De (on)zin van cardiale screening bij (top) sporters

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Geen disclosures

Hoe denkt de zaal?

- (Ethische) vraag: moeten we een *asymptomatische* sporter anders beschouwen/benaderen dan onze niet-sportende patiënten?
  - Ja/nee

- Vraag: cardiale screening van een *asymptomatische* sporter vind ik zinvol
  - Ja/nee/afhankelijk van leeftijd en type sport

Een beladen/boeiend onderwerp

deV

Columns Opinie

INTERVIEW KASPER HJULMAND

Deense bon terug op ha Eriksen tijd horrorfilm, sprookje’

AD

Weer de komende dagen TV-Gids

NIEUWS REGIO SPORT

Nederlands voetbal Buitenlands voetba

▲ © AP

American football-s Hamlin mag weer m hartstilstand

American-footballer Damar Hamlin, die c zijn club Buffalo Bills tegen Cincinnati B hartstilstand, mag weer meetrainen bij z de National Football League maakte bek mag hervatten.

Sportredactie 18-04-23, 19:16

deVolkskrant

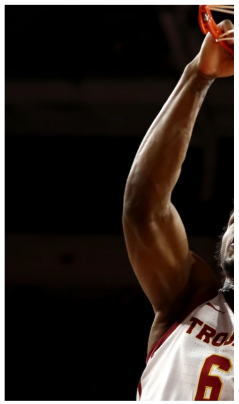
Topverhalen vandaag Opinie Cartoons Cultuur & Media

PROFIEL

Hartprobleem of niet, Bronny James is voorbestemd om te spelen in de NBA

In juli werd Bronny James, de 19-jarige zoon van superster LeBron James, getroffen door een hartstilstand. Nu staat het basketbaltalent weer op het veld. Samenspelen met zijn beroemde vader in de NBA behoort nog altijd tot de mogelijkheden.

Koen van der Velden 15 decem



Bronny James tijdens de warming-up

Van Hooydonck (27) zet vanwege hartproblemen punt achter wielerloopbaan

'Voorjaarsspecialist' Vanmarcke stopt door hartproblemen met wielrennen

Colbrelli stopt noodgedwongen: defibrillator betekent einde wielerloopbaan

Inhoud

- Plotse hartdood; wat zijn de cijfers?
- Cardiale screening in sport; standpunt ESC, RIVM, NVVC
- Overweging voor-en nadelen van cardiale screening bij sporters
- Cardiale diagnostiek bij sporters
  - ECG
  - Ergometrie
  - Echocardiografie
  - Cardiale MRI
  - Cardiale CT
- Interpretatie en consequenties?

Wat zijn de cijfers?

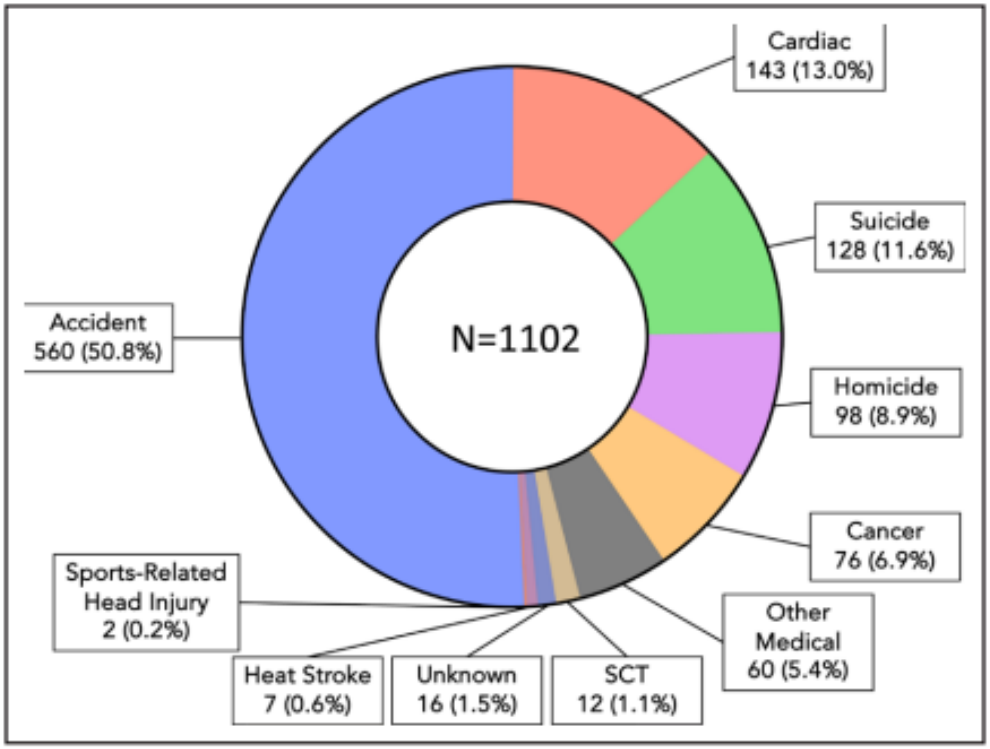


Figure 1. Causes of death among National Collegiate Athletic Association athletes (n=1102).
SCT indicates sickle cell trait.

Petek et al. Circulation. 2023

Circulation
Volume 149, Issue 2, 9 January 2024; Pages 80-90
https://doi.org/10.1161/CIRCULATIONAHA.123.065908

ORIGINAL RESEARCH ARTICLE

Sudden Cardiac Death in National Collegiate Athletic Association Athletes: A 20-Year Study

Editorial, see p 91

Bradley J. Petek, MD, Timothy W. Churchill, MD, Nathaniel Moulson, MD, Stephanie A. Kliethermes, PhD, Aaron L. Baggish, MD, Jonathan A. Drezner, MD, Manesh R. Patel, MD, Michael J. Ackerman, MD, PhD, Kristen L. Kucera, PhD, MSPH, LAT, AT, David M. Siebert, MD, Lauren Salerno, BA, Monica Zigman Suchsland, MPH, Irfan M. Asif, MD, Joseph J. Maleszewski, MD, and Kimberly G. Harmon, MD

Wat zijn de cijfers?

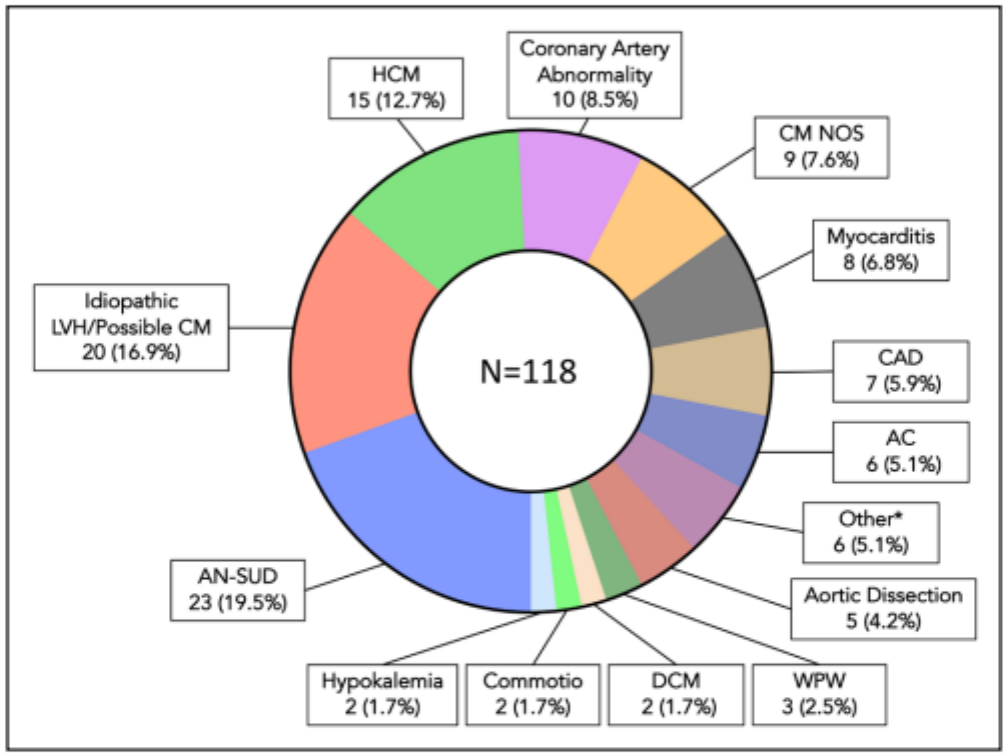


Figure 3. Causes of sudden cardiac death or findings on cardiac autopsy among National Collegiate Athletic Association athletes (n=118).

*Other: 1 each of long QT syndrome, complications of congenital heart disease, idiopathic left ventricular hypertrophy (LVH)/possible sickle cell trait, Kawasaki disease, complications after heart transplant, and sudden cardiac death in individual with pacemaker for idiopathic atrioventricular block. AC indicates arrhythmogenic cardiomyopathy; AN-SUD, autopsy-negative sudden unexplained death; CAD, coronary artery disease; CM, cardiomyopathy; DCM, dilated cardiomyopathy; HCM, hypertrophic cardiomyopathy; NOS, not otherwise specified; and WPW, Wolff-Parkinson-White syndrome.

Petek et al. Circulation. 2023

Wat zijn de cijfers?

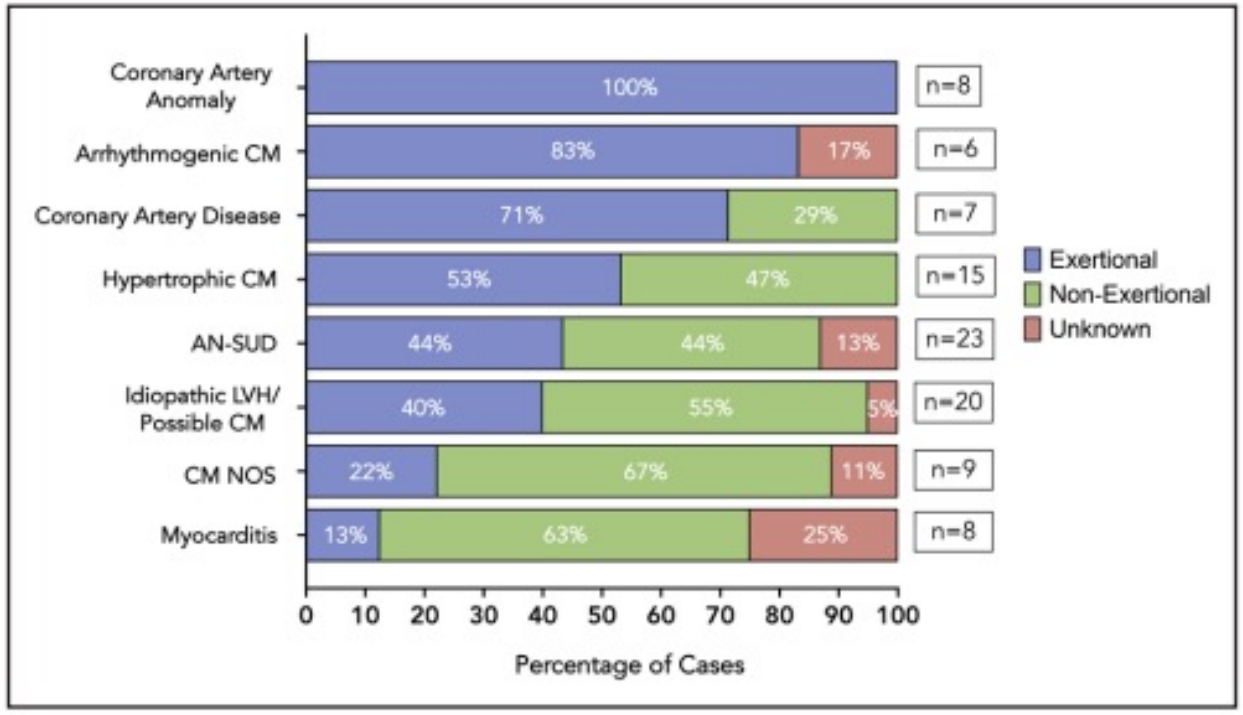


Figure 4. Exertional status at time of death by common causes of sudden cardiac death.
AN-SUD indicates autopsy-negative sudden unexplained death; CM, cardiomyopathy; LVH, left ventricular hypertrophy; NOS, not otherwise specified; and SCD, sudden cardiac death.

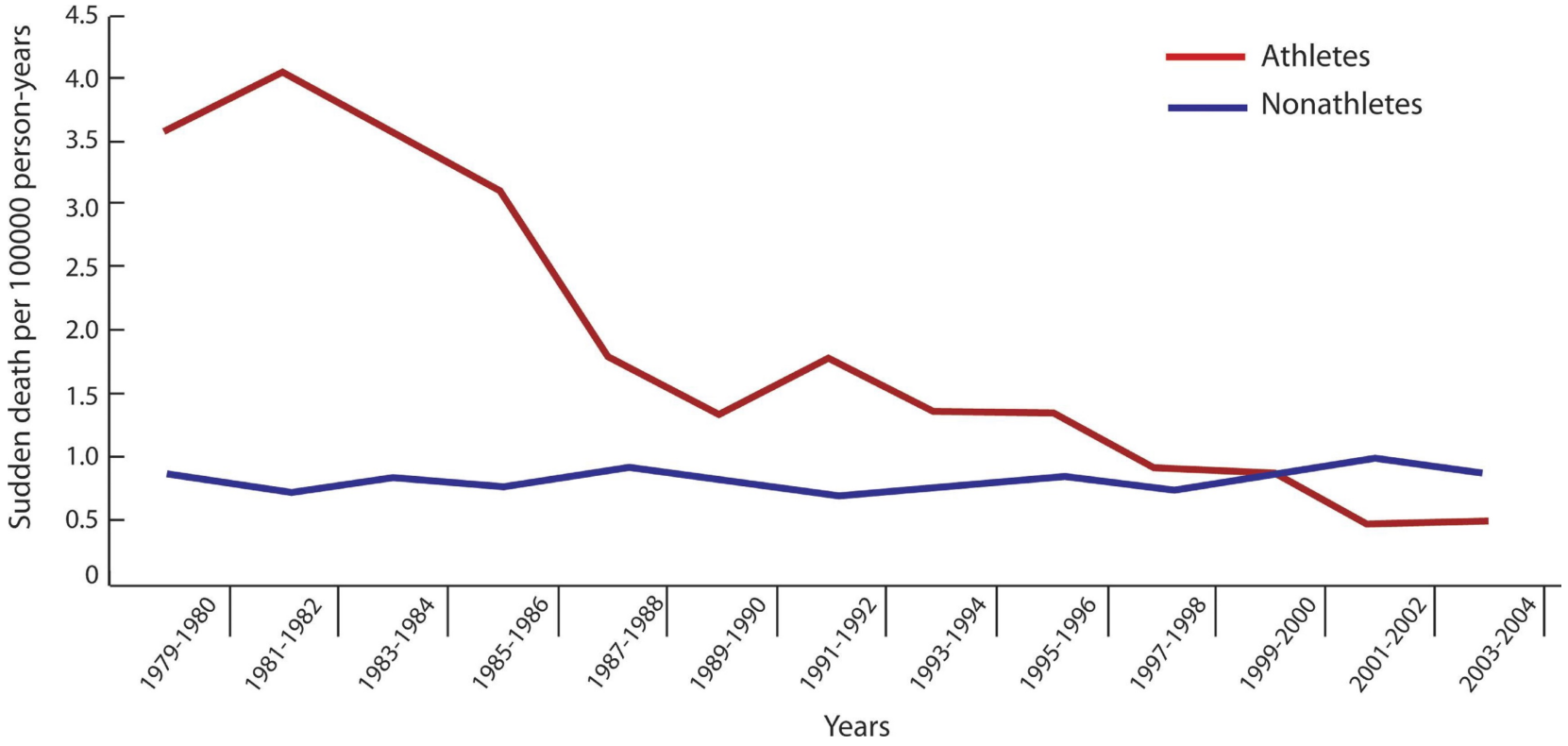
Petek et al. Circulation. 2023

Plotse hartdood tijdens sport in Nederland (’06-’09)

- 143/2.524 (5,7%) van “out of hospital cardiac arrest” tijdens sport
  - Wielrennen (49), tennis (22), sportschool (16), zwemmen (13), overig (43)
  - Slechts 10 (7%) vrouw, slechts 7 (5%) < 35 jaar oud
  - 1-2/100.000 jonge atleten/jaar

- Overleving out of hospital cardiac arrest:
  - 46% (sport gerelateerd) vs. 17% (niet-sport gerelateerd)

The “Italian cardiac screening design”



Corrada et al. JACC. 2009

Wat zegt het RIVM?

rivm

Rapport 260264001/2009
P.M. Engelfriet | P.F. van Gils | H.A. Smit

Preparticipatiescreening om plotse dood te voorkomen: Italian design voor Nederlandse sporters?

De voornaamste conclusie van dit rapport is dan ook dat het niet zinvol lijkt om een pilot-onderzoek uit te voeren dat tot doel heeft de kosteneffectiviteit van screening aan te tonen.

Echter, een op vrijwillige basis aangeboden screening van sporters met een ecg kan wel een belangrijke bijdrage leveren aan het opsporen (naast de cascadescreening die al bestaat) van erfelijke en aangeboren hartafwijkingen die kunnen leiden tot plotse dood op jonge leeftijd.
Om een goede afweging voor het nut van preparticipatiescreening in Nederland te kunnen maken, is het van belang om meer inzicht te verkrijgen in de prevalenties van de onderliggende hartafwijkingen die met plotse hartdood samenhangen en de daarmee geassocieerde risico's. Ook is er behoefte aan een grotere kennis over de kenmerken van het ecg bij sporters en over organisatorische en financiële consequenties van een grootschalige screening.

Wat zegt de ESC guideline sportcardiology?

3.6 Screening modalities for cardiovascular disease in young athletes

Most experts believe that early detection of potentially lethal disorders in athletes can decrease CV morbidity and mortality through risk stratification, disease-specific interventions, and/or exercise modifications.[22,57,58,71] CV screening by history and physical examination or by electrocardiogram (ECG) presents unique challenges and limitations. Several studies have documented the low sensitivity and high positive response rate of pre-participation history questionnaires.[64,65,72–75] In CV screening studies in which experienced clinicians use contemporary ECG interpretation standards, ECG screening outperforms history and physical examination in all statistical measures of performance.[58,59,62,64,65,74,76]

While echocardiography may identify additional structural disorders, there is insufficient evidence to recommend an echocardiogram for routine screening.[77]

3.7 Screening for cardiovascular disease in older athletes

The recommendations and evidence base for CV screening in athletes >35 years of age are limited. CV screening in adult and senior athletes must target the higher prevalence of atherosclerotic CAD. However, routine screening for ischaemia with exercise testing in asymptomatic adults has a low positive predictive value and a high number of false-positive tests and is not recommended.[78–80]

A screening ECG may still discover undiagnosed cardiomyopathies and primary electrical disorders in older athletes, and risk factor assessment for CVD may identify higher risk individuals who warrant additional testing. Thus, consistent with a 2017 ESC position paper on pre-participation CV screening, exercise ECG testing should be reserved for symptomatic athletes or those deemed at high risk of CAD based on the ESC Systematic Coronary Risk Evaluation (SCORE) system (see chapters 4 and 5).[6,81]

Exercise testing may also be useful to evaluate the blood pressure (BP) response to exercise, the occurrence of exercise-induced arrhythmias, and to assess symptoms or physical performance and its relation to exercise training.[81] In adult and elderly individuals, especially those naïve to moderate to vigorous PA, exercise testing or cardiopulmonary exercise testing (CPET) is a useful means to assess overall CV health and performance, allowing individualized recommendations regarding sports and exercise type and intensity, as will be discussed in subsequent sections.[82]

2020 ESC Guidelines on sports cardiology and exercise in patients with cardiovascular disease

Wat zegt de NVVC werkgroep sport cardiologie?

- Keuring bij alle topsporters (A, bond- en talent status) en nationale selecties van 12 tot 35 jaar
  - “Lausanne protocol”: vragenlijst, lichamelijk onderzoek en ECG

- Voor alle overige sporters een vrijwillige keuring of een verplichte keuring op advies van betreffende sportbond

Wat zegt de FIFA?

Prevention

Pre-participation screening is promoted to identify footballers with pre-existing conditions at risk of SCA. The Pre-Competition Medical Assessment (PCMA) as recommended by FIFA[7–9] involves a player-focused medical history, family medical history, cardiac-specific physical medical examination, and an annual resting 12-lead electrocardiogram (ECG) on all players.[10,11] Echocardiography should be undertaken by an experienced cardiologist when abnormal results are found and should be considered at least once in a player's early career[11] to detect better structural disorders not routinely identified by ECG. A screening Exercise Test should be considered in athletes older than 35 years of age.

FIFA Pre-Competition Medical Assessment (PCMA) 2013

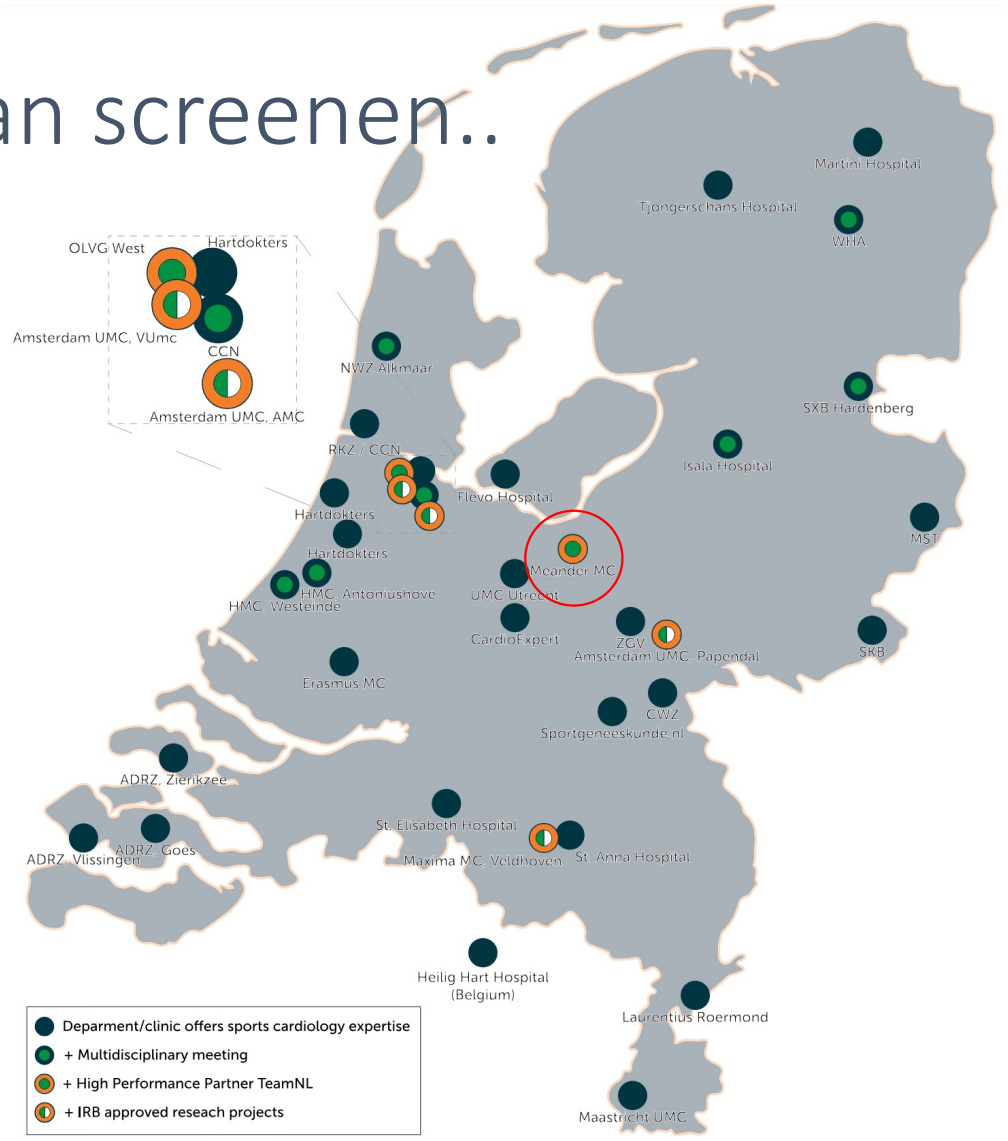
Ja, cardiale screening van sporters, doen:

- Hoge fysieke belasting
  - in soms risicovolle situaties
    - duikers, piloten, wielersport, autosport etc.
- Elk te voorkomen event telt
- Het is soms verplicht
  - vooraf aan race, of vanuit sportbond
- Beeldvorming media, “zou voorkombaar zijn”..
- Onrust/angst (bij pt, familie, huisarts)
- Het wordt door verzekeraar aangeboden..
- Geen medische verwijzing nodig..
- Financiële belangen..
- Data verzamelen over het “sporthart”; andere normaal waardes?
- Onze sportartsen moeten immers ook brood op de plank houden.. ☺

Nee, meer nadelen dan voordelen, niet doen:

- Pt is toch asymptomatisch bij reeds hoge fysieke belasting?
- Incidentie plotse hartdood (erg) laag
- Fout negatieve screening, “schijnveiligheid?”
- Fout positieve screening
  - Overdiagnostiek, onrust en psychische gevolgen
  - Kosten en zinnige zorg
- Bij veel asymptomatische hartziekten bestaan geen sport restricties
- Kan een sport carrière breken, terwijl het meestal goed gaat
- Beschikbaarheid AED neemt toe
- Ethiek: waarom dan geen structurele/populatie screening?

Maar als we dan toch gaan screenen..



The Netherlands Sports Cardiology Map. Neth Heart J. 2021

Het ECG en sport

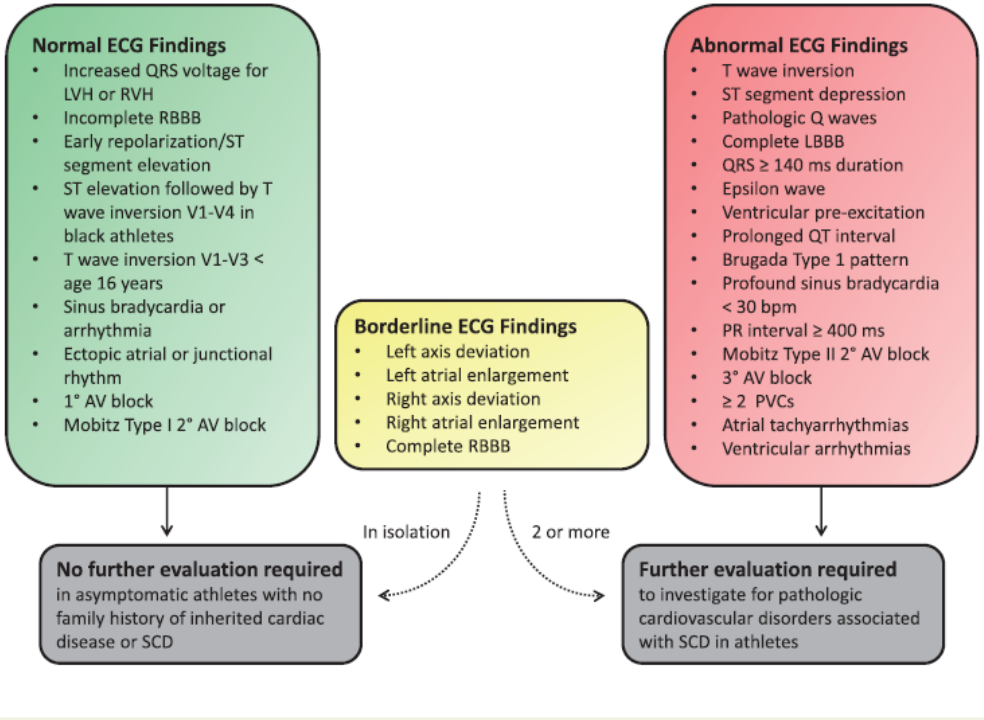


Figure 1 International consensus standards for electrocardiographic interpretation in athletes. AV, atrioventriular block; LBBB, left bundle branch block; LVH, left ventricular hypertrophy; RBBB, right bundle branch block; RVH, right ventricular hypertrophy; PVC, premature ventricular contraction; SCD, sudden cardiac death.

Sharma et al. International recommendations for electrocardiographic interpretation in athletes. Eur Heart J 2018

Denk niet te snel aan LVH

- Geïsoleerde QRS voltages (LV en RV) gelden niet

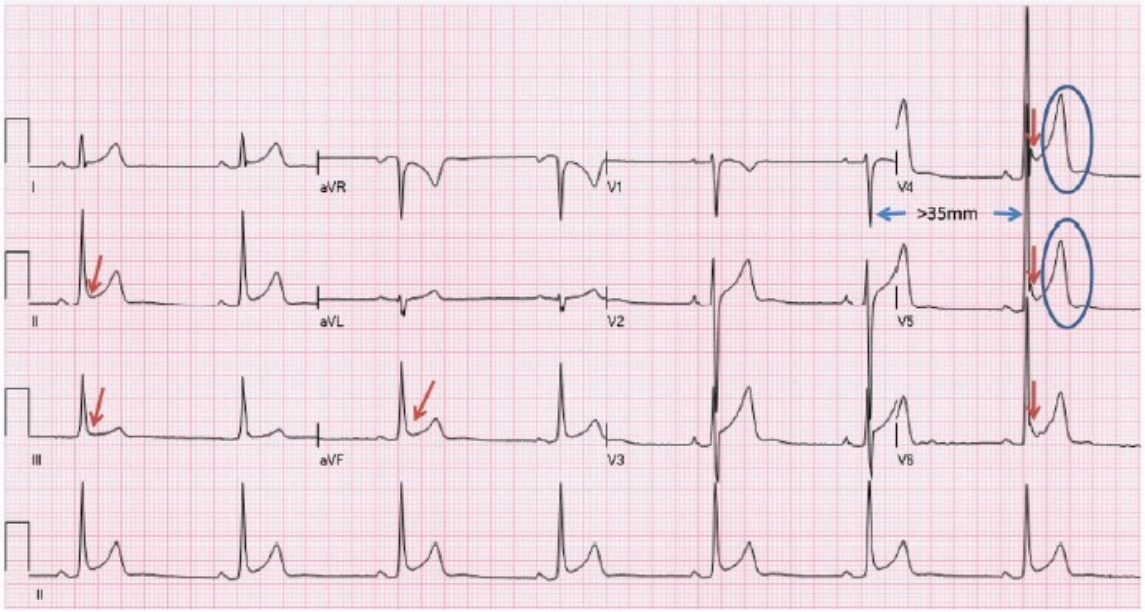
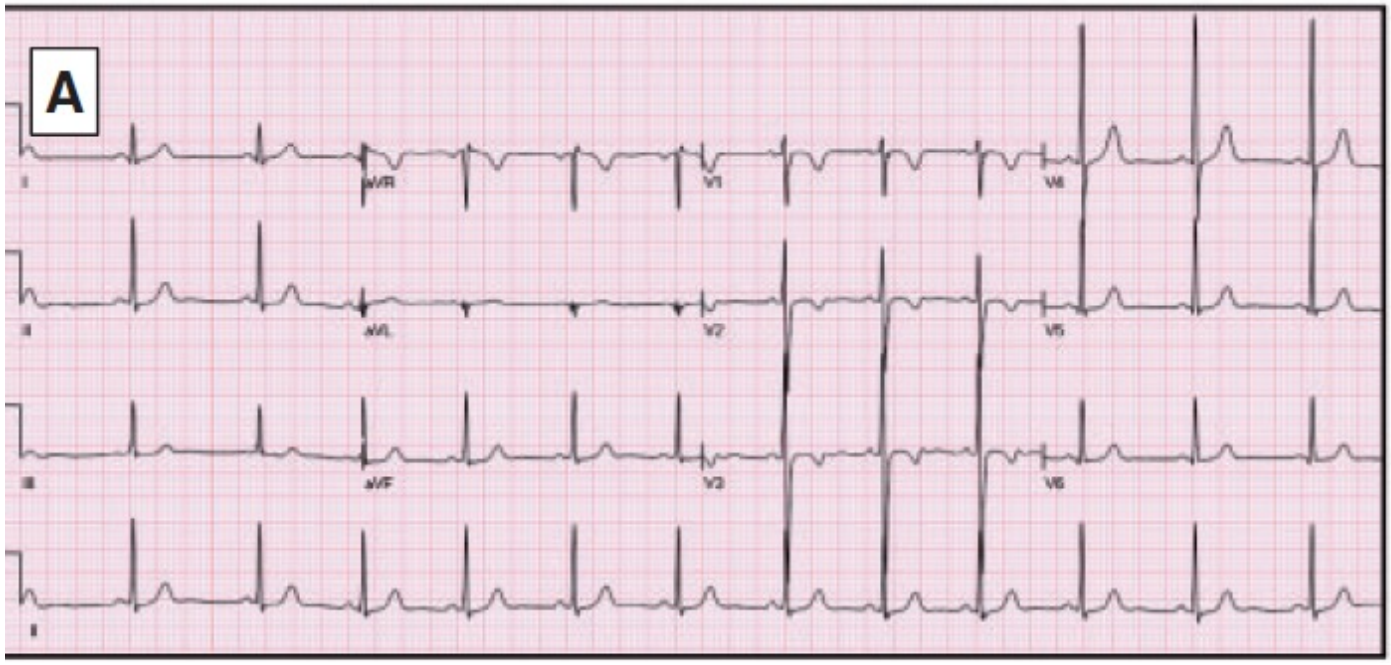


Figure 2 Electrocardiogram of a 29-year-old male asymptomatic soccer player showing sinus bradycardia (44 bpm), early repolarization in I, II, aVF, V5–V6 (arrows), voltage criterion for left ventricular hypertrophy (S-V1 + R-V5 > 35 mm), and tall, peaked T waves (circles). These are common, training related findings in athletes and do not require more evaluation.

Het juveniele ECG

- T-top inversie (of bifasische T) V1-3 <16 jaar niet afwijkend



Sharma et al. International recommendations for electrocardiographic interpretation in athletes. Eur Heart J 2018

Etniciteit heeft invloed op repolarisatie

- J-punt elevatie en convex ST segment met negatieve T V1-4 bij Afro-Amerikaanse atleet niet afwijkend

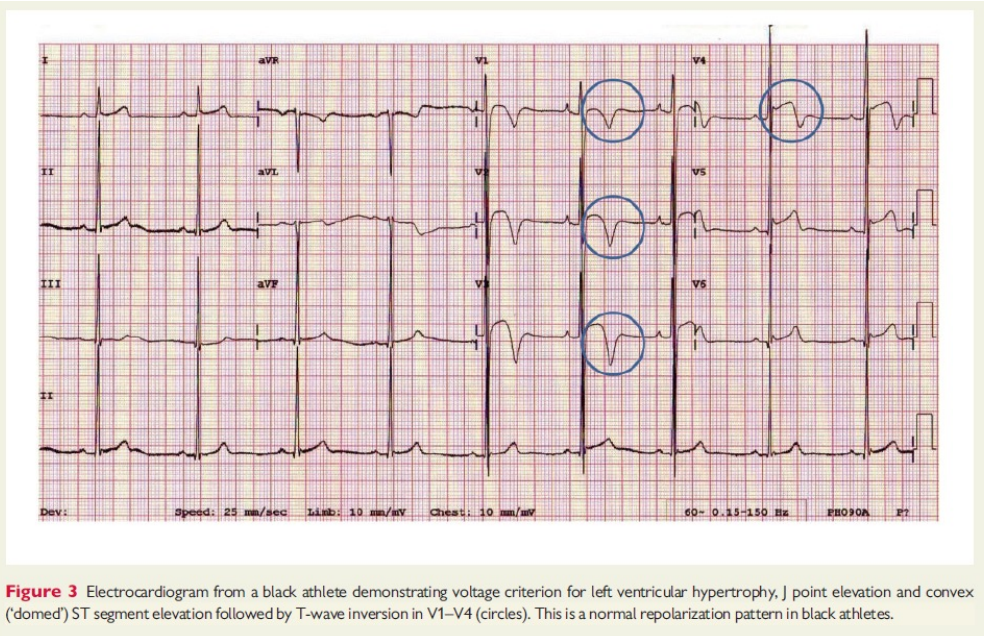


Figure 3 Electrocardiogram from a black athlete demonstrating voltage criterion for left ventricular hypertrophy, J point elevation and convex ('domed') ST segment elevation followed by T-wave inversion in V1–V4 (circles). This is a normal repolarization pattern in black athletes.

Sharma et al. International recommendations for electrocardiographic interpretation in athletes. Eur Heart J 2018

Maar het verschil kan subtiel zijn..

- Negatieve T top >V3, zonder J-punt elevatie en downsloping ST hoort niet

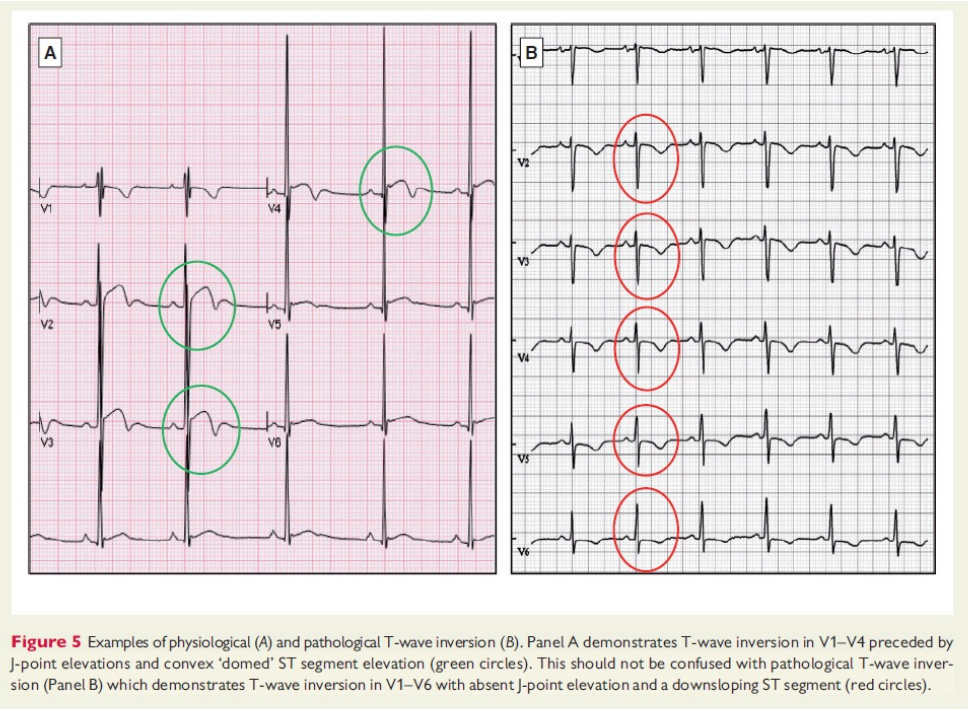


Figure 5 Examples of physiological (*A*) and pathological T-wave inversion (*B*). Panel A demonstrates T-wave inversion in V1–V4 preceded by J-point elevations and convex 'domed' ST segment elevation (green circles). This should not be confused with pathological T-wave inversion (Panel B) which demonstrates T-wave inversion in V1–V6 with absent J-point elevation and a downsloping ST segment (red circles).

Sharma et al. International recommendations for electrocardiographic interpretation in athletes. Eur Heart J 2018

JACC: CLINICAL ELECTROPHYSIOLOGY
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VOL. 4, NO. 12, 2018

NEW RESEARCH PAPERS

Electrocardiographic Features Differentiating Arrhythmogenic Right Ventricular Cardiomyopathy From an Athlete's Heart

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FIGURE 3 Diagnostic Accuracy of the Calore et al. (10) Criteria (<1 mm JPE and/or TWI beyond lead V_4) in Identifying Patients With ARVC

Applying this algorithm, 73% of athletes were incorrectly classified as having suspected ARVC, and 8% of subjects with ARVC were incorrectly classified as being normal. The overall accuracy of the proposed algorithm was 60%. JPE = J-point elevation ≥1 mm in at least 1 lead in leads V_1 to V_4 demonstrating TWI-wave inversion; +ve = positive; −ve = negative; other abbreviations as in Figure 1.

Ergometrie en sport

Table 1
Sensitivity and specificity of TMT in people with 25% prevalence of significant CAD.

TMT Result	People with CAD	People without CAD	No. of tests
TMT test positive	34 True positive	35 False positive	69 Positive tests
TMT test negative	16 False negative	115 True negative	131 Negative tests
No. of people	50	150	200

CAD, coronary artery disease.
Sensitivity 34/50 = 68%; specificity 115/150 = 77%.

Table 2
Positive and negative predictive values of TMT in people with 25% prevalence of significant CAD.

Disease status	TMT test positive	TMT test negative	Total
People with CAD	34	16	50
People without CAD	35	115	150
Total	69	131	200

CAD, coronary artery disease.
Positive predictive value 34/69 = 49%; negative predictive value 115/131 = 88%.

Table 3
Positive and negative predictive values of TMT in people with 5% prevalence of significant CAD.

Disease Status	TMT test positive	TMT test negative	Total
People with CAD	68	32	100
People without CAD	570	1330	1900
Total	638	1362	2000

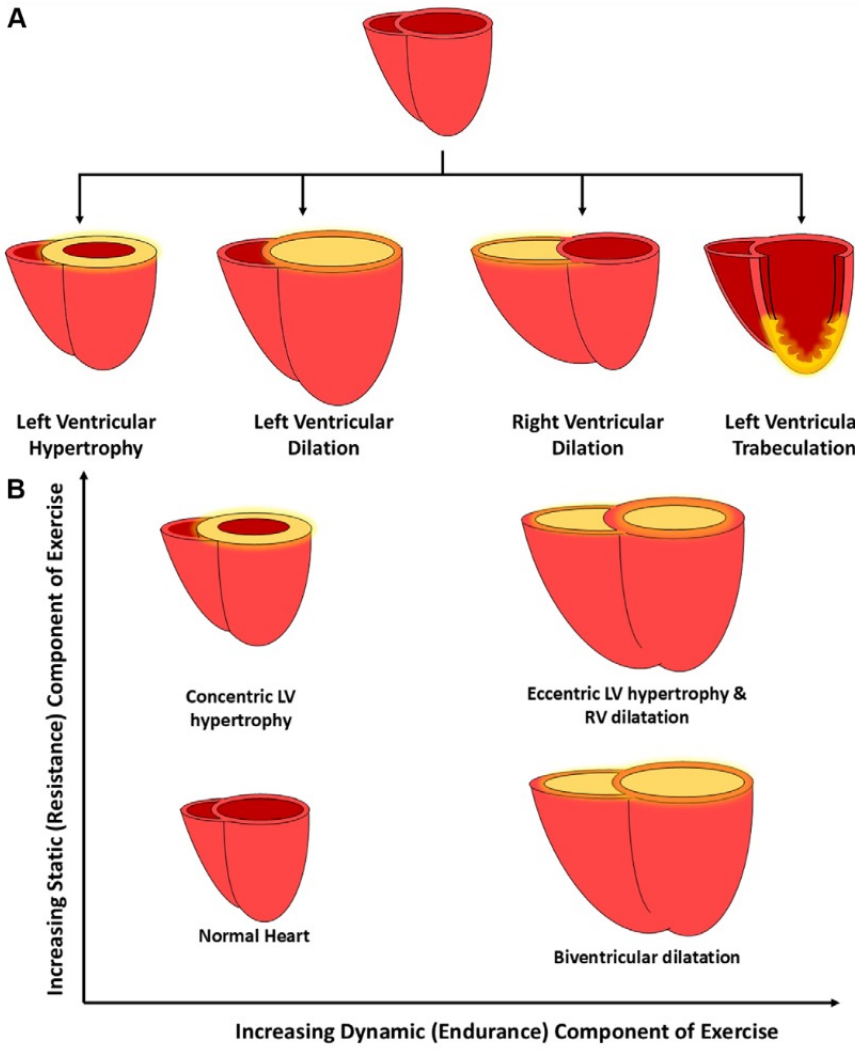
CAD, coronary artery disease.
Positive predictive value 68/638 = 11%; negative predictive value 1330/1362 = 98%.

Pais et al. Indian Heart J. 2018

Echocardiografie en cardiale MRI in sport

- *Cardiale remodelering* door volume en/of druk belasting vs pathologie
  - Afhankelijk van type sport alsook intensiteit ervan

- 5 fenotypes
  - LV hypertrofie
    - Symmetrie? 13-16mm grijs gebied (prevalentie +-20% van sporters), statische/kracht sport
  - LV dilatatie
    - 50% van elite duursporters LVEDD >60mm, tot soms wel 72mm
  - RV dilatatie
    - RV/LV ratio >1,2 pathologisch
  - LV functie
    - LVEF 40-45% in 25% van elite duursporters, LVEF <40% pathologisch
  - LV trabecularisatie
    - Veel voorkomend, zonder klachten en LV dysfunctie ip geen verdere actie



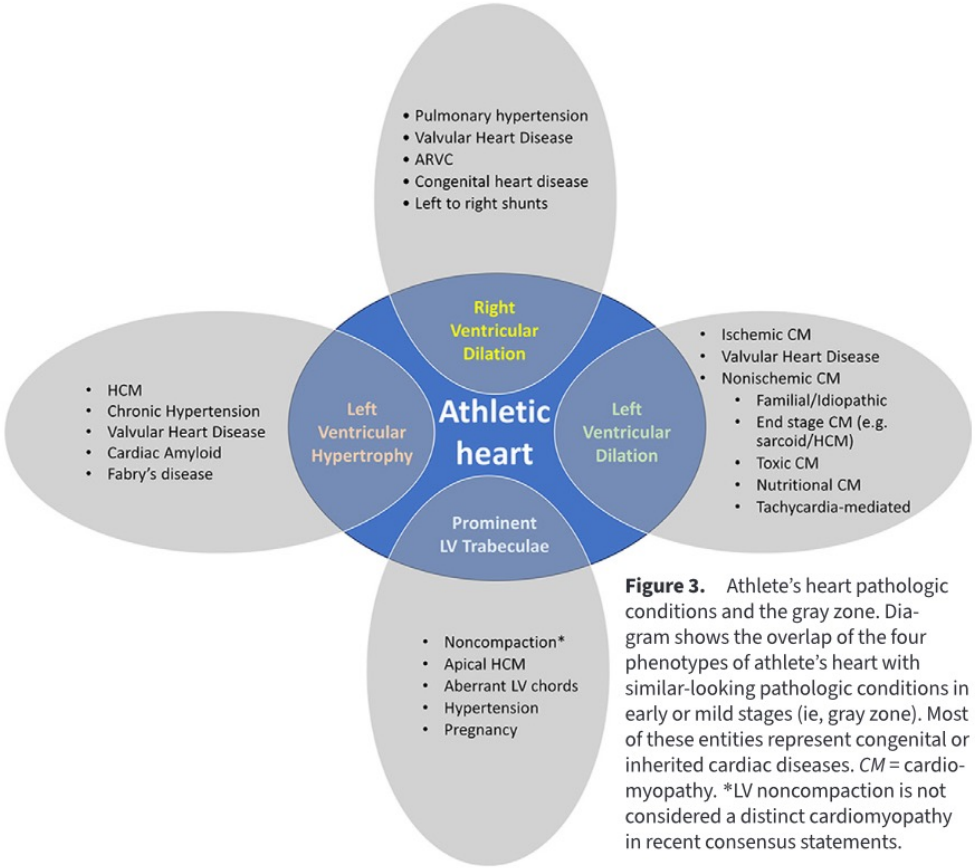


Figure 3. Athlete's heart pathologic conditions and the gray zone. Diagram shows the overlap of the four phenotypes of athlete's heart with similar-looking pathologic conditions in early or mild stages (ie, gray zone). Most of these entities represent congenital or inherited cardiac diseases. *CM* = cardiomyopathy. *LV noncompaction is not considered a distinct cardiomyopathy in recent consensus statements.

Rajiah et al. Radiographics. 2025

Echocardiografie en sport

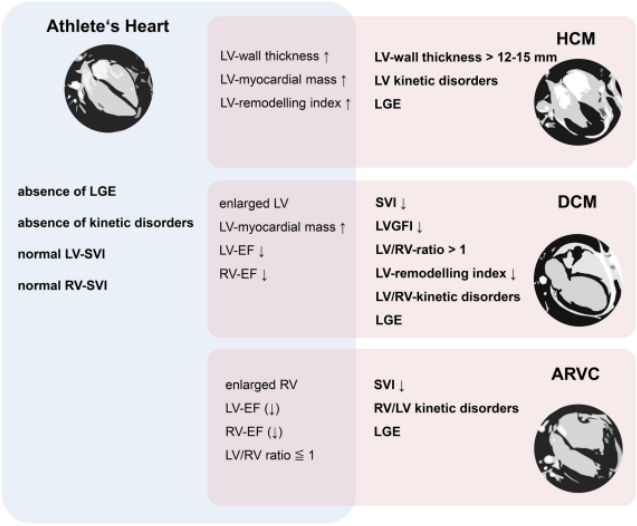
	Athlete's heart	HCM	IDC	LVNC	ARVD
LV dimension	Normal-mild symmetric hypertrophy <13 mm (Power athlete) Normal-mild dilatation <60 mm (Endurance athlete)	Moderate-severe asymmetric hypertrophy ≥15 mm (Gray zone 13–15 mm)	Moderate-severe dilatation ≥60 mm	Normal in early disease Dilatation in advanced disease	-
Diastolic dysfunction (E/A)	Absent	Present	Present	Present	-
LV filling pressure (E/e')	Normal	High	High	-	-
Left atrial dimension	Normal-mild dilatation	Moderate-severe dilatation	Mild or moderate or severe dilatation	-	-
LV GLS	Normal-supranormal	Reduced	Reduced	Reduced	-
LV ejection fraction	Preserved (>50%)	Preserved (>50%)	Reduced (<50%)	Normal in early disease Reduced in advanced disease	-
Stress echo LV contractile reserve	Normal >10% or supranormal	Normal	Reduced (<10%)	Reduced (<10%) in advanced disease	-
LV trabecular location	Midcavity	-	-	Apical	-
RV enlargement	Global or RVD1 mild dilatation (Endurance athlete)	-	-	-	Early dilatation
Ratio RV/LV volumes	<1	<1	<1	-	≥1
RV regional motion abnormalities	Absent	Absent	-	-	Present
RV systolic function (TAPSE-FAC-GLS)	Normal or supranormal	Normal	-	-	Reduced

HCM=Hypertrophic cardiomyopathy, IDC=Idiopathic dilated cardiomyopathy, LV=Left ventricle, LVNC=LV non-compaction cardiomyopathy, GLS=Global longitudinal strain, RV=Right ventricle, RVOT=RV outflow tract, FAC=Fractional area change, TAPSE=Tricuspid annular plane systolic excursion, ARVD=Arrythmogenic right ventricular cardiomyopathy, RVD1=Right ventricular diameter

Radmilovic et al. J Cardiovasc Echogr. 2019

Cardiale MRI en sport

- Handig indien echocardiografie twijfelachtig of afwijkend
  - Nauwkeurigere metingen
  - Aanwezigheid van “late gadolineum enhancement” (LGE/fibrose)
  - Weefsel karakterisatie (mapping van oedeem, extracellulair volume



Kubler et al. Int J Cariovasc Imaging. 2021

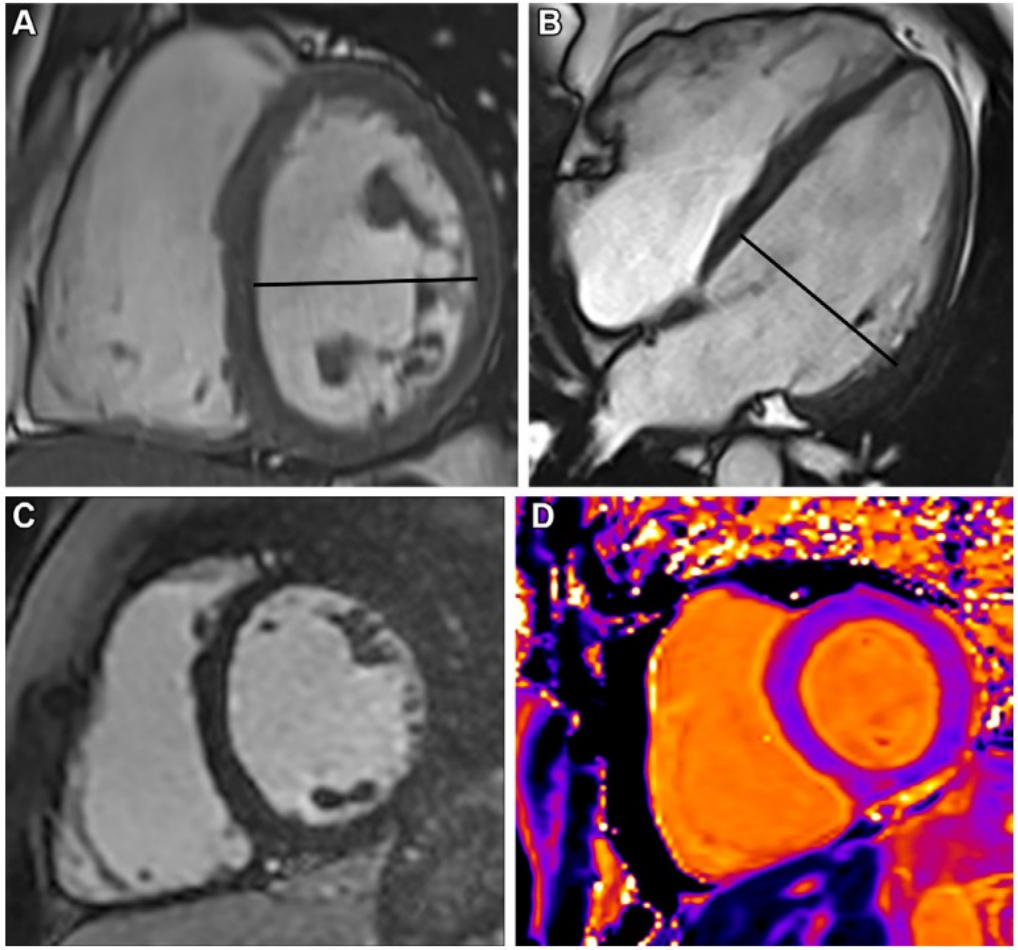


Figure 5. Athlete's heart (dilated phenotype) in a 45-year-old competitive dancer with a family history of SCD. MRI was performed during preparticipation screening. **(A, B)** Short-axis **(A)** and four-chamber **(B)** cine SSFP images show dilated LV with end-diastolic diameter of 60 mm and EDVi of 119 mL/m^2 (normal, <99 mL/m^2). Ejection fraction was normal at 55%. The RV is also mildly dilated with EDVi of 111 mL/m^2 (normal, <105 mL/m^2). **(C)** No abnormal LGE is seen on the short-axis delayed enhancement image. **(D)** Short-axis T1 map shows normal myocardial T1 values. This was diagnosed as athlete's heart.

Rajiah et al. Radiographics. 2025.

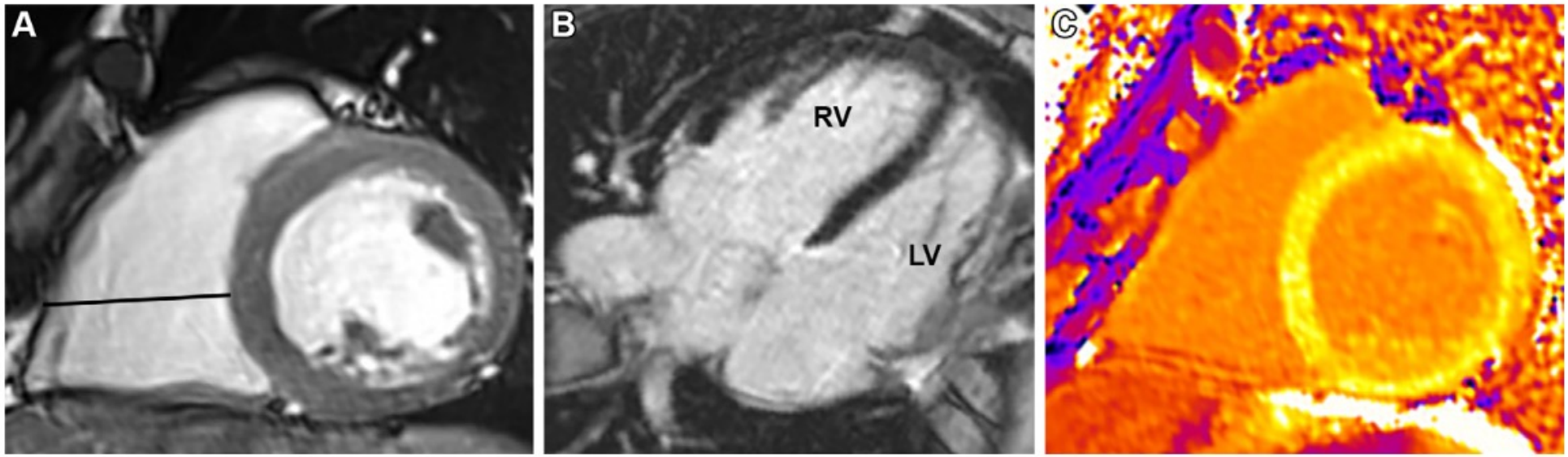


Figure 6. Athlete's heart (dilated RV phenotype) in a 51-year-old male competitive marathon runner with echocardiographic findings suspicious for dilated cardiomyopathy. **(A)** Short-axis cine SSFP image shows dilatation of the RV with an end-diastolic diameter of 52 mm (black line) and EDVi of 111 mL/m^2 (normal, <105 mL/m$^{/2}$) with normal ejection fraction. The LV is normal in size (EDVi, 110 mL/m^2) with normal ejection fraction. **(B)** Four-chamber PSIR image shows a dilated RV. No abnormal LGE was seen in the LV or RV. **(C)** Short-axis T1 map shows normal T1 values. ECV was slightly reduced to 21%, which is typical for athletes. With this constellation of findings, athlete's heart was diagnosed.

Rajiah et al. Radiographics. 2025.

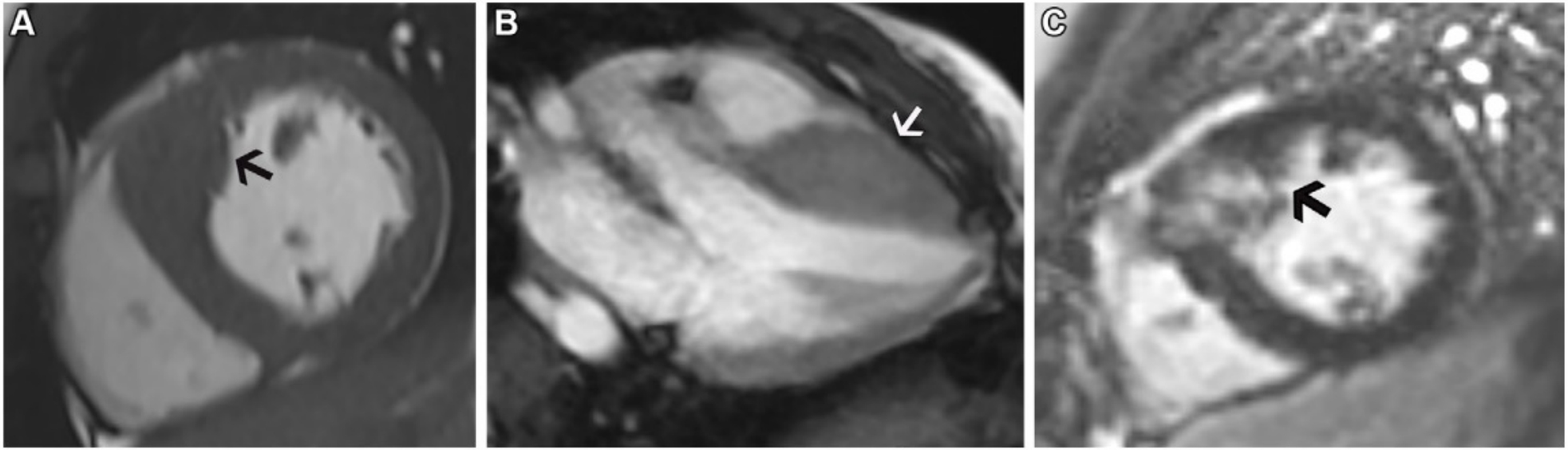


Figure 10. HCM in a 19-year-old male swimmer who is asymptomatic but has a maternally inherited *MYBPC3* mutation. **(A)** Short-axis cine SSFP image shows severe asymmetric hypertrophy of the basal anteroseptum (arrow), measuring 23 mm. No systolic anterior motion of the anterior mitral valve leaflet, LV outflow obstruction, or mitral regurgitation was seen. **(B)** Three-chamber cine SSFP image shows severe asymmetric hypertrophy in a reverse-curve pattern (arrow). **(C)** Short-axis PSIR image shows extensive LGE (arrow) that involves approximately 20% of the total myocardial mass.

Rajiah et al. Radiographics. 2025.

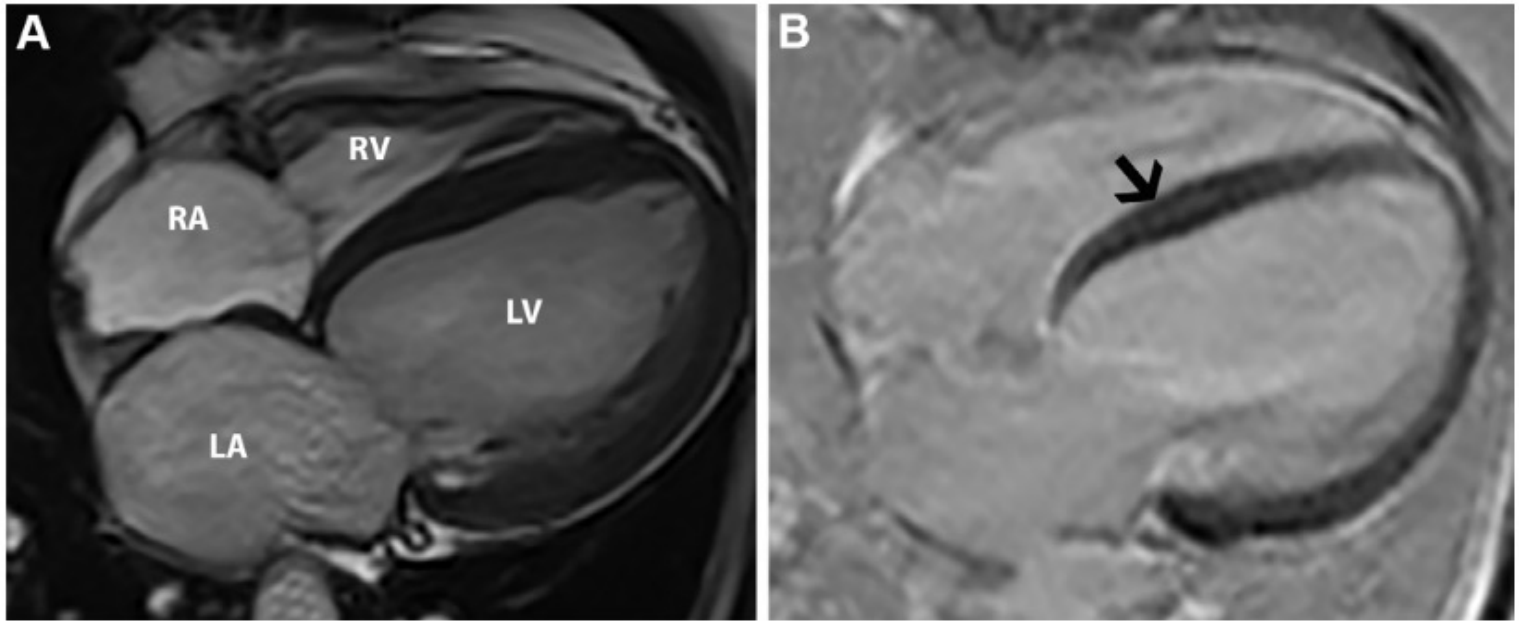


Figure 14. Dilated cardiomyopathy in a 19-year-old male basketball player who presented with lightheadedness and palpitations. Monomorphic ventricular tachycardia was seen with Holter monitoring, with a less than 1% premature ventricular complex burden. **(A)** Four-chamber cine SSFP image shows severe enlargement of the LV with an end-diastolic diameter of 70 mm and EDVI of 150 mL/m^2. Ejection fraction was decreased to 25%. (See also Movie 6.) No regional wall motion abnormalities were seen. *LA* = left atrium, *RA* = right atrium. **(B)** Four-chamber delayed-enhanced phase-sensitive inversion-recovery image shows linear midmyocardial enhancement in the ventricular septum (arrow). The constellation of findings is consistent with idiopathic dilated cardiomyopathy.

Rajiah et al. Radiographics. 2025.

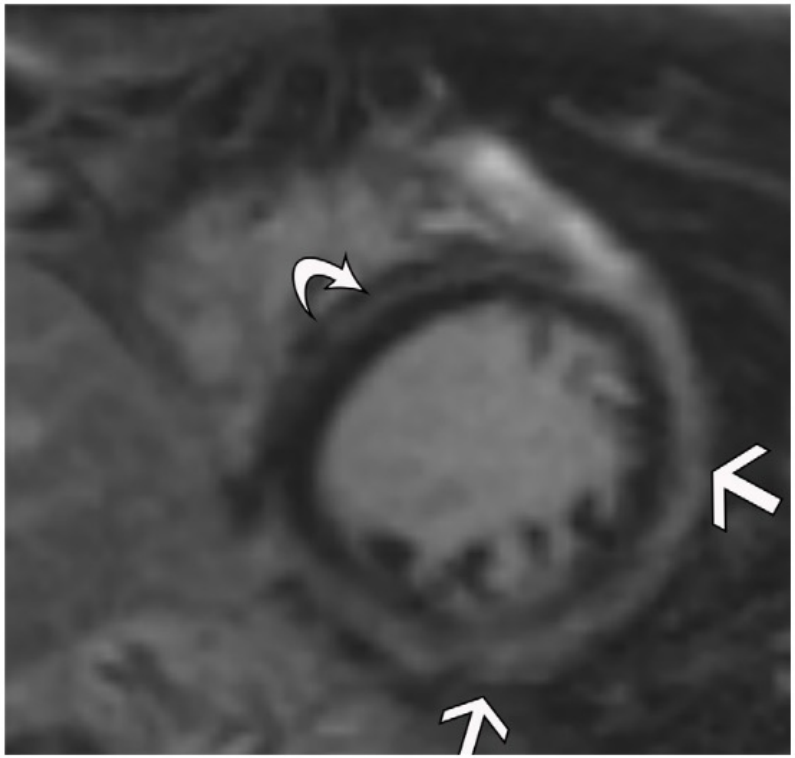


Figure 17. Acute myocarditis in a 19-year-old male professional hockey player who presented with cough, syncope, and monomorphic complex ventricular tachycardia. Short-axis PSIR image shows subepicardial LGE in the lateral and inferior walls (straight arrows). Midmyocardial LGE is seen in the anteroseptal wall (curved arrow). The patient also had elevated T2 values (not shown here). Cine image (Movie 9) shows hypokinesis of the inferolateral and inferior walls. The findings are consistent with acute myocarditis.

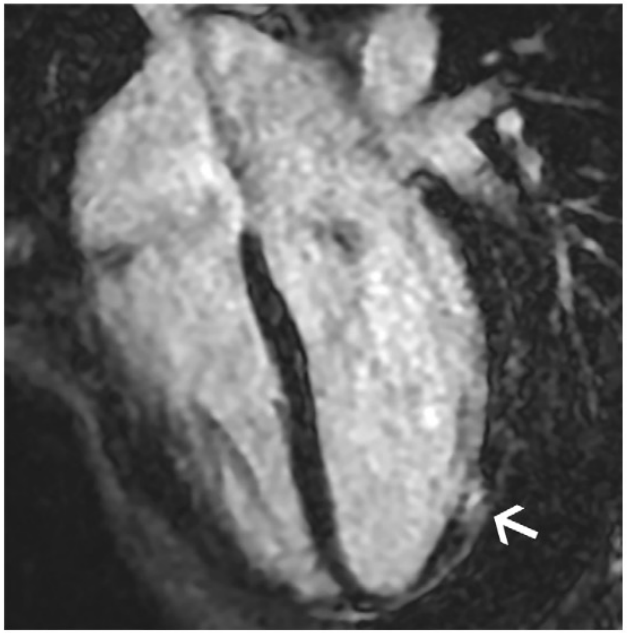


Figure 18. COVID-19 myocarditis in a 20-year-old male cross country athlete who presented with chest pain. High-sensitivity troponin levels were elevated and the patient was also positive for COVID-19. Coronary CT angiography was normal (not shown). Cine SSFP clip (Movie 10) showed mild global systolic dysfunction with an ejection fraction of 45%, along with hypokinesis of the lateral wall. Four-chamber PSIR image shows focal subepicardial to midmyocardial LGE in the basal and mid lateral wall (arrow). The myocardial T1 value obtained with the MOLLI sequence with a 1.5-T MRI unit was elevated to 1090 msec (normal, 980–1070 msec). The T2 value was also elevated to 60 msec (normal, <55 msec). MRI findings fulfill Lake Louise criteria for acute myocarditis, likely related to COVID-19 infection.

Rajiah et al. Radiographics. 2025

Late Gadolinium Enhancement (LGE) en sport

Domenech-Ximenos *et al. Journal of Cardiovascular Magnetic Resonance* (2020) 22:62
https://doi.org/10.1186/s12968-020-00660-w

Journal of Cardiovascular Magnetic Resonance

RESEARCH Open Access

Prevalence and pattern of cardiovascular magnetic resonance late gadolinium enhancement in highly trained endurance athletes

B. Domenech-Ximenos[1,2*], M. Sanz-de la Garza[2,3], S. Prat-González[2], A. Sepúlveda-Martínez[4,5], F. Crispi[4], K. Duran-Fernandez[2], R. J. Perea[1,2,3,4,5,6], B. Bijnens[6,7,8] and M. Sitges[2,3]

Abstract

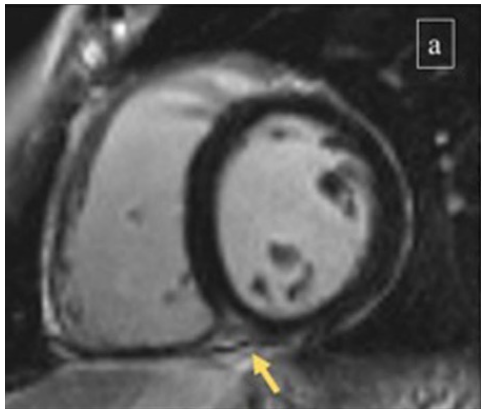
Background: Intensive endurance exercise may induce a broad spectrum of right ventricular (RV) adaptation/remodelling patterns. Late gadolinium enhancement (LGE) has also been described in cardiovascular magnetic resonance (CMR) of some endurance athletes and its clinical meaning remains controversial. Our aim was to characterize the features of contrast CMR and the observed patterns of the LGE distribution in a cohort of highly trained endurance athletes.

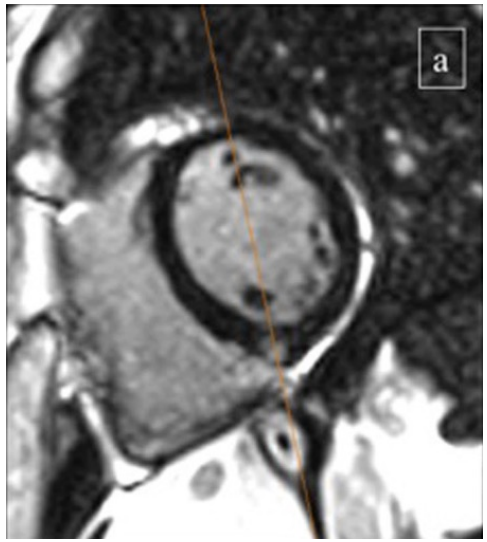
Methods: Ninety-three highly trained endurance athletes (> 12 h training/week at least during the last 5 years; 36 ± 6 years old; 53% male) and 72 age and gender-matched controls underwent a resting contrast CMR. In a subgroup of 28 athletes, T1 mapping was also performed.

Results: High endurance training load was associated with larger bi-ventricular and bi-atrial sizes and a slight reduction of biventricular ejection fraction, as compared to controls in both genders ($p < 0.05$). Focal LGE was significantly more prevalent in athletes than in healthy subjects (37.6% vs 2.8%; $p < 0.001$), with a typical pattern in the RV insertion points. In T1 mapping, those athletes who had focal LGE had higher extracellular volume (ECV) at the remote myocardium than those without (27 ± 2.2% vs 25.2 ± 2.1%; $p < 0.05$).

Conclusions: Highly trained endurance athletes showed a ten-fold increase in the prevalence of focal LGE as compared to control subjects, always confined to the hinge points. Additionally, those athletes with focal LGE demonstrated globally higher myocardial ECV values. This matrix remodelling and potential presence of myocardial fibrosis may be another feature of the athlete's heart, of which the clinical and prognostic significance remains to be determined.

Keywords: Athletes, Fibrosis, Magnetic resonance imaging





ORIGINAL ARTICLE

Outcomes of Cardiac Screening in Adolescent Soccer Players

Authors: Aneil Malhotra, M.B., B.Chir., Ph.D. , Harshil Dhutia, M.B., B.S., Gherardo Finocchiaro, M.D., Sabiha Gati, M.B., B.S., Ph.D., Ian Beasley, M.B., B.S., Paul Clift, M.B., B.S., M.D., Charlotte Cowie, M.B., B.S., +15 , and Sanjay Sharma, M.B., Ch.B., M.D. Author Info & Affiliations

Published August 8, 2018 | N Engl J Med 2018;379:524-534 | DOI: 10.1056/NEJMoa1714719 | VOL. 379 NO. 6

- Cardiale screening van 11.168 asymptomatische voetballers (16y)
  - Lausanne + echocardiografie

- 7,4% nader onderzoek, waarvan:
  - 5% geen afwijkingen
  - 2% hartafwijking, *niet* geassocieerd met plotse hartdood
  - 0,4% hartafwijking, *in theorie* geassocieerd met plotse hartdood

Malhotra et al.nNew England J Med. 2018

Table 2. Summary of Cardiac Conditions Detected According to Screening Tool.

Condition	No. of Athletes	No. of Athletes with Abnormal Result			
		History	Examination	ECG	Echocardiography
Any cardiac condition	267	6	76	84	237
Condition associated with sudden cardiac death	42	3	2	36	12
Hypertrophic cardiomyopathy	5	0	0	5	5
Arrhythmogenic right ventricular cardiomyopathy	2	1	0	1	2
Dilated cardiomyopathy	1	1	0	1	1
Coronary-artery anomalies	2	0	0	0	2
Bicuspid aortic valve–associated disease*	3	1	2	0	3
Long-QT syndrome	3	0	0	3	0
Wolff–Parkinson–White ECG pattern	26	0	0	26	0
Other cardiac condition	225	3	74	48	225
Bicuspid aortic valve	68	1	32	15	68
Atrial septal defect	62	1	6	26	62
Aortic regurgitation	29	0	16	2	29
Mitral-valve prolapse	24	0	12	3	24
Patent ductus arteriosus	18	0	1	1	18
Ventricular septal defect	13	0	3	1	13
Pulmonary stenosis	9	1	4	0	9
Cor triatriatum	2	0	0	0	2

Malhotra et al. New England J Med. 2018

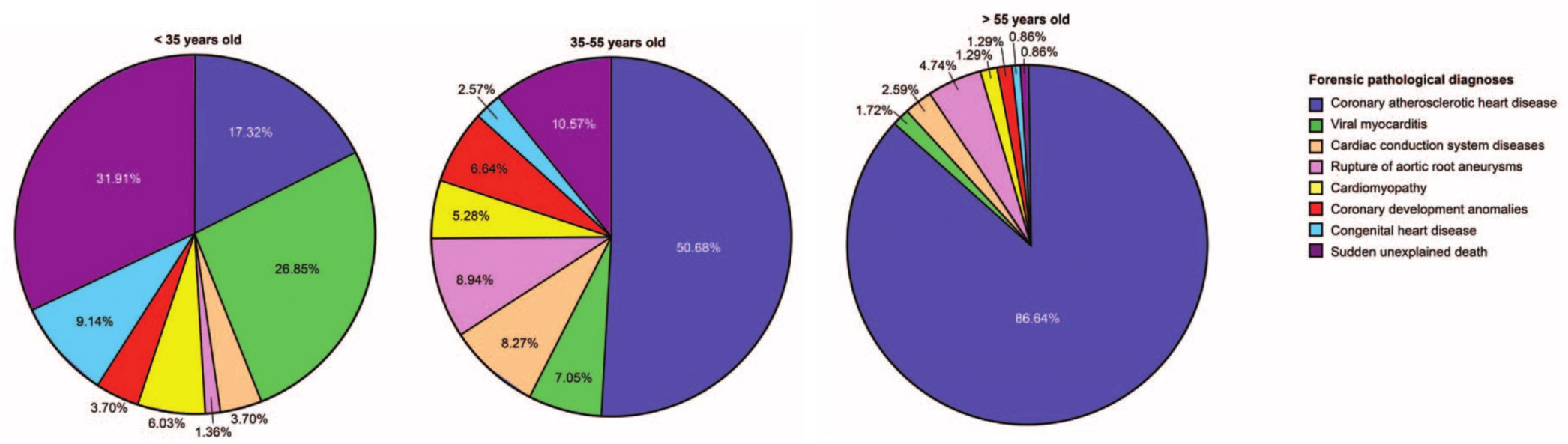
- Na 10 jaar follow-up:
  - 23/11168 (0,2%) overleden, wv 8 (0.07%) door plotse dood
  - Bij 6/8 ptn was initiële cardiale screening normaal!
    - 2/8 ptn hadden negatief sport advies genegeerd..

Table 3. Characteristics of Athletes with Sudden Cardiac Death.

Athlete No.	Sex and Age	Race*	Years from Screening to Death	Diagnosis	Initial Screening Result	Blind Reading (Reviewer 1)	Blind Reading (Reviewer 2)
1	M, 16.8 yr	Black	0.1	Idiopathic left ventricular hypertrophy	Negative	Negative	Negative
2	M, 16.6 yr	Mixed	1.0	Hypertrophic cardiomyopathy	Abnormal ECG and echocardiogram	NA	NA
3	M, 16.6 yr	Black	3.3	Hypertrophic cardiomyopathy	Negative	Negative	Negative
4	M, 16.3 yr	Black	7.7	Dilated cardiomyopathy	Negative	Negative	Negative
5	M, 17.0 yr	White	7.9	Arrhythmogenic right ventricular cardiomyopathy	Negative	Negative	Negative
6	M, 17.2 yr	White	9.7	Arrhythmogenic right ventricular cardiomyopathy	Negative	Negative	Negative
7	M, 15.7 yr	White	11.5	Hypertrophic cardiomyopathy	Abnormal ECG and echocardiogram	NA	NA
8	M, 16.8 yr	White	13.2	Sudden arrhythmic death syndrome	Negative	Negative	Negative

Malhotra et al. New England J Med. 2018

Leeftijd en etiologie van plotse hartdood



CT calcium/coronairen en sport

- MARC studie
- CT coronairen in 318 asymptomatische manlijke sporters >45 jaar
  - Low-risk groep, ECG en ergometrie normaal
- “Occult coronary disease”
  - Agatston score >100: 52/318 (16%)
  - Agatston score <100, maar >50% stenose: 8/318 (2,5%)

Braber et al. Eur J Prev Card. 2016

Interpretatie MARC-studie

- Bijna 20% van gescreende groep heeft “occult coronay disease”
  - Re-classificatie van laag naar hoog cardiovasculair risk?
- Aanname, effect preventief statine gebruik in high risk: NNT/5 jaar = 30 ptn
  - Number needed to screen (NNS) met cardiale CT = 159 (183 indien alleen calcium score)
- Ter vergelijk:
  - NNS = 279 ptn met hypertensie (140-60mmHg) ter preventie van 1 CV-event
  - NNS = 2451 vrouwen 50-60 jr ter preventie van 1 overlijden aan borstkanker

Sportkeuring 45+'ers schiet tekort

Toegevoegd: zaterdag 6 sep 2014, 08:46

Update: zaterdag 6 sep 2014, 08:48

De sportkeuring van mannen boven de 45 jaar lijkt tekort te schieten. Bij een deel van de sporters wordt een vernauwing van de kransslagaders niet ontdekt, blijkt uit onderzoek van het Meander Medisch Centrum en UMC Utrecht.

Aan het onderzoek deden 314 sporters mee die zonder problemen door de sportkeuring waren gekomen. Ze kregen een aanvullende CT-scan. Bij 17% bleken de kransslagaders vernauwd door vet- of kalkafzettingen. Dat verhoogt de kans op een hartstilstand.5% kreeg het advies om niet meer tot het uiterste te gaan.

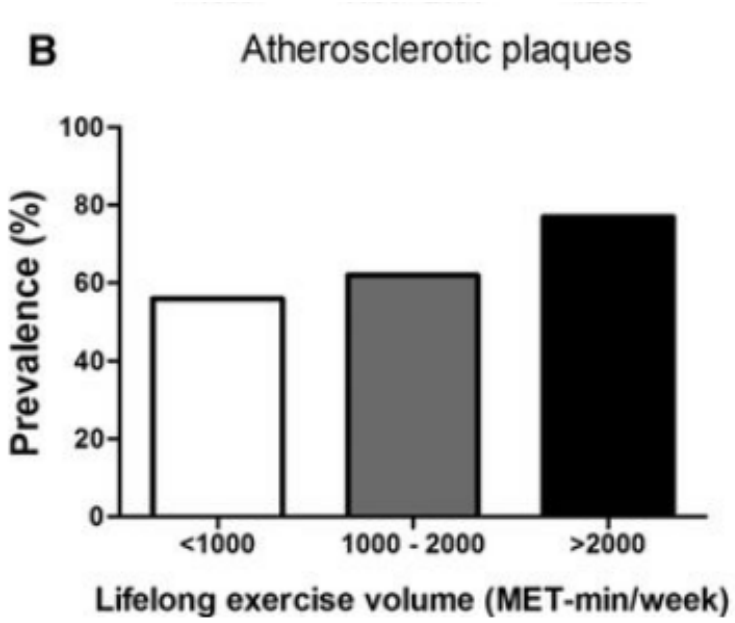
De keuring moet worden aangevuld met een CT-scan, adviseren de onderzoekers.

Deel deze pagina

Nieuwsoverzicht | Nieuws binnenland

Vervolg MARC studie, en dan wordt het bijzonder (ingewikkeld)

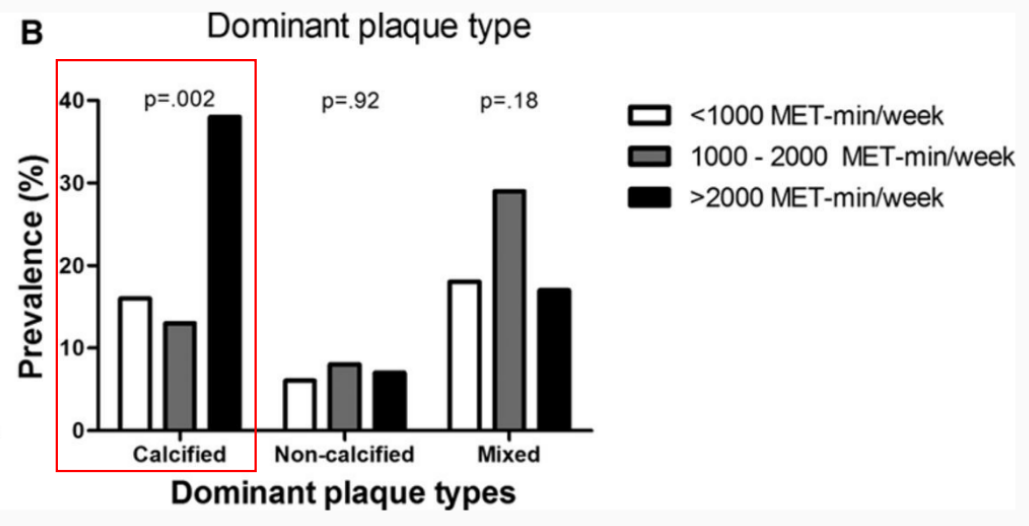
- Meer coronair sclerose bij intensievere sporters!



Aengevaeren et al. Circulation. 2017

Vervolg MARC studie, en dan wordt het bijzonder (ingewikkeld)

- Echter, type plaque is anders:
  - Voornamelijk gecalcificeerde plaque bij sporters, benigne?



Aengevaeren et al. Circulation. 2017

Hoe moeten we deze CT data interpreteren?

- Occult coronary disease komt toch wel frequent voor
- Sporters lijken dus een hogere calcium score te hebben
- De intensiteit van het sporten lijkt hierin een rol te spelen
- De samenstelling van de plaque lijkt bij sporters anders te zijn
- Wat is de klinische relevantie hiervan?

ESC European Society of Cardiology
European Journal of Preventive Cardiology (2025) **32**, 52–62
https://doi.org/10.1093/eurjpc/zwae272

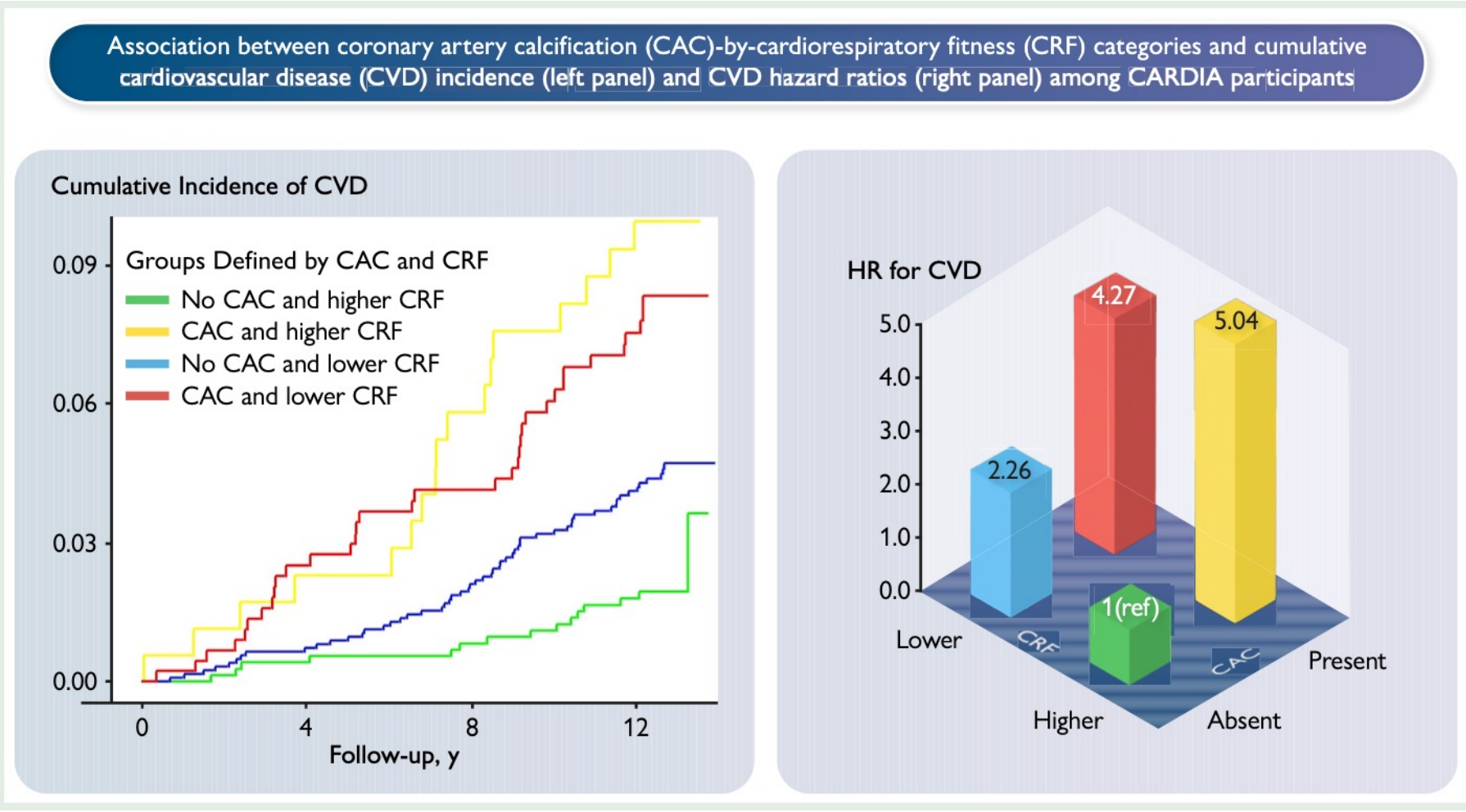
FULL RESEARCH PAPER
Physical activity

The relationship of cardiorespiratory fitness, physical activity, and coronary artery calcification to cardiovascular disease events in CARDIA participants

Yariv Gerber [1]*, Kelley Pettee Gabriel[2], David R. Jacobs, Jr[3], Jennifer Y. Liu[4], Jamal S. Rana[4], Barbara Sternfeld[4], John Jeffrey Carr [5], Paul D. Thompson[6], and Stephen Sidney[4]

- 3141 ptn, leeftijd 45 jr, gescreend met CT calcium
- Follow-up van 14 jr
- “Cardio-respiratory fitness (CRF)”

Gerber et al. Eur J Prev Car. 2025

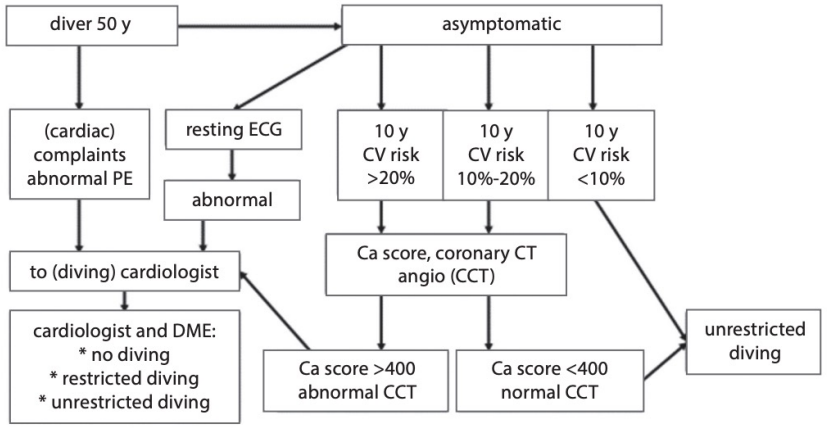


"Coronary artery calcium is not benign in individuals with higher CRF"

Gerber et al. Eur J Prev Car. 2025

Een rol voor CT in de keuring van duikers?

FIGURE 2
FLOWCHART: Assessment of cardiovascular risk in cardiac investigations of divers

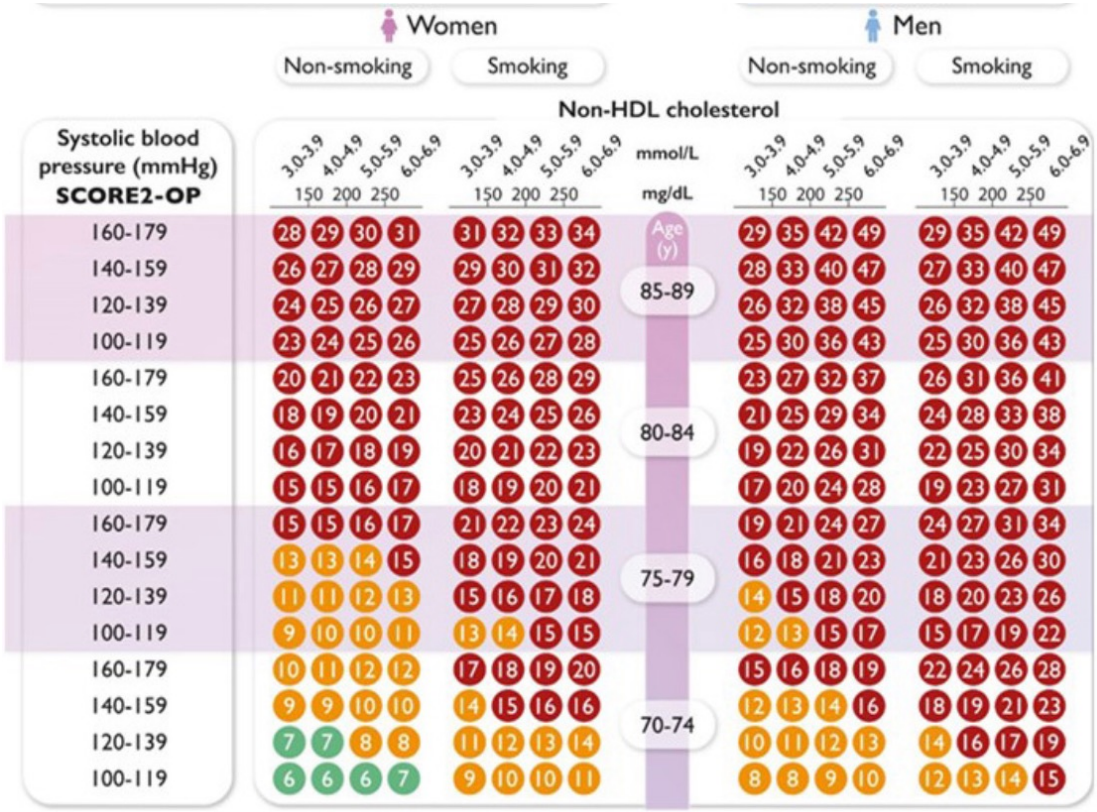


Cardiac complaints: chest pain, palpitations, dyspnea (depending on effort), dizziness, (pre) syncope. Abnormal PE (physical examination): e.g., murmurs, signs of heart failure, cyanosis

DME: Dive Medical Examiner*
Cardiovascular risk: Assessed risk of mortality and morbidity (%/10 year).
CCS is related to cardiovascular risk as follows:
CCS = 0: very low risk of cardiovascular events (< 1% at 10 years)
CCS = 1–100: low risk of cardiovascular events (1–10% at 10 years)
CCS = 101–400: intermediate risk of cardiovascular events (10–20% at 10 years)
CCS > 400: high risk of cardiovascular events (>20% at 10 years).
Here a CCS of > 400 is considered a cutoff because when ≤ 400, the annual cardiac event rate is < 2%.
For a CCS ≤ 100, the annual cardiac event rate is < 1%. The decision to use a CCS of 100 or 400 as a cutoff value is an organizational decision.

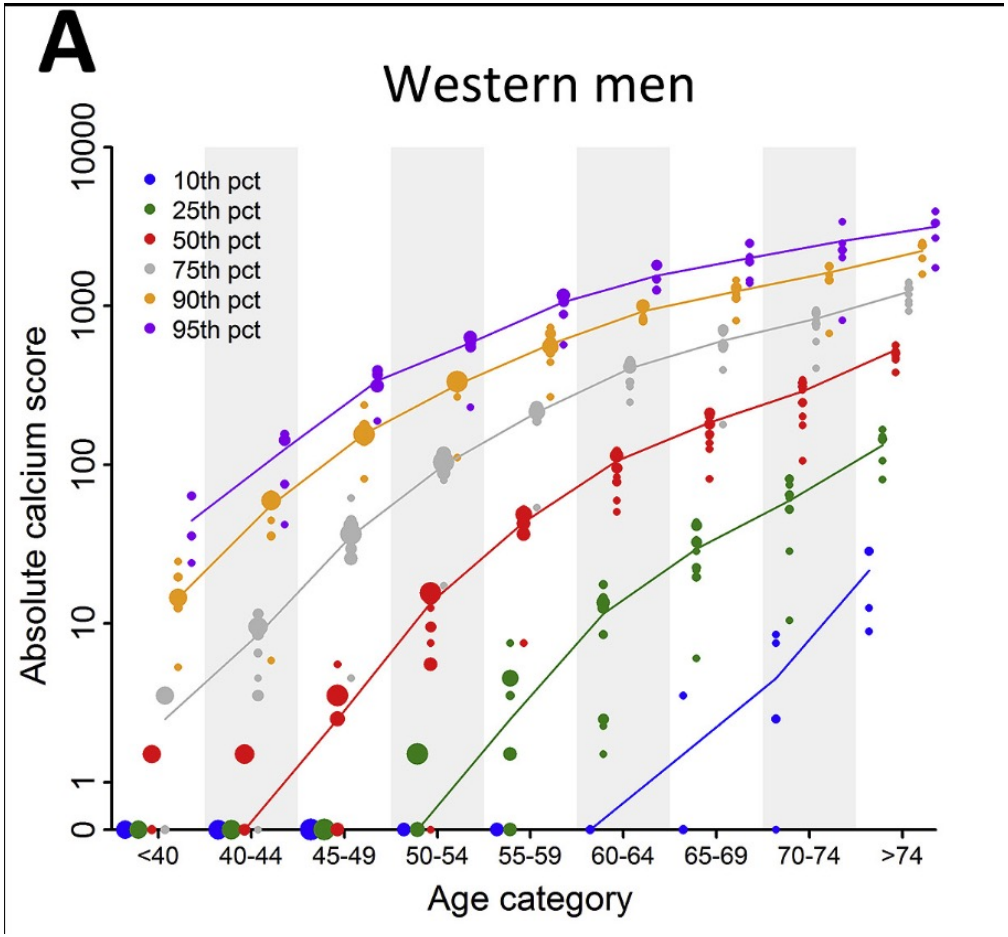
Rienks et al. Undersea Hyperb Med. 2022

SCORE2 en SCORE2-OP



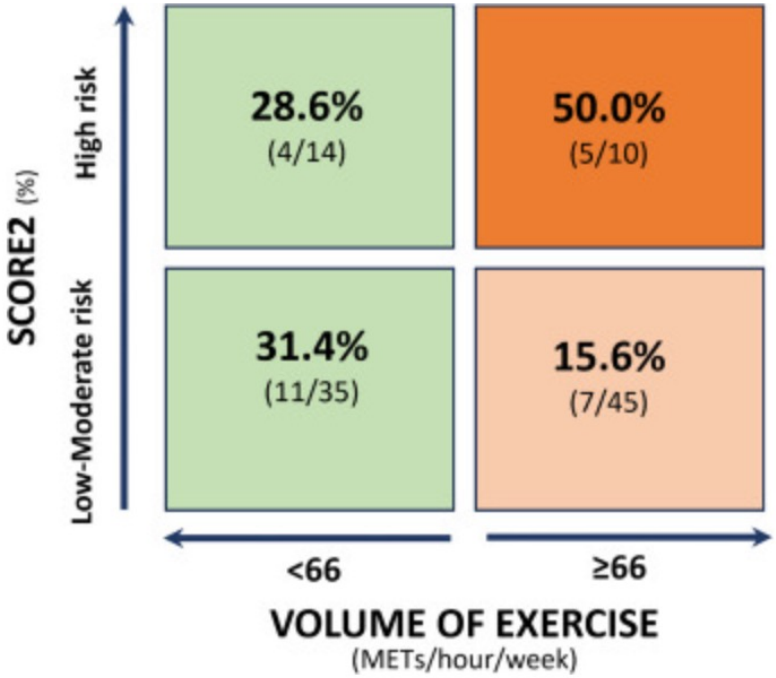
Aanzienlijk percentage >65 jr heeft risico >10%

Calcium score is sterk leeftijds afhankelijk



De Ronde et al. JCCT. 2020

Afhankelijk van cardiovasculaire risicofactoren?



Coronary atherosclerotic burden in veteran athletes: The relationship between cardiovascular risk and volume of exercise

Joana Certo Pereira[a,*], Rita Santos[a], Francisco Moscoso Costa[a,b], José Monge[b], Pedro de Araújo Gonçalves[a,b,c,d], Hélder Dores[b,c,d]

Athletes with high cardiovascular risk and high exercise volume (above the median) showed significantly high coronary atherosclerotic burden compared to those with low-moderate risk and high volume (50.0% vs. 15.6%; p=0.017). Among athletes with low to moderate risk, a high volume of exercise tended to be protective, while in those with low volume, there was similar rate of high coronary atherosclerotic burden, regardless of CV risk.

Fig: Percentage of high coronary atherosclerotic burden on CT, based on CV risk and volume of exercise

Pereira et al. Rev Port Car. 2024

Consequenties van een afwijkende cardiale screening

- In geval van afwijkende cardiale CT
  - Preventieve medicatie? Ascal? Statine? Bloeddruk?
  - Aanvullende diagnostiek?
  - Revascularisatie?
    - Anders dan bij niet-sporters?

Indications for revascularization in patients with stable angina or silent ischaemia

Extent of CAD (anatomical and/or functional)		Class[a]	Level[b]
For prognosis	Left main disease with stenosis >50%.[c] [68–71]	I	A
	Proximal LAD stenosis >50%.[c] [62,68,70,72]	I	A
	Two- or three-vessel disease with stenosis >50% with impaired LV function (LVEF ≤35%).[c] [61,62,68,70,73–83]	I	A
	Large area of ischaemia detected by functional testing (>10% LV) or abnormal invasive FFR.[d] [24,59,84–90]	I	B
	Single remaining patent coronary artery with stenosis >50%.[c]	I	C
For symptoms	Haemodynamically significant coronary stenosis[c] in the presence of limiting angina or angina equivalent, with insufficient response to optimized medical therapy.[e] [24,63,91–97]	I	A

- Wel/niet sporten?
  - Tot welke intensiteit? Competitief? Type sport?
  - Return to play na behandeling?

Conclusies

- Vergeet niet: sporten is gezond!
  - sporten reduceert cardiovasculaire ziekte met 30-40%
- Kans op plotse hartdood (tijdens sport) is zeer klein
- Het blijft een niet altijd te voorkomen gebeurtenis
- Bij symptomen of afwijkende familie geschiedenis zeker nadere analyse!
- Cardiale screening <45 jaar, zonder klachten: weinig (geen?) evidence
- Cardiale screening >45 jaar, zonder klachten: afhankelijk van risico factoren(?)
  - Familie geschiedenis, roken, suikerziekte, cholesterol, bloeddruk, ECG?
  - Overweeg additioneel cardiale CT, maar interpretatie hiervan kan complex/onzeker zijn

Het gaat wel de goede kant op..

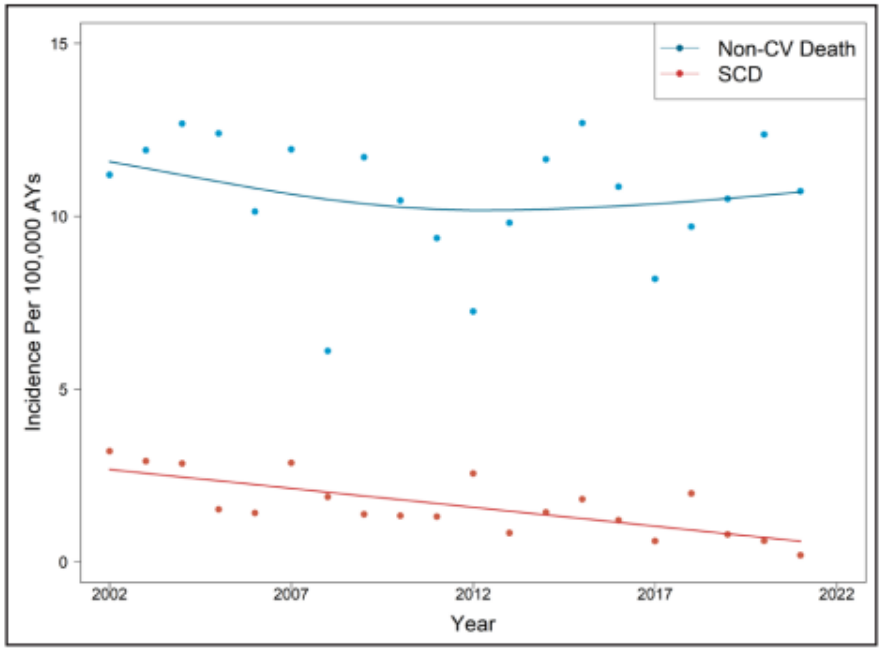


Figure 2. Yearly non–cardiovascular death and sudden cardiac death incidence among National Collegiate Athletic Association athletes.

Blue dots indicate non–cardiovascular death yearly incidence rate; blue line, cubic smoothing spline curve of non–cardiovascular (CV) death incidence over the study period; red dots, sudden cardiac death (SCD) yearly incidence rate; and red line, cubic smoothing spline curve of SCD incidence over the study period. AY indicates athlete-year.

Petek et al. Circulation. 2023

Bedankt voor uw aandacht!

- Voor vragen spreek mij aan tijdens de borrel en/of diner of mail mij op s.velthuis@meandermc.nl