

Screening for Sudden Cardiac Death Before Participation in High School and Collegiate Sports

American College of Preventive Medicine Position Statement on Preventive Practice

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The College's Current Position

The American College of Preventive Medicine (ACPM) supports an evaluation prior to participating in high school and collegiate sports using a standardized history and physical (H&P) (i.e., using standardized items as developed by the American Heart Association [AHA] to ensure uniformity and consistency in risk factor assessment; Table 1).¹ ACPM recommends against routine screening for potential sudden cardiac death (SCD) with electrocardiogram (ECG), echocardiography, and genetic testing in individuals without personal risk factors. The recommendations by ACPM address only mass screening approaches to detecting SCD and are not targeted toward individuals who may be identified by their healthcare provider as "above average" risk who may benefit from additional testing with the modalities mentioned above. ACPM supports the adoption of the National Heart, Lung, and Blood Institute (NHLBI) Working Group research agenda to evaluate the effectiveness of any screening program in reducing SCD, its cost-benefit ratio, and its impact on health outcomes (Table 2).² The full-length version of the current article can be found on the ACPM website (www.acpm.org/?page=Policy_Statement).

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Background

The risk of sudden cardiac death among high school athletes in U.S. is 0.7/100,000 person-years.³ The incidence of deaths among athletes due to cardiovascular collapse is twice that caused by trauma associated with sports.⁴ SCD is more common in men than in women at a ratio of 5:1 to 9:1.⁵ White athletes appear to be more affected than other races (55% vs 45%); however, the incidence of SCD due to hypertrophic cardiomyopathy is higher in African-American athletes.⁶ In 30%–50% of sudden cardiac deaths, it is the first clinically identified expression of heart disease.⁷

The most common cause of SCD in young athletes in U.S. is hypertrophic cardiomyopathy (26%–36%)^{5,8} followed by anomalous origin of the coronary artery (17%).⁵ Other causes of SCD include dilated cardiomyopathy; Wolff-Parkinson-White syndrome (pre-excitation syndrome; WPW); Lènegre conduction disease (idiopathic progressive cardiac conduction disease); long- and short-QT syndromes; and Brugada syndrome, an inherited cardiac arrhythmia syndrome.

Supporting Evidence/Areas of Incomplete or Lacking Data

Studies addressing the efficacy of screening with clinical outcomes are currently lacking, and the utility of specific screening modalities remains unclear. An H&P developed by the AHA, which includes 12 criteria comprising personal and family history and a physical examination,¹ is widely used, although opinions differ about its usefulness. Although an H&P costs less, requires minimal resources, and is efficient to administer, it has low sensitivity in detecting hypertrophic cardiomyopathy and other asymptomatic cardiac diseases.⁹ Another limitation is the poor utilization of a standardized H&P for pre-participation sports evaluation.¹⁰

Implementing routine ECG screening to detect signs of cardiac disease to prevent SCD is also controversial.

Table 1. The 12-element AHA recommendations for pre-participation cardiovascular screening of competitive athletes¹

MEDICAL HISTORY ^a	
Personal history	
1.	Exertional chest pain/discomfort
2.	Unexplained syncope/near-syncope ^b
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, or otherwise) before age 50 years due to heart disease, in ≥ 1 relative
7.	Disability from heart disease in a close relative aged < 50 years
8.	Specific knowledge of certain cardiac conditions in family members: hypertrophic or dilated cardiomyopathy, long-QT syndrome or other ion channelopathies, Marfan syndrome, or clinically important arrhythmias
PHYSICAL EXAMINATION	
9.	Heart murmur ^c
10.	Femoral pulses to exclude aortic coarctation
11.	Physical stigmata of Marfan syndrome
12.	Brachial artery blood pressure (sitting position)

^aParental verification is recommended for high school and middle school athletes.

^bJudged not to be neurocardiogenic (vasovagal); of particular concern when related to exertion.

^cAuscultation should be performed in both supine and standing positions (or with Valsalva maneuver), specifically to identify murmurs of dynamic left ventricular outflow tract obstruction.

AHA, American Heart Association

ECG has been shown in some studies to be more sensitive than H&P in detecting underlying cardiac conditions known to cause SCD.^{11,12} However, the false-positive rate is higher for screening with ECG and H&P as compared to H&P alone.¹³ In an Italian pre-participation study, ECG was shown to detect 77% more hypertrophic cardiomyopathy than H&P alone.¹⁴ Normal variations in ECG may result in low specificity for cardiac disease in the population of athletes.¹⁵ RCTs and long-term prospective cohort studies are lacking in determining the utility of ECG as a screening tool to prevent SCD. A recent study in Israel demonstrates that pre-participation programs involving routine ECG testing and physical examinations do not reduce mortality rates or cardiac arrest.¹⁶

Studies that directly evaluate ECG screening and improved health outcomes are lacking. A limited number of studies suggest that combining H&P and ECG screening for SCD may be cost effective. An Italian cost-effectiveness analysis of 33,735 athletes, using a more conservative approach (10% of affected athletes would live an additional 20 years), estimated the cost per year of life saved at approximately \$20,000 for the Italian model (H&P and ECG) and about \$53,350 for the U.S. model (H&P alone).¹⁷ The AHA estimates the cost of mass ECG screening,

followed by echocardiogram and other indicated testing, to be \$2.0 billion for 10 million middle and high school athletes.¹ Pending further prospective studies involving U.S. participants, the cost effectiveness of routinely combining H&P and ECG in cardiovascular pre-participation screening in students cannot be conclusively determined.

Recommendations of Other Societies

The American Heart Association: Recommends cardiovascular pre-participation screening with a focused H&P to identify or raise the suspicion of those cardiovascular diseases known to cause sudden cardiac death or disease progression. The AHA recommends against ECG as universal screening because of its low specificity and costly additional workups.^{18–20}

European Society of Cardiologists: Recommends screening all young competitive athletes with a complete H&P and 12-lead ECG.^{21,22}

International Olympic Committee: Recommends a systematic cardiovascular evaluation (including 12-lead ECG) for all young competitive athletes.²¹

American College of Sports Medicine: Supports pre-participation H&P without routine ECG for athletes.²³

Table 2. Recommendations of the NHLBI Working Group to address the identified knowledge gaps in evaluating screening for SCDY²

Epidemiology and etiology of SCDY
Develop an SCDY registry to prospectively estimate the incidence of SCDY
Perform case-control studies using registry-defined cases to identify risk factors for SCDY
Performance of the screening methodology in the target population
Perform pilot ECG screening studies to test the characteristics of the ECG in target populations
Perform comparative effectiveness studies to determine the incremental value of various screening methodologies, including history and physical examination, ECG, echocardiogram, and genetic testing
Management of asymptomatic heart disease identified by ECG screening
Develop evidence-based management strategies for asymptomatic patients
Evaluate risk stratification, prevention, and therapeutic strategies
Use novel study designs and innovative recruitment strategies when studying low-prevalence diseases
Impact of a screening program
Evaluate the impact of a screening program on individuals and families using quality-of-life studies and patient-preference measurements
Use decision analysis to evaluate overall effectiveness of a screening program, as well as cost and resource utilization
Other resources to facilitate research
Redefine the diagnostic criteria for the long-QT syndrome in the genetic era
Define ECG norms in the U.S. population, taking into account demographic variability

ECG, electrocardiogram; NHLBI, National Heart, Lung, and Blood Institute; SCDY, screening for sudden cardiac death in the young

Rationale for the College's Current Position

The American College of Preventive Medicine acknowledges that studies addressing the efficacy of screening with clinical outcomes are lacking and that the utility of specific screening modalities remains unclear. However, at the present time, the H&P is the most widely used modality for pre-participation evaluation despite its limited sensitivity in detecting certain cardiac conditions. Promoting an H&P using standardized items as that developed by the AHA will ensure uniformity and consistency in risk factor assessment (Table 1).¹

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References

1. Maron BJ, Thompson PD, Ackerman MJ, et al. Recommendations and considerations related to preparticipation screening for cardiovascular abnormalities in competitive athletes: 2007 update: a scientific statement from the American Heart Association Council on Nutrition, Physical Activity, and Metabolism: endorsed by the American College of Cardiology Foundation. *Circulation* 2007;115(12):1643–55.
2. Kaltman JR, Thompson PD, Lantos J, et al. Screening for sudden cardiac death in the young: report from a national heart, lung, and blood institute working group. *Circulation* 2011;123(17):1911–8.
3. Maron BJ, Haas TS, Ahluwalia A, Rutten-Ramos SC. Incidence of cardiovascular sudden deaths in Minnesota high school athletes. *Heart Rhythm* 2013;10(3):374–7.
4. Cantu RC. Congenital cardiovascular disease—the major cause of athletic death in high school and college. *Med Sci Sports Exerc* 1992;24(3):279–80.
5. Maron BJ, Doerer JJ, Haas TS, Tierney DM, Mueller FO. Sudden deaths in young competitive athletes: analysis of 1866 deaths in the United States, 1980–2006. *Circulation* 2009;119(8):1085–92.
6. Maron BJ, Carney KP, Lever HM, et al. Relationship of race to sudden cardiac death in competitive athletes with hypertrophic cardiomyopathy. *J Am Coll Cardiol* 2003;41(6):974–80.
7. Myerburg RJ. Sudden cardiac death: exploring the limits of our knowledge. *J Cardiovasc Electrophysiol* 2001;12(3):369–81.
8. Maron BJ, Shirani J, Poliac LC, Mathenge R, Roberts WC, Mueller FO. Sudden death in young competitive athletes. Clinical, demographic, and pathological profiles. *JAMA* 1996;276(3):199–204.
9. Corrado D, Basso C, Schiavon M, Pelliccia A, Thiene G. Pre-participation screening of young competitive athletes for prevention of sudden cardiac death. *J Am Coll Cardiol* 2008;52(24):1981–9.
10. Glover DW, Maron BJ. Profile of preparticipation cardiovascular screening for high school athletes. *JAMA* 1998;279(22):1817–9.

11. Fuller CM, McNulty CM, Spring DA, et al. Prospective screening of 5,615 high school athletes for risk of sudden cardiac death. *Med Sci Sports Exerc* 1997;29(9):1131–8.
12. Wilson MG, Basavarajaiah S, Whyte GP, Cox S, Loosemore M, Sharma S. Efficacy of personal symptom and family history questionnaires when screening for inherited cardiac pathologies: the role of electrocardiography. *Br J Sports Med* 2008;42(3):207–11.
13. Baggish AL, Hutter AM Jr, Wang F, et al. Cardiovascular screening in college athletes with and without electrocardiography: a cross-sectional study. *Ann Intern Med* 2010;152(5):269–75.
14. Corrado D, Basso C, Schiavon M, Thiene G. Screening for hypertrophic cardiomyopathy in young athletes. *N Engl J Med* 1998;339(6):364–9.
15. Pelliccia A, Maron BJ, Culasso F, et al. Clinical significance of abnormal electrocardiographic patterns in trained athletes. *Circulation* 2000;102(3):278–84.
16. Steinvil A, Chundadze T, Zeltser D, et al. Mandatory electrocardiographic screening of athletes to reduce their risk for sudden death: proven fact or wishful thinking? *J Am Coll Cardiol* 2011;57(11):1291–6.
17. Corrado D, Basso C, Schiavon M, et al. Cost-effectiveness analysis of preparticipation screening strategies for the prevention of sudden death in young competitive athletes. American Heart Association Scientific Sessions; 7–10 Nov 2004, New Orleans, LA, USA [abstract 321].
18. Chaitman BR. An electrocardiogram should not be included in routine preparticipation screening of young athletes. *Circulation* 2007;116(22):2610–4; discussion 2615.
19. Hamilton B, Jaques R, Budgett R. Observations on the "Lausanne Recommendations" on sudden cardiovascular death in sport. *Br J Sports Med* 2007;41(2):e1.
20. Shephard RJ. Mass ECG. screening of young athletes. *Br J Sports Med* 2008;42(9):707–8.
21. Bille K, Figueiras D, Schamasch P, et al. Sudden cardiac death in athletes: the Lausanne Recommendations. *Eur J Cardiovasc Prev Rehabil* 2006;13(6):859–75.
22. Corrado D, Basso C, Pavei A, Michieli P, Schiavon M, Thiene G. Trends in sudden cardiovascular death in young competitive athletes after implementation of a preparticipation screening program. *JAMA* 2006;296(13):1593–601.
23. American College of Sports Medicine. ACSM current comment: preparticipation physical exam. ACSM, 2006. www.acsm.org/docs/current-comments/pre-participationexam.pdf.

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