DOI: 10.14744/ejmi.2018.54154
EJMI 2019;3(1):54–58

Research Article

Sports Pre-participation Evaluation in Children

Huseyin Dag, Meric Ocal, Hasan Dursun, Ahmet Irdem

Department of Pediatrics, University of Health Sciences, Istanbul Okmeydani Training and Research Hospital, Istanbul, Turkey

Abstract

Objectives: Sudden cardiac death (SCD) in athletes is tragic and does not sometimes show symptoms until death. This event may occur during competition and training and while resting. SCD is defined as death that occurs within 1 h and 24 h after symptom onset in witnessed and unwitnessed cases, respectively. SCD mortality rates are generally unpredictable. The question as to which parameters should be tested before a sports activity is still debatable. This study was conducted to identify the risk groups and draw attention to this delicate subject.

Methods: Children younger than 18 years who presented to our hospital between April 2016 and January 2018, who were referred to the Pediatric Cardiology Outpatient Clinic by pediatricians and family physicians to obtain a medical certificate before performing sports activities, and whose case report forms were completely filled out in accordance with the 12-element American Heart Association (AHA) screening guide were enrolled in this retrospective study. Data were evaluated using SPSS 16.0 software.

Results: The study included 974 children. Of them, 661 (67.9%) were male and 313 (32.1%) were female. Their mean age was 11.38±3 years, whereas the mean age of female and male participants was 11.6±3 and 11.29±2.99 years, respectively. Among the participants, 83.3% had normal sinus rhythm, 15.8% had sinus arrhythmia, 0.2% had ventricular extra beats, and 0.2% had long QT. Four patients had aortic root dilatation. Six patients were deemed unfit for sports.

Conclusion: Consequently, although sports preparticipation evaluation is important in many aspects, how to conduct such an evaluation is still controversial. Previous evaluation of an athlete who experienced SCD can be normal, whereas an athlete without any health problems may be deemed unfit for sports. Data that will be obtained from future multicenter studies and postmortem data can provide guidance in creating guidelines.

Keywords: Children, sports, sudden cardiac death

Cite This Article: *Dag H, Ocal M, Dursun H, Irdem A. Sports Pre-participation Evaluation in Children. EJMI 2019;2019;3(1):54–58.*

Sudden cardiac death (SCD) in athletes is a tragic event and does not sometimes show symptoms until death. This event may take place during competition and training and even while resting. SCD is defined as death that occurs within 1 h after symptom onset in witnessed cases and within 24 h after symptom onset in unwitnessed cases. In addition, possible causes related to cerebrovascular and respiratory events as well as drug use should be eliminated.[1–3] Athletes are generally described as the healthiest and strongest individuals who usually have outstanding physical success in the society. The unexpected death of an athlete during training or competition has a negative impact on not only the family but also the society.[4, 5]

Although the incidence of SCD during a sports activity has a wide range, it is accepted as 1/50000 and 1–3/100000 according to the data obtained from retrospective and prospective studies. These rates differ depending on the sports activity, ethnicity, and age. The mortality rate is higher in the black race, basketball players, and men. These mortality rates are generally unpredictable.[6, 7]

Address for correspondence: Huseyin Dag, MD. Istanbul Okmeydanı Egitim ve Arastirma Hastanesi, Saglık Bilimleri Universitesi, Pediatri Anabilim Dalı, İstanbul, Turkey
Phone: +90 553 393 34 98 **E-mail:** huseyindag2003@gmail.com

Submitted Date: November 28, 2018 **Accepted Date:** December 19, 2018 **Available Online Date:** January 21, 2019

The most common causes of sudden cardiac arrest are structural and arrhythmogenic heart diseases. The rate of proven causes of cardiac origin varies between 52% and 72% in previous studies. The most common structural heart disease is hypertrophic cardiomyopathy (HCM). Abnormal origins of the coronary arteries, especially the left coronary artery originating from the right sinus of Valsalva, are more common.[2]

Efforts were made to determine and implement various strategies to reduce unexpected deaths in sports. The most important link of this strategy is to identify and disqualify candidates of SCD from competitive sports before cardiac death occurs. According to the AHA guidelines, athletes can only participate in sports activities after providing a thorough medical and family history and undergoing a detailed physical examination in the USA.

In Turkey, a consensus has not been reached yet concerning the screenings that should be conducted before participation in sports activities and the scope of these screenings. This study was conducted to identify the risk groups before participation in sports and draw attention to this subject.

Methods

Children younger than 18 years who presented to our hospital between April 2016 and January 2018 and were referred to the Pediatric Cardiology Outpatient Clinic by pediatricians and family physicians in order to obtain a medical certificate before undertaking sports activities and whose case report forms were completely filled out in accordance with the 12-element screening guide of the AHA were enrolled in this retrospective study (Table 1). The approval for this study was obtained from the Ethics Committee of the University of Health Sciences Istanbul Okmeydanı Health Practice and Research Center. Case report forms containing personal medical history, family history, anthropometric characteristics, physical examination, sports history, and electrocardiographic (ECG) and echocardiographic information were filled out for all patients who were included in this study. Patients with incomplete file records and patients older than 18 years were excluded from the study.

For ECG, records were obtained from DI, DII, DIII, aVR, aVF, aVL, and 6 chest leads (V1–6) at a standard speed of 25 mm/s and 10 mm/mV using the Firstmed ECG-300 device. Rate, rhythm, axis, PR interval, QRS amplitude and duration, QTc, T wave, and ventricular hypertrophy criteria were evaluated from ECG traces.

Findings of the transthoracic echocardiography (TTE) performed using GE Vivid S5 device by the same experienced pediatric cardiologist were obtained from the files.

Table 1. American Heart Association 12-element screening guide

Personal medical history
1. Chest pain with exercise
2. Unexplained syncope/presyncope
3. Severe dyspnea and fatigue associated with exercise
4. Previously detected murmur
5. High blood pressure
Family History
6. Early mortality associated with cardiovascular disease at an age >50 years among the first-degree relatives
7. Cardiovascular disease at an age > 50 years
8. Hypertrophic cardiomyopathy, dilated cardiomyopathy, long QT syndrome and other channelopathies, significant arrhythmias, and Marfan syndrome
Physical examination
9. Murmur
10. Checking femoral and radial pulses to eliminate coarctation of the aorta
11. Sign of Marfan syndrome
12. Brachial artery blood pressure

Patients with complete case report forms containing personal medical history, family history, anthropometric characteristics, physical examination, sports history, and ECG and TTE information were included in this study. The data obtained in the study were evaluated using SPSS 16.0 software.

Results

The study included 974 children. Of these, 661 (67.9%) were male and 313 (32.1%) were female. The mean age of the children included in the study was 11.38±3 years, whereas the mean age of female and male participants was 11.6±3 years and 11.29±2.99 years, respectively.

The mean height of the children included in the study was 148.02±18.2 cm. The mean height of female and male participants was 147.09±16.6 cm and 148.47±18.8 cm, respectively. The mean body weight of male and female participants was 44.68 ±18.03 kg and 44.12± 15.1 kg, respectively.

The mean systolic and diastolic blood pressures of the male participants were 106.3±10.18 mmHg and 65.2±8.9 mmHg, respectively, and the mean systolic and diastolic blood pressures of the female participants were 105.75±9.7 mmHg and 65.10±8.7 mmHg, respectively.

Thirty patients (3.1%) had a pathological finding according to the 12-element screening guide of the AHA (Table 1). Among these patients, 1 had aortic root dilatation.

Among the participants, 83.3% had normal sinus rhythm, 15.8% had sinus arrhythmia, 0.2% had ventricular extra beats, and 0.2% had long QT (Table 2). Patients who were previously diagnosed with long QT syndrome (LQTS) were subjected to genetic testing after exercise ECG and 24-hour Holter monitoring. A long QT diagnosis was confirmed.

Among the patients who applied for a medical certificate before undertaking sports activities, 931 (95.6%) had normal echo reports based on their echocardiograms. Forty-three patients had a pathology in their TTE report, while 4 patients had aortic root dilatation (Table 3).

Of the included patients, 968 (99.4%) were given a medical certificate to participate in sports, whereas 6 (0.6%) were given a report indicating that sports activities could be undesirable for them from the cardiac aspect.

Discussion

It has become highly questionable whether children or adolescents are fit for sports activities due to the increasing participation in sports activities and increasing incidence of SCD in asymptomatic patients. This in turn led to the emergence of sports preparticipation evaluation (SPPE).[9–11] A medical screening is necessary before starting a sports activity. However, a consensus on the screening procedure has not been reached yet. The main purpose of examination before participation in sports activities is to reveal an underlying and latent cardiovascular abnormality that could cause SCD.[12, 13] Despite the undeniable contribution of ECG and/or TTE evaluations in addition to medical history, family history, and physical examination findings, i.e., the basis of SPPE, to decrease morbidity and mortality, costs and false positivity concerns constitute the controversial issues. Therefore, the scope and effectiveness of preparticipation cardiovascular evaluation for individuals participating in competitive sports have been discussed for many years. During the screening of athletes, the presence of exercise-related cardiac symptoms and heart murmur that could be clinically significant as well as a heart disease or unexpected sudden death in the family history raises clinical suspicion for many cardiovascular diseases.

Table 2. Electrocardiogram findings in our patients

	Number (n)	Percentage (%)
Normal sinus rhythm	812	83.4
Sinus arrhythmia	154	15.8
Sinus tachycardia	4	0.4
Ventricular extra beat	2	0.2
Long QT syndrome	2	0.2
Total	974	100

Table 3. Echocardiogram findings in our patients

Results	n	Percentage (%)
Aortic root dilatation	4	0.4
Atrial septal defect (ASD)	3	0.3
Aortic regurgitation	3	0.3
Mitral regurgitation (mild)	13	1.3
Mitral and aortic regurgitation (mild)	2	0.2
Mitral valve prolapse and mitral regurgitation	2	0.2
Mitral regurgitation (mild) and patent foramen ovale	1	0.1
Pulmonary stenosis (mild)	1	0.1
Pulmonary hypertension (mild)	1	0.1
Patent foramen ovale	13	1.3
Normal	931	95.6

The 12-element AHA Recommendations published in 2007 is an evaluation that consists of 5 questions regarding personal medical history, 3 questions regarding family history, and 4 questions regarding physical examination (Table 2). When the answer to 1 question is yes, further tests and research are necessary.[9, 14] The AHA has not included ECG screening in this evaluation due to various reasons, unlike the European Society of Cardiology. However, the sensitivity of medical history and physical examination was between 0 and 33% and 60 and 80%, respectively, in patients who experienced sudden death and did not previously have signs and symptoms according to some studies.[15–18] In this study, 2 patients were diagnosed by ECG and 4 patients were diagnosed by echocardiography. Among our patients, only 1 had a pathology according to the 12-element evaluation of the AHA. According to this evaluation, 5 patients could remain undiagnosed or 4 patients would remain undiagnosed as the European Society of Cardiology uses ECG as a routine procedure.

Adherence to the AHA criteria in obtaining the detailed medical history and performing the physical examination remains to be another problem. In a study by Madsen et al., 53% of healthcare personnel were not aware of the AHA criteria. Moreover, only 5.7% of the physicians obtained medical history and performed physical examination completely in accordance with the AHA criteria during athlete screenings.[19]

It is estimated that adding ECG to medical history and physical examination results in at least twofold increase in sensitivity.[20, 21] According to a study by Corrado et al., adding

ECG to medical history and physical examination reduced the rate of sudden death by 89% in the Veneto region of Italy.[21, 22] Besides the mentioned advantages, adding ECG also leads to increased costs, increased rate of false positivity, and decreased specificity. The fact that physiological changes cannot always be easily distinguished from pathological changes is considered another problem. Screenings with ECG have a false positivity rate of nearly 10% to 40%, and therefore, a large number of tests are conducted.[15, 17, 22] The exact opposite of this situation is false negativity in ECG. Nearly 10% of the patients with HCM may not have any signs in ECG.[23] According to a study by Pelliccia et al., nearly half of the athletes who had serious cardiac problems did not show any signs in ECG.[24]

Corrected QT (QTc) interval ≥480 ms and detection of LQTS mutation or QTc interval ≥460 ms in patients with unexplained syncope in which long QT cannot be explained by any other reason is defined as LQTS. The mean age of patients presenting to the hospital with LQTS is approximately 14 years. Annual mortality rates vary between 0.33% and 0.9%. It is recommended to avoid drugs that prolong the QT interval, correct electrolyte disturbances, and avoid specific triggers such as swimming for patients with LQTS.[25, 26] Among the patients we diagnosed, 2 patients were applying for the medical certificate to become professional licensed soccer players, wherein they were not allowed to play sports after obtaining the approval of their families.

The European Society of Cardiology 2015 guidelines on sudden death and AHA 2015 guidelines on athletes with cardiovascular abnormalities recommend that athletes with symptomatic LQTS should refrain from competitive sports. The same guidelines recommend that athletes with asymptomatic phenotype and negative genotype can be considered to continue playing sports as long as they avoid drugs that prolong the QT interval; avoid electrolyte imbalance, dehydration, and hyperthermia; and keep a personal external defibrillator and provided that the teams devise the emergency plans.[27, 28]

Echocardiography that will be performed in case of a clinical requirement before participation in sports is a very important diagnostic tool, especially in the clinical investigation of left ventricular (LV) hypertrophy.[13] Echocardiography facilitates the diagnosis of conditions that can lead to sudden death in young athletes such as valvular heart diseases (mitral valve prolapse, aortic valve stenosis), aortic root dilatation seen in Marfan syndrome and related syndromes, and LV dysfunction and/or hypertrophy associated with dilated cardiomyopathy or myocarditis. In our study, 4 patients were not allowed to participate in sports activities as they were diagnosed with aortic root dilatation with this diagnostic tool.

SPPEs should be considered as an opportunity for follow-up of an athlete and for conducting certain screenings. Identified risk factors (hypercholesterolemia, hypertension, anemia, etc.) may create awareness in family members besides protecting the athlete by means of taking the necessary precautions.

Consequently, although SPPE is important from many aspects, how to conduct such an evaluation is still debatable globally and in Turkey. Previous evaluation of an athlete who experienced SCD can be normal, and an athlete without any health problems may not be deemed fit for sports, either. Data that will be obtained from future multicenter studies as well as postmortem data can provide guidance in creating guidelines. Apart from all these studies, it is of utmost importance to design sports fields in a manner to enable all sorts of first aid applications.

Disclosures

Ethics Committee Approval: The approval for this study was obtained from the Ethics Committee of the University of Health Sciences Istanbul Okmeydanı Health Practice and Research Center.

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Authorship Contributions: Concept – Hu.D., A.I.; Design – Hu.D., A.I., M.O., Ha.D.; Supervision – Hu.D., A.I., M.O., Ha.D.; Materials – Hu.D., A.I., M.O., Ha.D.; Data collection &/or processing – Hu.D., A.I., M.O.; Analysis and/or interpretation – Hu.D., A.I., Ha.D.; Literature search – Hu.D., M.O., A.I., Ha.D.; Writing – Hu.D., M.O.; Critical review – Ha.D., A.I., Ha.D.

References

1. Adabag AS, Luepker RV, Roger VL, et al. Sudden cardiac death: epidemiology and risk factors. Nature reviews Cardiology. 2010;7:216–25. [CrossRef]
2. Myerson M, Sanchez-Ross M, Sherrid MV Preparticipation Athletic screening for genetic heart disease. Prog Cardiovasc Dis. 2012;54:543–52. [CrossRef]
3. Maron BJ, Zipes DP. Introduction: eligibility recommendations for competitive athletes with cardiovascular abnormalities-general considerations. J Am Coll Cardiol 2005;45:1318–21.
4. Maron BJ. Sudden death in young athletes. N Engl J Med 2003;349:1064–75. [CrossRef]
5. Sweeting J, Ingles J, Ball K, et al. Sudden deaths during the largest community running event in Australia: a 25-year re-

view. Int J Cardiol 2015;203:1029–31. [CrossRef]
6. Harmon KG, Drezner JA, Wilson MG, et al. Incidence of sudden cardiac death in athletes: a state-of-the-art review. Br J Sports Med 2014;48:1185–92. [CrossRef]
7. Harmon KG, Asif IM, Klossner D, et al. Incidence of sudden cardiac death in National Collegiate Athletic Association athletes. Circulation 2011;123:1594–600. [CrossRef]
8. Hirzinger C, Frolicher VF, Niebauer J. Pre-participation examination of competitive athletes: role of the ECG. Trends Cardiovasc Med 2010;20:195–9. [CrossRef]
9. Maron BJ, Thompson PD, Ackerman MJ, Balady G. Recommendations and considerations related to preparticipation screening for cardiovascular abnormailities 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;115:1643–55. [CrossRef]
10. Corrado D. Cardiovascular pre-participation screening of young competitive athletes for prevention of sudden death: proposal for a common European protocol: Consensus Statement of the Study Group of Sport 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. Eur Heart J 2005;26:516–24. [CrossRef]
11. Ljungqvist A, Jenoure P, Engebretsen L. The International Olympic Committee (IOC) Consensus Statement on periodic health evaluation of elite athletes March 2009. Br J Sports Med 2009;43:631–43. [CrossRef]
12. Corrado D, Thiene G. Protagonist: routine screening of all athletes prior to participation in competitive sports should be mandatory to prevent sudden cardiac death. Heart Rhythm 2007;4:520–4. [CrossRef]
13. Maron BJ, McKenna WJ, Danielson GK. American College of Cardiology/European Society of Cardiology clinical expert consensus document on hypertrophic cardiomyopathy: a report of the American College of Cardiology Foundation Task Force on Clinical Expert Consensus Documents and the European Society of Cardiology Committee for Practice Guidelines. J Am Coll Cardiol 2003;42:1687–713. [CrossRef]
14. Seto CG. The preparticipation physical examination: an update. Clin Sports Med 2011;30:491–501. [CrossRef]
15. Asif IM, Rao AL, Drezner JA. Sudden cardiac death in young athletes: what is the role of screening? Curr Opin Cardiol 2013;28:55–62. [CrossRef]
16. Cohen YB, Silka MJ. The pre-sports cardiovascular evaluation: should it depent on the level of competition, the sport, or the state? Pediatr Cardiol 2012;33:417–27. [CrossRef]
17. Siddiqui S, Patel DR. Cardiovascular screening adolescent athletes. Pediatr Clin N Am 2010;57:635–47. [CrossRef]
18. Marijon E, Tafflet M, Celermajer DS, Dumas F, Perier MC, Mustafic H et al. Sports-related sudden death in the general population. Circulation 2011;124:672–81. [CrossRef]
19. Maron BJ. Distinguishing hypertrophic cardiomyopathy from athlete's heart physiological remodelling: clinical significance, diagnostic strategies and implications for preparticipation screening. Br J Sports Med 2009;43:649–56. [CrossRef]
20. Garrick JG, Regua RK. Injuries in high school sports. Pediatrics 1978;61:465–9. [CrossRef]
21. Corrado D, Migliore F, Bevilacque M, Basso C, Thiene G. Sudden cardiac death in athletes. Herz 2009;34:259–66. [CrossRef]
22. 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;52:1981–9. [CrossRef]
23. Rowin EJ, Maron BJ, Appelbaum E, Link MS, Gibson CM, Lesser JR et al. Significance of false negative electrocardiograms in preparticipations screening of athletes for hypertrophic cardiomyopathy. Am J Cardiol 2012;110:1027–32. [CrossRef]
24. Pelliccia A, Culasso F, Di Paolo FM, Accettura D, Cantore R, Castagna W, et al. Prevalance of abnormal electrocardiograms in a large, unselected population undergoing preparticipation screening. Eur Heart J 2007;16:2006–10. [CrossRef]
25. Priori SG, Wilde AA, Horie M, et al. Executive summary: HRS/EHRA/APHRS expert consensus statement on the diagnosis and management of patients with inherited primary arrhythmia syndromes. Europace: European pacing, arrhythmias, and cardiac electrophysiology: journal of the working groups on cardiac pacing, arrhythmias, and cardiac cellular electrophysiology of the European Society of Cardiology 2013;15:1389–406.
26. Moss AJ, Schwartz PJ, Crampton RS, et al. The long QT syndrome. Prospective longitudinal study of 328 families. Circulation 1991;84:1136–44. [CrossRef]
27. Priori SG, Blomstrom-Lundqvist C, et al. 2015 ESC Guidelines for the management of patients with ventricular arrhythmias and the prevention of sudden cardiac death: The Task Force for the Management of Patients with Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death of the European Society of Cardiology (ESC). Endorsed by: Association for European Paediatric and Congenital Cardiology (AEPC). European heart journal 2015;36:2793–867. [CrossRef]
28. Ackerman MJ, Zipes DP, Kovacs RJ, et al. Eligibility and Disqualification Recommendations for Competitive Athletes With Cardiovascular Abnormalities: Task Force 10: The Cardiac Channelopathies: A Scientific Statement From the American Heart Association and American College of Cardiology. Circulation 2015;132:e326–9. [CrossRef]