Competitive Sports for Children and Adolescents: Should an Electrocardiogram Be Required in the Pre-Participation Physical Examination?

Cláudio Aparício Silva Baptista, Antonio Foronda e Luciana de Pádua Silva Baptista.

Centro Olímpico de Treinamento e Pesquisa (COTP) - Secretaria Municipal de Esportes de São Paulo; Hospital Sírio Libanês; Hospital Nove de Julho, São Paulo, SP, Brasil.

Summary

The growing number of children and adolescents, aged 7 to 17 years, that participate in competitive sports requires preventive medical care. The pre-participation physical examination (PPE) requires appropriate medical knowledge to insure safe medical clearance. Recent sudden death events related to sports practice have raised doubts concerning the need for a medical evaluation based on medical tests, which due to the delay in its implementation may result in demotivation and abandonment of the sports practice. This is a review study, including data collected during a period of 30 years at the Olympic Training and Research Center (COTP) of the Municipal Secretary of Sports of São Paulo, where future athletes are identified, socially included and trained; and the objective of the study was to evaluate the need for the involvement of medical organizations in the preparation of a EPP protocol for the cardiovascular assessment of this population, according to the Brazilian reality. We had no normative standard, and so we relied on data collected from protocols that were established by other countries, but we defined which conduct to be taken with each of our individuals.

Introduction

This is a routine clinical scenario: A mother goes to a Basic Health Care Unit, in a Brazilian city, accompanied by her children (child, adolescent), for pediatric evaluation. After waiting for days or weeks, she schedules an evaluation to obtain a certificate of medical clearance that will allow her children to participate in the school's sports competitions, such as, for example, the "Children/Juvenile Games of the City of São Paulo". For the reader's clarification, these games include many sports modalities, and around 30 thousand children and adolescents, within a universe of one million and a hundred thousand local students, are expected to participate each year. The medical evaluation is conducted with all the appropriate questionnaires and with a thorough physical examination. After a routine consultation, the physician provides the certificates with the medical clearance for the sports competitions. This medical conduct raises some questions: Is this medical clearance a correct medical conduct? Should additional medical tests, a 12-Lead ECG, an exercise test, an echocardiogram or other tests be required? Would the physician be liable if a heart problem occurs? Would the physician have medical evidence to support this clearance? Would requesting additional medical tests be considered a practice of "defensive medicine"?

In the United States, approximately 361,000 high school students participate in competitive sports activities, involving around 1,200 schools each year[1]. In Brazil, we have no official statistical information, but the number of children and adolescents, aged 7 to 17 years, that participate in sports competitions is increasing. The vast majority of children and adolescents who engage in sports activities are healthy, with no cardiovascular symptoms whatsoever. The rarity of prodomal symptoms is prevalent, even in cases of congenital heart diseases, acquired heart diseases or myocardiopathies. The possible presence of a heart murmur due to anatomic heart defects, high blood pressure, arrhythmias, among others, raises doubts about this medical clearance for sports participation.

Although early age sports participation is an issue that should undergo the scrutiny of medical, educational and psychological discussions, the number of these participants is growing steadily. It is very difficult to quantify the total organic demand, including the heart performance of a child or adolescent who engages in sports competition (athlete) or recreational sports, as to the intensity of the exercise — an athlete is defined as a person who engages in routine physical training within a competitive timetable. Those who participate in school, club or even street competitions fully and exhaustively engage in sports practice, aiming at victory, and it is virtually impossible to differentiate them from "federated athletes".

Specifically, the pre-participation physical examination (PPE)[2], which in routine medical conduct is also applied to the general population of sports practice beginners, should be conducted by an experienced physician, and its objective should be:

- To evaluate the general health conditions of the participant.

- Identify previous signs and symptoms of conditions that could cause adverse effects to the participants during sports practice, such as, for example, heart diseases.

Key Words

Sports; child; adolescent; medical care; medical examination.

Mailing Address: Luciana de Pádua Silva Baptista•
Rua Indiana 463, Brooklin, 04.562-000, São Paulo, SP, Brasil.
E-mail: clabap@ip2.com.br
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- To provide behavior counseling concerning the participant's life and habits.

- To provide support for legal and institutional implications.

The PPE does not aim at excluding people from physical activity, and less than 1% (0.3 to 0.6%) of this population is disqualified and recommended not to participate in sports competitions; in the majority of cases, this a unique opportunity for a medical and interdisciplinary contact[3-4]. As there is no established standard, the involved organizations create their own protocols, with medical evaluations and tests, according to their realities. In our public services there is no standard medical conduct, because none has been established, specially for children and adolescents that participate in sports competitions. As to the PPE, a discussion about an almost ideal heart risk stratification is needed, in view of doubts and fears concerning the safe medical clearance of this population for competitive sports practice at all levels.

Sudden Death in Sports Competitions

Sudden Death (SD), though very rare in this population, is always tragic and impressive, involving several medical and legal aspects. Unfortunately, some SD events that occurred in competitions for older groups are extrapolated into this age group, and they serve as a basis for a systematic methodology. Among some published series, two studies from Minnesota stand out. A study conducted by Maron et al[5], monitoring 1400000 student athletes, in 27 sports modalities, during a period of 12 years, estimated 1 SD / 200000 cases per year. And a study conducted by Van Camp et al[6], estimated 1 SD / 133000 males and 1 SD / 769000 females, in a population of high school student athletes. We noted that both published studies have not specifically mentioned SD in children and/or adolescents, and all the related data was entirely estimated.

Preventive Efforts

Unfortunately, the "zero risk" for SD in this population, as well as in adults, using the EPP, is not achieved in clinical practice, despite the use of more inclusive methodology. However, this is an objective that should always be sought for. The EPP must be based on clinical history and physical examination, which are irreplaceable propaedeutic tools when cardiovascular disease risk is suspected in sports practice, and the expertise in the use of these tools is an essential part of a good professional medical training.

Recently, scientific discussions and controversies involving the European Society of Cardiology[7] and the International Olympic Committee[8,9] concerning the risk stratification for heart disease, proposed compulsory 12-Lead ECG as a complementary methodology to clinical history and physical examination, pointing out the advantages of its routine use in the prevention of heart diseases, which are a potential risk related to sports practice and SD. The American Heart Association (AHA) is opposed to this position, offering relevant arguments against it[10].

It is noteworthy that the vast majority of heart diagnoses in this population of children and adolescents can be reached by clinical history and physical examination. It is important to stress that the information obtained by clinical history in this age group is discordant or omitted in 30 to 40% of cases, when parents are further questioned, confirming the importance of the participation of the parents in clinical data collection[11]. In the last 5 years, at the Olympic Training and Research Center (COTP) of the Municipal Secretary of Sports of São Paulo, a questionnaire to be completed by parents with questions concerning the health of their children was created, and it facilitated and substantially improved the quality of the PPE in this center. Additional medical tests sometimes are unnecessary, and they should be cautionally indicated, because they can result in a costly secondary assessment and motivate concern[12]. For example, a physiological heart murmur may be auscultated in the majority of children at some stage of their development. The experience of the examiner is important to distinguish it from an organic or pathological murmur. McCrindle et al[13] evaluated 222 children for murmur clarification, and the physical examination resulted in a sensibility of 92% and a specificity of 94%, with a positive predictive value of 88%, and a negative predictive value of 96%, for pathological murmurs. Therefore, it is always important to recognize the value of clinical history and physical examination[14].

12-Lead ECG

The opinion of those who advocate the compulsory 12-Lead ECG is based on the fact that it is impossible to diagnose channelopathies through clinical history and physical examination, specially the Long-QT syndrome, the Short-QT syndrome and the Brugada syndrome, which are responsible for about 0.3% of cases of SD in adult athletes[10], although there are no specific records on children and adolescents. With only the clinical history and the physical examination it is impossible to diagnose the Wolff-Parkinson-White syndrome and some cases of Hypertrophic Cardiomyopaty (HCM), and the latter served as a basis for the creation of the European protocol[7]. In a short and objective way, we will discuss some diagnostic aspects related to these diseases, with special emphasis on whether a 12-Lead ECG should or should not be required to prevent cardiovascular risk in sports practice.

Long-QT Syndrome

The syndrome of congenital Long-QT is related to Child SD (CSD). Many CSD victims had normal QT interval, without previous symptomatic arrhythmia and no family history of SD or Long-QT syndrome. The first association between CSD and L-QTS was made by Maron et al[15] through 12-Lead ECG evaluation of close relatives of CSD victims; therefore, this was a secondary assessment after a first family event. Arnestad et al[16] proposed , due to genetic variants found in 201 CSD cases, the use of the 12-Lead ECG for risk stratification of L-QTS detection, as early as in the neonatal period.

Other studies[17,18] disagree with this position, due to the large regional variations in the cost-effectiveness/benefits of

this procedure according to the medical system involved, the accuracy of its interpretation, the psychosocial aspects generated by false positive results of the 12-Lead ECG, the ineffectiveness of the treatment in confirmed cases, and the political difficulties of its implementation.

In another study, Berul et al[19] reported that, besides the difficulty in measuring the QT interval and the multiplicity of factors involved in CSD, the 12-Lead ECG does not identify the CSD risk in a vast majority of children. The study also points out the variability that frequently occurs at this age, with spurious and transient increases in the first week after birth, and in the transition to the neonatal period. There are genetic tests available for the different sub-groups described in this syndrome: L-QST 1, L-QST 2, L-QST 3, L-QST 4, L-QST 5, related to the membrane ionic channel, and the type 4, linked to another genetic mutation. SD in swimming can be related to L-QTS 1. However, an indication of these tests in routine preventive efforts is impractical and unaffordable in almost all the medical services[20].

Monitoring 2000 elite athletes during a period of 10 years, Basavarajaiah et al[21] found 7 athletes (0.35%), 6 of them male, following the recommendations of the 36th Conference of Bethesda, published in 2005[22], which established QTc>450ms as the exclusion criterion for competition. They conducted genetic tests in 5 athletes (2 declined: QTc=460ms and QTc=492ms), and only 1 female swimming athlete, with QTc=515ms, showed a positive genetic alteration for L-QTS 1. The other 2, with QTc=550ms and QTc=570ms, had negative tests. They proposed a revision of the Bethesda criterion, which should only exclude those with QTc>500ms.

These considerations show the challenges in early or asymptomatic diagnosis of this syndrome. They also explain why the clinical and methodological investigations, in almost all studies on SD related to physical activities and L-QTS, are conducted after individual or family events, and ocasionally in routine examinations.

The Brugada Syndrome

The Brugada syndrome results in an autosomal dominant genetic alteration, and it is an arrhythmogenic disease. The most prevalent factor associated with the onset of arrhythmia and SD is fever, which most often occurs at rest, while sleeping at night. It predominates in male adults (>90%), 34 to 53 years of age, and it is more common in the Asian race.

It has typical eletrocardiographic patterns in right precordial leads (V1-V2-V3)[23]. Probst et al[24] evaluated 30 children and adolescents with the syndrome, with an average age of 8, 22 of them with less than 12 years of age. In 12 cases, syncopes (11/12 cases) and recovered cardiorespiratory arrest (1/12 cases) were the clinical conditions that led to the diagnosis of this syndrome. The remaining subjects were asymptomatic, and the syndrome was diagnosed by family history as the clinical history was collected; therefore, the diagnosis was reached after a personal or family event. In this pediatric population, the author highlighted some characteristics that were similar to those found in adults: More frequent symptoms with typical ECG patterns, and arrhytmic events that occurred most often after fever and at rest. To achieve a sample of 30 patients, 30 centers, in many cities, in three European countries, had to be included.

Since its discovery, 15 years ago, this syndrome has had an average prevalence of less than 3 children per reference medical center, contrasting with that found in the adult population, in which more than 1500 cases were reported. This confirms the extreme rarity of the syndrome in childhood[24].

In view of the above, would compulsory 12-Lead ECG, as a routine procedure for the prevention of CSD related to sports practice in this healthy population, in an effort to detect the Brugada syndrome, be cost/effective? Due to its rarity, the association between SD / child / adolescent / Brugada / physical activities should be individualized by appropriate clinical and family history, before widespread and perhaps costly 12-Lead ECG requests become mandatory.

Wolff-Parkinson-White

It is estimated that 0.1 to 0.3% of the general population, while in sinus rhythm, present ECG alterations that are suggestive of the Wolff-Parkinson-White (WPW) syndrome, and relevant discussions concerning the best therapeutic approach in these cases are still under way[25]. Specifically in children, the natural history of the WPW syndrome is unknown, due to the limited follow-up period and the small sample of cases, and also the lack of criteria in the selection of the studied series[26].

Papone et al[27] conducted a 5-year study (1999-2004) in 165 asymptomatic children, aged 5 to 12 years, with WPW. They were sent to Italian medical reference centers, where electrophysiological studies were conducted for risk stratification according to an established protocol. After this assessment, 47 children were allocated as being at high risk for arrhythmic events, and they were divided in 2 groups: Ablation Group (AG, n=20) and Control Group (CG, n=27). During an average follow-up period of 34 months, for AG, and 19 months, for CG, 1/20 (5%) and 12/27 (44%) arrhythmic events occurred, respectively. The authors stressed the importance of a more aggressive treatment, including ablation. During this follow-up period, 8 patients of the CG were referred for ablation. In summary, from the initial group of 165 patients, ablation was not proposed in 137, even after electrophysiological exams. There was a case of SD in the CG, but the fatal arrhythmia was not identified, and no relationship with physical effort was mentioned.

Hein and Wellens[28], of the Maastricht Cardiovascular Research Institute, Netherlands, opposes the conclusions reached by Pappone et al[27], especially concerning the criteria for risk stratification with the electrophysiological study. It's interesting to note that 200000 routine 12-Lead ECGs would be necessary for the identification of 165 asymptomatic children with WPW. Hein and Wellens[28] concluded that, although this routine has been mandatory in Italy since 1982, compulsive 12-Lead ECG in PPE would not be indicated or adopted by other European countries, nor in the stratification of the WPW. Although the ablation in children over 6 years and asymptomatic and competitive adolescents is a trend, the debate is still under way.

Similarly to most previous studies, this syndrome is searched for after arrhythmic events or in casual routine examination, and a normal 12-Lead ECG does not necessarily excludes its presence. This is a much debated issue, and its specific association with child and adolescent SD in sports practice is rarely mentioned, and when mentioned, it is not appropriately documented.

Hypertrophic Cardiomyopathy

The first reports by Maron et al[29] indicated HCM as the most important SD cause in young athletes (<35 years). In that sample, we observed that the SD average age was 23 years, and not the younger group, which is the subject of this discussion. Most HCM diagnoses (90%) were reached after clinical events, especially arrhythmia-related symptoms, such as syncopes or pre-syncopes, chest pain and fatigue. It should be stressed that a normal 12-Lead ECG does not exclude the diagnosis of HCM, and in some cases, the definitive diagnosis is reached only by echocardiogram or MRI. As we will discuss afterwards, its earlier diagnosis by 12-Lead ECG became the basis for the European protocol.

Congenital Anomalies of the Coronary Arteries

Congenital anomalies of the coronary arteries are also mentioned as an important SD cause in young athletes. Usually the subjects are clinically asymptomatic and have a normal 12-Lead ECG[30]. Therefore, CSD risk stratification with compulsory 12-Lead ECG would also be questionable in this group of patients, because most often the infantile (malignant) form has exuberant clinical manifestations, presenting CHF as early as in the neonatal period or in the first months of life, and the adult form, when benign, allows late coexistence, being sometimes asymptomatic and associated with the presence of collateral circulation. Therefore, its early diagnosis in an asymptomatic child is very difficult.

Arrhythmogenic Right Ventricular Dysplasia

This is a genetic cardiovascular disease characterized by the replacement of myocardial fibers by fatty tissue in the right ventricle, which creates an arrhythmogenic substrate, rarely affecting the left ventricle. Similarly to the heart diseases mentioned above, the diagnostic research is preceded by symptoms and signs (pre-syncope, syncope, palpitations, ventricular tachycardia, frequent ventricular premature heartbeats), therefore it is a secondary research and/or in a subsequent family research. It is a cause of sudden death in young athletes with less than 35 years mentioned by Corrado et al[7] in 22.4%, and by Maron et al[29] in only 2.6%, with an average age above 20 years, therefore not corresponding to the population of this study. This discrepancy is mainly explained by the regionalization of the evaluated samples. Although intense exercise can induce arrhythmias, most events occur at rest or during routine daily activities, according to a series of 200 cases of SD related to this disease[31], confirming it to be very rare in the age group that was evaluated in this study. Besides, a normal 12-Lead ECG does not exclude its presence, and even an altered ECG does not confirm the disease. Rawlins et al[32] evaluated T-wave inversion in 1653 teenagers athletes, aged 14 to 18 years, 83% of them male, in the United Kingdom, and found no difference in its prevalence among athletes, when compared to 400 healthy and matched (4% and 3%) young subjects. Only 0.2% of the athletes aged 16 years or over had it, and after secondary investigations no cases of dysplasia or HCM have been described.

The European Protocol

The European protocol was specifically established in Italy, based on the initial results of a study conducted in 1998, by Corrado et al[33]. In this study, involving 33735 athletes under 35 years, in the Veneto region, with a 25-year follow-up, there was a reduction by 95% in SD events in athletes, mainly due to the more frequent and earlier diagnosis of HCM, after the introduction of compulsory 12-Lead EGC in PPE, along with the clinical history and the physical examination. The main causes of SD in 49 athletes were: arrhythmogenic right ventricular dysplasia (n = 11; 22.4%); coronary artery disease (n = 9, 18.4%); congenital anomaly of coronary arteries (n = 6; 12.2%); and other less frequent causes, with only 1 case (2%) of MCH, thus differing from the results of the study conducted by Maron et al[29], which indicated HCM as the most frequent cause of SD. Of the 33735 athletes, 3016 (8.9%) were stratified for echocardiogram, aiming at the detection of HCM, which was confirmed in 22 athletes. It is noteworthy that in only 12 of these 22 athletes the stratification was achieved by previous electrocardiographic alterations (0.0004% / 33735). In the remaining 10 - 3 with family history of HCM, 2 by the detection of a murmur and 5 by the presence of premature heartbeats - these manifestations were detected by clinical history and physical examination. These results were reviewed and updated by the authors in 2003[34]. Due to these data, the compulsory 12-Lead ECG became mandatory in 1982, along with the clinical history and physical examination, as a determining factor in the creation of the European protocol[35,36].

The American Protocol (American Heart Association - AHA)

According to Thompson et al[37], the study conducted by Corrado et al[34] requires a better conclusive evaluation, because it did not compare the direct stratification of athletes and non-athletes, resulting in an observational and populational study; also, its regionalization did not allow for extrapolated data.

In 1996, the first recommendations of the American Heart Association (AHA) Scientific Statement for the PPE were set forth[38]. In 2007, there were no relevant modifications, and a medical history, including family history and a thorough physical examination result in an excellent methodology for the detection of heart diseases in young competitive athletes[10]. The AHA highlights twelve topics as mandatory in the PPE, divided as follows:

Personal History

- Exercise-induced chest pain or discomfort.

-Unexplained or physical exercise-induced syncopes or pre-syncopes (not vasovagal or neurocardiogenic mediated).

-Unexplained or exercise-induced shortness of breath or fatigue.

-Heart murmur, personal history.

-High blood pressure.

Family History

-Premature SD (before the age of 50 years), unexplained or recognized to be due to heart disease in one or more close relatives.

-Close relative exclusion for sports before the age of 50 years.

-Recognized specific family conditions: HCM or dilated myocardiopathy; L-SQT syndrome; Marfan syndrome; other channelopathies, such as Brugada syndrome, or clinically relevant arrhythmias.

Physical Examination

-Heart murmur (auscultated in the supine or standing position, with Valsalva maneuver, especially for left ventricle outflow murmurs).

-Peripheral pulse palpation (for coarctation of the aorta).

-Physical features of Marfan syndrome.

-Measurement of blood pressure in both arms and preferably in the sitting position.

This standard evaluation is recognized by the AHA as a sound medical practice, and it is also a reference basis for cases and situations with legal involvement[39]. According to the European protocol, the Federal and State laws do not require a compulsory 12-Lead ECG at rest, in this specific population[40].

The AHA protocol (USA) versus the European protocol (Italy)

In Europe, some institutions, such as, for example, the Danish School of Cardiology[41], indicated that some considerations should be taken into account concerning the European regulations on compulsory 12-Lead ECG for children and adolescents:

-low cost-effectivenes in early detection of heart diseases in this population, as most of them are not detected with 12-Lead ECG, revealing themselves as "false negatives".

-high prevalence of "false positive" cases, generating expenses with unecessary subsequent evaluations.

-the possibility of arousing emotional problems and extreme anxiety for athletes, candidates, family members and coaches, and promoting discrimination.

-excessive expenses for health care systems, especially operational expenses, which would render the method unfeasible in most countries.

The AHA[10] is also opposed to compulsory 12-Lead ECG, adding the following considerations:

-the USA territory extension is 6 times larger than that of Italy

-it is estimated that, in the USA, 10 million boys and girls begin to practice sports and have to undergo PPE every year, which renders the compulsory 12-Lead ECG unfeasible.

-the compulsory 12-Lead ECG would cost the health care systems about US$ 2 billion per year for its implementation at national level; it would also require secondary evaluations, which are ineffectual in most cases.

Several studies involving from 200 to 2,000 high school students reported that the introduction of routine 12-Lead ECG in the PPE did not significantly improve the detection of heart diseases[42].

From 1990 to 2005, Katayoun et al[43] compiled the number of non-traumatic cardiorespiratory arrests (CRA) occurred in 600 schools, covering kindergarten, elementary school, junior high school, high school and university students, aged 3 years or over, in Seattle and King Country, in Washington. 97 cases of CRA were recorded: 12 among students, 33 among employees (teachers and assistants) and 45 among non-employed adults (7 adults with indeterminate school association). This study prompted the installation of automated external defibrillators in schools, which were present in 13 schools in 1999, and in 118 schools by 2005. 6 of the 12 CAR cases in students reportedly ocurred in sports practice locations, although their specificity was not mentioned. The question arises again: 12-Lead ECG in all of them? Between 1989 and 1997, Tanaka et al[44] recruited 37,807 students from a school in Kagoshima, Japan, who were followed for 20 years. A questionnaire was applied and a 12-Lead ECG was taken before the physical examination for heart disease risk stratification, not necessarily for sports practice. They reported that although their protocol seemed to be less expensive than AHA's, it was not sufficient for this objective. They concluded that a national registry, including necropsy data, in all cases, would be necessary for a better understanding of the mechanisms involved in SD and the preventive measures that should be taken.

OLYMPIC TRAINING AND RESEARCH CENTER (COTP)

After selective tests that are regulated by technical norms, children and adolescents of both genders are admitted for training. The athletes must undergo medical and interdisciplinary (nutritional, psychological, dental, social) evaluations to be accepted. During their association with the COTP, they are submitted to a compulsory evaluation each year or whenever required by the coach or the athlete. This initial medical evaluation is comprised of a thorough clinical history and a physical examination; also, since the foundation of the center, all these data are collected in a standard and updated medical record, including questions about the athlete's health conditions, for the purpose of guaranteeing safe competitive sports practice. The athlete is only referred for additional medical tests in any medical or interdisciplinary areas when doubts arise. The athletes participate in highly intense training sessions, with at least 20 hours per week. They are involved in a broad competitive federated annual calendar, and supervised by experienced coaches with excellent achievement in sports, including some Olympic athletes.

About 15000 consecutive participants were evaluated by this methodology and followed during the last 25 years (1981 to 2006), totaling 20,000,000 (20 million) training hours, not including competitions. It is important to emphasize that the SD final record in this long period was ZERO. In the last 15 years, 5 athletes (0.3%) were initially excluded, a rate similar to that found in the literature (0.3 to 0.6%), and recommended against the practice of competitive sports. They were all referred to and consulted in a partnership with the Sports and Cardiology Sector of the Dante Pazzanese Institute of Cardiology (IDPC). The following are the descriptions of these cases:

- Male, 13 years, full field soccer, with coarctation of the aorta and ventricular septal defect that were suspected at the PPE.

Female, 13 years, indoor soccer, with myocardiopathy and complex ventricular arrhythmia that were suspected at the PPE.

Female, 14 years, basketball, with myocardiopathy and complex ventricular arrhythmia that were suspected at the PPE.

-Male, 15 years, volleyball, with Marfan syndrome, whose signs were observed in the PPE.

-Female, 13 years, full field soccer, who presented palpitation symptoms during training, which were diagnosed in the outpatient clinic of the COTP as paroxistic supraventricular tachycardia by an electrocardiograph record, having been initially cleared in the PPE. The arrhythmia was reverted with vagal maneuvers, and the patient was referred to the IDPC for detailed reevaluation. What is noteworthy about this athlete: Normal 12-Lead ECG, normal exercise test, normal echocardiogram. In the electrophysiological laboratory the arrhythmia was induced by the mapping of the implicated bundle. An ablation was indicated by the specialized team of the IDPC, with excellent clinical improvement afterwards.

We stress that all COPT athletes practiced regular competitive sports before being admitted to the center. As to the data obtained at the COTP, although the sample was much smaller than the 200,000 athletes required for establishing a protocol, they represented evident, unique, undisputed and absolutely real results, in a sample of 15000 highly competitive athletes of the appropriate age group. As an objection, a non-compulsory 12-Lead ECG would imply ECG alterations that would require a secondary evaluation.

To support these data, we point out the study conducted by Pellicia et al[45] which assessed the prevalence of ECG abnormalities in 32652 (26050 males) Italian amateur athletes, aged 8 to 78 years, in the PPE. Of these, 3853 (11.8%) presented abnormalities, and in 29799 (88.2%) the ECG was normal. These "non-usual" abnormalities were considered relevant and, therefore, they required a secondary evaluation: T-wave inversion in more than 2 precordial and/or limb leads (n=751; 2.3%); elevation of R/S voltage suggestive of left ventricle hypertrophy (n=247; 0.8%); complete right bundle branch block (n=351; 1%); left anterior superior divisional block (n=162; 0.5%); complete left bundle branch block (n=19; 0.1%); pre-excitation (n=42; 0.1%); and L-SQT-1 (0.03%). Altogether, the "unusual" abnormalities totaled 1567 cases (4.8%). The following abnormalities were considered as "usual", and they did not require a secondary evaluation: PR interval prolongation, incomplete right bundle branch block pattern, premature repolarization, corresponding to 2280 athletes (7%), predominantly (>75%) in young athletes and in those aged over 30 years. 1170 athletes (3.6%) presented rhythm abnormalities—sinus bradychardia predominated in 340 (1%); supraventricular premature beats in 377 (1.1%); ventricular premature beats in 349 (1.1%); supraventricular tachycardia in 29 (0.09%); atrial flutter or fibrillation in 5 (0.02%); polymorphic ventricular premature beats in 40 (0.1%); non-sustained ventricular tachycardia in 3 (0.01%); and second degree atrioventricular block type 1 in 14 (0.04%). They concluded that the abnormalities found in the 12-Lead ECG which suggested structural heart diseases had low prevalence (< 5%) and could not represent an obstacle for its inclusion in the PPE. Some relevant considerations concerning these results are:

- The "unusual" alterations described in this study were those found in athletes' hearts, showing that most of the evaluated subjects had already been participating in competitions and, therefore, they were adapted to training and sports practice.

- 4.8% (1567) of the 32652 subjects were investigated, and also no secondary evaluations were mentioned in the extreme rare cases of rhythm abnormalities.

- The diagnosis of the possible original heart diseases have not been mentioned in these abnormalities; therefore, the "false positive" cases have not been elucidated, a fact that was acknowledged by the authors.

- No references to signs and symptoms that should accompany the abnormalities were identified; therefore, the clinical history and the physical examination would be very important in the secondary evaluation.

- The exclusion of deaths, including SD and exercise-induced, was not mentioned in this study, which had the objective of assessing the impact of a previous procedure - in this case a 12-Lead ECG - as a prevention measure, therefore hindering the interpretation and conclusion.

Conclusion

The pre-participation physical evaluation is mandatory and requires constant updating. In view of the current reality, would the medical clearances mentioned in the introduction be a correct medical conduct? This study does not intend to define conducts, but to promote a discussion and, in this review, to propose:

1 – Professional Qualification: more incentive and investment in the qualification and training of the professionals who will be responsible for collecting data in the PPE, and also of the interdisciplinary team involved, facilitating multidisciplinary updating.

2 – Prevention: easier overall access for children and adolescents to health care services (Healthcare Basic Unit and others), which are the appropriate and necessary locations for pediatric diagnosis and subsequent referrals, when needed.

3 – Protocol: the involvement of the Brazilian Pediatric Society, the Brazilian Sports Medicine Society, the Brazilian Society of Cardiology and other organizations in the creation of a child and adolescent population-based protocol, at national level, according to our reality, for a safe and much needed sports practice, which would serve as a basis and support for the guidance of the involved professionals.

The hindrances must be better analyzed, because it is well known that, in the future, physical inactivity will be responsible for more deaths than sports practice; therefore, the latter should be encouraged from an early age, initially as a recreational activity. In this population, those who have abilities for specific sports modalities and for competitive sports practice should be referred to experienced sports professionals. It is always worthwhile to stress the importance of the compulsory PPE, because sports practice should be a way to a better life, not a shortcut to death.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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