Cardiovascular Evaluation for the over 40's Prior to Engaging in Moderate to High Intensity Sports

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INTRODUCTION

The benefits of regular physical exercise on the human body are multiple and indisputable. The improvements in cardiovascular (CV) risk profile associated with exercise are partly secondary to its positive impact on atherosclerotic risk factors such as blood pressure, lipid profile, body mass index, and insulin resistance[1]. There is a is a dose effect relationship between exercise and CV all-cause mortality, with a 20-30% reduction in adverse events compared with sedentary individuals[2, 3].

Paradoxically, the hemodynamic and metabolic stresses of intense and excessive exercise, may promote fatal arrhythmias and even myocardial infarction in some individuals with underlying undetected, subclinical cardiac diseases[4]. The causes of deaths are very much age-dependent and in young people, considered less than 35 years, the most common causes of death are inherited conditions such as the cardiomyopathies, ion channel disease, sudden arrhythmic death syndrome, coronary anomaly and myocarditis[5]. In athlete >35 years of age, more than 80% of all sudden cardiac death (SCD) is due to atherosclerotic coronary artery disease (CAD), and vigorous physical exertion is associated with an increased risk of SCD and acute myocardial infarction[6]. The individuals at greatest risk are those with little or no systematic training background. Exercise induced acute coronary syndrome results from atherosclerotic plaque rupture and thrombosis[6]. Greater than 50% of patients have no pre-exiting symptoms or history of CAD[7, 8].

The concept of screening and recommendations for sport eligibility is to maximise benefits of exercise at the lowest risk. The early detection of advanced CAD in asymptomatic athletes, may potentially decrease CV mortality and morbidity through risk stratification, disease specific intervention and exercise modification[9].

The 2020 European Society of Cardiology (ESC) guidelines on sports cardiology and exercise in patients with cardiovascular disease recommend pre-participation evaluation for cardiovascular disease in older athletes[9]. Acknowledging, that the evidence base for CV screening is limited and controversial for athletes >35 years of age, screening utilising a health questionnaire, ECG and examination, may discover undiagnosed cardiomyopathies, primary electrical disorders and subclinical CAD.

In recent years, there has been a drive to improve health and fitness in the population, resulting in an increase in amateur participation in sporting events such as half-marathons and marathons. Similarly, there is an expanding population of older veterans and amateur athletes competing in high-intensity events. The estimated prevalence of sport-related sudden death occurs in approximately 5 to 17 cases per million in the general population with a peak between the ages of 40-60 years of age[10-13]. The incidence of sports related sudden cardiac arrest is between 22-58 per million per year. The majority (94%) of all exercise related deaths in the community occur in middle age and older individuals engaging in recreational sports[10]. Consequently, pre-participation screening programmes in this age range of middle-aged/senior athletes engaging in either competitive or leisure-time sports is proposed as the optimal age range for cardiovascular risk assessment. The 40-year lower age recommendation also coincides with the NHS Health Check programme in England, which invites adults from 40-74 years for a cardiovascular health check[14].

OBJECTIVE OF THE PROPOSED SCREENING PROGRAMME

Based on the above background, the objective of the proposed screening programme is to detect silent cardiovascular abnormalities in middle-aged/senior athletes, already practising, or who wishes to participate in leisure time sports, especially individuals naive to moderate to vigorous physical activity. The implementation of a pragmatic and practical screening programme algorithm to identify high-risk individuals can mitigate the risk of SCD and cardiovascular morbidity in middle-ages/senior athletes. As CAD accounts for the vast majority of fatalities in this age range, the proposed algorithm is focused mainly in detecting subclinical CAD, although other conditions such as cardiomyopathies, electrical disorders, valvular and structural heart disease can be detected during the screening process. Furthermore, cardiovascular risk prevention is in keeping with the NHS England agenda for treating Cardiovascular Disease[15].

COMPARISON TO OTHER RECOMMENDATIONS

The American Herat Association science advisory committee recommends pre-participation screening for master competitive master athletes (defined as > 40 years old). Screening involves a history, physical examination, and maximal exercise testing of all men above 40 years (women > 50) with one additional risk factor and those with symptoms, as well as all master athletes above 65 years of age, regardless of risk factors or symptoms[16]. Our screening protocol also includes adult/senior nonprofessional active or sedentary individuals engaging in leisure-time physical/sports activities. We also selectively recommend further testing in individuals with higher risk of CAD according to the QRISK score.

IDENTIFYING INDIVIDUALS AT HIGH RISK OF CORONARY ARTERY DISEASE AND CARDIOVASCULAR RISK ASSESSMENT

Health questionnaire

Identifying individuals at high risk of coronary artery disease begins with a history and risk assessment. A history of chest pain or SOBE should raise suspicion of underlying CAD. Sudden cardiac arrest during sports activity in middle-age individuals is associated with a history of pre-existing heart disease (16%), cardiac risk factors for CAD (56%) and symptoms typical of cardiovascular disease in the prior week (36%)[13]. Therefore, a health questionnaire will be used in the proposed screening protocol, which is included in the index.

Risk Scores

Cardiovascular risk prediction models, such as the European Society of Cardiology Systematic Coronary Risk Evaluation (SCORE) calculator or the QRISK score can be used to determine the likelihood of subclinical CAD[17, 18]. These models take into consideration individual risk factors and medical conditions predisposing to coronary atherosclerosis. In the UK, General Practice Centres use the QRISK cardiovascular risk model[18], which can easily be calculated using the electronic patient

records. Consequently, the QRISK score in the proposed screening algorithm will be used to determine low versus high cardiovascular risk for subclinical coronary artery disease (Figure 1).

Limitations of cardiovascular risk scores and role of CT coronary angiography

Cardiovascular risk scores are based on epidemiological studies and probabilistic models are often used to try and estimate cardiovascular risk. These scores can underestimate in the young and overestimate in the elderly[19]. An alternative strategy is to directly screen for the disease rather than calculate the probabilistic risk scores. CT coronary angiography (CTCA) provides non-invasive information on coronary anatomy and atherosclerosis and provides better CV risk discrimination beyond traditional risk factors[19-21] and has been suggested as a promising tool for screening asymptomatic veteran athletes[22]. However, CTCA is costly, exposes the individual to a small amount of radiation on modern scanners, potential risk of contrast reactions, and suffers from a lack of outcome data in the athletic population. Nevertheless, there is emerging data that the early detection and implementation of preventative strategies may improve long-term cardiovascular benefits[23]. Consequently, the role of CTCA in the proposed screening programme will only be used in highly selected individuals.

EXERCISE TOLERANCE TESTING (ETT)

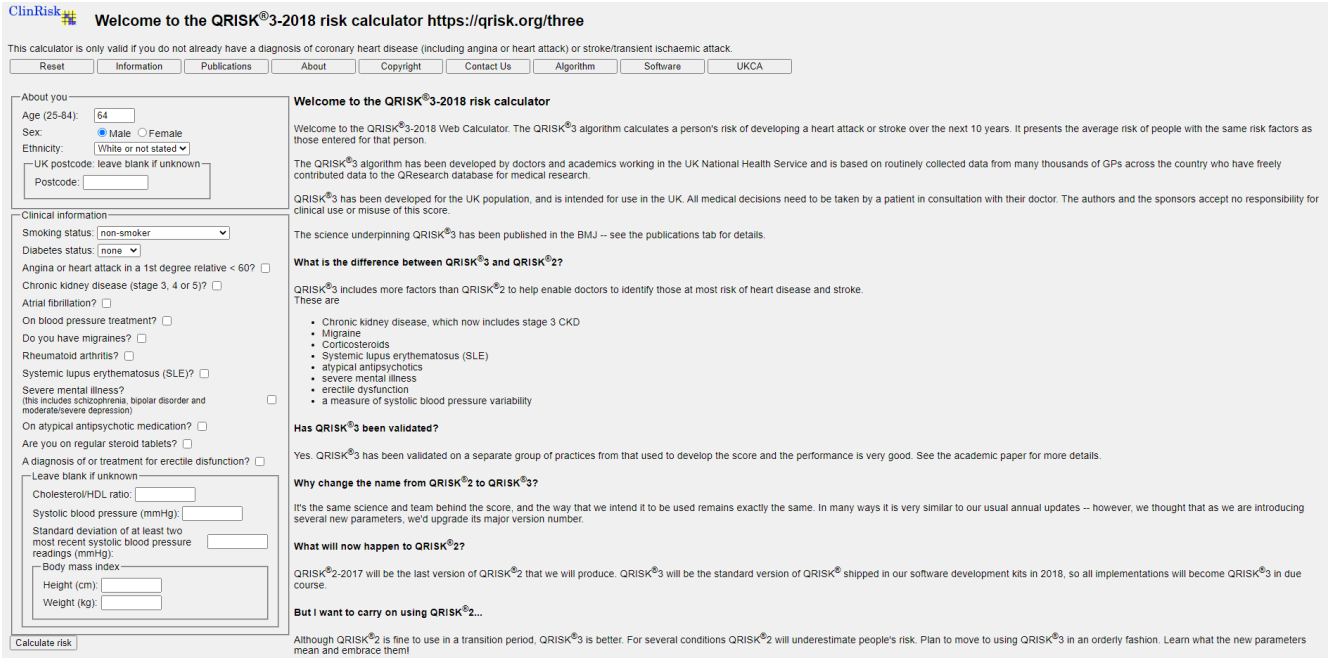
Exercise tolerance testing is low cost and can assess for ischaemic and arrhythmia changes, and BP response during exercise. Although the use of maximal ETT in asymptomatic healthy individuals with a low risk of cardiovascular events, has a low positive predictive value[16, 24], in populations with risk factors for CAD, a positive exercise test has been shown to identify individuals with an increased risk of subsequent coronary events[25, 26]. In the Seattle Heart Watch Study, during the 5-year follow-up period, asymptomatic men with more than one coronary risk factor and more than two abnormal findings on ETT, had a 30 times higher risk for cardiac events[27].

Other IMAGING Modalities

Current evidence suggests that the accuracy of all cardiac imaging modalities is insufficient to justify their use as primary screening modalities in athletes[28]. However, if any abnormalities are detected on exercise tolerance testing or on a CTCA, then either an exercise stress echocardiogram or perfusion

myocardial scan will be arranged to determine the burden of myocardial ischaemia, as they are locally available with expertise.

Figure 1. QRISK cardiovascular risk calculator (https://qrisk.org/three/)



Proposed Pre-Participation Algorithm for cardiovascular assessment in asymptomatic individuals > 40 years

The methodology of how middle-aged and older individuals should be screened before engaging in regular physical activity is both complex and controversial. The proposed methodology employed in this screening programme is based on the recommendation from the 2020 ESC Guidelines on Sports Cardiology[9]. It is practical, patient-centred and based on the individual's cardiac risk profile and the intended level of physical activity. Individuals considered to be at risk will require further assessment.

Phase I

Following preliminary evaluation from the self-assessment questionnaire, a physical examination to detect any relevant clinical findings such as an irregular pulse, elevated jugular venous pressure, blood pressure, and heart murmurs will be conducted followed by an ECG.

ECG

The ECG will be interpreted within the context of the International recommendations for ECG interpretation in athletes[29], recognising that the majority of screened individuals will be engaging in recreational/leisure time activities and therefore would be interpreted as in the general population. While the ECG increases the ability to detect underlying cardiovascular conditions, it has limited sensitivity and specificity in patients with anomalous coronary arteries, premature coronary atherosclerosis and aortopathies.

Phase II (figure 2)

- In individuals with low CVD risk Score (QRISK3 score <5%), no cardiovascular risk factors, and physically active, then no further investigations are required, and can participate in sporting activities including competitive sports.
- In patients with an abnormal ECG; high CVD risk score (QRISK3 ≥ 5%) or additional risk factors; sedentary with little physical activity; or suffering from Diabetes Mellitus should undergo further assessment prior to participating in high-intensity, very high-intensity, or competitive sports.
- A maximal exercise tolerance test (ETT) will be the initial preferred functional test[9].
- In borderline or equivalent ETT results, or an uninterpretable baseline ECG (e.g. LBBB or repolarisation abnormalities), a CT coronary angiogram is recommended[9].
- If further myocardial ischemia assessment is required, either an exercise stress echocardiogram or a perfusion cardiac MRI scan will be arranged.
- Invasive coronary angiography with consideration of coronary revascularisation, if there is : a significantly positive ETT, obstructive coronary artery disease on CTCA (>70% proximal stenosis of a major coronary artery vessel or > 50% left main stem stenosis) or significant ischaemic burden (stress echocardiography: >_3 of 16 segments with stress-induced hypokinesia or akinesia; stress cardiovascular magnetic resonance: >_2 of 16 segments with stress perfusion defects or >_3 dobutamine-induced dysfunctional segments)[9]. Difficult and uncertain cases will be discussed at the Heart Team Meeting.

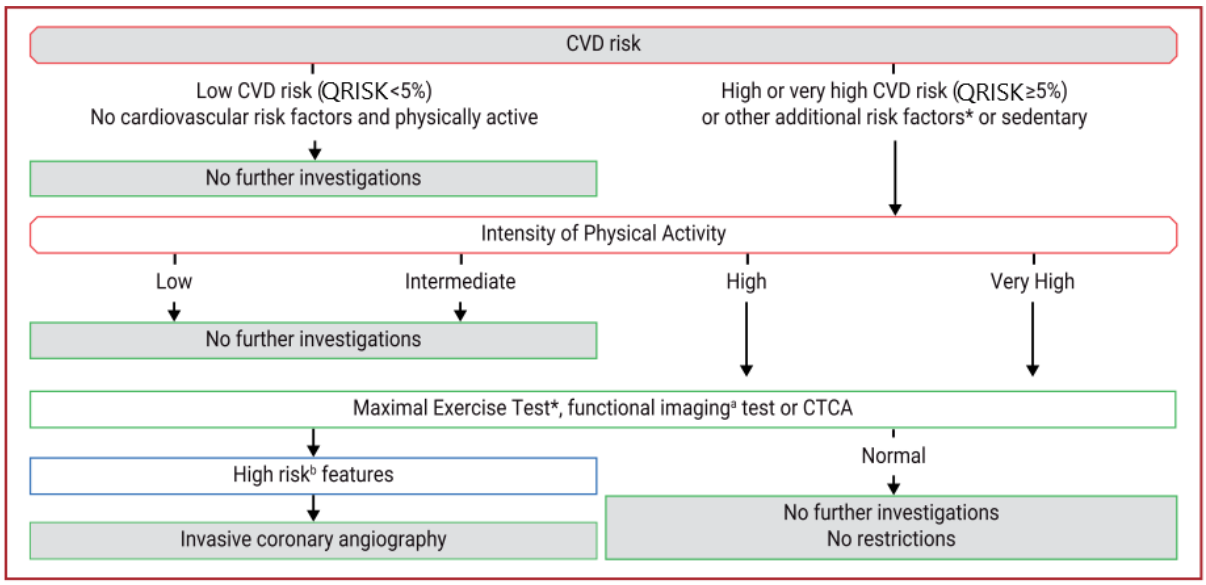


Figure 2. Proposed Pre-Participation Algorithm for cardiovascular assessment in asymptomatic individuals > 40 years. Adapted from A. Pelliccia et al. ESC guidelines on Sports Cardiology[9].

ETHICAL CONSIDERATIONS

The proposed screening programme includes all middle-aged/senior athletes and non-athletes with varying degrees of physical activity. Although it may be ethically justified to offer pre-participation screening, there are a number of ethical repercussions that can arise. For instance, the finding of significant coronary artery disease in an asymptomatic athlete can result in disqualification and significant financial loss. Similar findings in non-athletes can result in higher health and insurance premiums, and even a lack of coverage. Restriction from competitive sports or even exercise can have significant psychological distress and underscores the potential to mental health. In competitive athletes, emotions are often high not only with the individual involved but also with other stakeholders such as the team manager, coach, co-athletes, and family members, highlighting the need for collaborative decision making[30].

WORLD HEALTH ORGANISATION SCREENING CRITERIA

Health screening must meet certain criteria to be medically and financially acceptable. The most recognized criteria were determined by Wilson and Jungner in 1968, and forms the World Health

Organization standards by which screening tests are judged and determined (table 1)[31]. The proposed screening programme follows these standards.

Table 1

Wilson and Jungner Criteria for Disease Screening (Adopted by the World Health Organization)		
		Comment
1. The condition sought should be an important health problem	✓	Cardiovascular disease is a leading cause of death worldwide and accounts for up to a third of all global deaths[32].
2. There should be an accepted treatment for patients with recognized disease	✓	Early primary prevention strategies for cardiovascular disease can reduce cardiovascular-related mortality and morbidity.
3. Facilities for diagnosis and treatment should be available	✓	Facilities to instigate primary and secondary prevention, and treatment strategies are available in the UK.
4. There should be a latent or early symptomatic stage	✓	Coronary atherosclerosis is a process with a long asymptomatic phase with symptom onset when coronary blood flow fails to match myocardial demand.
5. There should be a suitable test or examination	✓	Functional testing (ETT, stress echocardiogram, perfusion CMR, PET/SPECT scans), and anatomical assessment with CTCA.
6. The test should be acceptable to the population	✓	Cardiovascular risk assessment using the QRISK or SCORE models can be used to estimate cardiovascular risk.
7. The natural history of the condition, including development from latent to declared disease, should be adequately understood	✓	Coronary atherosclerosis is one of the most studied pathologies in cardiovascular medicine.
8. There should be an agreed policy on who to treat as patients	✓	Patients with significantly abnormal functional or coronary artery anatomical imaging as discussed in the text.
9. The cost of case finding (including diagnosis and treatment of patients diagnosed) should be economically balanced in relation to possible expenditure on medical care as a whole	✓	Early detection of cardiovascular disease will allow primary or even secondary prevention strategies thereby offsetting potential future cardiovascular events such as anginal symptoms, heart attacks, strokes, which can be costly to manage in the long term.
10. Case finding should be a continuing process and not a “once and for all” project From World Health Organization.	✓	If cardiovascular pathology is identified, further follow up will continue either in primary or secondary care.

CONCLUSION

Considerable attention has focussed on screening in young athletes, whilst the risk of sudden cardiac death is higher amongst middle-aged sports participants with the greatest risk in the fifth decade. In general, inherited and congenital cardiac conditions are the most frequent cause of SCD in young athletes, while acquired heart disease, principally coronary artery disease, is most frequent in athletes of middle-aged and older. The methods of how middle-aged and older individuals should be evaluated before engaging in physical activity remain controversial and vary between counties and sporting bodies. The screening proposal discussed is based on the ESC 2020 guidelines on Sports Cardiology, which offers a pragmatic, practical, patient-centred approach. Specific investigations should be

focussed on evaluating athletes in whom clinical suspicion is raised by symptoms, family history, clinical examination, abnormalities on an ECG, baseline level of fitness and intended level of physical activity.

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