SCREENING AND PREVENTING SUDDEN CARDIAC DEATH IN EXERCISE

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My Disclosures

When I was still young….
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.

Did Pheidippides die from SCD or was it heat stroke?
SAF officer dies in 10km race

Road marshals alerted the medical team on...

Modern day Pheidippides
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

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

Figure 2. Causes of death in National Collegiate Athletic Association athletes (from Harmon et al11).
1. Relative risk of SD after vigorous exertion was **16.9**
2. Absolute risk is very 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

<table>
<thead>
<tr>
<th>Study / Population</th>
<th>Prevalence of SCD and/or MI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physicians’ Health Study (men)</td>
<td>1 in every 1.5 million episodes of vigorous activity</td>
</tr>
<tr>
<td>Nurses’ Health Study (women)</td>
<td>1 in every 36.5 million hours of moderate or vigorous exercise</td>
</tr>
<tr>
<td>Joggers in RI</td>
<td>1 death per 396,000 hours of jogging</td>
</tr>
<tr>
<td>YMCA participants</td>
<td>1 death per 2,897,057 person-hours of exercise</td>
</tr>
<tr>
<td>Marathon and half-marathon runners</td>
<td>0.20 cardiac arrests and 0.14 SCD per 100,000 runner-hours</td>
</tr>
<tr>
<td>Supervised Cardiac Rehabilitation Programs</td>
<td>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</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Sport</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycling</td>
<td>251</td>
<td>30.61%</td>
</tr>
<tr>
<td>Jogging</td>
<td>175</td>
<td>21.34%</td>
</tr>
<tr>
<td>Soccer</td>
<td>107</td>
<td>13.05%</td>
</tr>
<tr>
<td>Hiking</td>
<td>41</td>
<td>5%</td>
</tr>
<tr>
<td>Swimming</td>
<td>31</td>
<td>3.78%</td>
</tr>
<tr>
<td>Basketball</td>
<td>29</td>
<td>3.54%</td>
</tr>
<tr>
<td>Rugby</td>
<td>18</td>
<td>2.2%</td>
</tr>
<tr>
<td>Tennis</td>
<td>15</td>
<td>1.83%</td>
</tr>
<tr>
<td>Diving</td>
<td>11</td>
<td>1.34%</td>
</tr>
<tr>
<td>Judo</td>
<td>11</td>
<td>1.34%</td>
</tr>
<tr>
<td>Hand-ball</td>
<td>10</td>
<td>1.22%</td>
</tr>
<tr>
<td>Alpine skiing</td>
<td>8</td>
<td>0.98%</td>
</tr>
<tr>
<td>Table tennis</td>
<td>6</td>
<td>0.73%</td>
</tr>
<tr>
<td>Body-building</td>
<td>5</td>
<td>0.61%</td>
</tr>
<tr>
<td>Volley-ball</td>
<td>5</td>
<td>0.61%</td>
</tr>
<tr>
<td>Other</td>
<td>97</td>
<td>11.83%</td>
</tr>
</tbody>
</table>

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

“Correct. And in the case of a cardiac arrest, every second counts. Who can tell me why? Anyone? Clock’s ticking.”
Individualised Risk of SCD =

1. Desired exercise intensity \( \times \)

<table>
<thead>
<tr>
<th>Intensity</th>
<th>Subjective measures</th>
<th>Physiological measures</th>
<th>Absolute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light</td>
<td>Talk and sing</td>
<td>&lt;64</td>
<td>&lt;3</td>
</tr>
<tr>
<td>Moderate</td>
<td>Talk but can’t sing</td>
<td>64-76</td>
<td>3-6</td>
</tr>
<tr>
<td>Vigorous</td>
<td>Difficult talking</td>
<td>&gt;76</td>
<td>&gt;6</td>
</tr>
</tbody>
</table>

Predicted max HR = 220 - age

2. Number of CAD risk factors / underlying CVS disease/CAD equivalents (DM, PVD, Symptomatic carotid disease, Framingham risk score \( \geq \)20%) \( \times \)

3. Male:female = 9:1 \( \times \)

4. Age
How can we prevent SCD during exercise?

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

Objective of Preparticipation Screening

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

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. Has a doctor ever said that you have a heart condition and recommended only medically supervised activity?</td>
</tr>
<tr>
<td></td>
<td>2. Do you have chest pain brought on by physical activity?</td>
</tr>
<tr>
<td></td>
<td>3. Have you developed chest pain in the past month?</td>
</tr>
<tr>
<td></td>
<td>4. Have you on 1 or more occasions lost consciousness or fallen over as a result of dizziness?</td>
</tr>
<tr>
<td></td>
<td>5. Do you have a bone or joint problem that could be aggravated by the proposed physical activity?</td>
</tr>
<tr>
<td></td>
<td>6. Has a doctor ever recommended medication for your blood pressure or a heart condition?</td>
</tr>
<tr>
<td></td>
<td>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?</td>
</tr>
</tbody>
</table>

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 and Thomas et al.

### Step 1. Self Assessment of Risk

Balady et al Circulation 1998;97:2283-93

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

Assess your health needs by marking all true statements.

**History**

- 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.

If you marked any 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.

**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.

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

<table>
<thead>
<tr>
<th>Medical history*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal history</td>
</tr>
<tr>
<td>1. Chest pain/discomfort/tightness/pressure related to exertion</td>
</tr>
<tr>
<td>2. Unexplained syncope/near-syncope†</td>
</tr>
<tr>
<td>3. Excessive and unexplained dyspnea/fatigue or palpitations, associated with exercise</td>
</tr>
<tr>
<td>4. Prior recognition of a heart murmur</td>
</tr>
<tr>
<td>5. Elevated systemic blood pressure</td>
</tr>
<tr>
<td>6. Prior restriction from participation in sports</td>
</tr>
<tr>
<td>7. Prior testing for the heart, ordered by a physician</td>
</tr>
<tr>
<td>Family history</td>
</tr>
<tr>
<td>8. Premature death (sudden and unexpected, or otherwise) before 50 y of age attributable to heart disease in ≥1 relative</td>
</tr>
<tr>
<td>9. Disability from heart disease in close relative &lt;50 y of age</td>
</tr>
<tr>
<td>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</td>
</tr>
<tr>
<td>Physical examination</td>
</tr>
<tr>
<td>11. Heart murmur‡</td>
</tr>
<tr>
<td>12. Femoral pulses to exclude aortic coarctation</td>
</tr>
<tr>
<td>13. Physical stigmata of Marfan syndrome</td>
</tr>
<tr>
<td>14. Brachial artery blood pressure (sitting position)§</td>
</tr>
</tbody>
</table>

AHA recommends
- Hx
- PE

Basic Hx and PE are still key
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 unnecessary 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)
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, prevalence 1.8/10000)**
  - USD $3.4 million to prevent 1 death

- Independent self financed sports organisations
  - eg. NBA, Singapore sports school, FAS
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 Criteria for LVH**
- > 35 mm if > 40 yrs
- > 40 mm if 30-40 yrs
- > 60 mm if 16-30 yrs

**Cornell Criteria (most accurate)**
- \( R \text{ aVL} + S \text{ V3} \)
  - > 28 in males
  - > 20 in females

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

\[ S \text{ V1} + R \text{ V5 or V6} = 10 + 36 = 46 \text{ mm} \]
ESC criteria 2010

ECG abnormalities in the athlete

(Group 1) Common (up to 80%)
- Sinus bradycardia
- First degree AV block
- Notched QRS in V1 or incomplete RBBB
- Early repolarization
- Isolated QRS voltage criteria for left ventricular hypertrophy

(Group 2) Uncommon (< 5%)
- T-wave inversion
- ST-segment depression
- Pathological Q waves
- Left atrial enlargement
- Left axis deviation/left anterior hemiblock
- Right axis deviation/left posterior hemiblock
- Right ventricular hypertrophy
- Complete LBBB or RBBB
- Long or short QT interval
- Brugada-like early repolarization
- Ventricular arrhythmias
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

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

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

Refined Criteria Training Related Normal Variants
Not Warranting Further Investigation*
- Sinus bradycardia
- First-degree AV block
- Incomplete RBBB
- Early repolarisation
- Isolated QRS voltage criteria for LVH

Refined Criteria Borderline Variants
Potentially Warranting Further Investigation
- Left atrial enlargement
- Right atrial enlargement
- Left axis deviation
- Right axis deviation
- Right ventricular hypertrophy
- TWI up to V4 in BAs†

Refined Criteria Training Unrelated Changes
Warranting Further Investigation
- ST-segment depression
- Pathological Q-waves
- Ventricular pre-excitation
- TWI beyond V1 in WAs beyond V4 in BAs
- Complete LBBB or RBBB
- QTc ≥470 ms in males
  ≥480 ms in females
- Brugada-like ER
- Atrial or vent. arrhythmias
- ≥2 PVCs per 10 sec tracing

If present in ISOLATION*

If TWO OR MORE present

or in association with recognized training-related ECG changes

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)

<table>
<thead>
<tr>
<th></th>
<th>Black Athletes (n=805)</th>
<th>White Athletes (n=2282)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>European Society of Cardiology</td>
<td>Seattle Criteria</td>
</tr>
<tr>
<td>Sensitivity, %</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>(39.8–100)</td>
<td>(39.8–100)</td>
</tr>
<tr>
<td>Specificity, %</td>
<td>40.1</td>
<td>79.3</td>
</tr>
<tr>
<td></td>
<td>(36.7–43.6)</td>
<td>(76.3–82.0)</td>
</tr>
<tr>
<td>Positive predictive value, %</td>
<td>0.8</td>
<td>2.4</td>
</tr>
<tr>
<td></td>
<td>(0.2–2.1)</td>
<td>(0.6–5.9)</td>
</tr>
<tr>
<td>Negative predictive value, %</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>(98.9–100)</td>
<td>(99.4–100.0)</td>
</tr>
<tr>
<td>False-positive rate, %</td>
<td>59.9</td>
<td>20.7</td>
</tr>
<tr>
<td>False-negative rate, %</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

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
- False negative

<table>
<thead>
<tr>
<th>Symptomatic</th>
<th>Sens 68%</th>
<th>Spec 77%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asymptomatic</td>
<td>Sens 46%</td>
<td>Spec 16%</td>
</tr>
</tbody>
</table>

Treadmill testing ≠ marathon/triathlon
- Prevalence rate of SCD in marathons/triathlons is too low to warrant routine screening
Other reasons for exercise testing

**Indications for ETT that are not related to prediction of MI or SD**
- Exercise prescription
- 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

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

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

All references based on studies that focused on asymptomatic subjects.
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
### 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

<table>
<thead>
<tr>
<th>TABLE 2.2. Atherosclerotic Cardiovascular Disease (CVD) Risk Factors and Defining Criteria (26,31)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk Factors</strong></td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>Family history</td>
</tr>
<tr>
<td>Cigarette smoking</td>
</tr>
<tr>
<td><strong>Sedentary lifestyle</strong></td>
</tr>
<tr>
<td>Obesity</td>
</tr>
<tr>
<td>Hypertension</td>
</tr>
<tr>
<td>Dyslipidemia</td>
</tr>
<tr>
<td>Prediabetes(^a)</td>
</tr>
<tr>
<td><strong>Negative Risk Factors</strong></td>
</tr>
<tr>
<td>High-density lipoprotein (HDL) cholesterol</td>
</tr>
</tbody>
</table>

\(^a\)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. \( \text{VO}_{2,\text{R}} \), oxygen uptake reserve.
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).
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).
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

A. Low
(<40 percent Max O₂)
- Billiards
- Bowling
- Cricket
- Curling
- Golf
- Riflery

B. Moderate
(40-70 percent Max O₂)
- Baseball/softball
- Fencing
- Table tennis
- Volleyball

C. High
(>70 percent Max O₂)
- Body building
- Downhill skiing
- Skateboarding
- Snowboarding
- Wrestling

- Boxing
- Canoeing/Kayaking
- Cycling
- Decathlon
- Rowing
- Speed-skating
- Triathlon

- Basketball
- Ice hockey
- Cross-country skiing
- (skating technique)
- Lacrosse
- Running (middle distance)
- Swimming
- Team handball

- Badminton
- Cross-country skiing
- (classic technique)
- Field hockey
- Orienteering
- Race walking
- Racquetball/squash
- Running (long distance)
- Soccer
- Tennis

Increasing static component

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

‘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
Thank you and
Don’t stop running please!
Just Not too far And Not too fast!