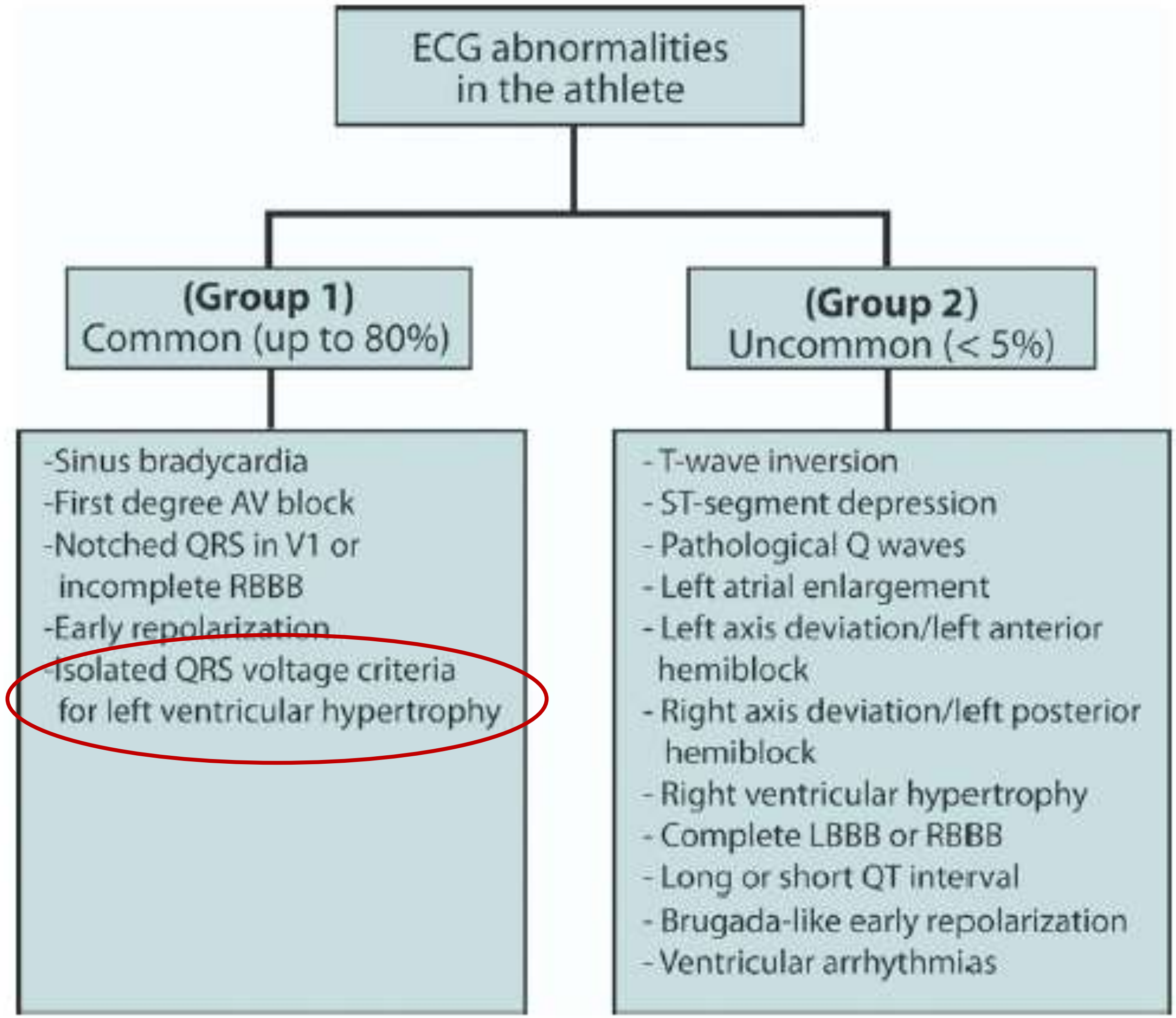
->20 in females

Look for associated left atrial enlargement, left axis deviation, repolarisation abnormalities ST-T changes, pathological Q waves



S V1 + R V5 or V6 = 10 + 36 = 46 mm (?LVH)

ESC criteria 2010



Seattle Criterias 2013

Box 1 Normal ECG findings in athletes

1. Sinus bradycardia (≥ 30 bpm)
2. Sinus arrhythmia
3. Ectopic atrial rhythm
4. Junctional escape rhythm
5. 1° AV block (PR interval > 200 ms)
6. Mobitz Type I (Wenckebach) 2° AV block
7. Incomplete RBBB
8. Isolated QRS voltage criteria for LVH
   - *Except*: QRS voltage criteria for LVH occurring with any non-voltage criteria for LVH such as left atrial enlargement, left axis deviation, ST segment depression, T-wave inversion or pathological Q waves
9. Early repolarisation (ST elevation, J-point elevation, J-waves or terminal QRS slurring)
10. Convex ('domed') ST segment elevation combined with T-wave inversion in leads V1–V4 in black/African athletes

These common training-related ECG alterations are physiological adaptations to regular exercise, considered normal variants in athletes and do not require further evaluation in asymptomatic athletes.

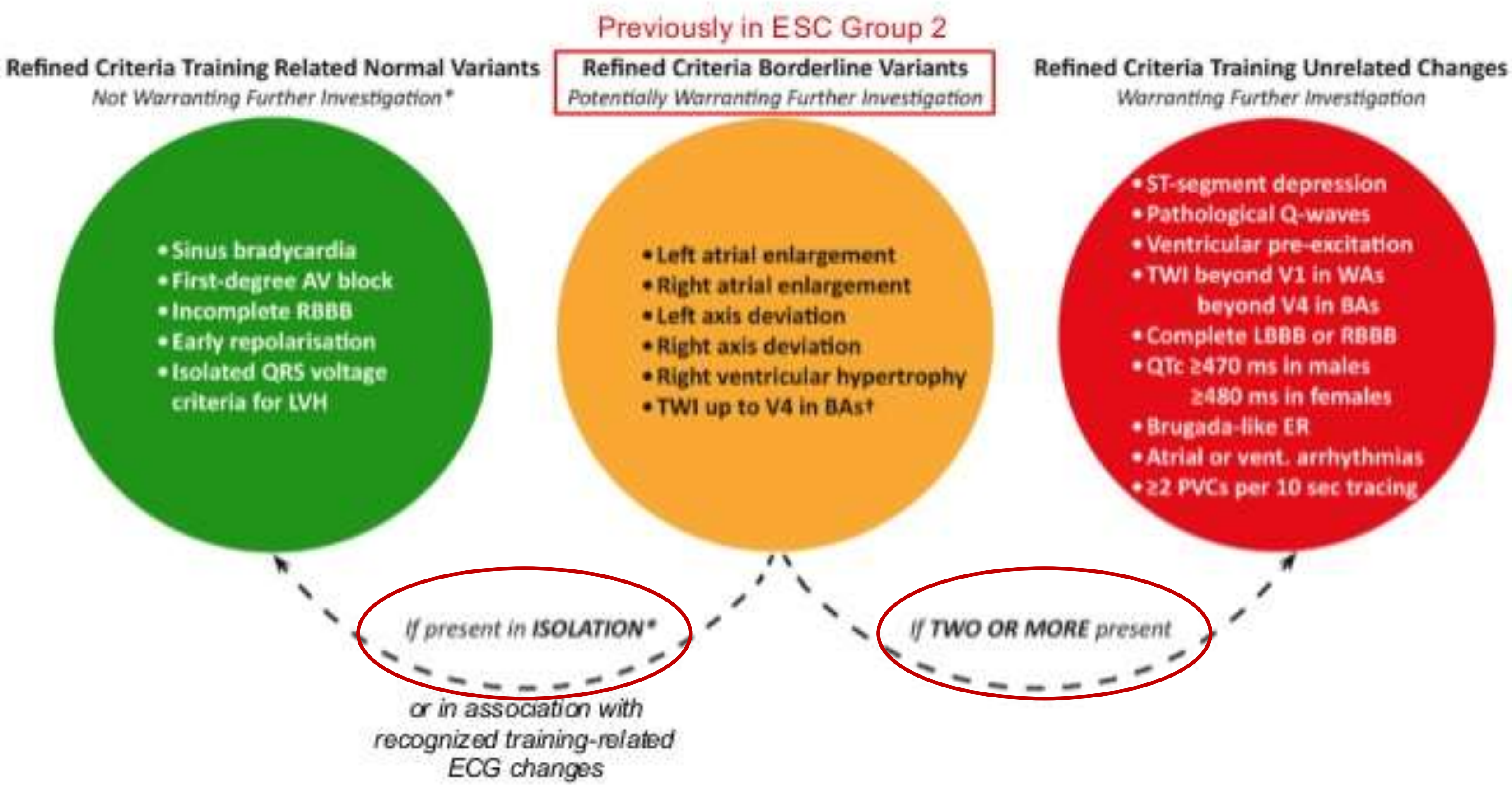
AV, atrioventricular; bpm, beats per minute; LVH, left ventricular hypertrophy; ms, milliseconds; RBBB, right bundle branch block.

Table 1 Abnormal ECG findings in athletes

Abnormal ECG finding	Definition
T-wave inversion	>1 mm in depth in two or more leads V2–V6, II and aVF, or I and aVL (excludes III, aVR and V1)
ST segment depression	≥0.5 mm in depth in two or more leads
Pathologic Q waves	>3 mm in depth or >40 ms in duration in two or more leads (except for III and aVR)
Complete left bundle branch block	QRS ≥120 ms, predominantly negative QRS complex in lead V1 (QS or rS), and upright monophasic R wave in leads I and V6
Intraventricular conduction delay	Any QRS duration ≥140 ms
Left axis deviation	−30° to −90°
Left atrial enlargement	Prolonged P wave duration of >120 ms in leads I or II with negative portion of the P wave ≥1 mm in depth and ≥40 ms in duration in lead V1
Right ventricular hypertrophy pattern	R−V1+S−V5>10.5 mm *AND* right axis deviation >120°
Ventricular pre-excitation	PR interval <120 ms with a delta wave (slurred upstroke in the QRS complex) and wide QRS (>120 ms)
Long QT interval*	QTc≥470 ms (male) QTc≥480 ms (female) QTc≥500 ms (marked QT prolongation)
Short QT interval*	QTc≤320 ms
Brugada-like ECG pattern	High take-off and downsloping ST segment elevation followed by a negative T wave in ≥2 leads in V1–V3
Profound sinus bradycardia	<30 BPM or sinus pauses ≥ 3 s
Atrial tachyarrhythmias	Supraventricular tachycardia, atrial-fibrillation, atrial-flutter
Premature ventricular contractions	≥2 PVCs per 10 s tracing
Ventricular arrhythmias	Couplets, triplets and non-sustained ventricular tachycardia

Note: These ECG findings are unrelated to regular training or expected physiological adaptation to exercise, may suggest the presence of pathological cardiovascular disease, and require further diagnostic evaluation.
*The QT interval corrected for heart rate is ideally measured with heart rates of 60–90 bpm. Consider repeating the ECG after mild aerobic activity for borderline or abnormal QTc values with a heart rate <50 bpm.

The Refined ECG Criteria



Sheikh et al, *Circulation* 2014;**129**:1637-49

Table 6. Sensitivity and Specificity of the Screening Process Using Different ECG Criteria to Detect Major Cardiac Abnormalities Only (95% Confidence Interval)

	Black Athletes (n=805)			White Athletes (n=2282)		
	European Society of Cardiology	Seattle Criteria	Refined Criteria	European Society of Cardiology	Seattle Criteria	Refined Criteria
Sensitivity, %	100 (39.8–100)	100 (39.8–100)	100 (39.8–100)	100 (71.5–100)	100 (71.5–100)	100 (71.5–100)
Specificity, %	40.1 (36.7–43.6)	79.3 (76.3–82.0)	84.2 (81.4–86.6)	73.5 (71.7–75.3)	92.1 (91.0–93.2)	93.9 (92.9–94.9)
Positive predictive value, %	0.8 (0.2–2.1)	2.4 (0.6–5.9)	3.1 (0.8–7.7)	1.8 (0.9–3.2)	5.9 (3.0–10.2)	7.4 (3.8–12.9)
Negative predictive value, %	100 (98.9–100)	100 (99.4–100.0)	100 (99.5–100)	100 (99.8–100)	100 (99.8–100)	100 (99.8–100)
False-positive rate, %	59.9	20.7	15.8	26.5	7.9	6.1
False-negative rate, %	0.0	0.0	0.0	0.0	0.0	0.0

Refined Criteria is best for now!

Screening Echo in Athletes

- Issues:
  - 10X more expensive than ECG (S$350), greater cost-effectiveness issue than ECG
  - Limitations:
    - **False Positive**
      - **Differentiation between athlete's heart and mild dCMP or HCM**
    - **False Negative**
      - **<14 yrs old patients with HCM**
  - Values, mainly in young athletes:
    - identify coronary anomalies
    - imaging modality of choice in detection of HCM (only 5%)
- Potential role of cheaper abbreviated 5 –min echo

PPS for the Older Athletes

- Focus on detection of CAD
- Resting 12 lead ECG is inaccurate in detecting CAD.
- Role of screening treadmill test
  - who needs it?
  - Limitations of treadmill test in asymptomatic individual

Typical profile of middle-aged SCD during Marathon

- Asymptomatic
- Male (male: female = 9:1)
- No prior documentation of heart disease
- Cardiac arrest due to VF
- Post-mortem : obstructive epicardial
- coronary plaques in 71 – 87%
- 1 mile away from finishing line

Limitations of Screening Exercise Testing

- Good prognostic value in symptomatic patients
- Low sensitivity and specificity, poor positive predictive value and high false positives in prediction of exercise-related MI and SD in asymptomatic individuals due to low event rates

Symptomatic	Sens 68%	Spec 77%
Asymptomatic	Sens 46%	Spec 16%

- False negative

Treadmill testing ≠ marathon/triathlon

- Prevalence rate of SCD in marathons/triathlons is too low to warrant routine screening

Other reasons for exercise testing

TABLE 2. Nonelectrocardiographic Exercise Test Variables of Prognostic Value in Asymptomatic Subjects

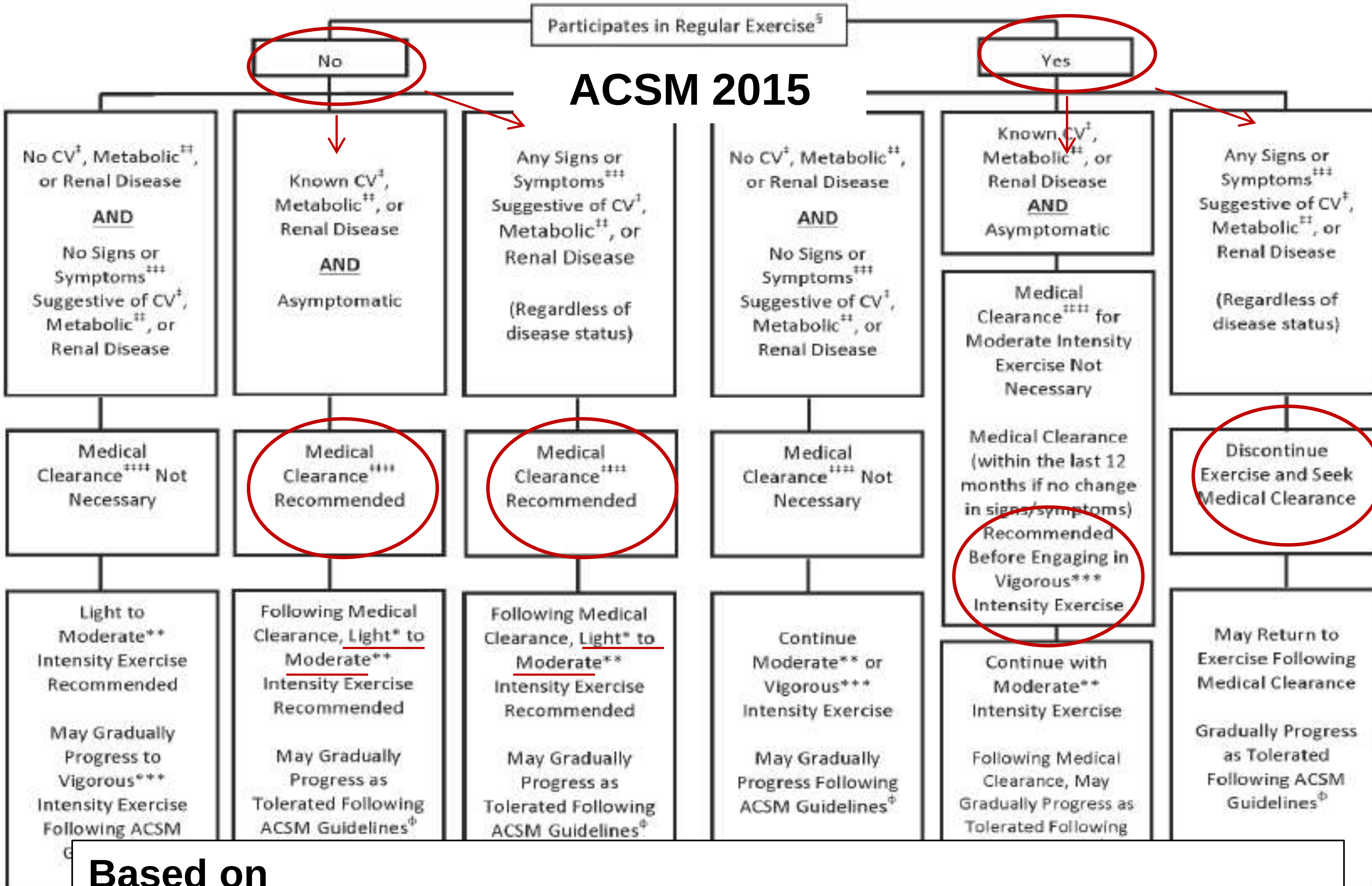
Exercise Test Variable	Method of Measurement	High-Risk Values and Remarks
Exercise capacity	Estimated according to protocol[51]	No widely accepted abnormal values for asymptomatic subjects Some derive abnormal values based on age and sex[20,28] Some advocate cutoff values of <5 METs, 5–8 METs, and >8 METs[31]
Chronotropic response	Peak HR	
	Achievement of target HR based on age[40]	85% of (220−age)
	Proportion of HR reserve used[32]	(Peak HR−resting HR)/(220−age−resting HR) Value of ≤0.80 higher risk[32]
HR recovery	Difference between HR at peak exercise and 1 or 2 min later[20,30,37]	Peak HR−HR 1 or 2 min later Abnormal value of ≤12 bpm after 1-min recovery based on use of a cool-down period[20]

All references based on studies that focused on asymptomatic subjects.

Indications for ETT that are not related to prediction of MI or SD

- Exericse prescripton
- Exercise related arrhythmias, abnormal BP responses
- Reassurance from normal test might encourage more vigorous exercise
- Intensify risk factors control if ETT suggests increased risk of all cause death

ACSM 2015



Based on

1. **current level of physical activity**
2. **Desired exercise intensity**
3. **Presence of signs or symptoms or/and known CVS, metabolic and renal disease**

TABLE 2.2. Atherosclerotic Cardiovascular Disease (CVD) Risk Factors and Defining Criteria (26,31)

Risk Factors	Defining Criteria
Age	Men ≥45 yr; women ≥55 yr (12)
Family history	Myocardial infarction, coronary revascularization, or sudden death before 55 yr in father or other male first-degree relative or before 65 yr in mother or other female first-degree relative
Cigarette smoking	Current cigarette smoker or those who quit within the previous 6 mo or exposure to environmental tobacco smoke
Sedentary lifestyle	Not participating in at least 30 min of moderate intensity, physical activity (40%–<60% $\dot{V}O_2R$) on at least 3 d of the week for at least 3 mo (22,30)
Obesity	Body mass index ≥30 kg · m^{-2} *or* waist girth >102 cm (40 in) for men and >88 cm (35 in) for women (10)
Hypertension	Systolic blood pressure ≥140 mm Hg and/or diastolic ≥90 mm Hg, confirmed by measurements on at least two separate occasions, *or* on antihypertensive medication (9)
Dyslipidemia	Low-density lipoprotein (LDL) cholesterol ≥130 mg · dL^{-1} (3.37 mmol · L^{-1}) *or* high-density lipoprotein[b] (HDL) cholesterol <40 mg · dL^{-1} (1.04 mmol · L^{-1}) *or* on lipid-lowering medication. If total serum cholesterol is all that is available, use ≥200 mg · dL^{-1} (5.18 mmol · L^{-1}) (21)
Prediabetes[a]	Impaired fasting glucose (IFG) = fasting plasma glucose ≥100 mg · dL^{-1} (5.55 mmol · L^{-1}) and ≤125 mg · dL^{-1} (6.94 mmol · L^{-1}) *or* impaired glucose tolerance (IGT) = 2 h values in oral glucose tolerance test (OGTT) ≥140 mg · dL^{-1} (7.77 mmol · L^{-1}) and ≤199 mg · dL^{-1} (11.04 mmol · L^{-1}) confirmed by measurements on at least two separate occasions (5)
Negative Risk Factors	**Defining Criteria**
High-density lipoprotein (HDL) cholesterol	≥60 mg · dL^{-1} (1.55 mmol · L^{-1})

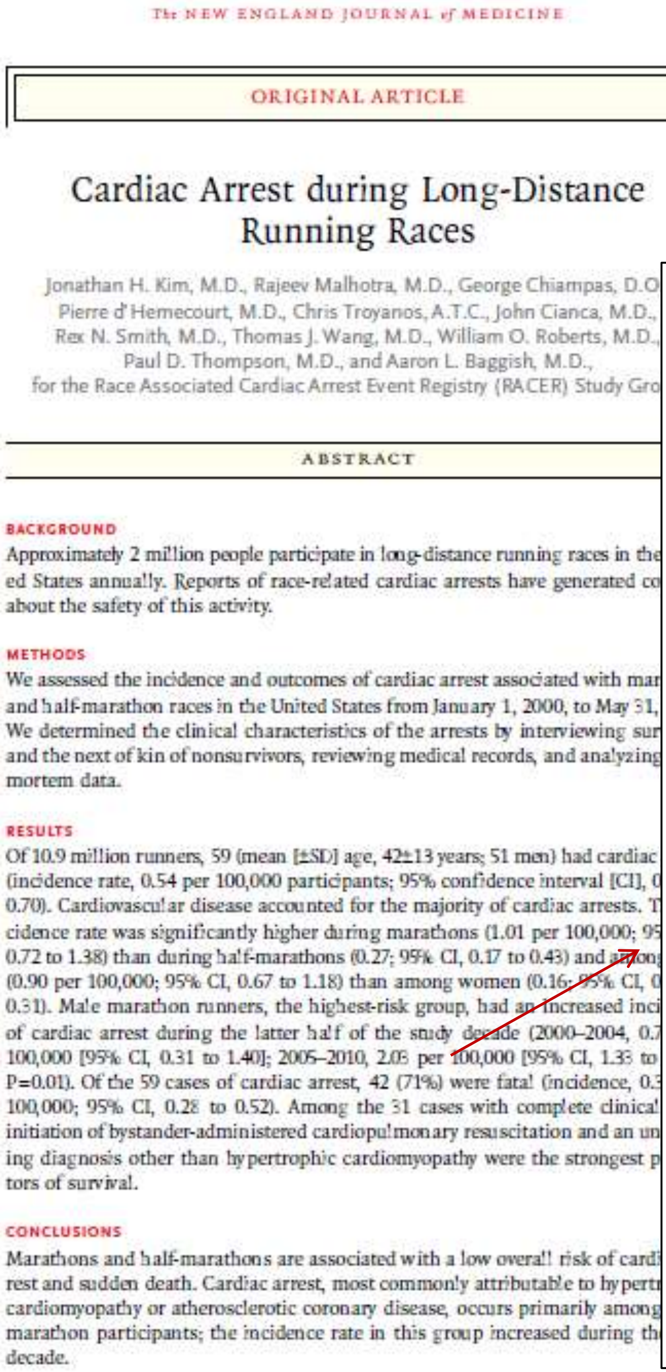
[a]If the presence or absence of a CVD risk factor is not disclosed or is not available, that CVD risk factor should be counted as a risk factor except for prediabetes. If the prediabetes criteria are missing or unknown, prediabetes should be counted as a risk factor for those ≥45 yr, especially for those with a body mass index (BMI) ≥25 kg · m^{-2}, and those <45 yr with a BMI ≥25 kg · m^{-2} and additional CVD risk factors for prediabetes. The number of positive risk factors is then summed.

[b]High HDL is considered a negative risk factor. For individuals having high HDL ≥60 mg · dL^{-1} (1.55 mmol · L^{-1}), for these individuals one positive risk factor is subtracted from the sum of positive risk factors.

$\dot{V}O_2R$, oxygen uptake reserve.

Who are considered high CVS risk?

1. Known CVS, renal and metabolic disease (ACSM)
2. CAD equivalents (NCEP)
   1. DM
   2. PVD
   3. Symptomatic carotid disease
   4. Framingham risk score ≥20%
3. Master Athletes ≥ 65yrs
4. Master Athletes male>40yrs, female>50 yrs with ≥ 1 risk factor
5. Multiple risk factors
6. Anyone with symptoms


The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Cardiac Arrest during Long-Distance Running Races

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Paul D. Thompson, M.D., and Aaron L. Baggish, M.D.,
for the Race Associated Cardiac Arrest Event Registry (RACER) Study Gro

ABSTRACT

BACKGROUND
Approximately 2 million people participate in long-distance running races in the
ed States annually. Reports of race-related cardiac arrests have generated co
about the safety of this activity.

METHODS
We assessed the incidence and outcomes of cardiac arrest associated with mar
and half-marathon races in the United States from January 1, 2000, to May 31,
We determined the clinical characteristics of the arrests by interviewing sur
and the next of kin of nonsurvivors, reviewing medical records, and analyzing
mortem data.

RESULTS
Of 10.9 million runners, 59 (mean [±SD] age, 42±13 years; 51 men) had cardiac
(incidence rate, 0.54 per 100,000 participants; 95% confidence interval [CI], 0
0.70). Cardiovascular disease accounted for the majority of cardiac arrests. T
cidence rate was significantly higher during marathons (1.01 per 100,000; 95
0.72 to 1.38) than during half-marathons (0.27; 95% CI, 0.17 to 0.43) and among
(0.90 per 100,000; 95% CI, 0.67 to 1.18) than among women (0.16; 95% CI, 0
0.31). Male marathon runners, the highest-risk group, had an increased inci
of cardiac arrest during the latter half of the study decade (2000–2004, 0.7
100,000 [95% CI, 0.31 to 1.40]; 2005–2010, 2.03 per 100,000 [95% CI, 1.33 to
P=0.01). Of the 59 cases of cardiac arrest, 42 (71%) were fatal (incidence, 0.3
100,000; 95% CI, 0.28 to 0.52). Among the 31 cases with complete clinical
initiation of bystander-administered cardiopulmonary resuscitation and an un
ing diagnosis other than hypertrophic cardiomyopathy were the strongest p
tors of survival.

CONCLUSIONS
Marathons and half-marathons are associated with a low overall risk of card
rest and sudden death. Cardiac arrest, most commonly attributable to hypert
cardiomyopathy or atherosclerotic coronary disease, occurs primarily among
marathon participants; the incidence rate in this group increased during th
decade.

Effectiveness of CPR and AEDs in a collapsed athlete

Results:

Of 10.9 million runners, 59 cardiac arrest (incidence rate 0.54 per 100000 participants).

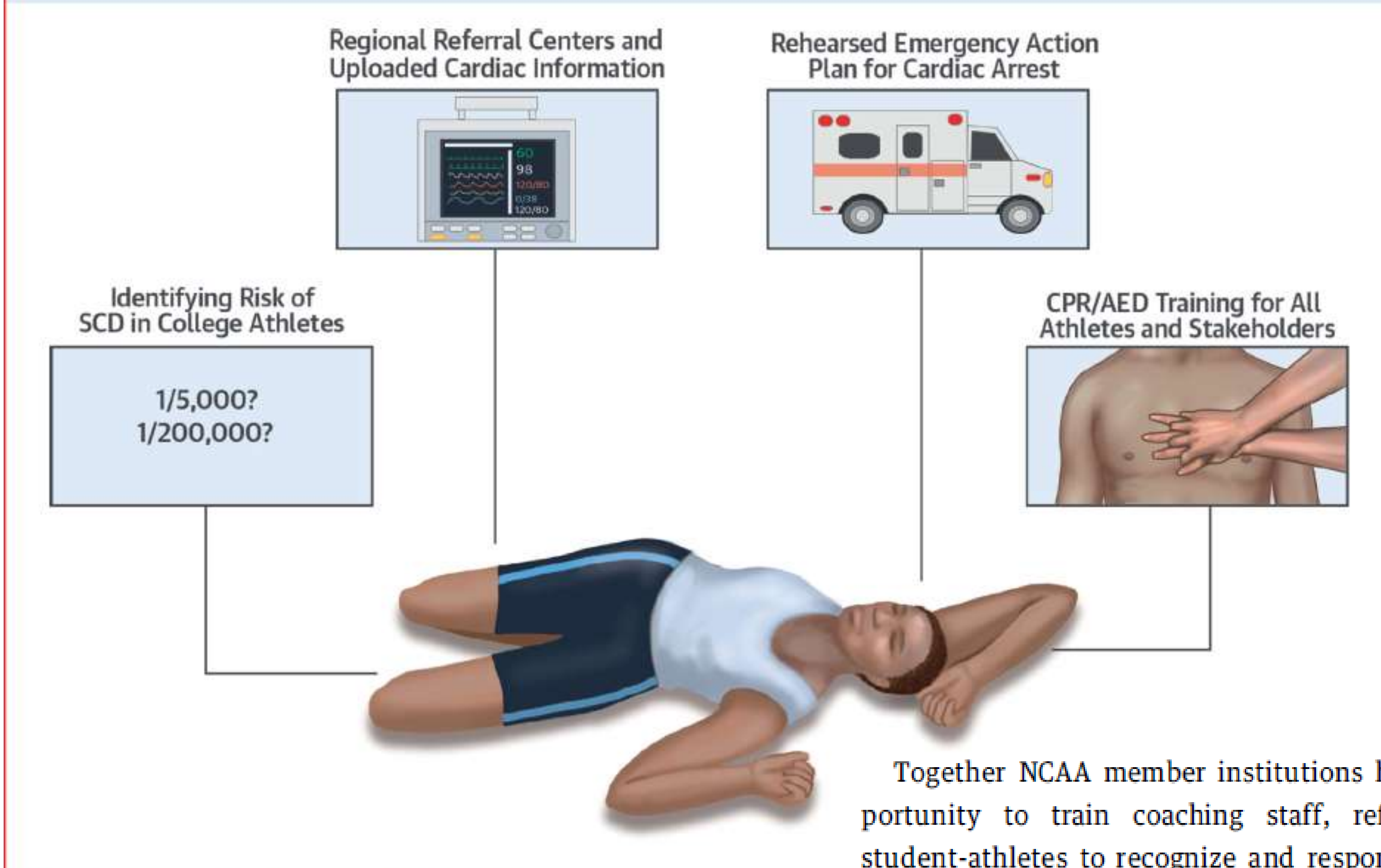
.. **Incidence rate significantly higher during marathons than half-marathons (1.01 vs 0.27).. among men than women (0.9 vs 0.16 per 100000)..**

.. **Initiation of bystander CPR and an underlying diagnosis other than hypertrophic CMP were the strongest predictors of survival.**

Conclusions:

Marathons and half marathons are a/w low risk of SCA. .. Occurs primarily in male marathon participants; **the incidence rate in this group has increased during past decade (0.71 to 2.03 per 100000, p =0.01).**

CENTRAL ILLUSTRATION A Summary of Cardiovascular Priorities in Collegiate Student-Athletes



Hainline, B. et al. J Am Coll Cardiol. 2016;■(■):■-■.

vascular priorities in college student-athletes range from more accurately defining the risk of S

plans. AED = automated external defibrillator; CPR = cardiopulmonary resuscitation; SCD =

Together NCAA member institutions have an opportunity to train coaching staff, referees, and student-athletes to recognize and respond to a cardiac emergency on the field and in the community and to become CPR ambassadors between the athletic programs and the larger student population. Management of cardiac arrest with prompt recognition, early activation of the emergency response system, early CPR, and early use of an AED provides the best chance of survival (Central Illustration).

18 April 2016

Eligibility Recommendations for Competitive Sports in Athletes with CVS abnormalities

Recommendations for competitive sports participation in athletes with cardiovascular disease

A consensus document from the Study Group of Sports Cardiology of the Working Group of Cardiac Rehabilitation and Exercise Physiology and the Working Group of Myocardial and Pericardial Diseases of the European Society of Cardiology

BETHESDA CONFERENCE REPORT

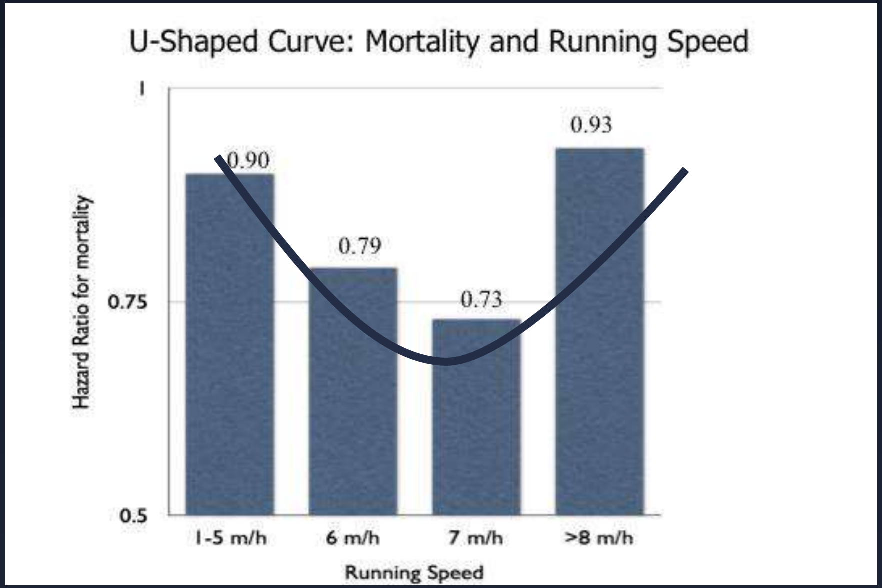
36th Bethesda Conference: Eligibility Recommendations for Competitive Athletes With Cardiovascular Abnormalities

Classification of sports

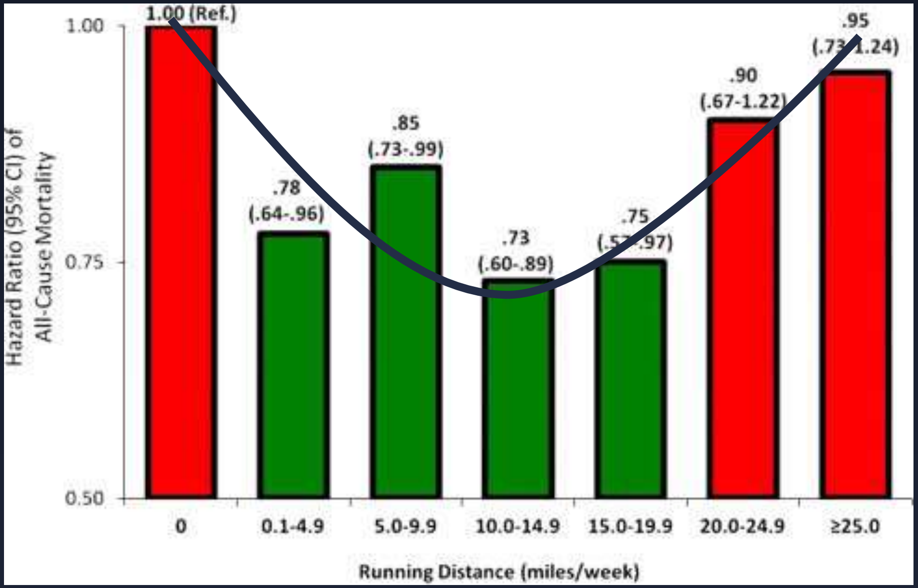
Increasing static component ↑	A. Low (<40 percent Max O_2)	B. Moderate (40-70 percent Max O_2)	C. High (>70 percent Max O_2)
III. High (>50 percent MVC)	Bobsledding/luge*• Field events (throwing) Gymnastics*• Martial arts* Sailing Sport climbing Water skiing*• Weight lifting*• Windsurfing*•	Body building*• Downhill skiing*• Skateboarding*• Snowboarding*• Wrestling*	Boxing* Canoeing/Kayaking Cycling*• Decathlon Rowing Speed-skating*• Triathlon*•
II. Moderate (20-50 percent MVC)	Archery Auto racing*• Diving*• Equestrian*• Motorcycling*•	American football* Field events (jumping) Figure skating* Rodeoing*• Rugby* Running (sprint) Surfing*• Synchronized swimming•	Basketball* Ice hockey* Cross-country skiing (skating technique) Lacrosse* Running (middle distance) Swimming Team handball
I. Low (<20 percent MVC)	Billiards Bowling Cricket Curling Golf Riflery	Baseball/softball* Fencing Table tennis Volleyball	Badminton Cross-country skiing (classic technique) Field hockey* Orienteering Race walking Racqetball/squash Running (long distance) Soccer* Tennis

Increasing dynamic component →

Benefits of exercise negated at
> 7 miles (11.2km) /hr



Benefits of exercise negated at
> 20 miles (32 km) /wk



n= 52000, fu 30 yrs
19% mortality reduction in 14000 runners

Lee DC, Blair SN et al. Med & Science in Sports & Exercise 2012;44(5):S699

Changi General Hospital

‘The right amount of nourishment and exercise, not too much, not too little, is the safest way to health’

HIPPOCRATES (460 -377 BC)
Father of Medicine
Contemporary of Pheidippides

Changi General Hospital

Thank you and

Don’t stop running please!

Just Not too far And Not too fast!