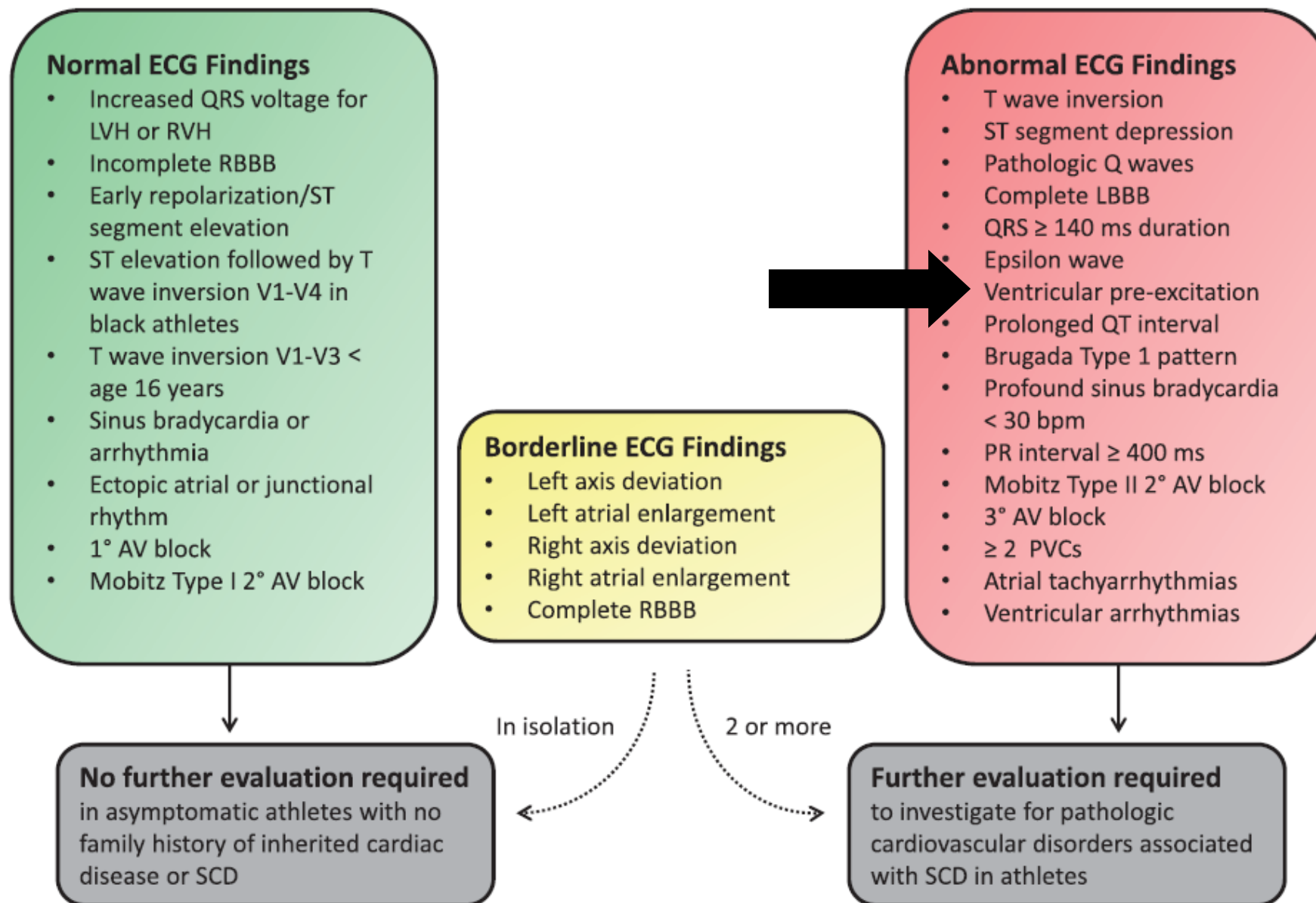


# Study methodology for screening candidates to athletes risk

- 1. Periodical Evaluations:** each 2 years.
- 2. Personal history:** Personal history of murmur in childhood; dizziness, syncope, palpitations, intolerance to exercise, precordialgia, dyspnea, dizziness or syncope during or after exercise, may indicate the presence of: HCM, dromotropic disorder, MVP, aortic stenosis or arrhythmia; Precordialgia intra- or post-strain may indicate early coronary atherosclerosis; Excessive/progressive dyspnea may indicate valvular diseases, pulmonary disease, or structural anomalies; Palpitations during or after exercise may be a sign of arrhythmia. Ask questions about the current or past use of legal (tobacco, alcohol) and illegal drugs; Recent history of virus infection may lead to symptoms compatible to myocarditis; History of congenital heart disease or cardiac surgery; Any background that may imply greater risk for congenital heart disease. E.g.: Maternal rubella, exposition to toxics used or environmental.
- 3. Family Clinical History:** SD in first-degree relatives under 45 years old; family members about HCM, LQTS, Marfan phenotype, sindactily, etc;
- 4. Physical Examination:** mandatory. Anthropometrical evaluation: weight, height, BP and percentage of body fat; identification and characterization (intensity, location and time of cycle) of murmurs and arrhythmias, standing and in supine position; recognize phenotypes: e.g. Marfan, Noonan and Holt-Oram syndrome, supraaortic stenosis, Williams syndrome. Measurement of BP in superior and inferior limbs, and assessment of femoral, radial and foot pulses to exclude Aorta coarctation. Auscultation must be performed in decubitus and standing to identify murmurs influenced by dynamic obstruction in the LVOT; detection of extracardiac clicks and sounds; Musculo-skeletal aptitude. Try to detect medical conditions or skeletal muscles that may predispose to injuries or diseases during a competition.
- 5. Do ECGs really lower mortality rates?:** Only in selected cases? Without consensus among USA and European researchers. Although they may increase the diagnostic power of history and physical examination, they are not advised as a routine “screening”. The three most used are: ECG, echocardiogram and ergometer test;

;



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

## International consensus standards for ECG interpretation in athletes: definitions of ECG criteria

Abnormal ECG findings in athletes These ECG findings are unrelated to regular training or expected physiologic adaptation to exercise, may suggest the presence of pathologic cardiovascular disease, and require further diagnostic investigation.

ECG abnormality	Definiton
T wave inversion <ul style="list-style-type: none"> <li>▪ Anterior</li> <li>▪ Lateral</li> <li>▪ Inferolateral</li> <li>▪ Inferior</li> </ul>	$\geq 1\text{mm}$ in depth in two or more contiguous leads; excludes leads aVR, III, and V1 V2–V4 – excludes: black athletes with J-point elevation and convex ST segment elevation followed by TWI in V2–V4; athletes < age 16 with TWI in V1-V3; and biphasic T waves in only V3. I and aVL, V5 and/or V6 (only one lead of TWI required in V5 or V6) II and aVF, V5-V6, I and aVL II and aVF
ST segment depression	$\geq 0.5\text{mm}$ in depth in two or more contiguous leads
Pathologic Q waves	Q/R ratio $\geq 0.25$ or $\geq 40\text{ms}$ in duration in two or more leads (excluding III and aVR)
Complete left bundle branch block	QRS $\geq 120\text{ ms}$ , predominantly negative QRS complex in lead V1 (QS or rS), and upright notched or slurred R wave in leads I and V6
Profound nonspecific intraventricular conduction delay	Any QRS duration $\geq 140\text{ ms}$
Epsilon wave	Distinct low amplitude signal (small positive deflection or notch) between the end of the QRS complex and onset of the T wave in leads V1-V3.

<b>Ventricular pre-excitation</b>	PR interval < 120 ms with a delta wave (slurred upstroke in the QRS complex) and wide QRS $\geq$ 120 ms) QTc $\geq$ 470 ms (male) QTc $\geq$ 480 ms (female) QTc $\geq$ 500 ms (marked QT prolongation)
<b>Brugada Type 1 pattern</b>	Coved pattern: initial ST elevation $\geq$ 2mm (high take-off) with downsloping ST segment elevation followed by a negative symmetric T wave in $\geq$ 1 leads in V1–V3.
<b>Profound sinus bradycardia</b>	< 30 bpm or sinus pauses $>_{\geq}$ 3 sec
<b>Profound first degree atrioventricular block</b>	$\geq$ 400 ms
<b>Mobitz Type II 2 atrioventricular block</b>	Intermittently non-conducted P waves with a fixed PR interval
<b>3 atrioventricular block</b>	Complete heart block
<b>Atrial tachyarrhythmias</b>	Supraventricular tachycardia, atrial fibrillation, atrial flutter
<b>PVC</b>	$\geq$ 2 PVCs per 10 s tracing
<b>Ventricular arrhythmias</b>	Couplets, triplets, and non-sustained ventricular tachycardia

### **Borderline ECG findings in athletes**

These ECG findings in isolation likely do not represent pathologic cardiovascular disease in athletes, but the presence of two or more borderline findings may warrant additional investigation until further data become available.

<b>ECG abnormality</b>	<b>Definition</b>
<b>Left axis deviation</b>	-30° to - 90°
<b>Right axis deviation</b>	> 120°
<b>Right atrial enlargement</b>	Prolonged P wave duration of $\geq 120$ ms in leads I or II with negative portion of the P wave $\geq 1$ mm in depth and $\geq 40$ ms in duration in lead V1
<b>Complete Right Bundle Branch Block</b>	rSR' pattern in lead V1 and a S wave wider than R wave in lead V6 with QRS duration $\geq 120$ ms

**Normal ECG findings in athletes** These training-related ECG alterations are physiologic adaptations to regular exercise, considered normal variants in athletes, and do not require further evaluation in asymptomatic athletes with no significant family history.

<b>Normal ECG finding</b>	<b>Definition</b>
<b>Increased QRS voltage</b>	Isolated QRS voltage criteria for left (SV1 + RV5 or RV6 > 3.5 mV) or right ventricular hypertrophy (RV1+SV5 or SV6 > 1.1 mV)
<b>Incomplete RBBB</b>	rSR' pattern in lead V1 and a qRS pattern in lead V6 with QRS duration < 120 ms
<b>Early repolarization</b>	J point elevation, ST elevation, J waves, or terminal QRS slurring in the inferior and/or lateral leads
<b>Black athlete repolarization variant</b>	J-point elevation and convex ('domed') ST segment elevation followed by T wave inversion in leads V1-V4 in black athletes
<b>Juvenile T wave pattern</b>	T-wave inversion V1–V3 in athletes < age 16
<b>Sinus bradycardia</b>	$\geq 30$ bpm
<b>Sinus arrhythmia</b>	Heart rate variation with respiration: rate increases during inspiration and decreases during expiration
<b>Junctional escape rhythm</b>	

Normal ECG finding	Definition
Ectopic atrial rhythm	P waves are a different morphology compared with the sinus P wave, such as negative P waves in the inferior leads ('low atrial rhythm')
Junctional escape rhythm	QRS rate is faster than the resting P wave or sinus rate and typically less than 100 beats/minute with narrow QRS complex unless the baseline QRS is conducted with aberrancy
First atrioventricular block	PR interval 200–400 ms
Mobitz Type II atrioventricular block	PR interval progressively lengthens until there is a non-conducted P wave with no QRS complex; the first PR interval after the dropped beat is shorter than the last conducted PR interval

ECG, electrocardiogram; PVC, premature ventricular contraction; RBBB, right bundle branch block.

A The QT interval corrected for heart rate is ideally measured using Bazett's formula with heart rates between 60 and 90 bpm; preferably performed manually in lead II or V5 using the teach-the-tangent method<sup>1</sup> to avoid inclusion of a U wave.

Consider repeating the ECG after mild aerobic activity for a heart rate < 50 bpm, or repeating the ECG after a longer resting period for a heart rate > 100 bpm, if the QTc value is borderline or abnormal.