SHOULD CARDIAC SCREENING BE COMPULSORY IN ATHLETES?

– Written by Nathan Riding, Qatar and Guido Pieles, United Kingdom

American writer Josh Billings once expressed that "half of the troubles of this life can be traced to saying yes too quickly and not saying no soon enough". The title appears to demand a simple answer to this seemingly binary question, but an important discussion needs to be had prior to any cardiac screening implementation. After several tragic and high-profile cases of sudden cardiac death (SCD), was an unequivocal advocacy of pre-participation screening premature? The discussion needn't to be complex, but implementing cardiac screening must be thought out, deliberate, and with a well-defined aim.

WHY DO WE SCREEN ATHLETES?

While their approaches may differ, both the European Society of Cardiology (ESC) and the American College of Cardiology (ACC) have endorsed the adoption of cardiac screening in athletes in the pursuit of a central goal. This aim for cardiac screening is simple and is to identify silent cardiovascular disease that may predispose an athlete to sudden cardiac arrest or death (SCA/D) during sports participation, and to allow early and appropriate management. The World Health Organisation in 1968 published principles a screening programme should meet to be deemed appropriate (Table 1).[1] It can be reasoned that cardiac screening among the athletic population meets all of the document's 10 criteria but as the authors Wilson & Junger stated, the path to its successful achievement is far from simple though sometimes may appear deceptively easy. While out of the scope of the current review to discuss all, any cardiac screening strategy needs to be benchmarked against these general screening principles.

Incidence of sudden cardiac death

Sudden cardiac death is generally classified as natural, unexpected death within one hour of the onset of symptoms, either of cardiac cause or with a history consistent with cardiac related death[2,3]. Incidence in the athletic population has high variability depending on the methodology used but typically lies around 1:50,000[3]. This issue of study methodology and means of SCA/D detection has been a major source of inconsistency and in turn complicates our understanding of the issue and the perceived importance for cardiac screening stakeholders.

A methodological consideration often ignored is what are we actually recording? Much of the literature detailing incidence relates to sudden cardiac death, and not arrest. It is recognised that 1 in 300 young people have an underlying cardiac condition, and while harbouring the potential not all will have an adverse cardiac event[4]. It does therefore raise a pertinent point, which is survival of a cardiac arrest. With survival decreasing around 10% for every minute that defibrillation is delayed[5], prompt bystander response is critical in this situation, as too is the access to an automated external defibrillator (AED). With on-site AED used in resuscitation however, survival reached 89% in a study of USA high schools compared to the mean survival rate of 48%[6]. With such improved rates of survival, it is likely that if we fail to account for those with aborted SCD the incidence rates are skewed lower than the true incidence, and we are in fact only highlighting the successful utilisation of AED response.

Recent data employing more robust methodology has shown that SCD incidence among NCAA athletes in the U.S.A to be higher than previously thought, especially among some subpopulations with males, African-Americans and basketball players at higher risk[7].

Taking this collegiate data into the premise of the current review, SCD incidence reported in male track and field athletes for example was 1 in 120,521, with 2 documented deaths[7]. It's difficult to make strong assertions on the back of two events but the figure represents an incidence of over half that of the NCAA average of 1 in 53,703[7]. Although SCD incidence is consistently higher among high intensity dynamic team sports, and the track and field athlete data represents a snapshot of a specific athletic population, it makes an important point. The demands and disciplines of track and field are so varied it is important to move away from categorising it as one sport. The physical demands of shot put evidently differ greatly to that of the marathon, as to do the demographic makeup of those competing in certain events; the American and African dominance of sprinting versus the European led javelin for example. Until more targeted research is conducted the specific risk of track and field events remains uncertain.

Table 1

	Principles
1	*The condition should be an important health problem*
2	*There should be an accepted treatment for those with recognised disease*
3	*Facilities for diagnosis and treatment should be available*
4	*There should be a recognisable latent stage of disease*
5	*There should be a suitable test*
6	*The test should be acceptable to the population*
7	*The natural history of the conditions should be understood*
8	*There should be an agreed policy on who to treat*
9	*It should be cost effective*
10	*It should be a continuing process*

Table 1: Principles of screening for disease, as outlined by the WHO[1].

Are athletes at greater risk?

The reason athletes have been targeted for cardiac screening in particular is based on the notion that among those that have an underlying structural heart condition, exercise per se may act as a trigger for cardiac arrhythmia and the potential for an arrest. This has been attributed to the possible interplay between the substrates of fibrosis or hypertrophy and the exercise induced effects of increased circulating catecholamines, enhanced cellular metabolism with resulting acidosis, dehydration and electrolyte imbalances. Indeed, while sport is not intrinsically associated with SCD, the results of a 20 year Italian study indicated that athletes had a 3 times greater incidence of SCD than their non-athletic peers[8], with a similarly increased relative risk found for high school student athletes in the USA in comparison to non-athletes[9], and in France, competitive athletes versus recreational athletes[10]. While studies have found contradictory findings[11,12], study methodology has again been shown to be an important discriminator.

Drezner and Harmon (2019) highlighted this by showing that studies with a prospective design and similar methodology for recording cases in both athletes and non-athletes found the relative risk to be higher for athletes, while all studies using a retrospective design and less reliable review of cases found athletes to be at lower risk[13].

THE CARDIAC SCREENING JUSTIFICATION JUXTAPOSITION

On the basis of the above rationale cardiac screening is widely implemented across the elite sporting world[14]. Ensuring the health of the elite athlete is embedded in the Olympic Movement Medical Code and pre participation screening is, among others, recommended by the IOC and the athletics governing body the IAAF[15]. Despite its widespread adoption there are still strong opponents to cardiac screening, with some arguing for its abandonment altogether[16].

A central tenet of this argument is that the justification for cardiac screening lies in the results of just one article[4]. This article looked at the trends in SCD in young athletes over a 26-year period prior to and following the implementation of a state sponsored screening programme[17]. The prominent finding was that SCD incidence fell by 89% during the period, leading the authors to state that this demonstrates the

benefit of the Italian screening programme. These findings are persuasive, however Maron et al presented the incidence of SCD in the state of Minnesota where screening is not performed. From the previous 22 years, they reported that SCD rates did not support a lower mortality rate linked to pre-participation screening as there was not a significant decrease in adverse events at any time point of the study period between their data and that of Corrado et al (2006)[18]. One of the few other studies to look at the incidence pre and post screening implementation was that of Steinvil et al (2011). They were able to look at the 10-year period either side and this time noted a small increase in incidence post the 1997 implementation (2.54 vs 2.66 per 100,000 athlete years respectively)[19]. This has been touted by some as a prime example of how screening does not work, but their 'systematic search' was done by looking at two main newspapers in the country, and thus considered methodologically unreliable by many. Importantly the two major cardiology organisations of the AHA[20] and the ESC[21] have endorsed the adoption of cardiac screening in elite athletes.

HOW SHOULD WE SCREEN?

There is indeed limited research investigating the true performance of cardiac screening on the ability to prevent sudden cardiac death, and while randomised controlled trials would be lengthy, costly and require input on a large scale, the most appropriate means of progressing is to develop better screening tools and critically assess these, at best prospectively[22], especially given the process is now widely advocated.

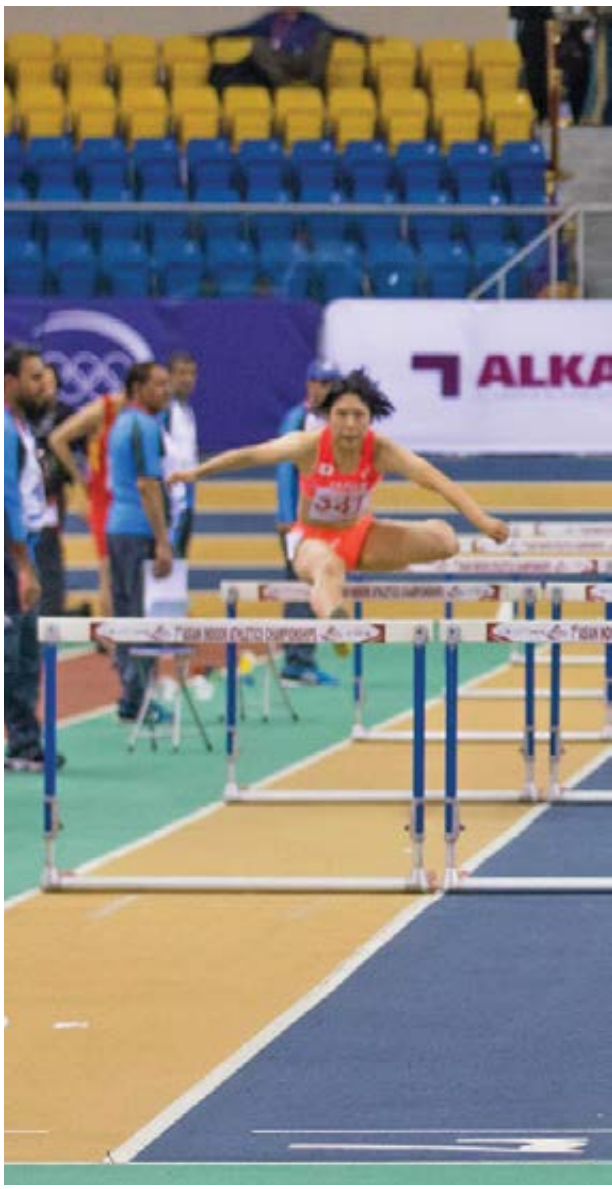
What has additionally hampered development in this field is the debate and inconsistency around screening protocols. The AHA has been steadfast in its endorsement of cardiac screening by history and physical examination alone, with the reasoning lying around the high false positive rate of ECG screening, asking the question: does the addition of an ECG do more harm than good? The rate of false positives even in the year 2010 was substantial. The implications of which are important, as these include anxiety induced from the temporary uncertainty of a positive finding to lifelong disqualification from sports. As more research has been published our understanding of the nuances of the athlete's heart and its differentiation between that of pathology has improved. Since 2010, the rate of false positives associated with ECG screening has fallen from 22.3% to 1.3% using the latest international recommendations[23,24]. Importantly, from the admittedly still limited data in paediatric athletes the rate also fell from 41% to 6.8% in our cohort[25] to as low as 1.5% in adolescent soccer players[26]. Evidently, using the rationale against screening based on false positive rates in 2010 was perhaps justified, but rates have fallen into what we now deem acceptable based on risk and positive predictive value.

The alternative approach and that recommended by the AHA is of history and physical exam without ECG. There are several renditions of the personal symptom and family history questionnaire, with the AHA, ESC, IOC and FIFA all having different versions, ranging from 11 to 31 steps[27]. Little consideration has been placed on how the questionnaire is interpreted especially among different ages, cultures and languages, with an important consideration here being whether the athlete's reporting is independent or whether it is tandem with a physician. These issues are likely to go towards the low sensitivity, which in a meta-analysis of 47,137 athletes was 20% for history and 9% for physical exam, compared to the 94% sensitivity of ECG[28].

It is important to note that some conditions that cause SCA/D are unlikely to be picked up by all the above screening tools and would require additional imaging (e.g. congenital coronary artery anomalies, aortopathies) or exercise stress testing (e.g. CPVT). While some organisations (UEFA, FIFA, English FA) include echocardiography into their protocols and local protocols also include exercise stress testing, data on their diagnostic screening accuracy in athletes are still limited.

Reassessing the mandate debate

While based upon medical, legal, and ethical grounds, screening is seen as a necessary step in the prevention of the often silent conditions associated with SCD; several sporting bodies such as FIFA, FISA, ITU and the UCI have taken a fully comprehensive stance by mandating the practice of pre-participation screening prior to their flagship events. While commendable in its aims, this approach is open to several logistical challenges; principally with regards to financial support, having the

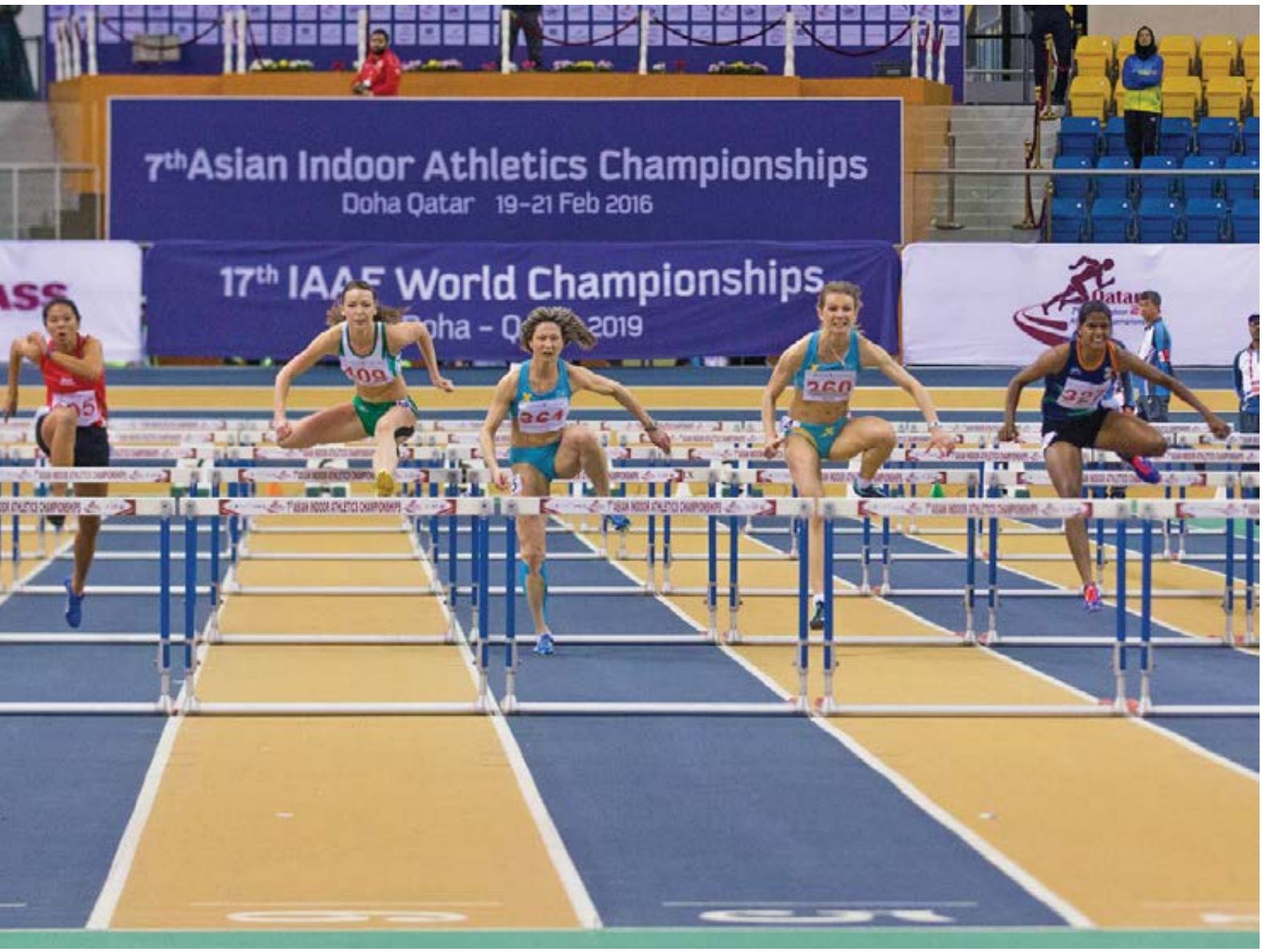


necessary qualified expertise to interpret the results, infrastructure and appropriate follow up pathways.

FINANCIAL IMPLICATIONS OF CARDIAC SCREENING

It is important to understand that cardiac screening does not come without costs, all of which vary depending on where in the world you are. In our 2013 study we identified that initial cost of screening in Qatar, with history, physical examination and ECG was 182 U.S. dollars ($). In the UK, charity subsidised screening means costs can be as low as $53 while in the USA cost studies show that charges can be as high as $535[29-31].

This has significant implications for sporting federations should any cardiac screening be mandatory. The USA topped the medal table in the 2017 IAAF world



championship fielding a 136 strong team. If all athletes were to undergo initial pre competition assessment, costs for basic screening alone could be between $7,000 and $73,000 using the above figures. With this in mind is the cost of screening a barrier for athletes of less economically developed competing nations?

Toresdahl et al were able to investigate this concept by surveying the leads for International Federations competing at the 2016 Olympics[32]. They found that 80% of nations performed some screening in most or all athletes, with 75% performing an ECG. Among the 10% of countries that did not perform an ECG in any athlete the most common reasons were the expense of follow up testing (56%), expense of performing ECG screening (44%), lack of cardiology consultation (44%) and lack of ECG equipment (33%). In their multivariate analysis they further identified that the two greatest indicators for a nation's adoption of ECG led screening was the number of athletes in the team and the gross domestic product per capita.

ARE THERE ENOUGH QUALIFIED AND EXPERIENCED PHYSICIANS?

A 2014 letter published in JACC highlighted the current lack of physicians available with expertise in ECG interpretation in the general cardiology community[33]. This has led to an overreliance on automated measurements and also led to some hospitals augmenting the reimbursement for ECG interpretation in order to find enough experienced physicians. The issue is likely exacerbated within sports cardiology where the numbers of athletes undergoing cardiovascular screening are ever increasing.

ECG interpretation in athletes over the past decade alone has advanced significantly with two iterations of guidelines[34,35]. As previously discussed, the rate of false positives have also subsequently decreased to levels deemed acceptable, however most of the research showing such findings are from expert centres with substantial sports cardiology experience. Given most sporting federations and teams will rely upon their sports medicine physician or local general cardiologist to perform screening we do not know if these low false positive rates are seen in such settings.

Agreement between cardiologists and sports medicine physicians was shown to be as low as 65% in a study from Berte et al, with the authors suggesting this could lead to 20% of screened athletes being referred on for further testing[36]. Among cardiologists it has been found that those experienced

in athlete screening were more successful than their inexperienced colleagues at both ECG interpretation accuracy and the choice of further investigations[37,38]. Notably in the previous study, 45% of cardiologists tasked with interpreting athlete ECGs failed to use any specific criteria. It echoes the findings from the 2016 Olympic study[32] where 23% of chief medical officers didn't know which criteria they used and only 6.9% used the latest international recommendations.

Coming out of this is a clear understanding that more needs to be done to raise awareness of the most recent guidelines and emphasis must be placed on physician education, especially outside of North America, Europe and Australasia where uptake of online education courses is lower[39].

Both ESC[40] and ACC[41] have dedicated sports cardiology sections within their remit and have detailed core curricula underpinning the necessary skills and knowledge required to practice effective and safe sports cardiology. While there is currently no official certification of competency or board certification for sports cardiology, the ESC outlined a detailed minimum recommendation of the number of procedures that should be completed. Both cardiology bodies proposed curricula evolve around the training of cardiologists for this role, yet we know that widespread reference centres are not established in many areas for such undertaking. It means it is often the sports medicine physician who would undertake the cardiovascular screening of athletes, and currently no universal standard for sports cardiology training exists for the sports medicine physician[42]. While this may be out of scope for many nations, as a foundation Asif & Drezner outline recommendations for sports cardiology training for the sports medicine physician, including performing at least 100 pre-participation cardiovascular screenings and the interpretation of at least 500 athlete ECGs[42].

The above challenges are multiplied when considering cardiac screening for the paediatric athlete, as current cardiac screening guidelines cannot be unequivocally applied to the paediatric heart. At present, too few paediatricians and paediatric cardiologists are sufficiently trained to provide expert opinion[43] and training pathways and a stronger engagement between paediatric and sports governing bodies are needed to improve this.

IS THERE A CLEAR PATHWAY FOR FURTHER INVESTIGATIONS AND FOLLOW UP?

While the discrepancies between clinicians over ECG interpretation is important, the divide between policy and practice has the largest implications for athlete care. One of the main reasons ECG screening was not conducted in the 2016 Olympic survey was the costs of follow up testing and a lack of cardiology consultation. A key ethical consideration for cardiac screening is the management of those athletes that have been identified with suspicions of pathology. Without these necessary pathways in place cardiac screening is unfeasible.

Among the major sporting federations in the USA, local cardiologists partner with official league medical staff to design and oversee athlete screening[44]. Tertiary centres or at least a national collaborative approach is being suggested as the most appropriate solution. Within the UK, the English Football Association have an approved cardiology consensus panel with formal reports being sent to the FA medical department, and any further evaluation being performed at a regional specialist centre[45]. This close working collaboration between local sports medicine physicians and sports cardiologists is seen as the necessary step. As stated by Baggish and Kovacs (2016) this process and establishment of a team should not be in response to an abnormal screening but in advance of any screening programme[46].

Once again, this process is desirable and quite likely achievable in some parts of the world, but rolling this out on a worldwide scale would be hugely challenging, especially in sports such as athletics where representation comes from all corners of the globe. FIFA, an organisation currently mandating cardiac screening, noted that its implementation would be difficult owing to ethnic, socio-economic and specific local conditions. Having performed a pilot screening among all players prior to the 2009 U-17 African championships they concluded that while such screening was feasible and accurate, more time and resources to follow-up on suspicious findings with further specific examinations should be considered for future screenings[47].

CONCLUSION

Cardiac screening is now a mainstay of athlete evaluation among many international federations and sports teams. It is however important to understand that while present protocols have helped reduce the number of exercise related cardiac events, based on the current medical, health-economic and policy evidence, it would be premature to call for a general screening mandate.

Future synergy between medical and sports organisations and governing bodies is required to ensure an evidence-based implementation of cardiac screening, as well as subsequent appropriate follow up and importantly, education of health care professionals, all of this independent of geographical and socio-economic differences as well as sporting discipline.

If such policies are in place, then cardiac screening appears beneficial for the athlete and federation alike and it would be a worthy aim to work towards a globally agreed cardiac screening strategy.

References

Available at www.aspetar.com/journal

Nathan Riding Ph.D.
Scientific Researcher
Aspetar – Orthopaedic and Sports Medicine Hospital
Doha, Qatar

Guido Pieles M.D. (Marb) Ph.D. (Han) D.Phil. (Oxon) M.Sc.H.E. (LSE) M.R.C.P.C.H.
Consultant Paediatric and Adult Congenital and Sports Cardiologist
Congenital Heart Unit, Bristol Heart Institute
Bristol, United Kingdom

Contact: nathanrriding@gmail.com