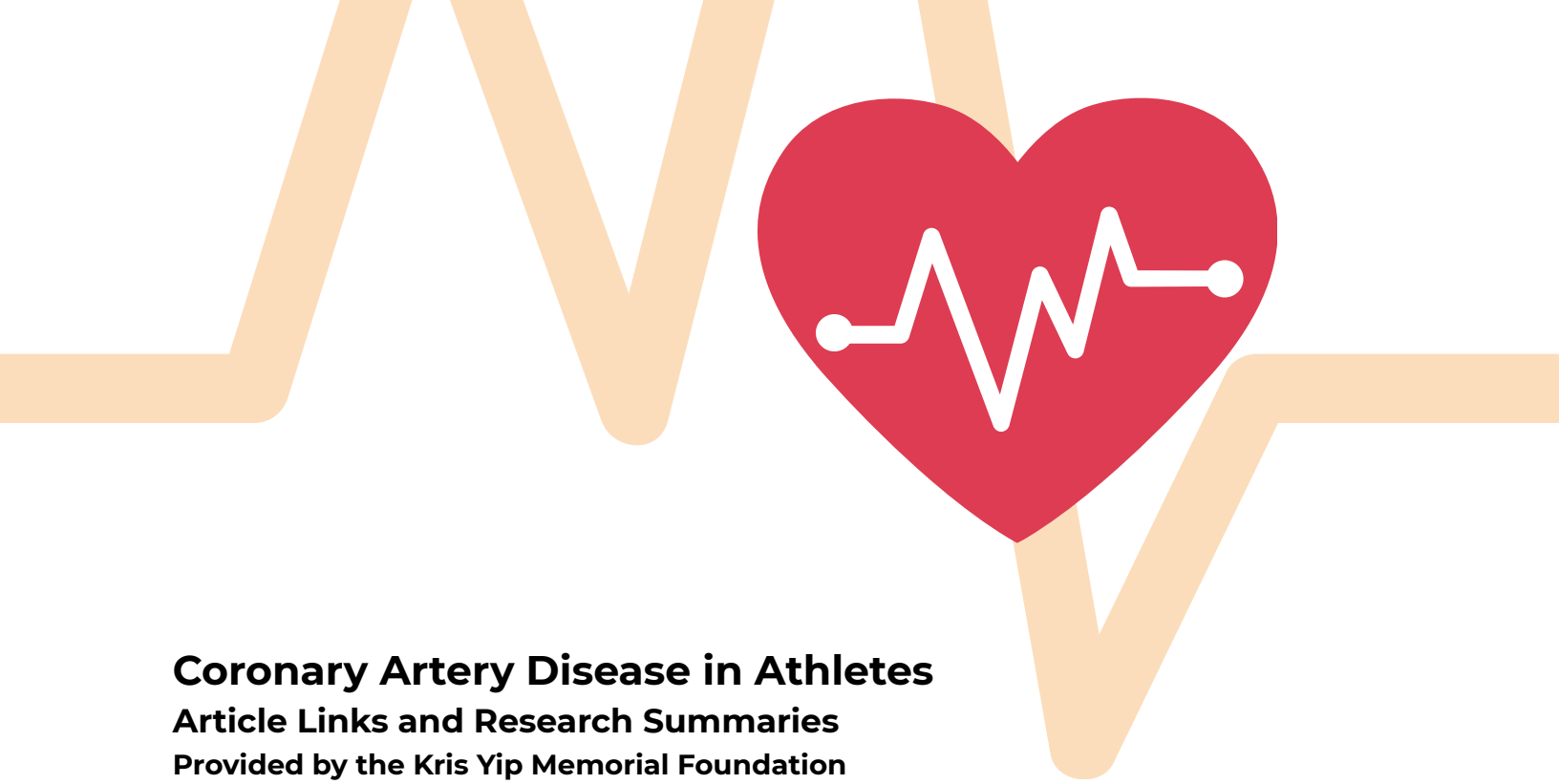

Coronary Artery Disease in Athletes

Article Links and Research Summaries

Provided by the Kris Yip Memorial Foundation

Endurance athletes are often viewed as the healthiest segment of the population. Regular exercise is widely promoted as protective against heart disease, and for most people, it is. However, a growing body of research shows that masters endurance athletes are not immune to coronary artery disease (CAD) and that the condition can develop silently, even in highly trained individuals with few or no traditional risk factors.

This resource accompanies the blog post "When Fitness Masks Heart Disease" and is intended to provide athletes, clinicians, and caregivers with direct access to the research behind current conversations about CAD in athletes. The studies summarized here explore why standard cardiovascular screening may fail to detect disease in athletic populations, how coronary plaque can differ in endurance athletes, and why advanced imaging is increasingly being discussed as part of athlete-specific risk assessment.

The goal of this document is not to discourage exercise. Fitness remains strongly associated with lower overall mortality and improved long-term health. Instead, this collection of research is meant to support informed decision-making, encourage meaningful conversations with health care providers, and highlight why screening approaches designed for the general population may not always translate well to endurance athletes.

How to Use This Resource

The articles and studies included in this document were selected because they consistently highlight several important themes relevant to masters endurance athletes:

- Coronary artery disease is the leading cause of sudden cardiac death in athletes over the age of 35
- Many athletes diagnosed with CAD are asymptomatic at the time of diagnosis
- Conventional screening tools such as resting ECGs, stress tests, and physical exams may fail to detect subclinical or non-obstructive disease
- Advanced imaging tools such as coronary calcium scoring (CS) and coronary CT angiography (CCTA) can reveal plaque burden and morphology that routine tests may miss
- High fitness levels can mask risk by normalizing fatigue, performance changes, or subtle symptoms

Each article summary highlights key findings and clinical implications, with direct links to the original sources for those who wish to explore the research in greater depth. While many studies focus primarily on male endurance athletes, this reflects the current state of available evidence and underscores the need for further research in female athletes and non-endurance sports.

This resource is educational in nature and is not intended to replace individualized medical advice. Athletes are encouraged to use this information as a starting point for discussions with their physician or sports cardiologist, particularly if they are over 35, have a long history of high-intensity training, or are experiencing unexplained changes in performance, fatigue, or recovery.

Understanding coronary artery disease in athletes is evolving. As research continues to refine how risk is identified and managed in this population, awareness remains a critical first step. If this information helps even one athlete ask better questions or seek appropriate screening, it serves its purpose.

Disclaimer

This document is provided for educational and informational purposes only. It summarizes publicly available research related to coronary artery disease (CAD) in endurance athletes and is not intended to diagnose, treat, or provide medical advice.

The Kris Yip Memorial Foundation does not offer medical opinions or individual health recommendations. Decisions about screening, imaging, training, or treatment should be made in consultation with a qualified health care provider who is familiar with the athlete's personal medical history, training background, and risk factors.

Research in this area is evolving. Many studies referenced in this document focus primarily on male endurance athletes, and findings may not apply equally to all individuals, sports, or levels of participation. The presence of coronary plaque, elevated calcium scores, or imaging findings does not automatically indicate imminent risk, nor does it imply that an athlete should stop exercising.

Exercise remains strongly associated with improved health outcomes and reduced overall mortality. The intent of this resource is to support informed conversations, not to discourage physical activity or promote fear.

By using this document, readers acknowledge that the Kris Yip Memorial Foundation assumes no responsibility for medical decisions made based on the information contained herein.

Coronary Artery Disease in Athletes Article Links and Summaries

1. **Revista Portuguesa de Cardiologia**

Reference Links
revportcardiol.org
(https://www.revportcardiol.org/pt-coronary-artery-disease-in-athletes-articulo-S0870255117301580)

- In veteran athletes (typically >35 years old), coronary artery disease (CAD) is the most common cause of sudden death (SCD).

- A U-shaped relationship is hypothesized between exercise dose and risk: while moderate exercise confers protection, extreme endurance training may increase the risk of CAD or adverse cardiac events.

- Plaque rupture in athletes often occurs from non-obstructive coronary plaques (i.e., plaques that wouldn't necessarily cause symptoms or blockages), meaning they can remain silent until an acute event.

- Mechanisms that may drive this increased risk include thrombogenic activation, increased shear stress, oxidative and inflammatory stress, sympathetic activation, and hyperdynamic circulation during intense exercise.

- Conventional risk stratification methods (clinical risk scores, resting ECG, exercise ECG, stress testing) frequently fail to detect subclinical CAD in athletes.
    - Up to one-third of people with angiographically confirmed CAD may have a normal baseline ECG.

    - Exercise/stress tests are limited because they detect mainly obstructive disease, not nonobstructive or early plaques.

- Coronary calcium scoring (CS) and coronary CT angiography (CCTA) are emerging as valuable tools in this athlete population:
    - CS is a noninvasive marker of subclinical atherosclerosis and adds to risk stratification beyond conventional factors.

- CCTA allows evaluation of plaque morphology (calcified, non-calcified, mixed), lesion location, and total plaque burden. Even when obstruction is absent.

- Newer CT technologies permit very low radiation doses (i.e., ~0.5 mSv), making screening more feasible.

- In the MARC study, about 18.9% of asymptomatic middle-aged sportsmen with low conventional risk scores were found to have occult CAD (either CS ≥100 or ≥50% stenosis) via CCTA.

- Among high-mileage veteran runners (>30 miles/week), a CS >70th percentile was observed in 39% of athletes, compared to 13% in runners doing <20 miles/week.

- In a study of marathoners vs controls, after adjusting for Framingham risk score, mean calcium score was significantly higher in athletes (36 vs 12, p=0.02).

2. Masters Athletes Screening Study (MASS): incidence of cardiovascular disease and major adverse cardiac events over five years of screening

Reference Links
academic.oup.com
(https://academic.oup.com/eurheartj/article/42/Supplement_1/ehab724.2706/6393306?login=false)

- Among masters athletes (typically age ≥35) undergoing screening, a substantial proportion were found to have underlying cardiovascular disease, despite low conventional risk profiles.

- Traditional screening tools (resting ECG, standard physical exam) show limited sensitivity in this athlete population. Meaning many cases of disease remain undetected.

- The study underscores the need for tailored screening protocols for older athletes, including consideration of advanced imaging (i.e., CT calcium scoring) rather than relying solely on standard risk-factor assessments.

- It highlights that being a highly trained athlete does not equal immunity from coronary artery disease (CAD); fitness may mask underlying pathology.

- **Study Population:** 798 masters athletes (62.7% male, mean age 54.6 ± 9.5 years) were screened in the first year.

- **Initial CVD Diagnoses:** In the first year, 91 (11.4%) athletes were diagnosed with CVD.

- **Subsequent Diagnoses:** Over the next four years, 89 additional CVD diagnoses occurred, with incidence rates of 3.58/100, 4.14/100, 3.74/100, and 1.19/100 athletes per year, respectively.

- **Common Diagnoses:**
  - Arrhythmias: 33 cases (37.1%)
  - Aortic dilatation: 20 cases (22.5%)
  - Coronary artery disease (CAD): 18 cases (20.2%)
  - Other conditions: 7 cases (7.9%)
  - Multiple diagnoses in 15 participants.

- **Major Adverse Cardiac Events (MACE)**: 10 MACE occurred (2 cardiovascular deaths, 5 myocardial infarctions, and 3 cerebrovascular accidents). All events occurred in male athletes (mean age 63.6 ± 12.5 years).

- **Screening Limitations:** Despite yearly screening, all athletes who experienced a MACE had abnormal screening results; however, functional tests (e.g., echocardiogram, electrocardiogram, nuclear stress tests) failed to detect underlying CAD in most cases.

- **Screening Recommendations:** The study suggests that offering computed coronary tomography angiography (CTA) to masters athletes with an intermediate or higher cardiovascular risk (e.g., Framingham Risk Score ≥10%) may help overcome the limitations of functional testing and assist with lifestyle and treatment modifications.

These findings highlight the importance of tailored cardiovascular screening protocols for masters athletes, as traditional screening methods may not adequately detect underlying cardiovascular conditions in this population.

3. **Assessment of cardiovascular risk and preparticipation screening protocols in masters athletes: the Masters Athlete Screening Study (MASS): a cross-sectional study**

Reference Links
bmjopensem.bmj.com
(https://bmjopensem.bmj.com/content/4/1/e000370)

- In a sample of 798 masters athletes (≥ 35 years old; mean age ~54.6 yrs) undergoing pre-participation screening, 11.4% were diagnosed with cardiovascular disease (CVD), and 7.9% were diagnosed with coronary artery disease (CAD).

- Among those diagnosed with CAD, 90% were asymptomatic at the time of diagnosis.

- The Physical Examination had a low positive predictive value (PPV); in contrast, a high Framingham Risk Score (FRS > 20%) had the highest PPV (38.2%) for underlying CAD.

- The average physical activity experience among participants was ~35 years, and weekly metabolic equivalents (MET) hours were ~80.8 ± 44.0.

- The study concludes that masters athletes are not immune to elevated cardiovascular risk and cardiovascular disease, despite high fitness levels.

- The findings suggest that screening protocols for athletes may need to go beyond standard questionnaires and physical exams and consider tailored approaches given the unique risk profile of this population.

4. **Coronary atherosclerosis in athletes: emerging concepts and preventive strategies**

Reference Links
academic.oup.com
(https://academic.oup.com/eurheartj/article/46/10/890/7951179)

- There should be no assumption that an athlete is immune to coronary artery disease (CAD) even when traditional cardiovascular risk factors appear well-managed.

- Recent cardiac imaging data suggest that long-term, high-volume, high-intensity endurance exercise may be associated with coronary atherosclerosis.

- CAD is the leading cause of sudden cardiac death (SCD) in athletes over age 35 (“Masters athletes”).

- Evaluating both traditional and non-traditional risk factors is critical in pre-participation evaluation of Masters athletes.

- Despite potential increased plaque burden, in the great majority of athletes, after excluding symptoms and inducible ischemia, the advice remains to continue exercising, because higher fitness levels are associated with a markedly lower incidence of coronary events.

Important Nuances to Consider

- While athletes may have more coronary plaques or calcification, the clinical event rate (heart attacks, death) has *not* been definitively shown to increase solely because of that.

- There remains uncertainty about how to interpret high coronary artery calcium (CAC) scores in athletes, how disease mechanisms differ, and what screening/treatment strategies should apply.

- Most current evidence is based on male endurance athletes; data in female athletes and in non-endurance sports are much more limited.

5. **The Spectrum of Coronary Artery Disease in Elite Endurance Athletes - A Long-Standing Debate: State-of-the-Art Review**

Reference Links
pmc.ncbi.nih.gov
(https://pmc.ncbi.nlm.nih.gov/articles/PMC11395881/)

- High-volume, long-term endurance exercise may accelerate coronary atherosclerosis rather than always protect against it.

- In athletes over age 35 (“Master athletes”), CAD is the leading cause of sudden cardiac death (SCD).

- Many endurance athletes show higher coronary artery calcium (CAC) scores and more high-risk plaque morphology on imaging, despite low traditional risk profiles.

- Plaque morphology in athletes may not be benign; non-obstructive plaques and high-calcium burdens still carry risk.

- Fitness and exercise remain highly beneficial (lower mortality), but the paradox remains: high volume athletes may harbour hidden CAD risk that standard screening misses.

- Screening in athlete populations should consider exercise dose/volume, imaging (CAC & CCTA), and tailored risk assessment rather than relying solely on traditional risk factors.

6. **Exercise Volume Versus Intensity and the Progression of Coronary Atherosclerosis in Middle-Aged and Older Athletes: Findings From the MARC-2 Study**

Reference Links
ahajournals.org
(https://www.ahajournals.org/doi/10.1161/CIRCULATIONAHA.122.061173)

- High-volume, long-term endurance exercise may accelerate coronary atherosclerosis rather than always protect against it.
- In athletes over age 35 ("Master athletes"), CAD is the leading cause of sudden cardiac death (SCD).
- Many endurance athletes show higher coronary artery calcium (CAC) scores and more high-risk plaque morphology on imaging, despite low traditional risk profiles.
- Plaque morphology in athletes may not be benign; non-obstructive plaques and high-calcium burdens still carry risk.
- Fitness and exercise remain highly beneficial (lower mortality), but the paradox remains: high volume athletes may harbour hidden CAD risk that standard screening misses.
- Screening in athlete populations should consider exercise dose/volume, imaging (CAC & CCTA), and tailored risk assessment rather than relying solely on traditional risk factors.

7. **Coronary Plaque in Athletes**

Reference Links
mdpi.com
(https://www.mdpi.com/2077-0383/13/7/2044)

- Athletes are not immune to coronary artery disease. Even people who train vigorously and appear very fit can develop atherosclerotic plaques in their coronary arteries.
- The prevalence of coronary plaque in athletes is meaningful, not trivial. Studies show a noticeable number of athletes develop plaque as they age, especially "master athletes" (often defined as 35 years and older).
- Plaque in athletes appears different. Compared with typical plaques, plaques found in athletes tend to be more calcified and less soft. Some research suggests that calcified plaques may be more stable and potentially associated with lower

near-term risk than softer plaques seen in others, but they still represent disease.

- Vigorous or prolonged high-intensity activity is associated with increased coronary artery calcium (CAC). Some studies show that people with very high lifetime exercise exposure have higher CAC scores than less active individuals.

- Traditional risk tools can underestimate risk in athletes. Standard cardiovascular risk calculators may not fully capture the actual burden of plaque seen in active individuals, meaning athletes might appear “low risk” by those tools even when significant plaques are present.

- CAD is still the main exercise-related cause of serious events in older athletes. Literature has identified coronary atherosclerosis as the leading cause of exercise-associated adverse events and sudden cardiac death in athletes over about age 35.