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Recommendations for cardiac screening and emergency action planning in youth football: a FIFA consensus statement

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ABSTRACT

Sudden cardiac death is the leading medical cause of death among football players. Determining the optimal cardiac screening, the use of carefully selected medical assessments to detect underlying cardiovascular conditions associated with sudden cardiac arrest/death, is a desired objective of the Fédération Internationale de Football Association (FIFA) for football players of all ages. To date, cardiac screening recommendations in football have primarily focused on adult competitive players. Acknowledging its responsibility for player health worldwide, FIFA convened an international working group of cardiology and sports medicine experts to develop cardiac screening recommendations for youth football players. This group performed structured literature reviews and ultimately congregated in January of 2024, when recommendations were presented, scrutinised and judged using a systematic process. The final FIFA recommendations for youth cardiac screening include personal medical history, family medical history, focused physical examination and resting 12-lead electrocardiography. This document provides detailed rationale and clinical recommendations for youth cardiac screening and emphasises the importance of emergency action planning.

INTRODUCTION

Sudden cardiac death (SCD) during sport is the leading medical cause of death among young athletes.¹ SCD is defined as an unexpected natural death within 1 hour of the onset of symptoms related to cardiac symptoms or disease.² The reported incidence of SCD among young athletes ranges from 0.5 to 2 deaths per 100 000 person-years,^{3–6} though there are relatively little data documenting SCD incidence rates in athletes below the age of 16 years. Among elite youth football players from the United Kingdom, the incidence of SCD has been reported to be 1 per 14 794 person-years, equivalent to 6.8 per 100 000 person-years.³

General population studies report a peak SCD risk in the first year of life (2.8/100 000), followed by decreasing incidence until the age of 10 years, after which the risk increases again with an incidence of

0.3–1.2/100 000 at the age of 12 years.⁷ Epidemiological studies on SCD incidence and aetiology in young athletes lack consistent methodology with reported data being highly dependent on study population and study methodology.⁸ Nonetheless, some evidence suggests that from age 12 onward, the risk of SCD in young athletes may be 2.8 to 4 times higher than in normally active children, underscoring the importance of optimising both prevention and management of SCD in youth football.^{9–11} Therefore, optimising both prevention and management of SCD in youth football is crucial.

Cardiac screening is the process by which carefully selected medical assessments are performed to detect underlying cardiovascular conditions associated with adverse outcomes including sudden cardiac arrest/death (SCA/D). The goal of cardiac screening in sport is to identify athletes who may benefit from disease-specific treatment(s) and individualised clinical decision-making regarding the risks and benefits of future sport participation. Numerous sport and medical oversight organisations recommend cardiac screening prior to and during competitive sport participation. The Fédération Internationale de Football Association (FIFA) currently mandates the performance of cardiac screening within 12 months prior to participation in all FIFA World Cup tournaments, including those that involve youth player participation, with non-adherence being a sanctionable offence.¹² However, the majority of cardiac screening recommendations developed to date have been designed primarily for use among adult athletes. FIFA Medical identified the clarification of youth player screening practices as an imperative to meet its responsibility for protecting the health of players worldwide. Accordingly, FIFA initiated a process to create an expert consensus statement, a format chosen given the strength of the relevant scientific evidence, containing recommendations for cardiac screening of youth players. This document details how this process was conducted and the recommendations that emerged. These recommendations are intended



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KEY POINTS

- ⇒ Cardiac screening of youth players represents 'best practice' and should be performed and/or overseen by clinicians with the requisite training and competence in all aspects of cardiac screening, including accurate ECG interpretation.
- ⇒ Individual confederations and football associations should implement a cardiac screening strategy which considers the availability of local resources. All screening programmes should include the clinical and social support infrastructures to facilitate timely downstream diagnostic testing, interpretation and risk stratification following the detection of abnormalities during screening.
- ⇒ It is recommended that cardiac screening for youth players begin at the age of 12 years and be performed subsequently at least every 2–4 years until the age of 18 when adult cardiac screening recommendations should be applied.
- ⇒ Cardiac screening for youth players should include a combination of personal medical history, family medical history, focused physical examination and resting 12-lead electrocardiography (12-lead ECG).
- ⇒ Transthoracic echocardiography is not recommended for routine cardiac screening of youth football players but may be considered as an adjunct to medical history, physical examination and 12-lead ECG to enhance detection of high-risk congenital anatomic coronary artery anomalies and aortic disease, assuming high-quality imaging, proper expertise and sufficient resources for interpretation and management of findings are available.
- ⇒ Exercise stress testing, ambulatory cardiac rhythm monitoring and cardiac magnetic resonance are not recommended components of routine cardiac screening in youth football players but should be available for downstream assessment of abnormalities detected during cardiac screening.
- ⇒ All teams, clubs and organisations that engage youth players should have and routinely practise an emergency action plan that includes training for the immediate recognition of sudden cardiac arrest, early cardiopulmonary resuscitation and access to an automated external defibrillator. Ideally, emergency action plans should also stipulate access to effective advanced cardiac life support and post-cardiac arrest care.

specifically for federations and players participating in FIFA Youth World Cups (and their medical teams). In addition, this document is intended to serve as 'best practice' recommendations for the broader global population of youth players participating at all levels of organised competitive football who perform, or endeavour to perform, cardiac screening.

METHODS

The project was initiated by FIFA Medical. A steering group, inclusive of content experts with experience in cardiac screening and the care of youth athletes selected by FIFA (ALB—committee chair; MB, GER, CS—steering committee members) and FIFA Medical team members (AM, KG, AS), was assembled to oversee the creation of this document. As the currently available literature was insufficient to substantiate evidence-based recommendations meeting criteria for a clinical guidelines document, an expert consensus approach yielding clinical recommendations for 'best practices' was chosen. The reporting follows the ACcurate COnsensus

Reporting Document recommendations.¹³ The protocol was not registered.

Panel selection

The steering group selected a diverse group of content experts representing paediatric cardiology, sports cardiology and sports medicine, with geographical and sex representation, as members of the consensus panel. Panellists were invited through an email invitation from FIFA Medical. One expert did not reply to the invitation, and a different expert was selected. All other experts accepted their invitation. Elite level football players (n=8 players, representing three countries) were included in the planning phase. Individual interviews were performed with eight international calibre player representatives to solicit input regarding timing and methods to perform cardiac screening in youth players. Universally, these player representatives expressed trust in the proposed process and felt their ongoing involvement would be unlikely to provide substantive content. Thus, players were not included in subsequent phases of the process.

Evidence review

The panel was divided into four working groups, each with an assigned content area related to the creation of cardiac screening recommendations. The groups were instructed to perform a comprehensive review of the scientific literature including original research publications and cardiology/sports medicine society guidelines relevant to their specific assigned content. Medical search engines including PubMed, OVID Medline, Embase and the Cochrane Library were suggested, and the use of multiple search engines was encouraged. This type of knowledge synthesis represents a pragmatic alternative to a comprehensive systematic review and accelerates the process to produce a definitive evidence base in a resource-efficient manner.¹⁴ Standardised assessment of study quality and risk of bias was not performed.

Each working group was provided with specific questions created by the steering committee:

Group 1 (General Principles of Youth Cardiac Screening): (a) What is the appropriate age to initiate cardiac screening in youth football players?; (b) What are the role and optimal time intervals of serial (ie, repeat) cardiac screening following the initial cardiac screening?; (c) What are the medico-legal issues (ie, consent/assent, parental/stakeholder engagement, etc) that are uniquely important to youth cardiac screening?

Group 2 (Core Components of Routine Youth Cardiac Screening): (a) What is the role of personal/family medical history and physical examination during youth cardiac screening?; (b) What is the role of 12-lead electrocardiography during youth cardiac screening?

Group 3 (Additional Diagnostic Testing During Youth Cardiac Screening): (a) What is the role of transthoracic echocardiography during youth cardiac screening?; (b) What is the role of additional testing including exercise stress testing, ambulatory rhythm monitoring, and cardiac MRI during youth cardiac screening?

Group 4 (Emergency Action Planning): (a) What recommendations should be provided about the resources needed to conduct a youth cardiac screening programme?; (b) What recommendations should be provided about the evaluation of abnormalities detected during youth cardiac screening?; (c) What are the basic elements of an effective emergency action plan (CPR proficiency, AED accessibility, emergency medical response coordination, etc) that should be in place irrespective of youth cardiac screening?

Each working group met virtually, a minimum of two times, to prepare a summary document including youth cardiac screening recommendations and a detailed bibliography prior to the consensus process in-person meeting.

Consensus process for adjudication of screening recommendations

An in-person meeting was held over 2 days at the Home of Football, FIFA, Zurich, Switzerland, on 15–16 January 2024. The meeting was conducted in English. During the first day, members of the steering committee provided brief didactic talks covering the following: (1) current cardiac screening guidelines, (2) prior SCD prevention activities by FIFA and other sports organisations, (3) data from the FIFA Sudden Cardiac Death Registry, an ongoing initiative designed to accrue SCA/D data within the sport of football, with a focus on youth players, and (4) general paediatric cardiology perspectives on youth cardiac screening. These talks were followed by presentations from each working group during which proposed screening recommendations, and the supporting literature were presented. Each working group presentation was followed by a group discussion (facilitated by Steering Committee Chair, AB) in which all panel members were encouraged to articulate assenting or dissenting opinions regarding the proposed screening recommendations and the quality of the supportive evidence. At the conclusion of the first day, the steering committee collated all comments provided during group discussions and revised the proposed screening recommendations for subsequent voting on the second day.

The second day was dedicated to voting on screening recommendations, discussion about the implementation of final recommendations, and areas of future work. Each proposed screening recommendation was presented to the full group for further discussion, based on revisions made following discussions on the prior day. Additional content or wording adjustments were discussed by the entire group before voting. Voting was initially intended to use a 9-point Likert scale ranging from 1 (strongly disagree) to 9 (strongly agree), based on the Grading of Recommendations Assessment, Development and Evaluation scale.¹⁵ Prior to voting, the group reached a majority opinion to use a simplified 3-point rating scale (1=disagreement with the recommendation, 2=neither disagreement nor agreement with the recommendation pending modification of the wording or 3=agreement with the recommendation). A recommendation was accepted if $\geq 80\%$ provided a vote of 3 and rejected if $\geq 80\%$ of the panel provided a vote of 1.¹⁶ For all recommendations that failed to meet either definitive acceptance or rejection, panel members were encouraged to voice their opinion regarding the content and suggested wording modification in preparation for an additional vote, which was performed in all cases that failed to reach a definitive outcome in the first vote.

All voting was performed anonymously using a web-based interactive voting software platform (Mentimeter, Mentimeter AB, Stockholm, Sweden), which was first piloted within the steering group. The FIFA Medical members of the steering group were not permitted to vote on the recommendations. For all recommendations that reached a definitive acceptance or rejection ($\geq 80\%$ consensus), panel members with residual dissenting opinions were encouraged to provide written dissenting viewpoints for inclusion in this manuscript with the option of anonymity.

Box 1 General considerations for cardiac screening in youth football players

1. Acknowledging that considerable resources are required to develop and maintain a high-quality cardiac screening programme, this document represents 'best practice' rather than a mandate for cardiac screening in competitive youth football players.
2. Cardiac screening programmes should have a doctor(s) trained and competent in all aspects of cardiac screening including accurate ECG interpretation.
3. Cardiac screening should be planned and conducted to ensure that sufficient time is available to evaluate and manage any abnormal findings prior to competition.
4. Cardiac screening programmes should have access to cardiology resources for evaluation of players with screening abnormalities, and management of players with confirmed cardiovascular disorders in a timely manner.
5. Abnormalities found during cardiac screening should be evaluated and managed based on contemporary disease-specific clinical guidelines, sports cardiology recommendations and the judgement of team doctor(s) and consulting cardiologists.
6. It is reasonable for FIFA or other football governing bodies to mandate a specific cardiac screening strategy prior to their respective competition(s).
7. It is reasonable for individual confederations and football associations to implement a cardiac screening strategy for their competitions which considers the availability of local resources and medical infrastructure.

External validation

An additional expert group consisting of paediatric cardiologists, sports cardiologists and team physicians with geographical and sex representation were invited to serve as an external document review board to increase the external validity of the recommendations. Any suggested minor changes provided by this group were integrated by the steering group and ultimately approved by the full consensus panel. Any suggested major changes were discussed in the steering group and shared with the panel for adjustment and potential new agreement voting. All expert reviewers are acknowledged by name in this document and included for transparency on medical search engines.

Equity, diversity and inclusion

Members of the writing committee and the external peer committee were selected to ensure representation of both genders and representation of the broad social, cultural and ethnic heterogeneity of the global FIFA Confederations. The inclusion of writing committee members representing lower income countries and regions was prioritised.

RECOMMENDATIONS FOR CARDIAC SCREENING IN YOUTH FOOTBALL PLAYERS

Two experts were unable to attend the in-person meeting and did not vote; thus, 15 experts provided votes on each recommendation. In total, 35 recommendations were presented for the initial voting, with 6 recommendations requiring an initial adjustment and 1 recommendation requiring a second adjustment prior to acceptance (online supplemental 1). The final recommendations are presented in **boxes 1–5** and discussed below. Residual

Box 2 Considerations regarding age of onset and repeat screening in youth football players

1. It is recommended that cardiac screening begin at the age of 12 years for youth players.
2. Repeat cardiac screening should be performed every 2–4 years for youth players until the age of 18 with a minimum of at least one additional screening at or before 16 years of age.
3. Adult cardiac screening recommendations should be applied at and after 18 years of age.

dissenting opinions for recommendations that reached consensus criteria are provided in online supplemental 2).

Age of first youth cardiac screening

The optimal age to initiate youth cardiac screening is largely dependent on age-related risks of the high-risk arrhythmias and phenotypic manifestation of arrhythmogenic cardiomyopathies and other inherited cardiac disease associated with SCA/D. However, age and underlying cardiac conditions are not the only parameters that determine the risk of SCA/D in young athletes. Additional modifiers include sport type and sex with males accounting for the majority of SCA/D. Several studies have demonstrated a discernible increase in SCA/D beginning at the age of 12.⁵ In addition, phenotypic manifestation of arrhythmogenic cardiomyopathies and other inherited cardiac disease often occur during pubertal development.^{17 18} Recent data document a cardiac screening yield for high-risk pathology of only 0.05% in children aged 7–11 years but an increased yield of 0.12% in athletes aged 12–18 years.⁷ Additionally, many sporting disciplines begin officially regulated competitions at the age of 12 and in countries with mandatory cardiac screening for athletes (eg, Italy); this process is initiated at age 12.¹⁹ In aggregate, these observations underlie the recommendation to begin youth cardiac screening at 12 years of age (Box 2).

Serial cardiac screening in youth football players

The rationale for serial youth cardiac screening is based largely on data from a 10-year screening programme of adolescent athletes in which only one-third (36%) of cardiac disease cases were identified at the initial screening evaluation, and the majority (64%) was detected during repeat screenings.⁷ Disease detection in this study was largely accounted for by cardiomyopathies, ion channelopathies and congenital anomalous coronary arteries. This observation reflects the fact that youth athletes with genetic heart disease demonstrate greater penetrance of overt phenotypic features with advancing age and pubertal development.^{20 21} Accordingly, many young athletes will not exhibit phenotypic manifestation at their initial assessment, making reassessment during later adolescence crucial for identifying occult disease.^{3 22 23} Certain countries routinely perform youth cardiac screening on an annual basis while other countries do not repeat youth cardiac screening. Acknowledging this heterogeneity, this consensus panel recommends repeat cardiac screening every 2–4 years following initial screening with a minimum of at least one additional screening at or before the age of 16 years. At age 18, cardiac screening recommendations for adult players should be implemented (Box 2).

Routine components of youth cardiac screening

Historically, personal and family medical history and a focused cardiovascular physical examination have formed the basis of all

Box 3 Recommendations for routine cardiac screening in youth football players

1. Cardiac screening should begin with an explanation of its purpose and its process. Youth players and parents/legal guardians should be provided ample opportunity to ask questions about the purpose and process. Youth player assent should be obtained prior to cardiac screening. The need for parental consent, which may be required by local governance, should be clarified prior to cardiac screening.
2. Cardiac screening should include a combination of personal medical history, family medical history, physical examination and resting 12-lead electrocardiography (ECG).
3. 12-lead ECG interpretation should be based on current international guidelines, recognising that normative data on paediatric athletes based on geographic and ethnic diversity are limited.
4. Ascertainment of personal medical history during cardiac screening for youth players should include the following items:
 - ⇒ Established cardiovascular disease and/or prescription medication for cardiovascular disease(s).
 - ⇒ Prior history of sudden unexplained collapse, seizure or syncope (excluding neurally mediated/vasovagal syncope and post-exercise associated collapse).
 - ⇒ Prior history of exertional chest pain.
 - ⇒ Prior history of sudden onset palpitations.
 - ⇒ Prior unexplained breathlessness that prevents the player from keeping up with their peers.

*A positive response to any of the items should prompt the acquisition of additional focused medical history to determine the need for further diagnostic testing.
5. Ascertainment of family medical history during cardiac screening for youth players, focusing on first-degree family members in whom any of these criteria were met before the age of 50 years, should include each of the following items:
 - ⇒ Confirmed sudden cardiac death, unexplained sudden death or cardiac arrest.
 - ⇒ Collapse, unexplained syncope or seizure.
 - ⇒ Inherited cardiovascular disease (ie, hypertrophic cardiomyopathy, arrhythmogenic cardiomyopathy, congenital long QT syndrome, Marfan syndrome), sport restriction due to a cardiac diagnosis, and/or cardiac procedures potentially related to genetic heart disease (ie, ICD implantation, cardiac surgery).

*A positive response to any of the above items involving a first-degree family relative of the youth player should prompt the acquisition of additional focused medical history to determine the need for further diagnostic testing.
6. Physical examination during cardiac screening for youth players should include each of the following items:
 - ⇒ General assessment of physical characteristics for features of Marfan syndrome.
 - ⇒ Measurement of resting upper extremity blood pressure.
 - ⇒ Cardiac auscultation to detect abnormal systolic murmurs or any diastolic/continuous murmur.

cardiac screening recommendations. The rationale to perpetuate the inclusion of these screening elements in the current youth cardiac screening recommendations is based on the notion that individuals suffering SCA/D may manifest disease-specific symptoms and/or signs prior to death.²⁴ However, we acknowledge

Box 4 Recommendations regarding additional testing modalities during cardiac screening in youth football players

1. Transthoracic echocardiography is not recommended for routine cardiac screening of all youth football players.
2. Transthoracic echocardiography may be considered as an adjunct to routine cardiac screening (ie, medical history, physical examination and 12-lead ECG) for youth players to enhance detection of high-risk congenital anatomic coronary artery anomalies and aortic disease when requisite expertise and financial resources are available.
3. Transthoracic echocardiography should only be added to routine cardiac screening in settings where high-quality imaging and proper expertise and resources for interpretation and management of findings are available.
4. Exercise stress testing is not recommended for routine cardiac screening in youth football players.
5. Ambulatory cardiac rhythm monitoring is not recommended for routine cardiac screening in youth football players.
6. Cardiac magnetic resonance is not recommended for routine cardiac screening in youth football players.

that there is no evidence that screening reliant solely on personal and family medical history and focused physical examination reduces the incidence of SCA/D. In addition, the majority of prior studies evaluating the diagnostic yield of cardiac screening (ie, the ability of screening to accurately identify conditions associated with SCA/D) with personal/family medical history and focused physical examination demonstrated low sensitivity and specificity.^{25–27}

Box 5 Considerations regarding emergency action planning (EAP) for youth football players

1. Each team, club and/or organisation should designate a person with basic life support training to be responsible for developing and coordinating their EAP.
2. Sudden cardiac arrest should be presumed in any collapsed and unresponsive player. In such cases, the EAP should be activated and cardiopulmonary resuscitation (CPR) with chest compressions should be started immediately.
3. Automated external defibrillators (AEDs) should be positioned to enable shock delivery within 3 min of collapse at all training and match venues.
4. Potential first responders including medical staff, non-medical team staff, coaches, referees and players should be trained in the recognition of the player with SCA, hands-only CPR and use of an AED.
5. At a minimum, an annual review of the EAP and a practice drill for SCA among anticipated first responders should be performed prior to the start of the season/competition. Organisations should document the timing, location and people participating in the EAP rehearsal.
6. A pre-match medical meeting between available home and visiting team staff (ie, coaches, referees and/or medical staff) should take place prior to the start of a match to review the site-specific EAP (eg, location of AEDs, emergency medical services (EMS) and venue exit routes, responder roles and communication). Venue medical staff and EMS should attend these meetings when on-site.

Despite its unproven efficacy for SCA/D risk reduction, this consensus panel unanimously agreed that personal and family medical history and focused physical examination should be performed during youth cardiac screening as it is the only way to detect symptomatic athletes with cardiac disease or a family history of significant cardiac disease (Box 3). This recommendation is also based on a holistic view of youth cardiac screening which emphasises the importance of communication and relationship building during the acquisition of personal/family medical history and the performance of the focused physical examination. The panel recognises this initial interaction between athletes and medical providers forms an important platform for education and awareness of cardiac health and cardiovascular disease ‘red flags’ and/or warning signs. All screening data including medical and family history should be obtained in the presence of a trained medical professional with experience in cardiac screening of youth athletes. The panel encourages the inclusion of parents or legal guardians during the acquisition of personal and family medical history whenever possible. In addition, the panel emphasises the importance of maintaining patient privacy by the provision of effective draping of exposed skin surfaces during group screening sessions.

In addition to personal and family medical history and focused physical examination, 12-lead ECG is recommended as a routine component of youth cardiac screening (Box 3). The inclusion of ECG during cardiac screening improves the sensitivity of disease detection in athletes as conditions associated with SCA/D have specific electrical manifestations that may go undetected by personal and family medical history and focused physical examination alone. Initial studies examining the performance of ECG in the screening setting documented unacceptable rates of false positive testing (ie, low specificity).^{28–30} Subsequent clarification of ECG patterns that are common in trained athletes has markedly reduced the magnitude of this problem,^{31–33} although imperfect sensitivity for the detection of disorders associated with SCA/D and the lack of convincing evidence that detecting these disorders reduces SCA/D are acknowledged. Recommendations for the interpretation of the athlete ECG, developed by an international group of experts including members of this panel, now differentiate benign training-related ECG changes from those suggestive of occult pathology and account for age, ethnicity and sex.³⁴ While the international criteria provide limited recommendations pertaining specifically to the youth athlete ECG, its utility in this age group has been demonstrated.³⁵ Future refinements of these criteria should prioritise more focus on the youth athlete ECG with additional attention to sex and ethnicity-based ECG variability.

Several aspects of a high-quality youth cardiac screening programme should precede or be tightly coupled with the personal and family medical history, focused physical examination and ECG including the following: (1) formal introduction of all members of the medical team, (2) clear explanation of the screening process using language appropriate for youth players, (3) provision of an opportunity for young players and legal guardians to pose questions about the screening process, (4) acquisition of verbal or written assent/consent as dictated by local regulations, (5) provision of interim screening findings to young players and legal guardians, (6) support for athletes and their families during the process of further downstream testing, and (7) the opportunity for feedback about the screening process from young players and legal guardians.

Additional testing during cardiac screening in youth players

Transthoracic echocardiography (TTE) may further increase the yield of cardiac screening based on its ability to detect some genetic and congenital diseases.³⁶ Specifically, TTE can identify high-risk congenital coronary artery anomalies^{37,38} and aortic diseases,³⁹ which may not be detected through personal and family medical history, focused physical examination or ECG. However, TTE significantly increases the financial cost of screening and provides minimal additional value in identifying cardiomyopathy in young asymptomatic athletes with a normal ECG.⁴⁰ In addition, performance of TTE, particularly for the assessment of coronary artery anatomy,⁴¹ requires expertise in image acquisition and interpretation. In addition, structural and functional adaptations to exercise training are often difficult to differentiate from phenotypic manifestations of cardiomyopathy.^{42,43}

Accordingly, and in line with contemporary athlete imaging guidelines,⁴⁴ TTE is not recommended as a routine component of youth cardiac screening (Box 4). However, the panel acknowledges that TTE may be included in youth cardiac screening when requisite expertise and financial resources are available. In the absence of definitive supportive data, additional advanced imaging techniques (ie, cardiac CT and MRI), exercise testing and extended duration ambulatory rhythm monitoring are not recommended for use during

routine youth cardiac screening. These diagnostic modalities should be reserved for the clinical evaluation of youth athletes who demonstrate abnormal findings during routine screening with personal and family medical history, physical examination and ECG. A summary of FIFA routine youth cardiac screening recommendations is summarised in figure 1.

Emergency action planning

Despite widespread implementation of cardiac screening programmes in adult athletes, SCA remains the leading cause of sudden death in football athletes.⁴⁵ No cardiac screening programme provides absolute protection against athlete SCA/D as evidenced by several recent high-profile SCA events, occurring in athletes with prior extensive cardiac screening, which have been successfully managed with early cardiopulmonary resuscitation (CPR) and prompt use of an automated external defibrillator (AED) (figure 2). Locations with early CPR and AED use have high SCA survival rates (~85%) in the FIFA Sudden Death Registry,⁴⁵ and similar SCA survival rates have recently been reported from the USA.^{46–48} Accordingly, the panel recommends that a comprehensive emergency action plan (EAP) be developed for all youth players irrespective of cardiac screening practices (Box 5).

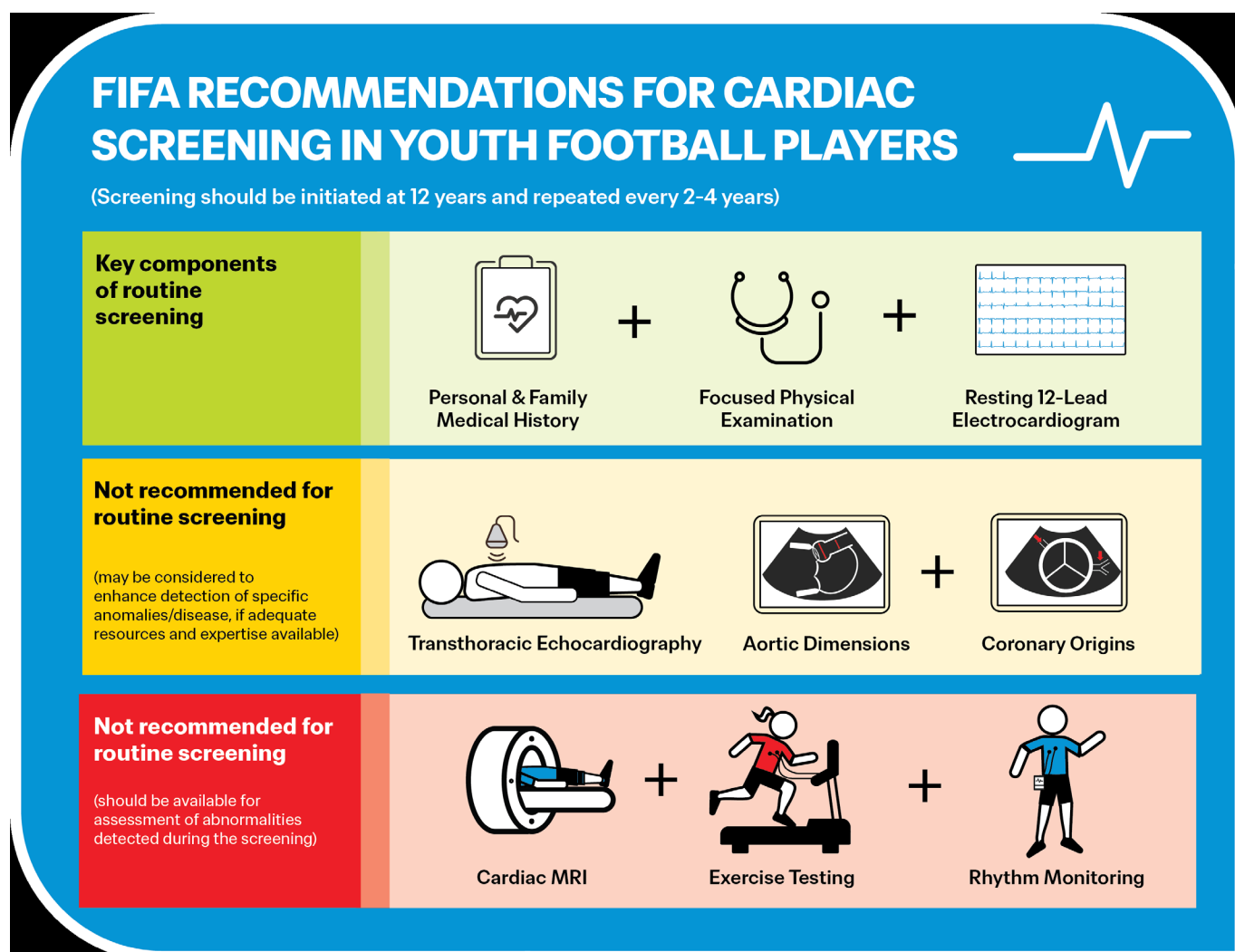


Figure 1 Overview of the FIFA youth cardiac screening recommendations.

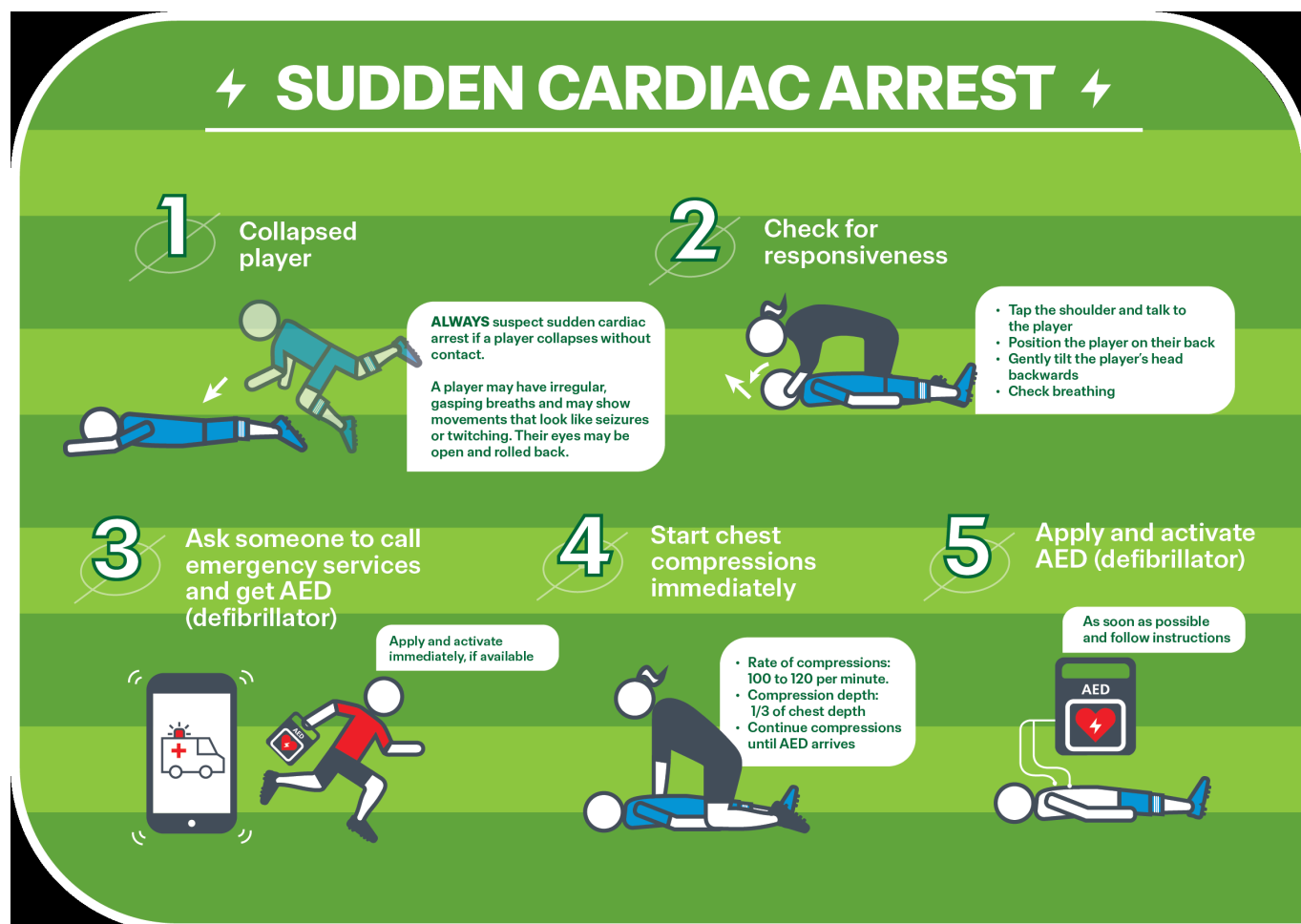


Figure 2 Overview of the fundamental elements of the 'pitch-side' emergency action plan

Key components of an effective EAP include immediate recognition of SCA, early initiation of CPR and rapid defibrillation as summarised by the phrase 'recognize, respond, and revive'. SCA should be assumed in any player who collapses and is unresponsive to a shoulder tap and verbal stimuli (figure 1). Common features of SCA include brief seizure-like activity, continued respiratory movements after collapse, and opened eyes in a rolled back position. Potential first responders including medical staff, other team staff, coaches and referees should be trained in SCA recognition, how to activate the EAP, hands-only CPR and use of an AED. Similar training should be considered for players and families. AEDs should be available for retrieval and use within 3 min of collapse and should be considered an essential part of the medical kit. AEDs must be maintained as recommended by manufacturers, including monthly readiness checks and scheduled battery and lead replacement.

Effective advanced cardiac life support and integration with post-SCA care should also be considered in the design of an emergency action plan. A communication plan to alert the on-site response team when a player collapses and is unresponsive is essential. This plan should include calling emergency medical services (EMS) if they are not on-site. It is essential to clarify if on-site physicians or EMS personnel will provide advanced cardiac life support if needed. Finally, it is essential to coordinate with EMS to ensure clear routes of transportation to and from training and competition venues, as well as designated hospitals capable of advanced SCA patient care.

A comprehensive EAP includes designation of an EAP coordinator. This person is responsible for developing and coordinating the EAP for a team, club or organisation. The EAP coordinator should develop the EAP in collaboration with key stakeholders, update it as necessary and practise it with potential responders on an annual basis at minimum. The EAP coordinator should tailor the EAP with venue specificity to ensure standardisation of AED locations, emergency equipment, ambulance locations and entry/exit points (if applicable), ambulance transportation routes, and designated hospital locations. This EAP coordinator is also responsible for providing this information to personnel before event coverage (eg, practice, game, strength & conditioning). In both practice and game settings, there should be clarification of who is responsible for activating the EAP, retrieving the AED and leading the medical care. Before all competitions, a pre-match medical meeting between the home and visiting medical staff, venue medical staff, EMS, referees and match officials is recommended to review the site-specific aspects of the EAP (eg, location of AEDs, EMS, responder roles, and communication and hand signals). Online supplemental figure 1 provides an example of the pre-match emergency action plan as recommended by FIFA.

Periodic reviews of the EAP coupled with practice drills are essential. At a minimum, these should be done on an annual basis prior to the start of each season. Practice drills to rehearse SCA response should include the anticipated first

responders (eg, coaches, managers, athletic trainers, physiotherapists, team physicians, team staff and coaches) and EMS providers with clear designation of roles and responsibilities. Organisations should document the time, date and staff attendance for each rehearsal and should ensure that new staff are appropriately trained and rehearsed when changes to the EAP team are necessary. Finally, socioeconomic disparities that may impact all aspects of the EAP should be considered. Disparities that may limit AED accessibility should be considered, and planning for funding to minimise inequities is recommended.

Additional considerations and areas of future work

The consensus panel addressed several areas of scientific uncertainty lending to potential opportunities for future research and broad-scale education. Although studies examining cardiac screening practices have increased dramatically over the last two decades, there remain sparse data documenting the impact of cardiac screening on the incidence of SCD.⁴⁹ To date, the majority of studies have compared different components of cardiac screening to one another (ie, medical history and physical examination vs 12-lead ECG) with an emphasis on the diagnostic yield for identifying cardiac pathology and screening accuracy (ie, false positive testing). Accordingly, future large-scale efforts incorporating gender balance, ethnic diversity, and socioeconomic determinants of health are warranted to better define the impact of cardiac screening on SCA/D incidence, particularly among youth athletes.⁵⁰

The panel further acknowledges several important considerations related to the global implementation of these youth cardiac screening recommendations. First, current cardiac screening practices vary across countries for several reasons (ie, legal mandates, clinical infrastructure, financial resources). As such, the recommendations herein provided are intended to represent a 'best practice' for youth cardiac screening rather than a universal mandate which may be impractical in some regions. Second, there exists substantial regional variability in parental and/or legal guardian participation in the care of youth players. Youth players who are accompanied by parents or legal guardians during cardiac screening may be more likely to be forthcoming with accurate responses to medical and family history questions, with input from parents and/or legal guardians, than youth players who are screened in the football academy setting. Accordingly, medical providers in football academy settings are encouraged to engage parents and legal guardians when feasible. Third, socioeconomic status, cultural norms, and youth athlete literacy may impact the efficacy of screening. For example, some cultures prohibit discussions about the death of a family member, thereby rendering youth athletes less informed about family medical history. Finally, financial resources vary by country and region. Accordingly, the implementation and maintenance of a youth cardiac screening programme may prove challenging in under-resourced locations. Nonetheless, the panel reached consensus that youth screening should be considered a high priority for all organisations that oversee youth football with prioritisation of EAP as a foundational step.

Transparent acknowledgement of these issues sets the stage for future work and educational campaigns. As previously noted, future studies examining the impact of screening on SCA/D incidence, perhaps most effectively accomplished by the creation of highquality national, regional and international SCA/D athlete registries, among youth players are needed. The writing committee emphasises the importance

of future data collection delineating the diagnostic yield and outcomes associated with youth cardiac screening. This work should emphasise the accrual of data from geographic locations that are under-represented in the current literature. In the interim, screening recommendations are based largely on expert opinions regarding best clinical practices. Within this document, any recommendation that failed to reach consensus is identified and dissenting opinions are provided (online supplemental 2). Educational campaigns pertaining to youth cardiac screening recommendations, including the inclusion of screening protocols and EAP implementation during coaching courses, are encouraged. Educational posters and concise educational videos related to SCA recognition and the provision of bystander CPR and AED use have been developed.^{51 52} Additional educational tools tailored to local sociocultural factors and their broad dissemination are suggested. Finally, the consensus panel identified the importance of future work geared towards designing, validating and implementing personal and family medical history questionnaires using language familiar to youth players.

CONCLUSION

This FIFA consensus statement provides best practice recommendations for cardiac screening in youth football. Cardiac screening for youth players should begin at age 12, be repeated every 2–4 years and include a combination of personal medical history, family medical history, physical examination and a resting 12-lead ECG. We acknowledge that the full implementation of these recommendations will require collaboration across multiple stakeholders including football federations, health authorities and community-based youth football programmes. Expansion of sports cardiology infrastructure to conduct highquality screening and the secondary evaluation and management of screening abnormalities is needed. As no cardiac screening programme provides absolute protection against athlete SCA/D, all youth football teams, clubs and/or organisations should implement an EAP including rapid access to an AED. Implementation of the EAP should be coupled with education and training for parents/legal guardians, coaches, match officials and team staff to ensure accurate SCA/D recognition and emergency response for youth players.

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