The Science Advisory and Coordinating Committee of the American Heart Association has developed guidelines for cardiac screening as part of the preparticipation physical examination for athletes. The recommendations include acquisition of a complete medical history and physical examination. The committee developed key history questions to assess risk for specific cardiac abnormalities. Specific physical examination procedures are recommended to identify individuals who are at risk for sudden cardiac death (SCD). Findings from the history or physical exam that suggest pathology should generate referral to a cardiologist.

SCD is defined as unexpected death from cardiac arrest within one hour of collapse. Age is an important variable associated with the cause of SCD. The majority of SCD among athletes under 35 years of age is attributable to structural non-atherosclerotic heart disease. In contrast, SCD among individuals over 35 years of age is typically caused by coronary artery atherosclerosis.

Over 7.3 million high school students and 400,000 college students participated in athletics during the 2006-07 academic year. The majority of these participants enjoyed the benefits of athletic participation, but some of them experienced injury, illness, and even death. The purposes of this report are to (a) identify the leading causes of SCD in athletes, (b) to present current methods for detection of cardiac abnormalities that create risk for SCD, and (c) to provide recommendations for preparticipation examination procedures to identify individuals who possess risk factors for SCD.

Causes of Sudden Cardiac Death

Risk factors for SCD have been documented in the research literature. Congenital abnormality has been identified as the leading cause of SCD in young athletes (under 35 years of age). Hypertrophic cardiomyopathy (HCM) is the leading congenital abnormality associated with SCD. Congenital coronary anomaly, particularly anomalous origin of

Key Points

- Hypertrophic Cardiomyopathy is the leading cause of sudden cardiac death in athletes.
- Identification of risk factors for sudden cardiac death may prolong life.
- High School and collegiate preparticipation examination forms often fail to include important cardiac screening information.
- Preparticipation examination forms should reflect American Heart Association recommendations.
the left main coronary artery, has been identified as the second most common cause of SCD. Ruptured aorta, tunneled left anterior descending coronary artery, aortic stenosis, cardiomyopathy, arrhythmogenic right ventricular dysplasia, mitral valve prolapse, and coronary artery disease have also been identified as causes of SCD in athletes.

Preparticipation examinations are universally utilized to identify athletes who are at risk for injury or illness. Unfortunately, many individuals who have risk for SCD are not identified and are therefore allowed to participate without knowledge of risk. One in 200,000 high school athletes are estimated to be at risk each year in the United States. This estimate is thought to be low, due to a lack of complete data. A prospective study conducted over 20 years in the Veneto Region of Italy documented 2.1 SCD cases per 100,000 athletes per year among athletes between 12 and 35 years of age. Structural abnormalities of the heart, which are primarily congenital, are present in the majority of SCD cases. Intense physical training probably increases the risk for SCD in individuals with underlying structural heart disease, but the extent to which risk is elevated cannot be quantified. Early detection of individuals at risk for SCD through preparticipation screening may prolong life by initiating an appropriate therapeutic intervention.

Physiologic myocardial hypertrophy is a normal response to regular exercise, which is dependent on the type, frequency, duration, and intensity of exertion and the gender of the athlete. Regular isotonic exercise produces a symmetric increase in the size of the left ventricle (LV) and an increase of up to 10% in left ventricular end-diastolic diameter (LVEDD), which is associated with a 53% increase in LV end-diastolic volume. As an adaptation to the increased tension on the wall of the LV, physiologic hypertrophy increases its mass. Because the increases in LV wall thickness and LVEDD are proportionate, the mass-to-volume ratio remains constant.

Contrary to the effect of isotonic exercise, regular isometric exercise produces in an increased mass-to-volume ratio. The increase in mass results from a dramatic increase in systolic blood pressure from increasing afterload (i.e., resistance to blood flow through the arteries). Without an increase in venous return, there is no increase in LVEDD during isometric exercise. Physiologic hypertrophy tends to be symmetric, whereas pathologic hypertrophy is more asymmetric. The term “athlete’s heart” refers to symmetric cardiac adaptations that result from intense physical training. Asymmetric structural enlargement may be identified as hypertrophic cardiomyopathy (HCM).

**Methods of Detection**

In an effort to reduce SCD, clinical researchers have evaluated different methods for identification of high-risk athletes. Echocardiography has been advocated as an effective method, but it is not considered to be a cost-effective option. Exercise stress testing is another effective method, but it is not considered cost-effective for screening large numbers of athletes.

**American Heart Association Guidelines**

In 1996, the Science Advisory and Coordinating Committee of the American Heart Association created a panel of cardiovascular specialists, other physicians with extensive clinical experience with athletes of all ages, and a legal expert for the following purposes: (a) to assess the benefits and limitations of preparticipation screening for early detection of cardiovascular abnormalities in competitive athletes; (b) to address cost-efficiency, feasibility, and the medical and legal implications of screening; and (c) to develop consensus recommendations and guidelines for the most prudent, practical, and effective screening procedures and strategies.

Recommendations concerning athletic participation eligibility for athletes with cardiovascular disorders were developed at the 16th Bethesda Conference. The recommendations were updated at the 26th Bethesda Conference to specify that approval for participation should be based on the severity of the cardiovascular disease, its association with SCD, and the success of medical or surgical intervention in treating the condition. Hemodynamic criteria and symptoms were also considered to be important in the decision about athletic participation eligibility.

Although the sudden death of an athlete is an uncommon occurrence, those at risk need to be identified and advised of the existence of the condition. Athletes with high-risk cardiac abnormalities should not be allowed to participate in competitive athletics. Knowledge of cardiovascular adaptations among trained athletes is vital for differentiation between physiologic hypertrophy and pathologic hypertrophy.