

# The Preparticipation Evaluation and Cardiovascular Screening in Young Athletes: Considering the Pros and Cons

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## ABSTRACT

Sudden cardiac death in young athletes is an uncommon but devastating event. The preparticipation evaluation affords an important opportunity to screen for cardiovascular disease and other health conditions but has certain limitations in its existing form. This article provides an overview of current screening practices and outlines the argument for and against the addition of a 12-lead electrocardiogram to the preparticipation exam in an effort to prevent sudden cardiac arrest.

**KEYWORDS:** Preparticipation exam, sudden cardiac death, athletes, 12-lead electrocardiogram

## INTRODUCTION

The health-related benefits of exercise are well known. However, a small segment of the population is at risk for exercise-associated sudden cardiac death (SCD) due to a variety of congenital, inherited, or acquired cardiovascular conditions. Atherosclerotic coronary artery disease is the most common cause of SCD in athletes over the age of 35. (1) Younger athletes are at greater risk from structural heart disease, such as cardiomyopathies and other congenital abnormalities. Although consensus recommendations and standard guidelines were developed by the American Heart Association for athletic Preparticipation Evaluation (PPE), these guidelines are inconsistently applied across the United States. Rhode Island is the only state that does not require any form of examination. (2) Nonetheless, the PPE is a widely accepted screening tool used to identify athletes at risk for SCD and other sports injuries, so that appropriate preventive measures can be taken. The addition of the 12-lead electrocardiogram (ECG) to preparticipation screening is the subject of considerable debate within the sports medicine community. Here we will briefly present both sides of the argument as it relates to youth athletes.

### Existing methods of screening are effective for ensuring safe participation in youth and interscholastic athletics.

**PRO (KHAUND):** Sudden cardiac death is reportedly the leading cause of death of athletes during sporting activity with estimates ranging from 0.5-3/100,000 athletes per year. (3-5) In the United States, preparticipation exams typically follow the AHA recommendations for a cardiac screening history

**Table 1.** AHA Recommendations for Preparticipation Cardiovascular Screening of Competitive Athletes (1)

| Personal Medical History  |
|---|
| 1. Exertional chest pain or discomfort  |
| 2. Unexplained syncope or near-syncope (particularly concerning when related to exertion)   |
| 3. Excessive exertional and unexplained dyspnea/fatigue, associated with exercise   |
| 4. Prior recognition of a heart murmur  |
| 5. Elevated systemic blood pressure   |
| Family History  |
| 6. Premature death (sudden and unexpected) before age 50 due to heart disease, in $\geq 1$ relative   |
| 7. Disability from heart disease in a close relative <50 years of age   |
| 8. Specific knowledge of certain cardiac conditions in family members (i.e., hypertrophic cardiomyopathy, ion channelopathies, or other clinically important arrhythmias) |
| Physical Examination  |
| 9. Heart murmur (auscultation is recommended in both supine and standing positions)   |
| 10. Femoral pulses to exclude aortic coarctation  |
| 11. Physical stigmata of Marfan syndrome  |
| 12. Brachial artery blood pressure (sitting, preferably in both arms)   |

*Adapted from Recommendations and Considerations Related to Preparticipation Screening for Cardiovascular Abnormalities in Competitive Athletes*

and exam. (Table 1) Based on the questionable specificity of further testing, coupled with concern for maintaining a cost effective approach, this has long been considered the standard of care. Given the existing lack of uniformity in this country regarding preparticipation evaluation, I suspect the addition of further testing will present inherent challenges. PPEs are often provided at nominal cost, without insurance involvement, in order to attract student-athletes to the screening process. To accomplish a broad outreach, PPEs are also commonly offered as large-scale and community-based programs which rely heavily on volunteer medical personnel. The addition of further testing that might increase cost and liability will only detract from our current efforts. Although data from abroad suggests that added testing can identify more athletes at risk, this does not appear to be practical within the current healthcare landscape. I strongly believe that our first priority is to engage the student-athlete in the healthcare system. As it stands, taking a thorough history and performing a proper exam must serve as the initial approach to screening and can provide useful information

regarding other medical conditions and risky behaviors. Only when we can consistently achieve this standard should we turn our attention to broadening the methods of screening.

**CON (FEDEN):** Sudden cardiac death in healthy young athletes is a rare but catastrophic event, with devastating impact on the family and the community. In an effort to enhance the safety of athletic participation, cardiovascular screening recommendations from the American Heart Association include a focused personal and family history, and a physical exam directed at identifying cardiovascular abnormalities that might predispose to sudden cardiac arrest. While this is a reasonable starting point, lack of standardization is a major limitation to current screening practices. Furthermore, available research demonstrates the value of adding electrocardiography to the preparticipation evaluation. Corrado and colleagues studied athletes in Italy over a 25-year period (1979–2004) and reported an 89% relative reduction in sudden cardiac death in athletes screened with history, physical, and 12-lead ECG. (6) This reduction resulted from the improved detection of cardiomyopathies and disqualification of athletes at risk. Even without the incorporation of the ECG, I agree with Dr. Khaund that improved standardization and application of current practices would certainly improve our existing approach to preparticipation screening.

### The preparticipation physical examination is our best screening tool for detecting cardiovascular disease in young athletes.

**PRO (KHAUND):** An optimal screening test incorporates cost effectiveness with a validated test that has optimized specificity (e.g., a low false-positive rate). As it stands in 2016, the growth of sports medicine as a field has helped to enable PPEs to become best practice. Relying on medical personnel, many of whom donate their time and services toward this goal, to reach out to the athletic population is of paramount importance. We must remember that an effective screening test is one that caters to the general population. Added diagnostic testing might narrow the cohort of professionals qualified to perform these evaluations, while also making it more difficult to recruit other volunteers due to increased liability exposure. Additional screening measures could be considered only with the understanding that we must continue to broaden our outreach. The current PPE as it pertains to cardiovascular disease is best suited for our existing healthcare resources. As studies and standards evolve regarding the use of further diagnostic testing, this may one day change. However, until we accomplish our primary goal of ensuring that all athletes undergo preparticipation evaluation in some form, adding further diagnostic testing would be akin to “putting the cart before the horse.”

**CON (FEDEN):** An effective screening tool must balance high sensitivity with acceptable specificity. However, several studies, including that by Maron et al., have demonstrated poor sensitivity for the detection of cardiovascular abnormalities by history and physical exam alone. Conditions that predispose to sudden cardiac death are often clinically

silent, and up to 80% of deaths may occur without warning. (7) In the United States, hypertrophic cardiomyopathy is the most common cause of sudden cardiac death in young athletes. (1) Although there may be clues in the family history or a systolic murmur auscultated on exam, an abnormal ECG is a more reliable finding. Echocardiogram is the gold standard for diagnosis, since the resting ECG is abnormal in up to 95% of cases, and a normal ECG has negative predictive value approaching 100%. (8,9) With the additional advantage of detecting cardiac conduction abnormalities, the 12-lead ECG is an arguably superior screening tool for the identification of otherwise silent cardiovascular conditions.

### ECG screening of young athletes is necessary to detect cardiovascular disease and prevent sudden cardiac death.

**PRO (FEDEN):** The repercussions of sudden cardiac death in the young athlete are far-reaching, and all available resources should be used for preventive efforts. Though we cannot expect to eliminate this problem altogether, even one preventable death might be considered one too many. Our current practice of screening for clinically silent conditions with history and physical, even when performed in systematic fashion as outlined by the AHA, is poorly sensitive and inadequate. The Italian experience offers compelling evidence that the simple addition of 12-lead ECG to the preparticipation evaluation improves diagnostic sensitivity and reduces the incidence of sudden cardiac death. The most common causes for sudden cardiac death in the athletic population under age 35 are frequently associated with ECG abnormalities. In addition, other inherited conditions may be discovered with a resting 12-lead ECG. Identification of those at-risk allows for selective disqualification, appropriate intervention, and overall risk reduction.

**CON (KHAUND):** There is no doubt that missing one preventable death is too many. However, we need to consider the cost-benefit analysis. Until we can achieve the primary goal of consistent and broad outreach to the athletic population with PPEs, mandatory ECGs will likely detract from that effort. It is important to understand the role of the PPE as a way to engage the athlete in the health care system. The ability to speak with and counsel athletes in general has significant implications for decreasing morbidity and mortality from all causes. While we may identify the rare cases of cardiac disease in a specific population, I would venture to say that broadening our outreach will improve all-cause morbidity and mortality. Although the screening ECG has been shown in numerous studies to help identify those with underlying cardiovascular disease, I do not believe that the existing PPE is ready for added screening measures at this point in time. The PPE is further meant to afford an opportunity for contact with athletes before participation to help optimize their overall health. The downstream consequences of investigating false-positive studies – cost, access to care, and psychological implications for the athlete – are not insignificant. The threat of more complicated and/or costly evaluations may result in less compliance and, therefore, narrowed outreach.

### Addition of routine ECG screening to the preathletic evaluation is feasible.

**PRO (FEDEN):** Despite the evidence demonstrating benefit to screening athletes with 12-lead ECG, opponents argue against the cost-effectiveness and feasibility of implementing a large-scale program. Concerns over ECG screening often focus on the financial burden associated with the additional investigation of false-positive ECGs, which is reported to be as high as 40%. (10) However, Marek and colleagues have successfully delivered such a program in the Chicago area using physician and trained community volunteers. (11) They screened 32,561 high school students over three years and found only 2.5% with abnormal ECGs requiring further evaluation. Unfortunately, the number of false-positives could not be determined since subsequent evaluation was directed by primary care physicians. Other critics cite the difficulties with ECG interpretation as a contributing factor to high false-positive rates, but Drezner and colleagues have reported that standardized ECG criteria allow for accurate interpretation with a sensitivity of 94% and specificity of 91% across physician specialties. (12) Although there is clearly a cost associated with further work-up, screening costs are minimal when there is an interest and investment from the local community.

**CON (KHAUND):** The addition of ECG screening to the preparticipation exam is not feasible in the United States at this time. The cost of including the ECG would likely decrease the availability of the PPE to the population at large. Furthermore, the liability associated with ECG interpretation and follow-up might discourage certain medical personnel from offering their services. At present, the primary focus should remain on access to PPEs for athletes. As future research elucidates the true sensitivity and specificity of ECGs as a screening tool in the United States, the pressure will likely mount to include ECGs in the screening process. Before this can occur, however, the logistics of obtaining ECGs on a large scale and standards for interpretation will need to be further established. An endorsement from the American Heart Association will also be crucial to this process. The pressure is clearly building in the United States to follow our European colleagues, and it would not be surprising to see changes in the coming years with organizations like the American Medical Society for Sports Medicine leading the charge.

### CONCLUSION

The identification of young athletes with cardiovascular conditions at risk for sudden cardiac death is an important issue confronting the athletic and sports medicine communities. Preparticipation screening with the history and physical exam is supported by the AHA but may not be sufficient for the detection of clinically silent conditions that predispose to sudden cardiac death. The experience of our Italian colleagues suggests that the addition of the 12-lead ECG improves sensitivity and reduces the incidence of

sudden cardiac death, but controversy surrounds the cost-effectiveness and feasibility of similar screening methods in the U.S. Regardless of the screening approach and the risks, we must appreciate the importance of athletic participation and remain committed to ensuring the health and safety of athletes of all ages.

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### Disclosures

None

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