Is sport dangerous for children?

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'The long-term beneficial effects of regular physical training by far outweigh the acute risk for sudden death in children.'

Recently, promoting physical activity in children has received much emphasis. The medical community, but also the general population, has gained conscience that physical activity offers an important short- and long-term contribution to children's health [1]. Even in high-risk groups, such as in children with congenital heart disease, the beneficial effects of a guided sports program have been proven [2]. Guidelines for safe participation of patients with congenital heart disease in competitive sports have been established [3].

The only real drawback to vigorously promoting exercise in all children is the constant sword of Damocles, the risk of sudden death during exercise. Although rare, every event of sudden death in an apparently healthy youngster during sports is a disaster to parents and friends, which is emphasized by the immediate and mostly spectacular media coverage, thus making a deep and frightening impression on the general public. Regularly, it is questioned as to why the thorough screening of young athletes, and especially children, is not recommended and the community calls for action. After such incidents, the amount of parents self-referred to pediatric cardiologists in order to obtain 'complete' reassurance that their child can safely practice sports, increases dramatically.

But can we really prevent sudden death in children practicing sports? And if so, then how? And to what cost? Should we limit these efforts to those engaged in competitive sports?

To answer these questions, one should be aware of the real importance of the problem. Although each sudden and unexpected death of a child is absolutely devastating to parents and the community, the real incidence appears to be low. The precise frequency of sudden cardiac death during competition or training is not known, but has been estimated to be between one per 200,000 and one per 300,000 high

school and college-aged athletes per year [4]. The incidence in children below the age of 16 years participating in sports is probably even lower [5]. The most common causes of exercise-related cardiac death in individuals under 35 years of age are hypertrophic cardiomyopathy (HCM), arrhythmogenic right ventricular dysplasia (ARVD, especially in Italy), myocarditis, contusio cordis, abnormal coronary artery anatomy, toxic drugs and rhythm disturbances [6,7]. For the first two anomalies (HCM and ARVD), the incidence and mortality are lower in the pediatric population when compared with adults [6]. Although sudden deaths occur during or after exercise in these anomalies, this does not appear to be the most important trigger for sudden death in children overall [5,8].

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If a screening program is deemed necessary, what screening program should be designed to discover the few individuals at risk? Some cardiologists, mostly those involved with adult cardiology, favor the use of electrocardiography (ECG) and echocardiography in each sporting youth as 'population' screening methods, and even prefer the inclusion of an exercise test. Theoretically, the use of ECG and echocardiography would identify most adults with HCM and long QT syndrome, but these techniques are not able to accurately diagnose ARVD, coronary anomalies and catecholamine-induced ventricular tachycardia. The likelihood of discovering these pathologies in a pediatric population are more restricted than in adults and an important overlap with normal 'sporting' youths may cause false-positives and -negatives [9]. The only study to date to demonstrate a benefit of regular screening of sporting youths is an Italian study reporting the methodological screening of young athletes (≤ 35 years of age), including routine ECG [7,10]. The study appeared to be capable of detecting the presence of HCM and even appeared able to reduce sports-related sudden

death from HCM in that cohort. As a result of this study and the current, justified concern surrounding sudden sports-related death in young athletes, the European Society of Cardiology proposed a prescreening protocol essentially based on a 12-lead ECG [11], starting at the age of 12–14 years, on a regular basis with a 2-year interval for each ‘normal’ athlete.

However, although this proposal appears logical from a medical and scientific point of view, one must be aware of some major practical problems. In Italy, the screening system is supported by highly trained physicians who are concentrated in specialized referral centers [7,11]. Even more so for the screening of children, these specialized physicians are not readily available in other countries. Further still, the question remains as to who has to pay for the technical examinations: the athlete, the club, the insurance company or the government? In addition, the number of false-positive results was important: 2% of all athletes were excluded from sports until further investigations, meaning that for the prevention of one cardiac death, 4500 individuals had to discontinue their sports activity temporarily or definitively [7,10,12].

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If the additional costs of more thorough examinations are included, one can estimate the cost per saved life to be around 100,000 to 200,000 Euro (US\$ 150,000–300,000) [12]. A program based on the Italian experience (routine ECG and echocardiography if the ECG is ‘positive’) would cost the USA \$1.835 billion each year. One of the most prominent advocates of preparticipation screening concluded that such a detailed program could never be implemented in the USA because of the ‘financial and psychological burden’ [13].

However, the potential cost of such a screening program based on technical examinations is not the only issue. Before the establishment of such large programs, regardless of certified outcome, one must not forget that good medical practice begins with an elaborated history and thorough physical examination. In many countries, preparticipation screening for sports is still not standardized and, equally, participation in school sports is not based on any preparticipation screening.

Instead of focusing on a technical program, a cheap and standardized preparticipation screening protocol for sports associations, and ideally also for schools, should first be promoted, based on a thorough personal and detailed family history and a physical examination, concentrating on known risk factors. The risk assessment should be repeated at periodic intervals. This screening program will not be able to identify all patients at risk for sudden death, but will hopefully be able to detect a decent percentage (estimates vary between 3 and 40% [6,8,14]). An interesting assessment form is offered by the American Society of Pediatrics [14]. This form is required to be completed by the athletes and their family and focuses on a broad range of alarm signals in personal and family history and physical symptoms. If implemented, this preparticipation protocol could be re-evaluated after a few years and readjusted according to the results. Possibly, one could add a short summary of the familial occurrence and clinical warning signs of rare diseases, such as Brugada syndrome, arrhythmogenic right ventricular dysplasia and catecholamine-induced ventricular tachycardia for the general physician and pediatrician, who is not always well acquainted with these particular diseases.

The lessons of the screening programs for sudden infant death syndrome (SIDS) should not be neglected, and support the establishment of a ‘simplified’ screening program prior to more sophisticated programs. Initially, these SIDS screening programs relied almost exclusively on expensive techniques, neglecting simple epidemiological evidence [15]. Later, it became obvious that despite growing evidence that SIDS is likely characterized by a predisposing polygenetic inheritance, simple and cheap programs reducing the environmental risk factors alone (Back to Sleep, the UK program for prevention of SIDS) decreased the incidence of SIDS by almost 50% [16,17].

Of course, one should encourage the inclusion of an ECG in well-designed smaller programs of preparticipation assessment for research purposes. To be fully effective, these ECG’s should be evaluated by medical professionals with knowledge of pediatric ECGs, specific features of ECGs in normal young athletes, pediatric physiology, sports physiology and pediatric cardiology. Such programs could be started in elite athlete programs. Often in these programs, enough money is available for screening of a relatively modest amount of athletes and a team of dedicated and experienced physicians is

available. Moreover, many of these athletes aim for a professional sports career and adequate counseling is essential to make this career choice as healthy as possible. The results of these screening programs, together with the follow-up of the larger school-population based programs utilizing history and physical examination, could provide important prospective information necessary for further improvements of preparticipation screening overall.

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Information on possible warning signs that warrant immediate counseling should be available and advertised in sporting clubs. Athletes, parents and coaches should be made aware of the dangers of exercise-related symptoms such as palpitations, syncope and sudden breathlessness. General precautions should be encouraged by coaches and sports federations: avoidance of competition in extreme circumstances (e.g., heat and cold) and avoidance of competition during periods of infection or fever.

Conclusion & recommendations

The long-term beneficial effects of regular physical training by far outweigh the acute risk for sudden death in children. Even most children with congenital heart disease can benefit from well selected sports if adequately counseled [3]. Of course, a realistic standardized screening program to identify individual children at risk for sports-related sudden death should be promoted. This program should be as specific and sensitive as possible, avoiding too many false-positives

and false-negatives and being as cost-efficient as possible in relation to the existing medical priorities of society. At the same time, general measures to decrease known risk factors should be advocated: avoidance of sports for children in extreme temperatures, avoidance of dehydration, avoidance of sports participation during episodes of fever or infection, and a need to react adequately when exercise-related symptoms appear, which should include referral to specialized pediatric cardiologists, and adequate screening of the child if a genetic cause of sudden death has been discovered in another family member. General physicians, pediatricians, pediatric cardiologists, emergency physicians, as well as families, school staff and sports team staff should be provided with easily accessible medical education on risk factors and warning signs for sudden death in children.

In the meanwhile, these screening programs should be regularly re-evaluated to assess their performance and adapted accordingly. All sudden pediatric deaths related to, but also those not related to sports, should be thoroughly studied (post-mortem, lab, family screening and genetics [18,19]) to identify the causes and to study the impact of exercise on the overall risk. Further research on the prevention of these deaths should be encouraged in well-controlled, precise prospective projects before implementing them on a larger population scale with uncertain yield and outcome.

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