Atrial Fibrillation in Athletes

Dr. James McKinney, M.D., FRCP(C)
Dr. Saul Isserow, M.D., FRCP(C)
Sports Cardiology BC

The Benefits of Exercise

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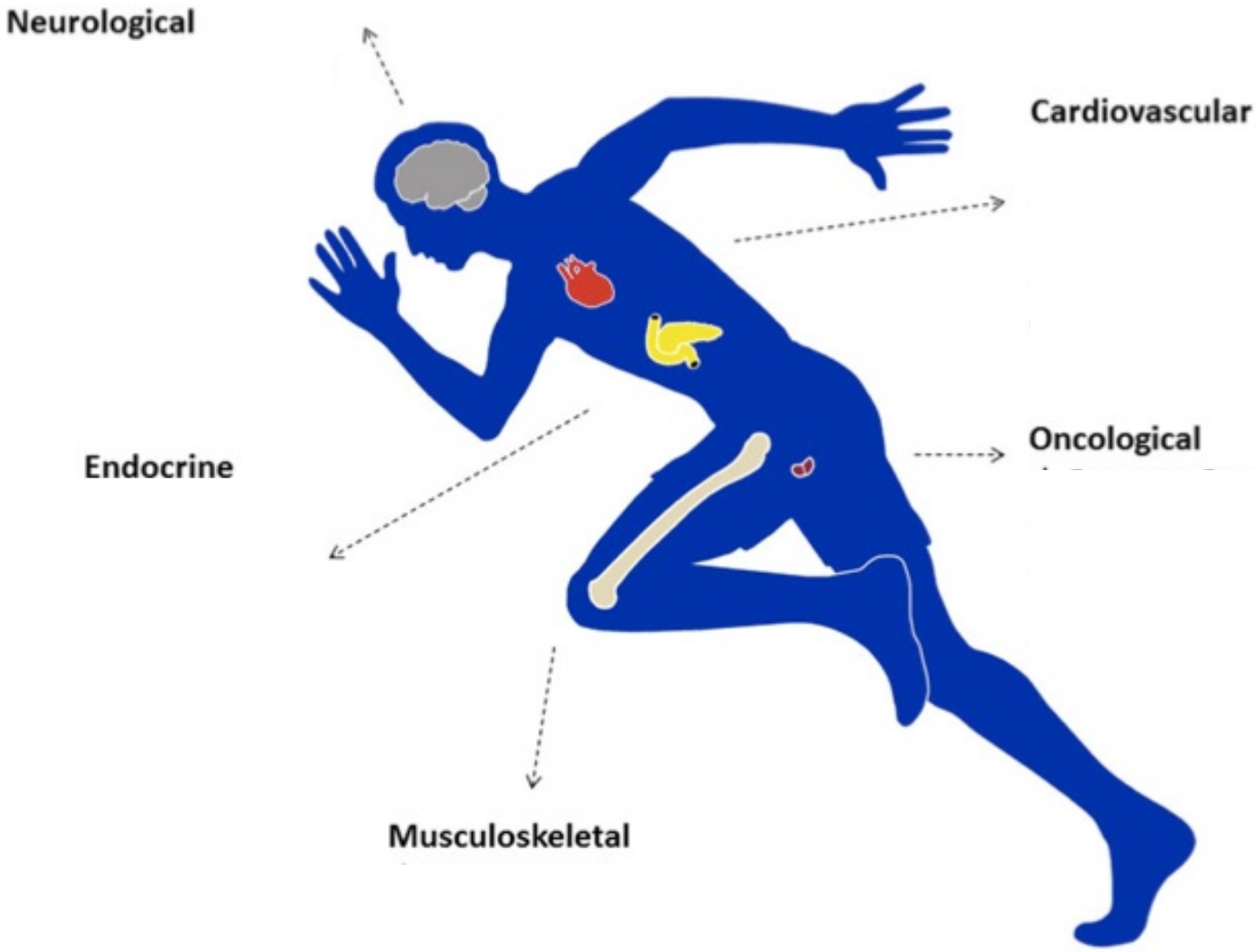

Marathon finishers

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Year	Estimated U.S. Marathon Finisher Total	
1976	25,000	
1980	143,000	
1990	224,000	
1995	293,000	
2000	353,000	
2004	386,000	
2005	395,000	
2006	410,000	
2007	412,000	
2008	425,000	
2009	467,000	
2010	507,000	
2011	518,000	
2012	487,000	*
2013	541,000	
2014	550,637	(all-time high)

Marathon finishers

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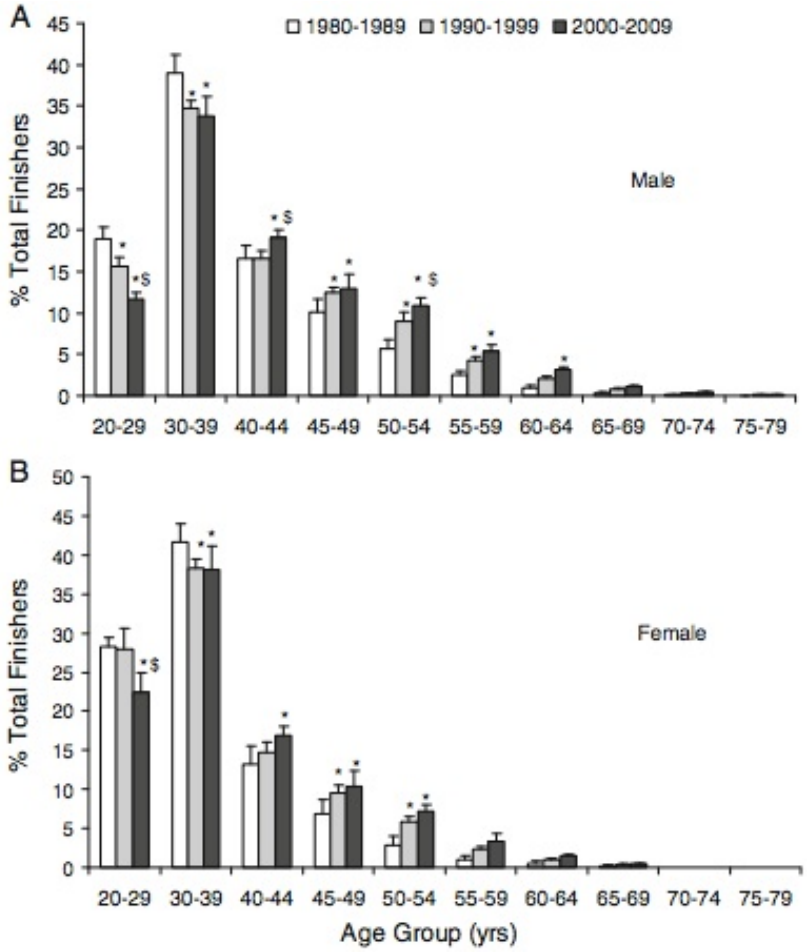

Lepers AGE 2012

Marathon finishers

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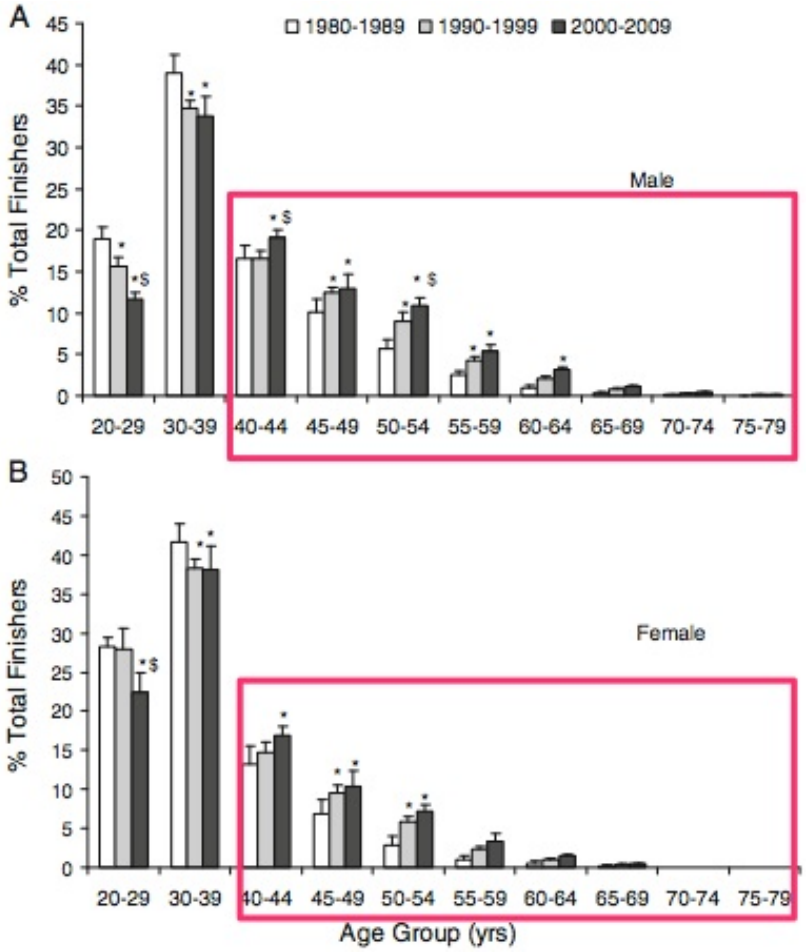

Lepers AGE 2012

Marathon finishers

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	1980	1995	2000	2005	2010	2011	2012	2013	2014
Women	10%	26%	38%	41%	41%	41%	42%	43%	43%
Men	90%	74%	62%	59%	59%	59%	58%	57%	57%
Masters (40 yrs+)	26%	41%	44%	44%	46%	46%	46%	47%	48%

MORE Women participating in marathons

More MASTERS ATHLETES participating in marathons

Atrial Fibrillation

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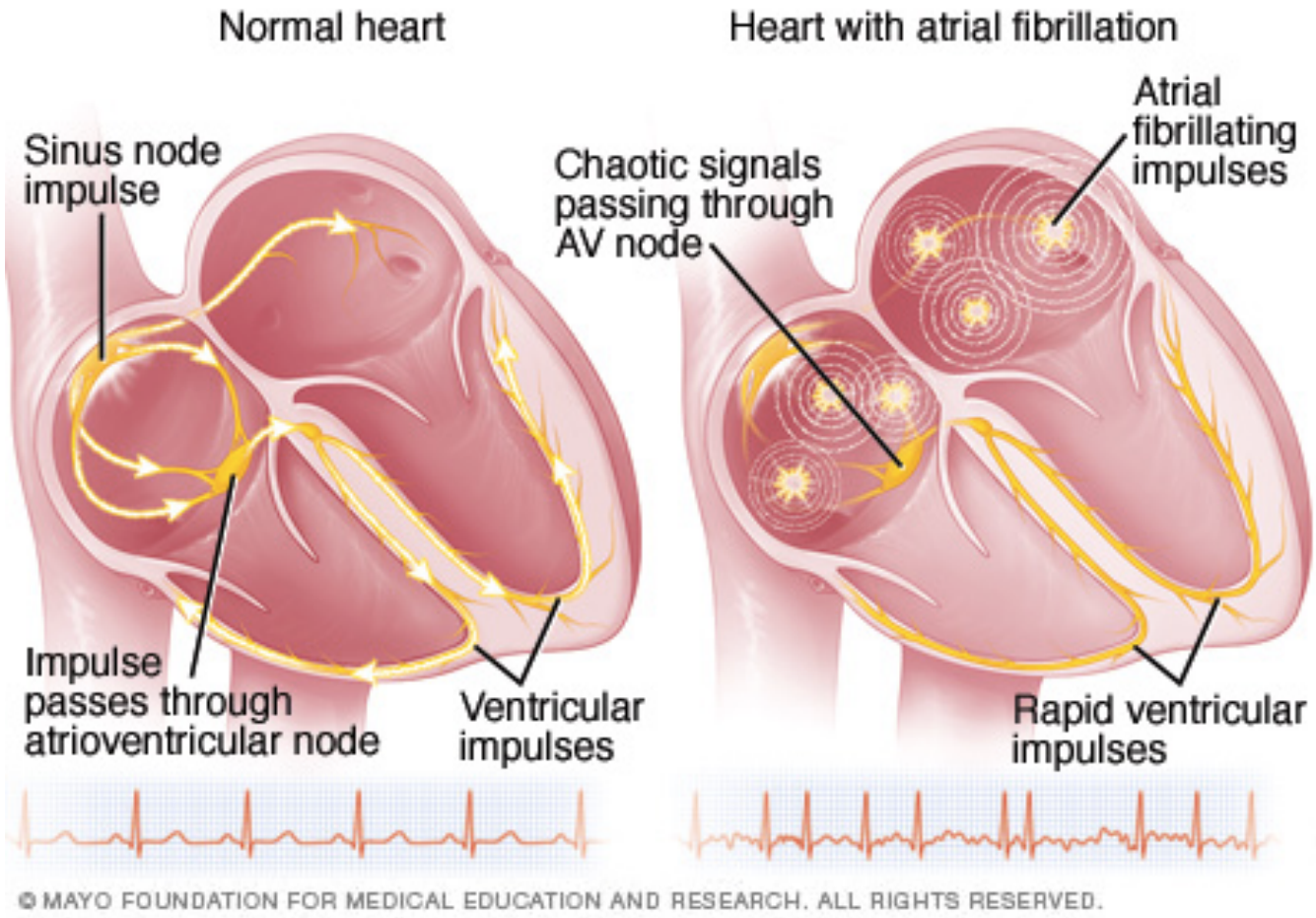

AF Prevalence

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- Prevalence increases with age:
  - persistent or paroxysmal AF
    - ~0.5% in subjects aged 45-54 years
    - ~1% at 55-64 years
    - ~4% at 65-74 years
  - diagnosed in 1% of the population by age 60
  - >10% when older than 80 year
- Most common treated arrhythmia seen in ATHLETES

Prevalence of AF in athletes

- Dependent on:
  - Age
  - Sport
  - Length of prior training
  - Intensity of prior training
  - Sex

AF prevalence in 'young' athletes is low

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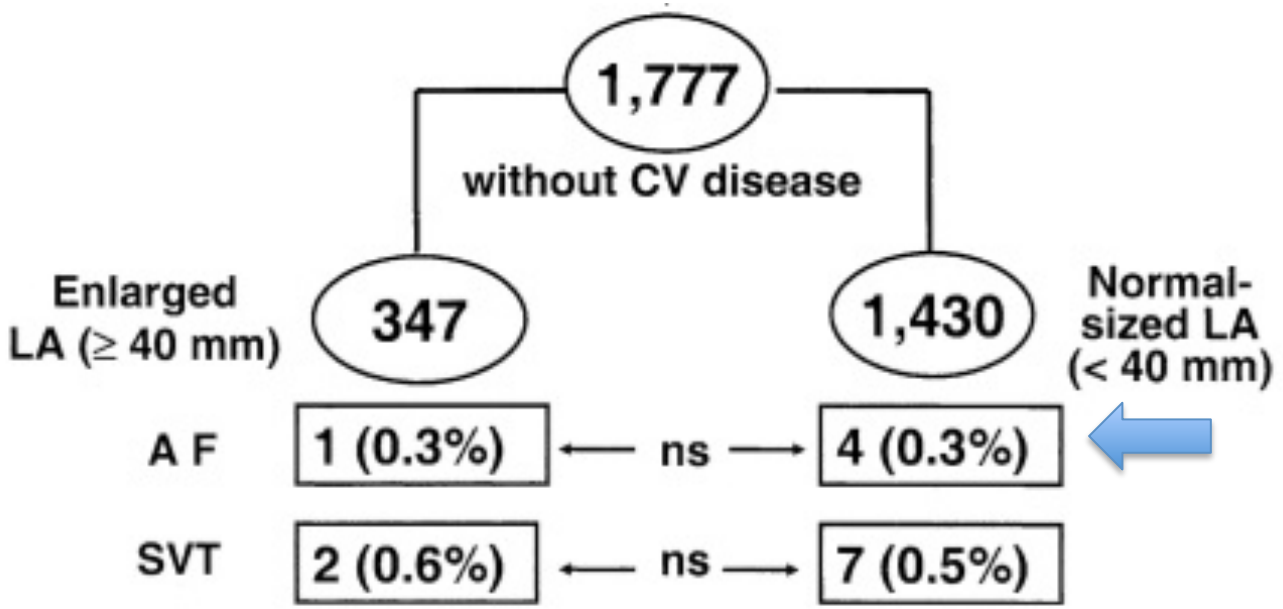
Athletics and Cardiac Function

Prevalence and Clinical Significance of Left Atrial Remodeling in Competitive Athletes

Antonio Pelliccia, MD,* Barry J. Maron, MD,† Fernando M. Di Paolo, MD,* Alessandro Biffi, MD,* Filippo M. Quattrini, MD,* Cataldo Pisicchio, MD,* Alessandra Roselli, MD,* Stefano Caselli, MD,* Franco Culasso, PHD‡



AF Risk Factors

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Conventional risk factors

- Advancing age
- Male
- Coronary heart disease
- Hypertension (above 140/90 mm Hg)
- Heart failure
- Valvular heart disease
- Diabetes mellitus
- Hyperthyroidism

Wyse, JACC 2014

AF Risk Factors

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Less established risk factors

- Chronic obstructive pulmonary disease
- Left atrial dilation
- Atrial conduction delay/PR interval
- Left ventricular diastolic dysfunction
- Left ventricular hypertrophy
- Obesity
- Obstructive sleep apnea syndrome
- Genetic factors

AF Risk Factors

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Emerging risk factors

- Subclinical atherosclerosis
- Borderline hypertension (between 120/80 mm Hg and 140/90 mm Hg)
- Chronic kidney disease
- Subclinical hyperthyroidism
- Inflammation
- Elevated natriuretic peptides
- Widened pulse pressure
- Excessive endurance exercise
- Excessive alcohol intake
- Increased height
- Increased birth weight
- Smoking
- Caffeine intake
- Ethnicity

AF Risk Factors

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Emerging risk factors

- Subclinical atherosclerosis
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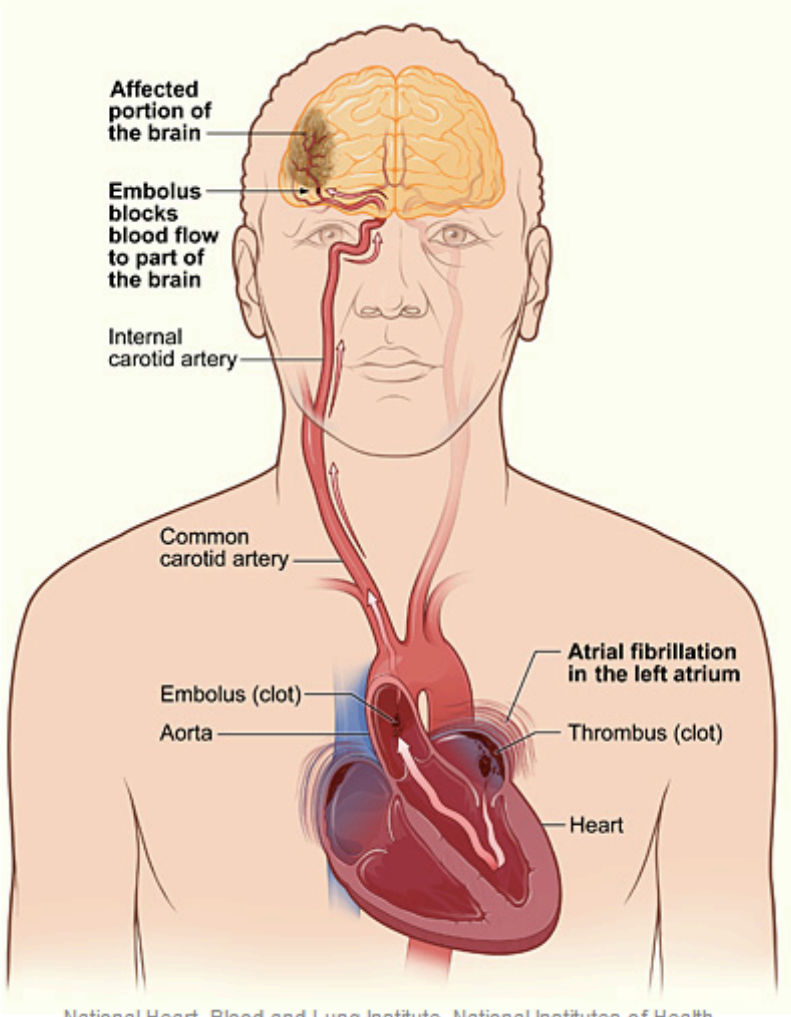
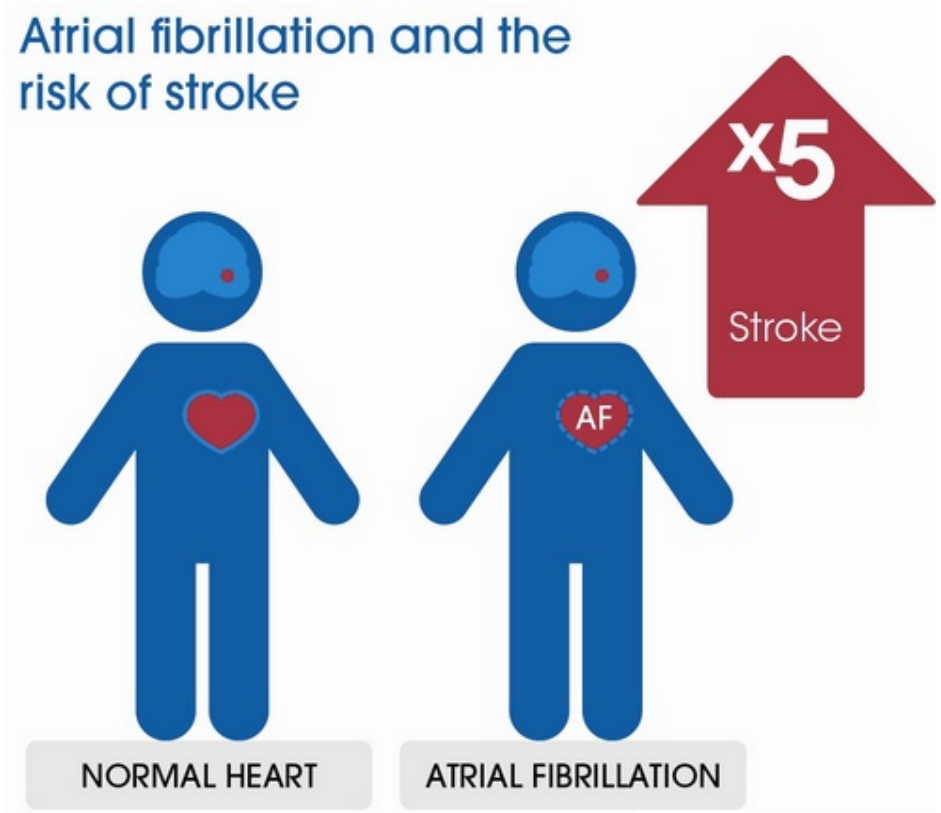
AF – why do we care so much?



National Heart, Blood and Lung Institute, National Institutes of Health



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Lone AF

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- Lone atrial fibrillation (LAF) is characterized by the presence of atrial fibrillation in the absence of structural heart disease or other identifiable cause of arrhythmia
- Sport participation to be more frequent in LAF patients than in the general population

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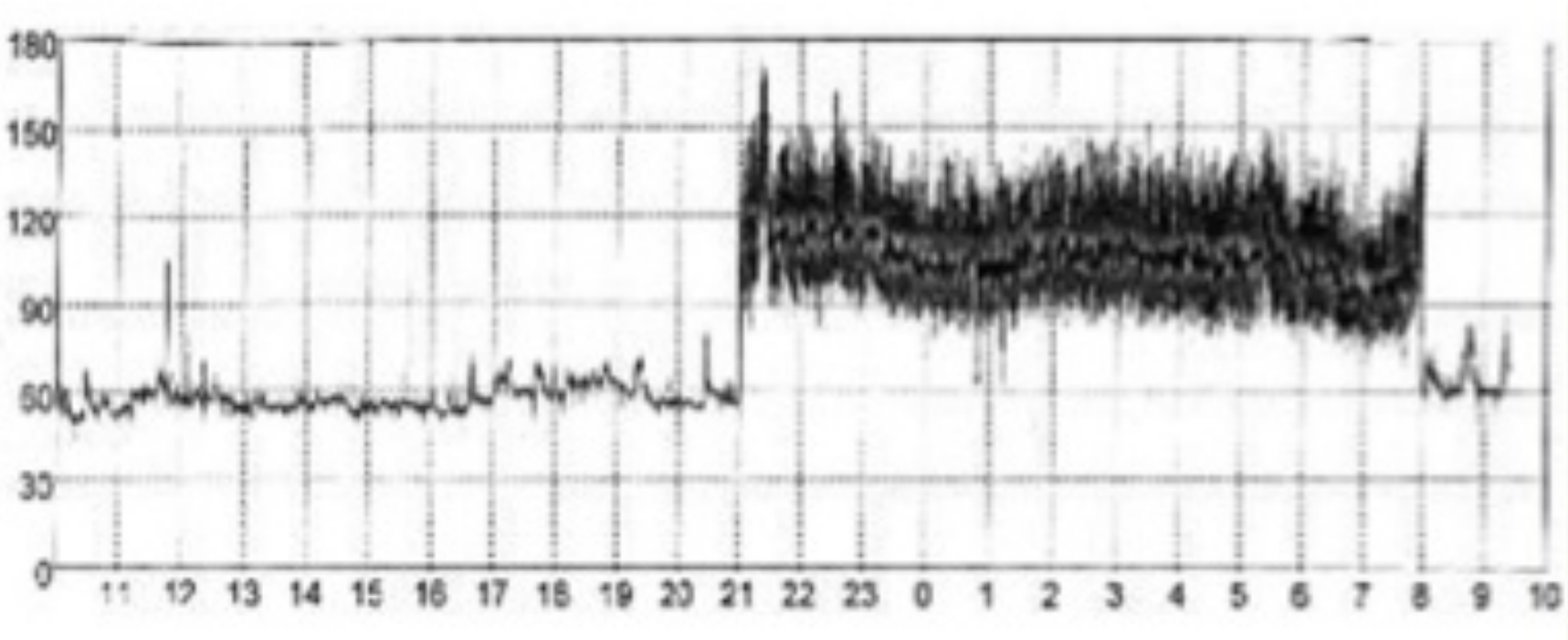

Vagal AF

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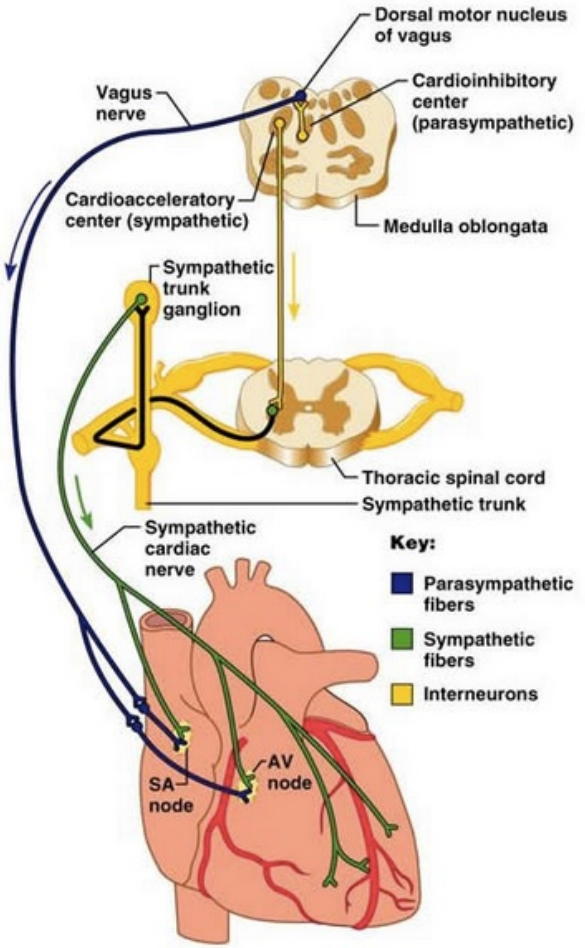
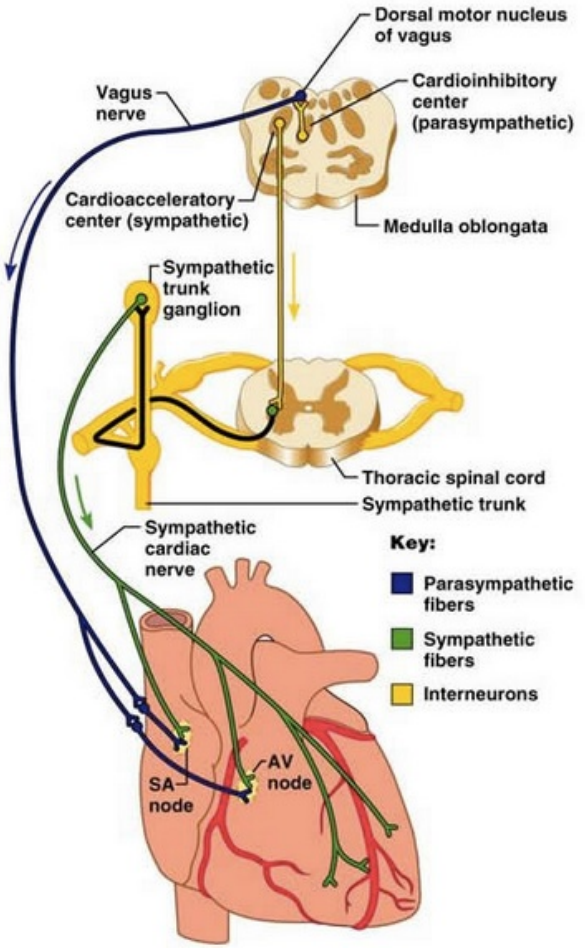
- >80% of episodes of AF occurred during the following:
  - Nocturnal
  - Postprandial period
  - Immediate hours after (intensive) exercise
- Increased vagal tone in athletes



Adrenergically induced AF

- >80% of episodes of AF occurred during the following
  - Daytime
  - Exercise
  - Stress
  - Stimulants



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Does exercise decrease AF?

Physical Activity and Incidence of Atrial Fibrillation in Older Adults

The Cardiovascular Health Study

Dariush Mozaffarian, MD, DrPH; Curt D. Furberg, MD, PhD;
Bruce M. Psaty, MD, PhD; David Siscovick, MD, MPH

- 5446 adults >65 years surveyed about their activity level and development of AF

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Mild activity = less AF incidence

Table 3. Risk of New-Onset AF in 5446 Older Adults According to Walking Habits

	No. of Events	Person-Years	Age- and Gender-Adjusted	Adjusted for Multiple Variables†
Walking distance, blocks/wk (n*)				
0–4 (n=1145)	272	8867	1.0 (Reference)	1.0 (Reference)
5–11 (n=855)	218	9188	0.78 (0.65–0.93)	0.78 (0.65–0.94)
12–23 (n=981)	212	9452	0.71 (0.59–0.86)	0.76 (0.63–0.91)
24–59 (n=1205)	191	9789	0.62 (0.51–0.75)	0.67 (0.55–0.81)
≥60 (n=1260)	168	9984	0.51 (0.42–0.63)	0.56 (0.45–0.69)
P for trend	...	...	<0.001	<0.001
Walking pace (n*)				
<2 mph (n=1656)	527	16 805	1.0 (Reference)	1.0 (Reference)
2–3 mph (n=2314)	427	22 494	0.62 (0.55–0.71)	0.68 (0.59–0.77)
>3 mph (n=1476)	107	7982	0.51 (0.41–0.63)	0.59 (0.48–0.74)
P for trend	...	...	<0.001	<0.001

Lone atrial fibrillation in vigorously exercising middle aged men: case-control study

Jouko Karjalainen, Urho M Kujala, Jaakko Kaprio, Seppo Sarna, Matti Viitasalo

- Lone AF diagnosed in:
  - 5.3% of orienteers
  - 0.9% of controls
  - RR – 5.5

- However, orienteers had lower prevalence of CHD and lower mortality (1.7 vs. 8.5%)

BMJ 1998

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Physical activity, height, and left atrial size are independent risk factors for lone atrial fibrillation in middle-aged healthy individuals

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Lluís Mont[1]*, David Tamborero[1], Roberto Elosua[3], Irma Molina[1], Blanca Coll-Vinent[2], Marta Sitges[1], Bárbara Vidal[1], Andrea Scalise[1], Alejandro Tejeira[1], Antonio Berruezo[1], and Josep Brugada[1] on behalf of the GIRAFA (Grup Integrat de Recerca en Fibril-lació Auricular) Investigators

	Odds ratio (95% confidence interval)	*P*-value
Cumulated moderate and heavy physical activity		
0–2077 h	1	
2078–9318 h	5.60 (1.59–19.75)	0.0075
≥9319 h	15.11 (3.75–60.83)	0.0001
Height		
155–164.9 cm	1	
165–176.9 cm	13.54 (2.47–74.30)	0.0027
177–195 cm	23.23 (2.48–217.56)	0.0059
Left atrial anteroposterior diameter (mm)	1.40 (1.17–1.67)	0.0003

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Who is more likely to get AF?

EUROPEAN SOCIETY OF CARDIOLOGY®

European Heart Journal (2008) **29**, 71–78
doi:10.1093/eurheartj/ehm555

CLINICAL RESEARCH
Arrhythmia/electrophysiology

Sinus node disease and arrhythmias in the long-term follow-up of former professional cyclists

Sylvette Baldesberger[1], Urs Bauersfeld[2], Reto Candinas[1], Burkhardt Seifert[3],

Europace (2009) **11**, 1156–1159
doi:10.1093/europace/eup197

Is the risk of atrial fibrillation higher in athletes than in the general population? A systematic review and meta-analysis

Jawdat Abdulla* and Jens Rokkedal Nielsen

Author/publication year	Type of athletes	Age (years) mean ± SD (athletes vs. controls)	Men (%)	Cases of AF/athletes	Cases of AF/controls
Karjalainen *et al.*[8]	Orienteers	48 ± 6 (46 ± 7 vs. 50 ± 5)	100	12/228 (5%)	2/212 (0.9%)
Heidbuchel *et al.*[9]	Mixed sports	55 ± 10 (53 ± 9 vs. 60 ± 10)	88	25/31 (81%)	50/106 (48%)
Elosua *et al.*[10]	Mixed sports	43 ± 12 (NA)	69	16/31 (51%)	35/129 (27%)
Molina *et al.*[11]	Marathon runners	45 ± 10 (39 ± 9 vs. 50 ± 13)	100	9/183 (5%)	2/290 (0.7%)
Mont *et al.*[12]	Mixed sports	48 ± 10 (NA)	100	83/120 (69%)	24/96 (25%)
Baldesberger *et al.*[13]	Cyclists	67 ± 7 (67 ± 7 vs. 67 ± 6)	100	6/62 (10%)	0/62 (0%)
Total studies ($n = 6$)	Mixed sports	51 ± 9	93	151/655 (23%)	113/895 (12.5%)

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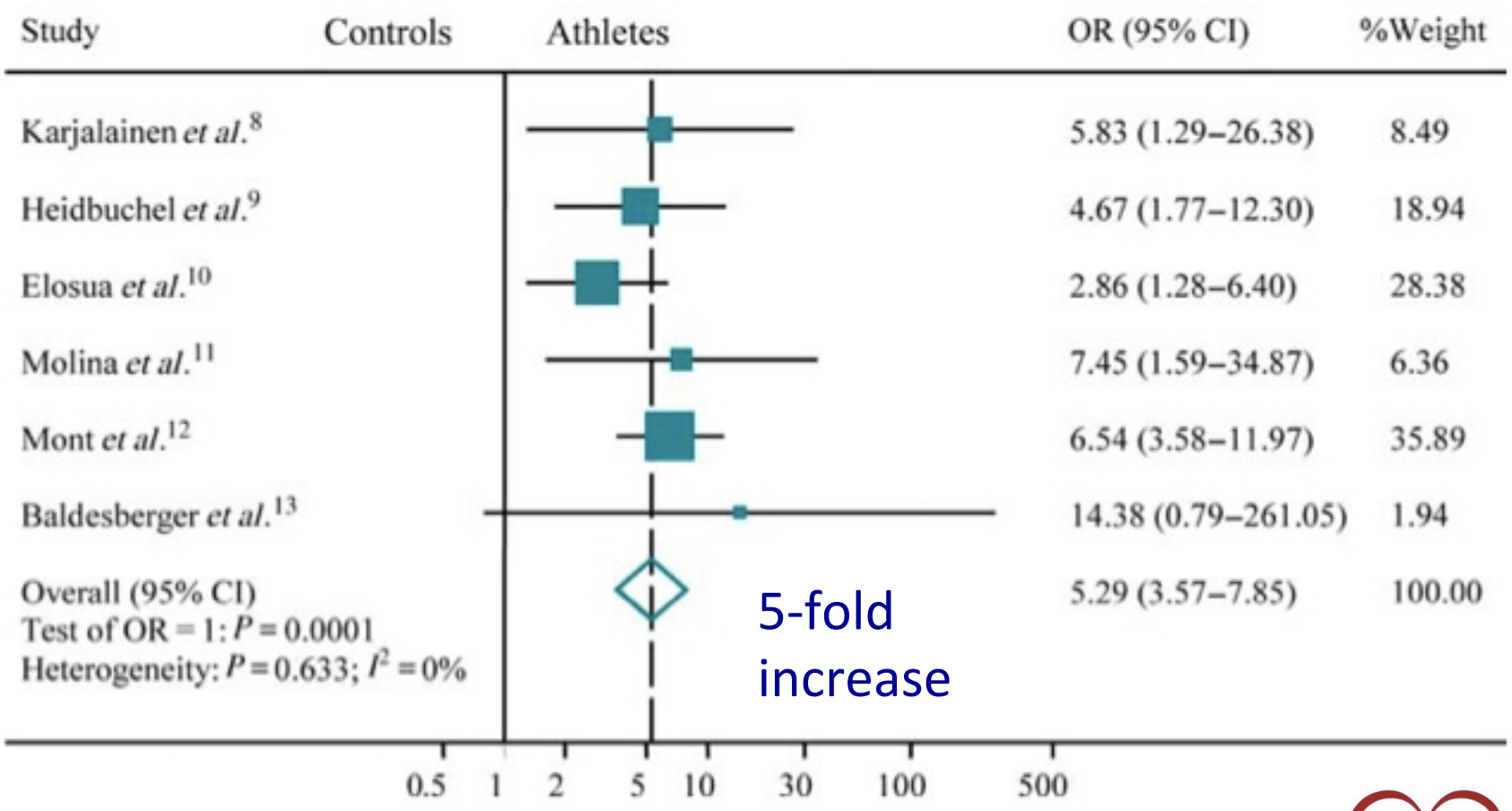
Endurance exercise increases AF?



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Risk of arrhythmias in 52 755 long-distance cross-country skiers: a cohort study

Kasper Andersen[1]*, Bahman Farahmand[2,3], Anders Ahlbom[2], Claes Held[1], Sverker Ljunghall[1], Karl Michaëlsson[4], and Johan Sundström[1]

Investigated the association of **number** of completed races and **finishing time** with risk of arrhythmias among participants of Vasaloppet, a 90 km cross-country skiing event

Faster = MORE AF

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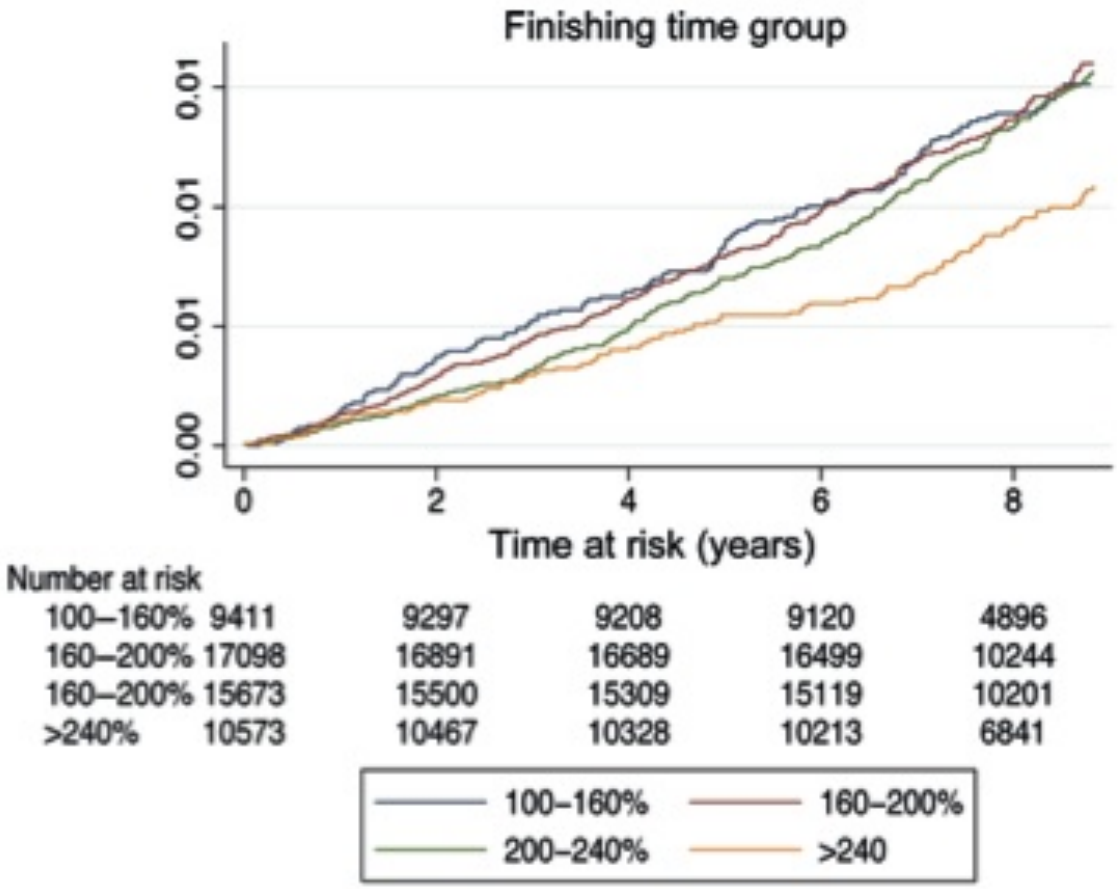

Those completing the race within 60% of the winner's time were **1.3 times** more likely to be diagnosed with an arrhythmia than those who took more than twice the time to complete the race

More races = MORE AF

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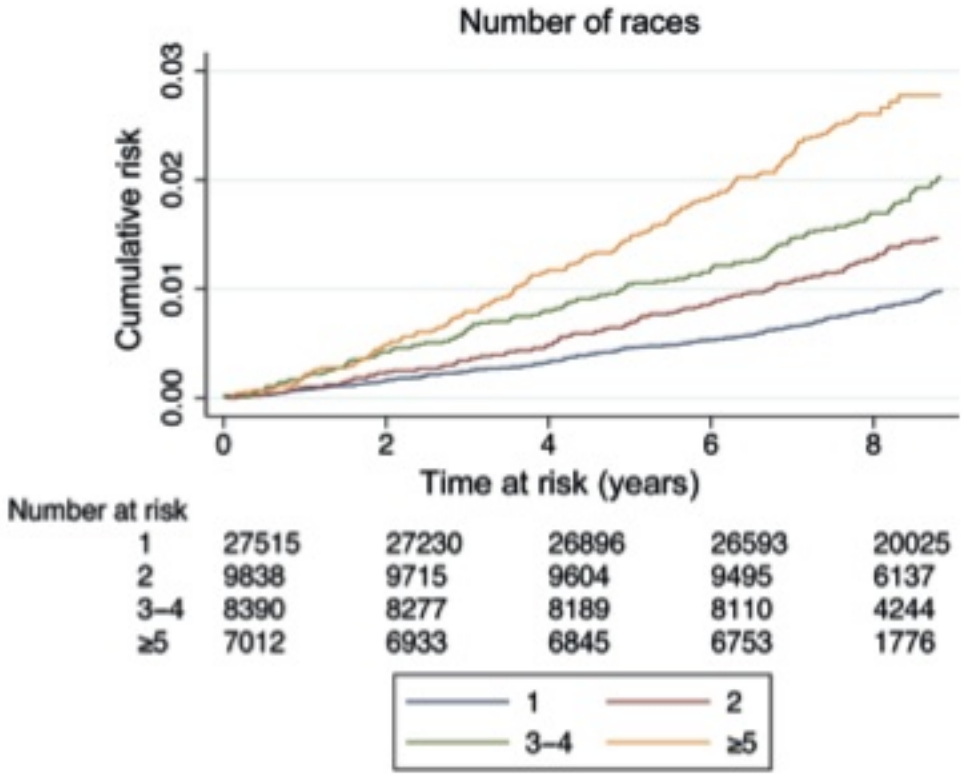

Those who had completed the race ≥5 times had a **1.3-fold** increase in arrhythmic risk as compared with those who completed the race only once.

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Who is more likely to get AF?

Who is more likely to get AF?

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Who is more likely to get AF?

Gender Differences of Atrial and Ventricular Remodeling and Autonomic Tone in Nonelite Athletes

Matthias Wilhelm, MD[a,*], Laurent Roten, MD[b], Hildegard Tanner, MD[b], Ilca Wilhelm, MD[c], Jean-Paul Schmid, MD[a], and Hugo Saner, MD[a]

(Am J Cardiol 2011;108:1489–1495)

- Male runners compared to female runners:
  - Higher SBP
  - More concentric remodeling
  - More sympathetic activity
  - Taller
  - Longer signal average P wave duration
  - *LA volume index and PACs were the same b/t sex
- pAF 6.7% in men vs. 0% in female

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U-shaped curve?

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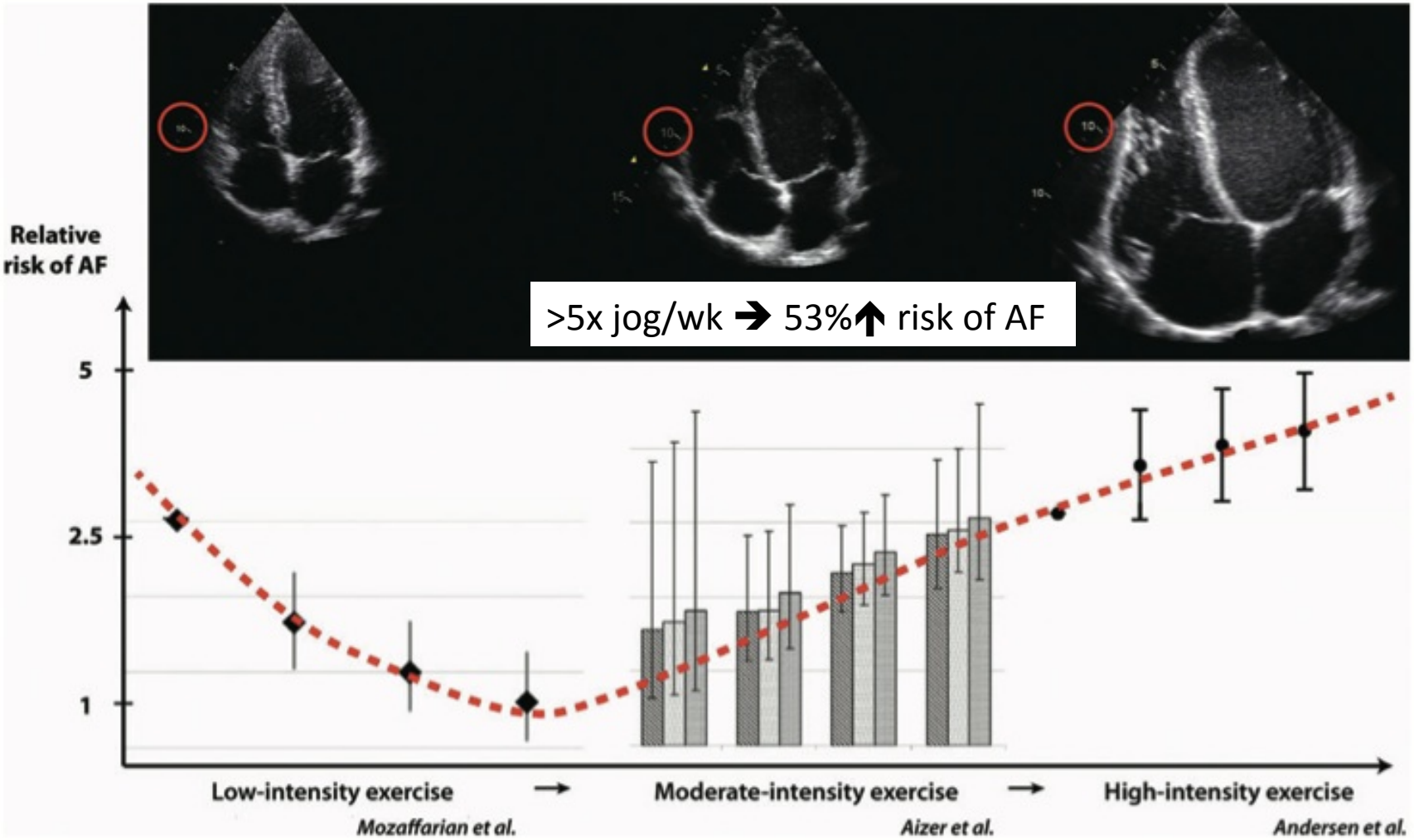

Natural history of AF in the athletes

Europace (2004) 6, 222–228

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Paroxysmal atrial fibrillation in male endurance athletes. A 9-year follow up

Jan Hoogsteen[a,*], Goof Schep[b], Norbert M. van Hemel[c], Ernst E. van der Wall[d]

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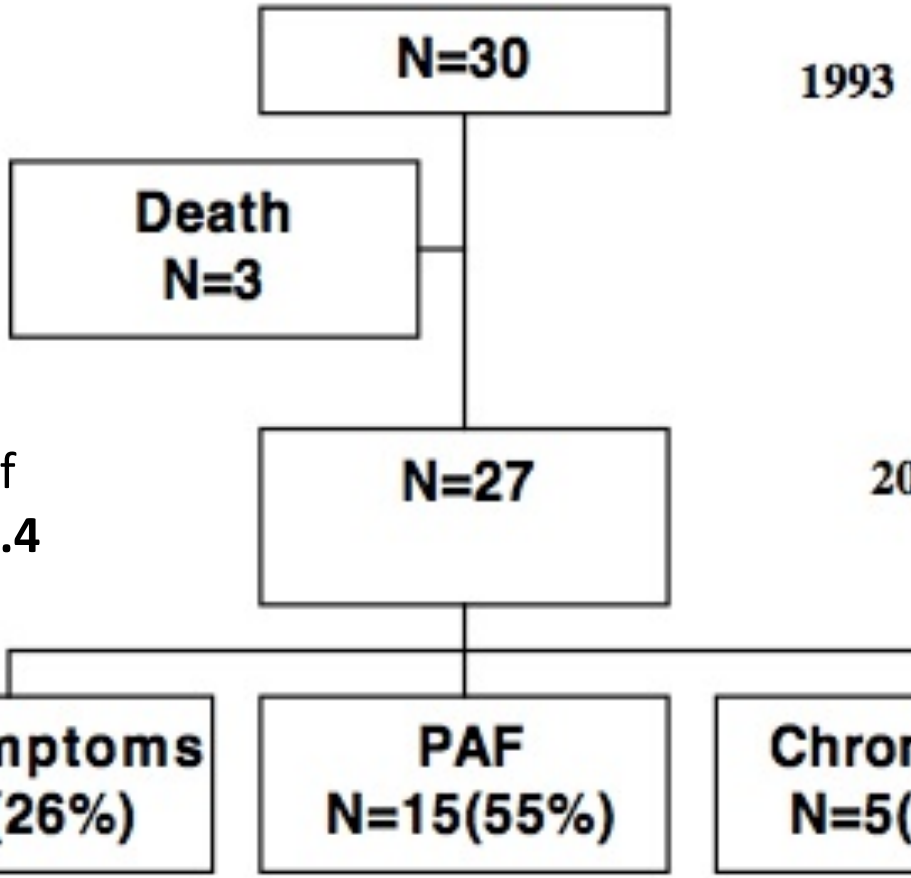
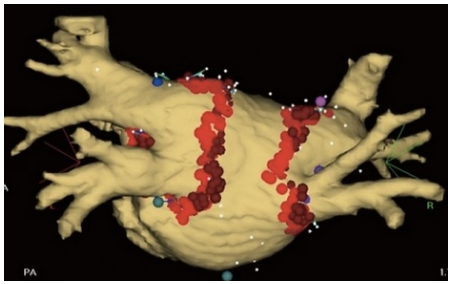
Paroxysmal atrial fibrillation in male endurance athletes. A 9-year follow up



Mean age of
AF onset **41.4**



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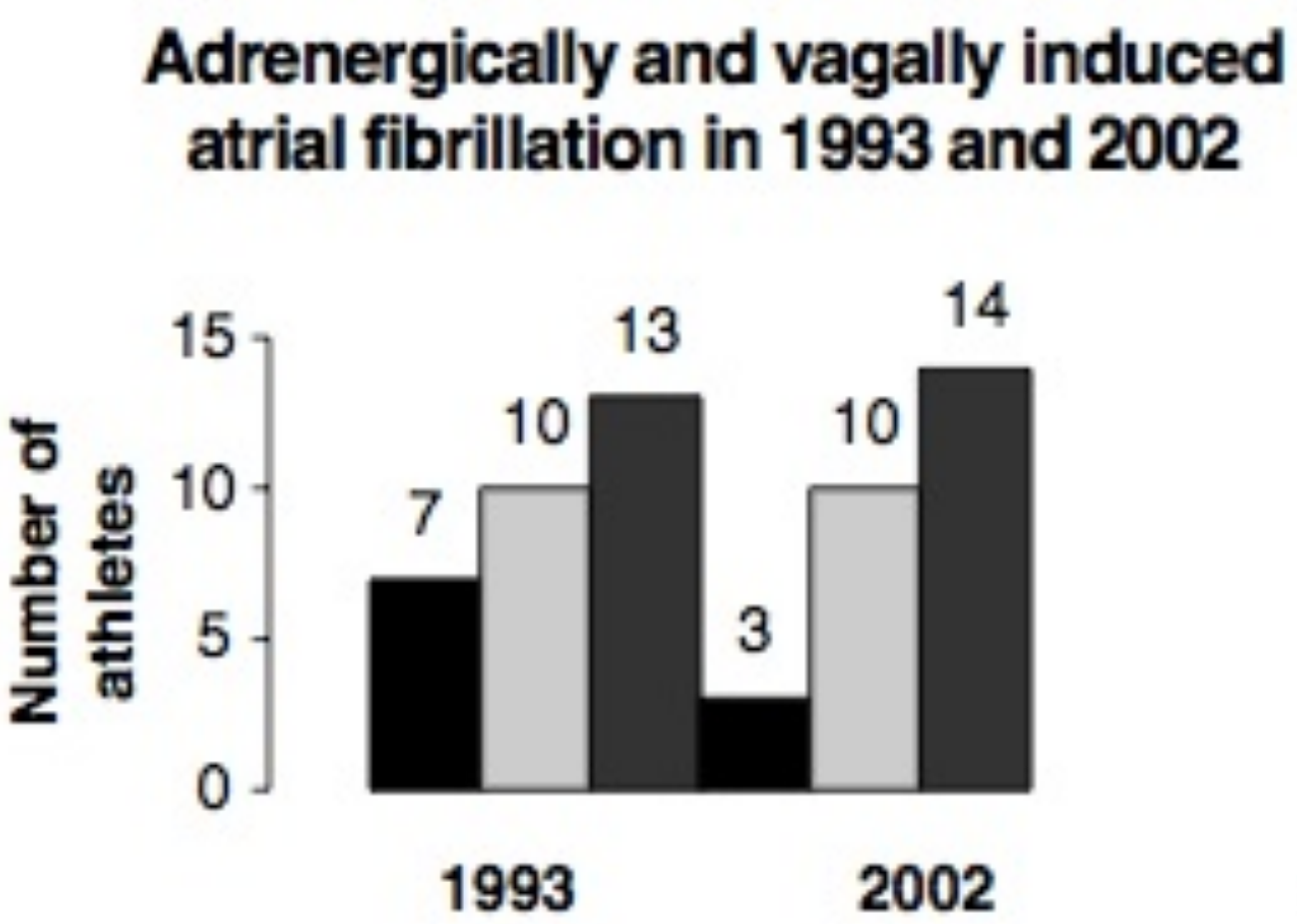
Paroxysmal atrial fibrillation in male endurance athletes. A 9-year follow up



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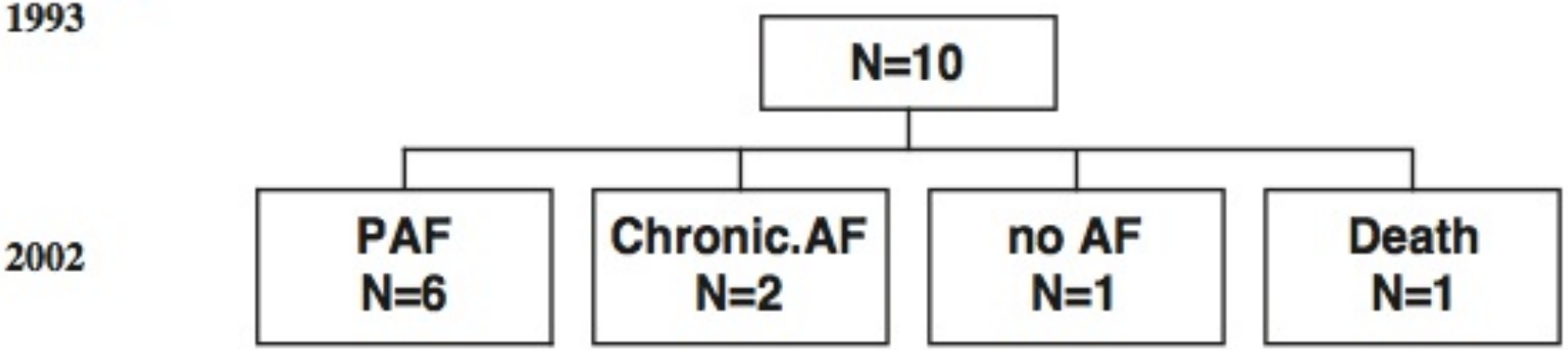
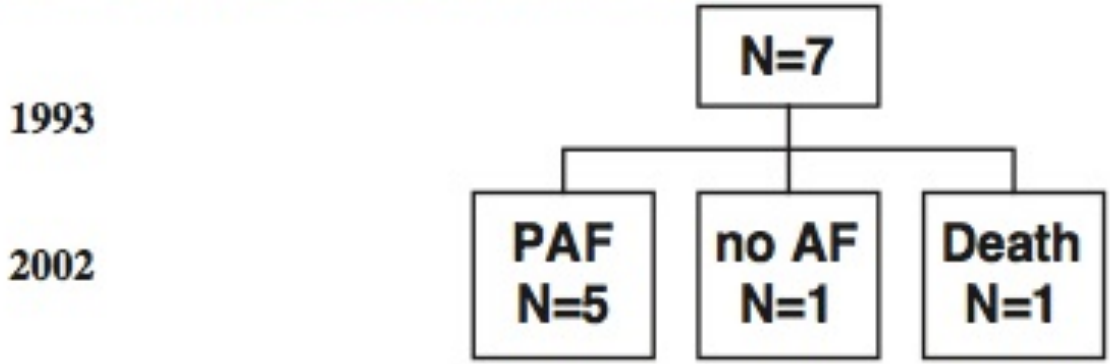
Paroxysmal atrial fibrillation in male endurance athletes. A 9-year follow up

Vagally induced atrial fibrillation



Adrenergically induced atrial fibrillation



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Paroxysmal atrial fibrillation in male endurance athletes. A 9-year follow up

Table 4 The subjective causal relation of atrial fibrillation and sport activity

Effect of mental stress	1993	2002	Relation to sport (subjective)	1993	2002
Improvement	0	0	Therapeutic	2	2
Indifferent	7	7	Indifferent	7	10
Light arousal	11	7	Light causal	12	8
Strong arousal	9	8	Intermediate causal	3	3
Unknown	0	4	Strong causal	3	2
	$N = 27$	$N = 26$		$N = 27$	$N = 25$

Athletes presume a casual relationship between AF and mental stress

The majority of athletes had experienced a causal relationship of AF and sporting activity

30% of athletes in 1993 and 11% of athletes in 2002 experienced a decrease in AF with detraining

..but ~50% of athletes did not experience a noticeable decrease in AF

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AF - How much is too much?

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International Journal of Cardiology 108 (2006) 332 – 337

International Journal of Cardiology

www.elsevier.com/locate/ijcard

Sport practice and the risk of lone atrial fibrillation: A case–control study

Roberto Elosua[a], Andreu Arquer[a], Lluís Mont[b,*], Antonia Sambola[b], Lluís Molina[c], Emilio García-Morán[b], Josep Brugada[b], Jaume Marrugat[a,d]

- An age-matched case–control study.
- 51 men with LAF were included (20 of them with vagal characteristics)
- 109 age matched controls from the general population
- A questionnaire to assess former and current sport practice and the number of lifetime hours of sport practice was administered

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Current sport and >1500h

	Vagal lone atrial fibrillation		
	Number cases–controls	OR (95% CI)	*p*
No sport practice/Former sport practice <1500 h/life	5–59	1	
Former sport practice >1500 h/life	9–35	3.03 (0.94–9.78)	0.063
Current sport practice <1500 h/life	0–1	–	–
Current sport practice >1500 h/life	6–14	5.06 (1.35–18.97)	0.016

Age and hypertension adjusted

Current and prolonged sport practice was associated with:

- **3x** higher prevalence of Lone AF
- **5x** times higher prevalence of vagal Lone AF

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Endurance exercise and atrial FLUTTER

Long-term endurance sport is a risk factor for development of lone atrial flutter

Guido Claessen, Erwin Colyn, André La Gerche, Pieter Koopman, Becker Alzand, Christophe Garweg, Rik Willems, Dieter Nuyens, Hein Heidbuchel

- Consecutive patients who underwent atrial flutter ablation
  - (>3 h of sports practice per week) among patients with lone atrial flutter was significantly higher than that observed in the general population (50% vs 17%; $p<0.0001$)
  - Long-term endurance sports (participation in cycling, running or swimming for >3 h/week) was also significantly higher in lone flutter patients than in controls (31% vs 8%; $p<0.0003$)

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AF mechanisms

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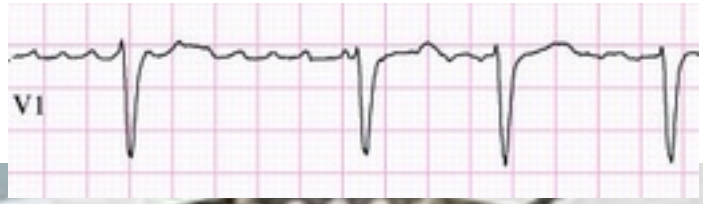
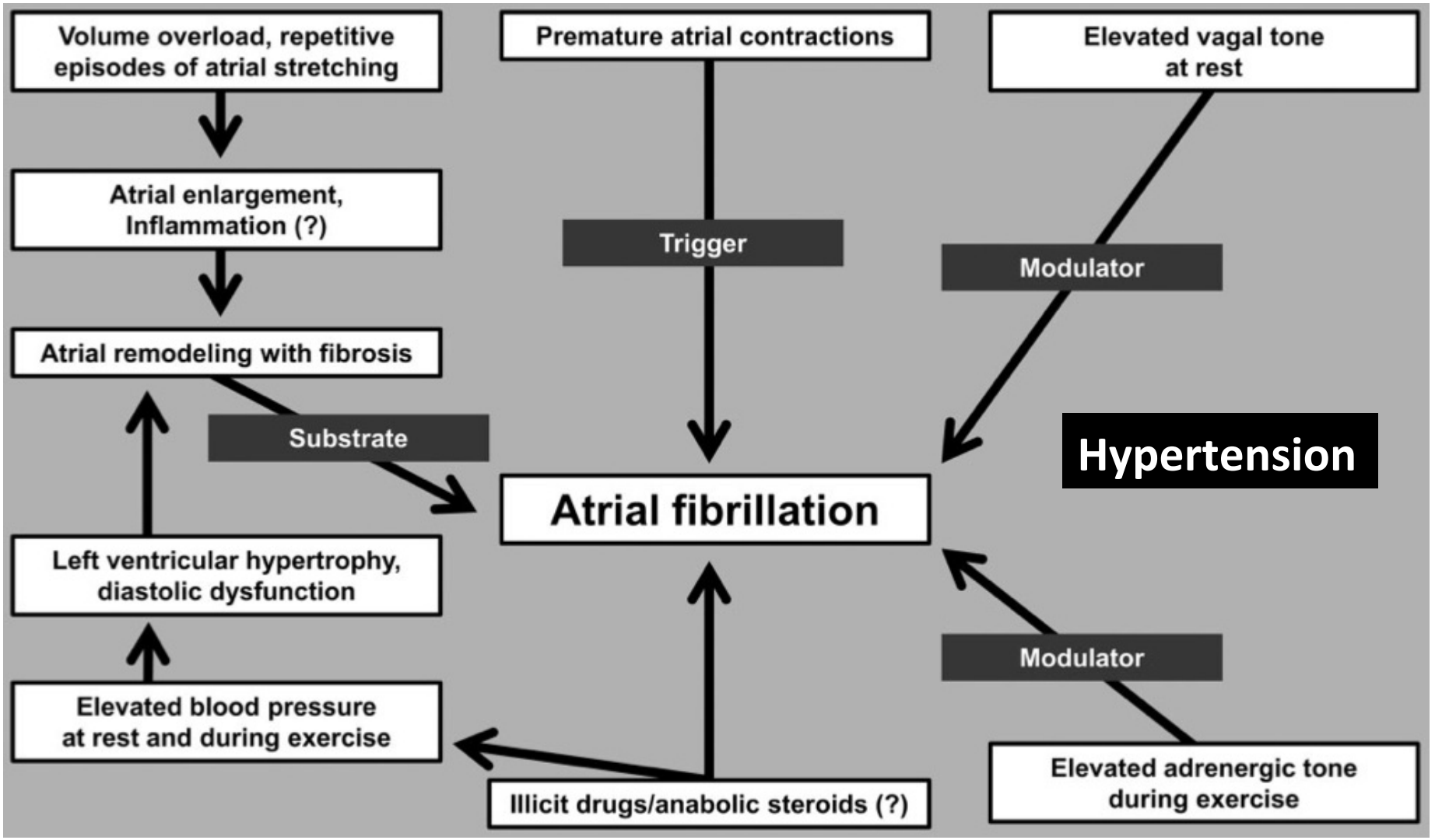


Potential mechanisms for AF induced by endurance exercise



AF mechanisms

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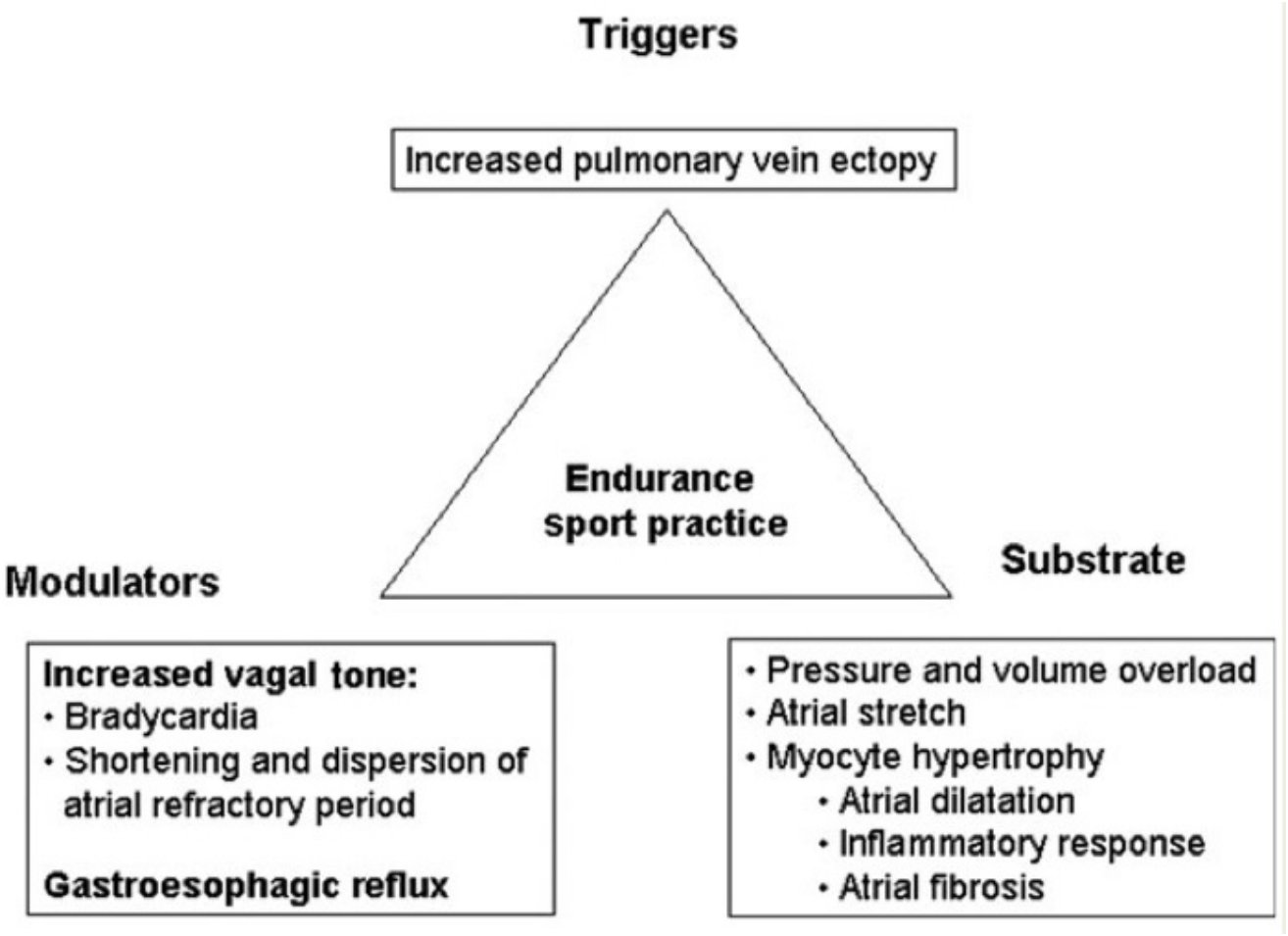

The left atrium of athletes

- Higher relative wall stress -> enlargement and remodeling
  - Repetitive episodes of atrial stretching and an elevated wall stress may stimulate atrial fibrosis
- LA size increases with age of athlete
- LA size increases with training hours
  - >80% of non-elite marathons had LA enlargement if >4500 training hours
  - The number of marathon participations was an independent predictor for left and right atrial enlargement

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Which rat is more likely to get AF?

Rats who were run on a treadmill for 1hr/day for 16 weeks compared to sedentary rats:

- increased AF susceptibility
- enhanced expression of fibrosis-related genes and promoted atrial fibrosis

Benito Circ 2009

World Anti-Doping Association list of drugs that may be associated with atrial fibrillation

Exogenous and endogenous anabolic androgenic steroids
Erythropoesis-stimulating agents (erythropoietin, darbopoeitin)
Growth hormone, insulin-like growth factor–1
Stimulants (amphetamines, ephedrine, adrenaline, pseudoephedrine, methylphenidate, etc)
β_2 agonists (salbutamol, formoterol, and salmeterol)
Alcohol, cannabinoids, ketamine, cocaine, ecstasy
Diuretics (can cause electrolyte abnormalities causing AF)

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Diagnostic evaluation of athletes

- History:
  - characterizing ppts and when they occur
  - use of PEDs/ETOH
- ECG/Holter/Zio patch
- ETT – recovery at least 5 minutes
- ECHO to r/o structural heart disease

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How to treat an athlete with AF

- Typically, athletes have ‘lone AF’
- Treatment of AF in endurance-trained athletes as well as estimating the prognosis is difficult because large-scale prospective, RCTs and guidelines focusing directly on the endurance-trained athletes are lacking.
- Apply current guidelines for the general population

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Treatment options in the athlete with AF?

- Restriction of dose and intensity of endurance exercise (decreased vagal AF recurrence)
- If HTN - ? Benefit with ARB and decreased AF
- Pill-in-the-pocket
- AADs (Flecanide) – helpful in vagal mediated AF
- OAC as per CHADS-VASc
  - Be mindful of type of sport and OAC

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Treatment options in the athlete with AF?

- Direct-current cardioversion
- Ablation strategies
  - ? as effective when compared to non-athletes
  - ~37% will require 2nd ablation
  - An early ablation strategy may be appropriate for some athletes with an impaired physical performance, especially when continuation of competitive activity is intended.

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Bethesda Guidelines - AF

- AF with no structural HD -> No restriction
- AF with structural HD -> as per structural HD restrictions
- AF with OAC -> avoid body contact sports
- AF after ablation -> 4 to 6 weeks before return to no restriction

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Exercise and AF

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- Regular moderate exercise has TREMENDOUS health benefits
- High-performance endurance athletes and Olympic athletes live longer than the general population

CARDIO-FIT study

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ORIGINAL INVESTIGATIONS

Impact of CARDIOrespiratory FITness on Arrhythmia Recurrence in Obese Individuals With Atrial Fibrillation

The CARDIO-FIT Study

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CARDIO-FIT study

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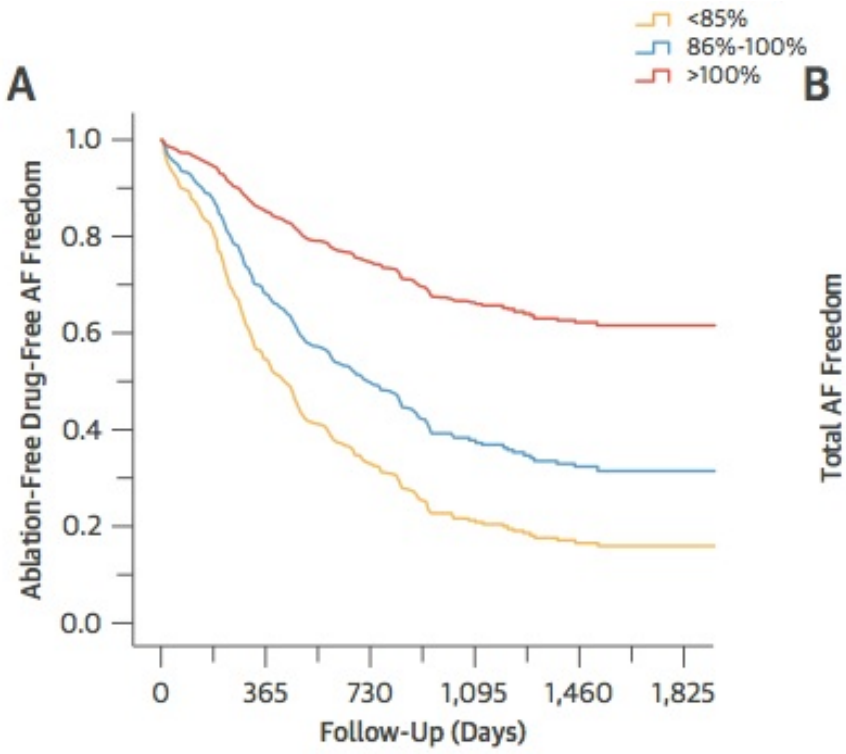

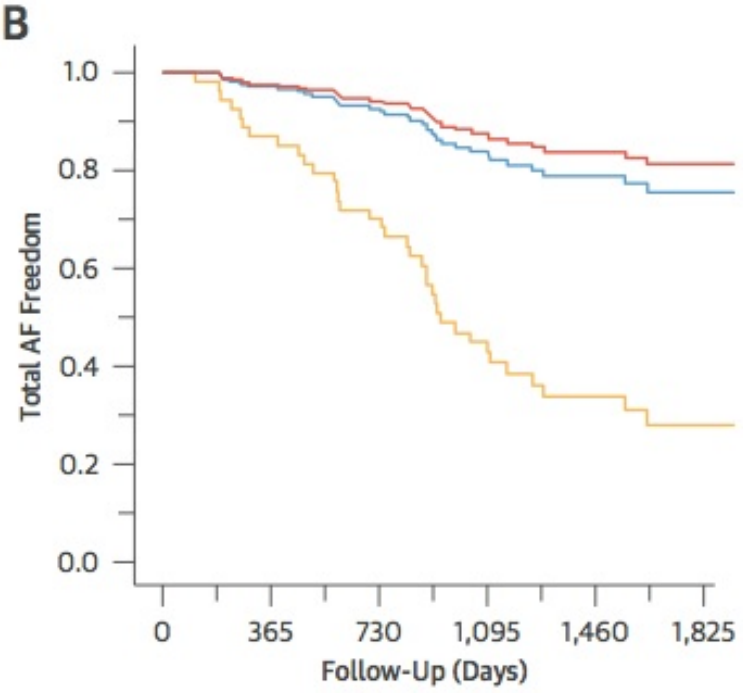

Time (Days)	0	365	730	1,095	1,460	1,825
<85% Predicted	95	54	36	16	12	6
86%-100% Predicted	134	93	56	34	19	11
>100% Predicted	79	63	50	36	26	18

0	365	730	1,095	1,460	1,825
95	78	58	33	20	11
134	133	119	86	56	33
79	78	63	51	36	21

CARDIO-FIT study

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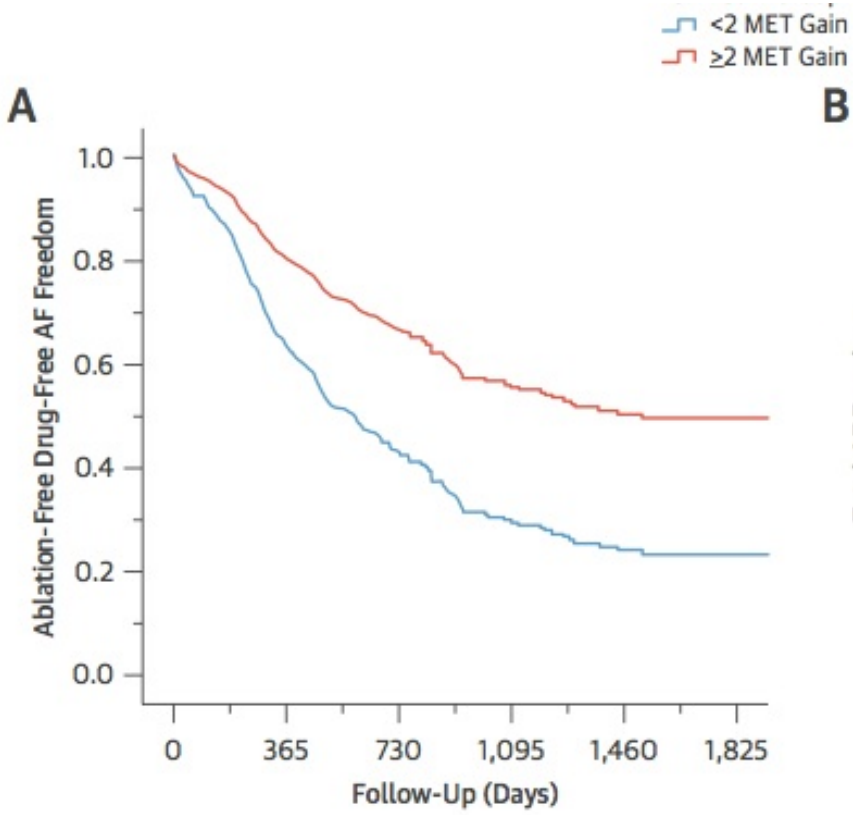
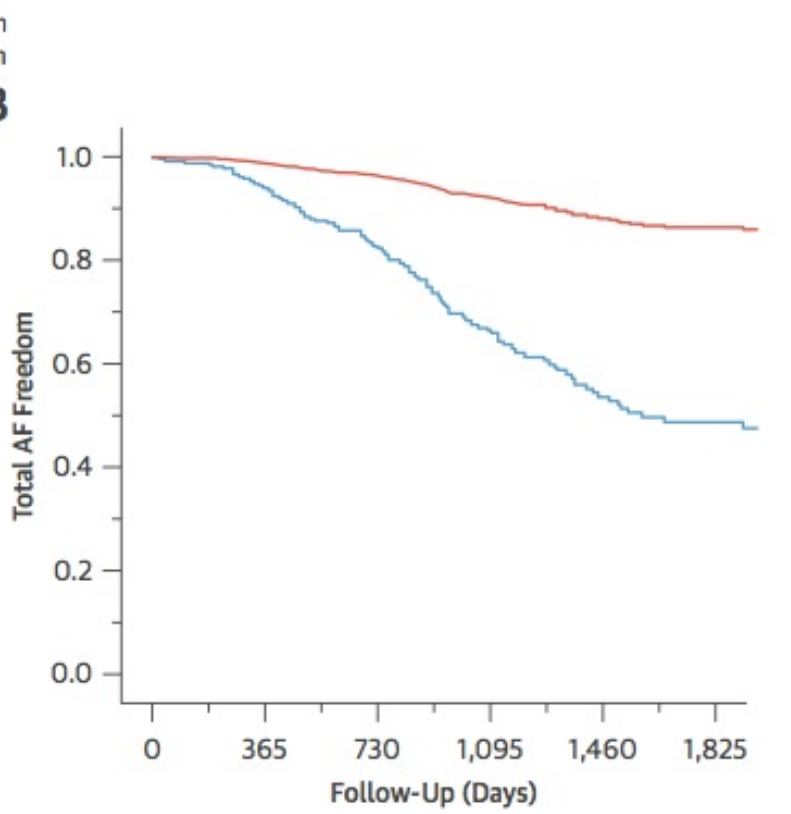


Time (Days)	0	365	730	1,095	1,460	1,825
≥2 MET Gain	127	105	78	52	38	19
<2 MET Gain	181	104	63	36	20	16



0	365	730	1,095	1,460	1,825
127	124	109	84	62	33
181	166	132	86	51	32

CARDIO-FIT study

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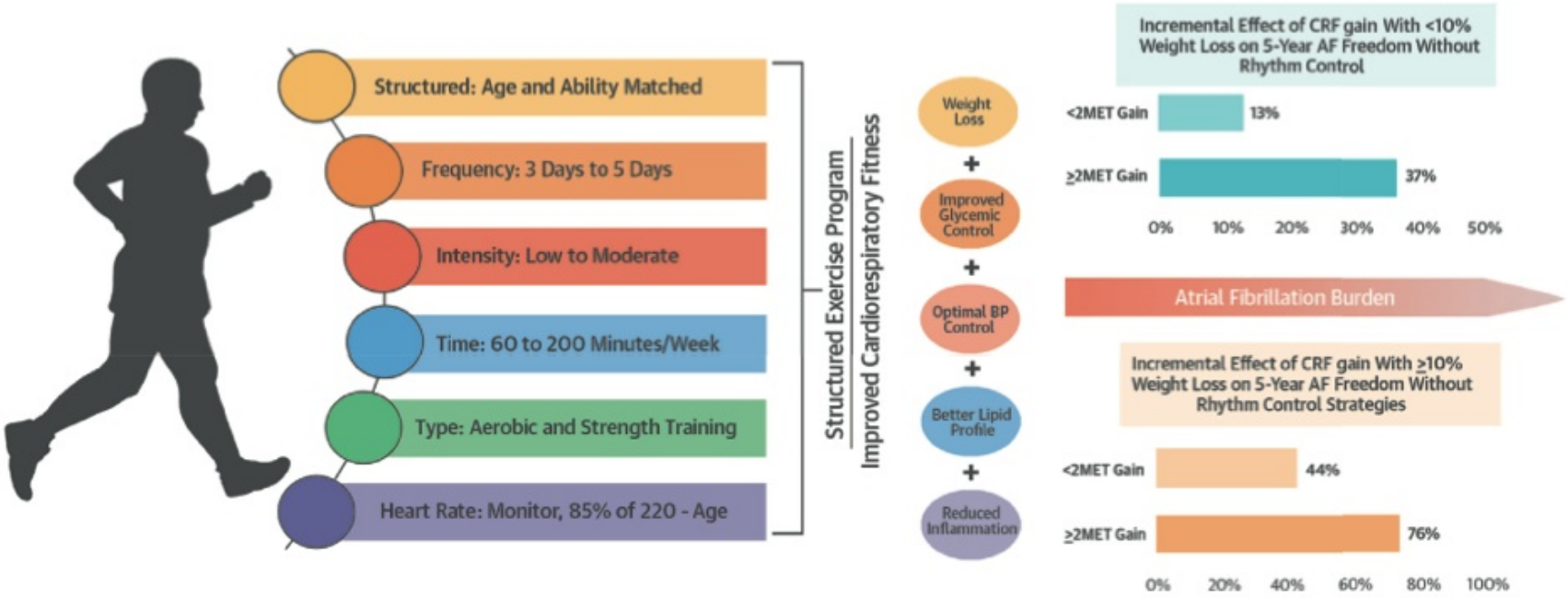

Conclusions

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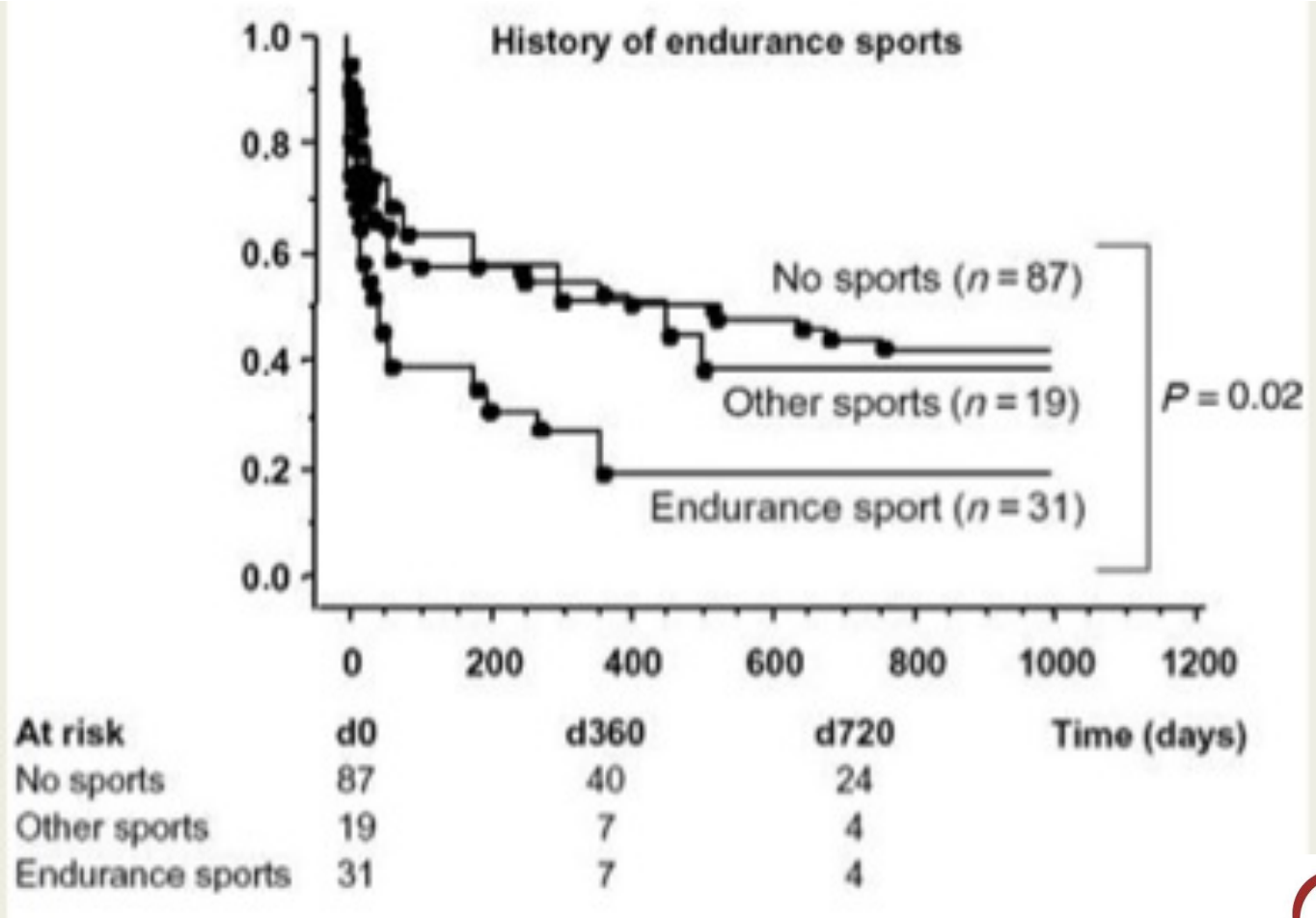
- Endurance exercise is *associated* with ~5 fold increase in AF
- The ‘dose’ of endurance exercise to put someone at increased risk is variable (but large volumes later in life seems to increase risk)
- Treat athlete with AF like a non-athlete with AF

Endurance sports is a risk factor for atrial fibrillation after ablation for atrial flutter.



At risk	d0	d360	d720
No sports	87	40	24
Other sports	19	7	4
Endurance sports	31	7	4

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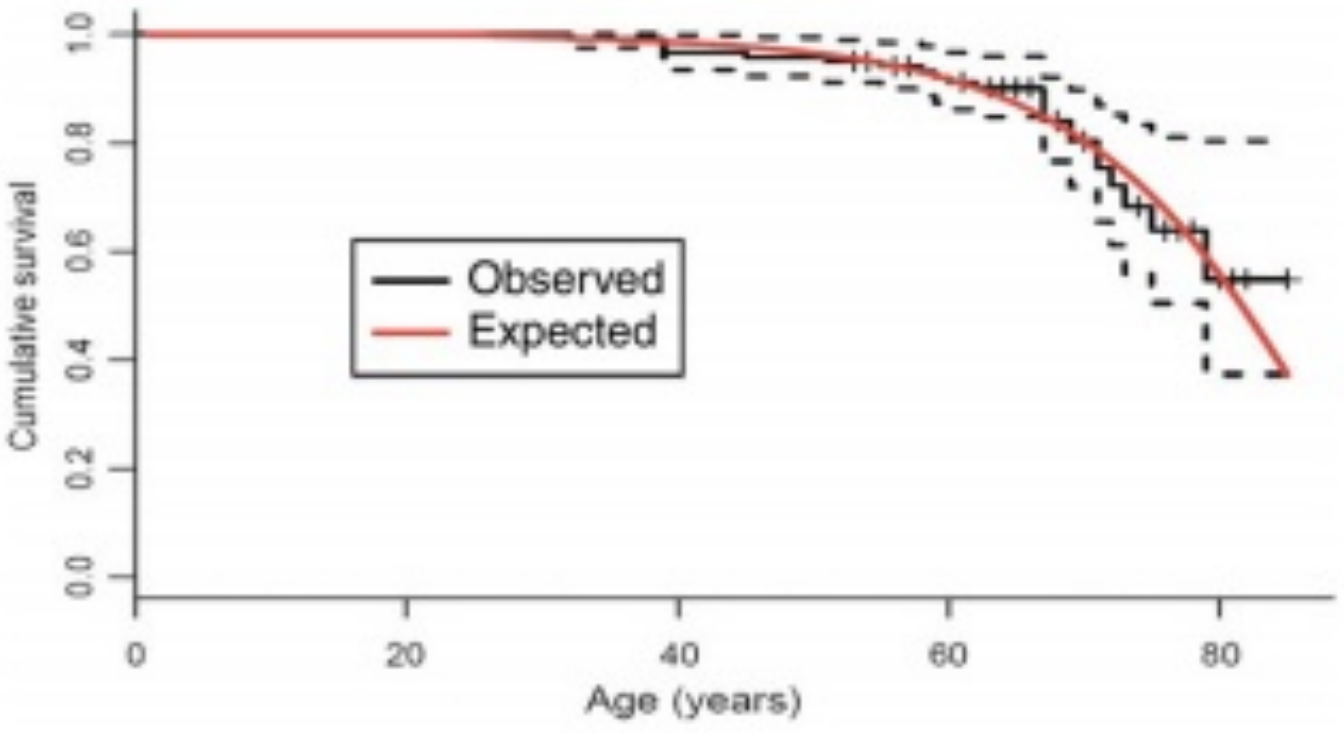
Survival of professional cyclists



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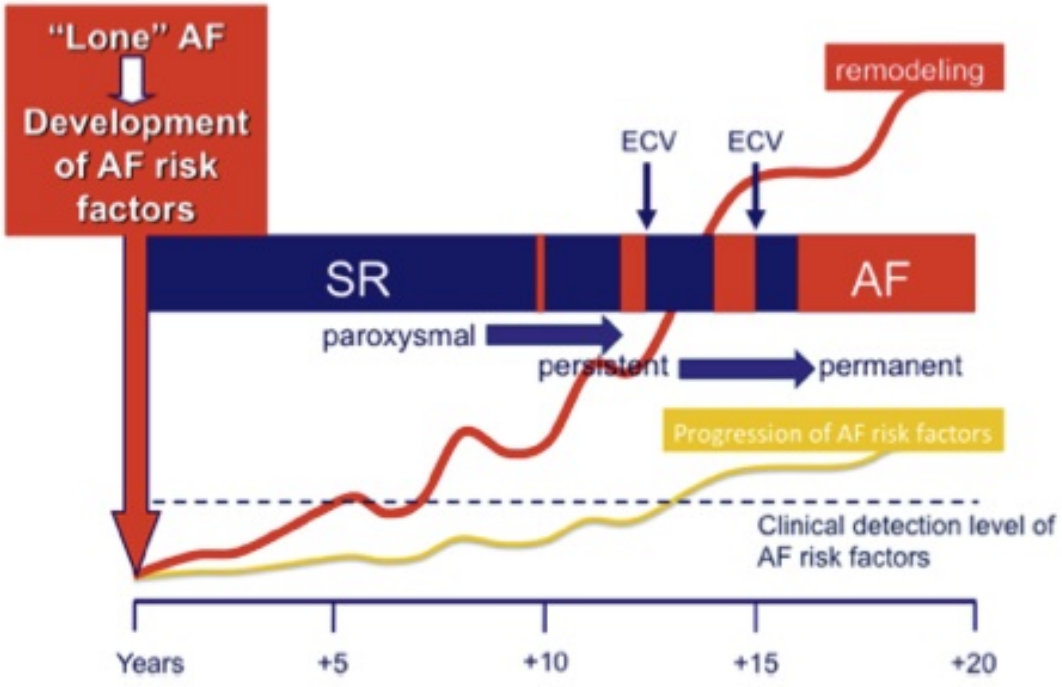
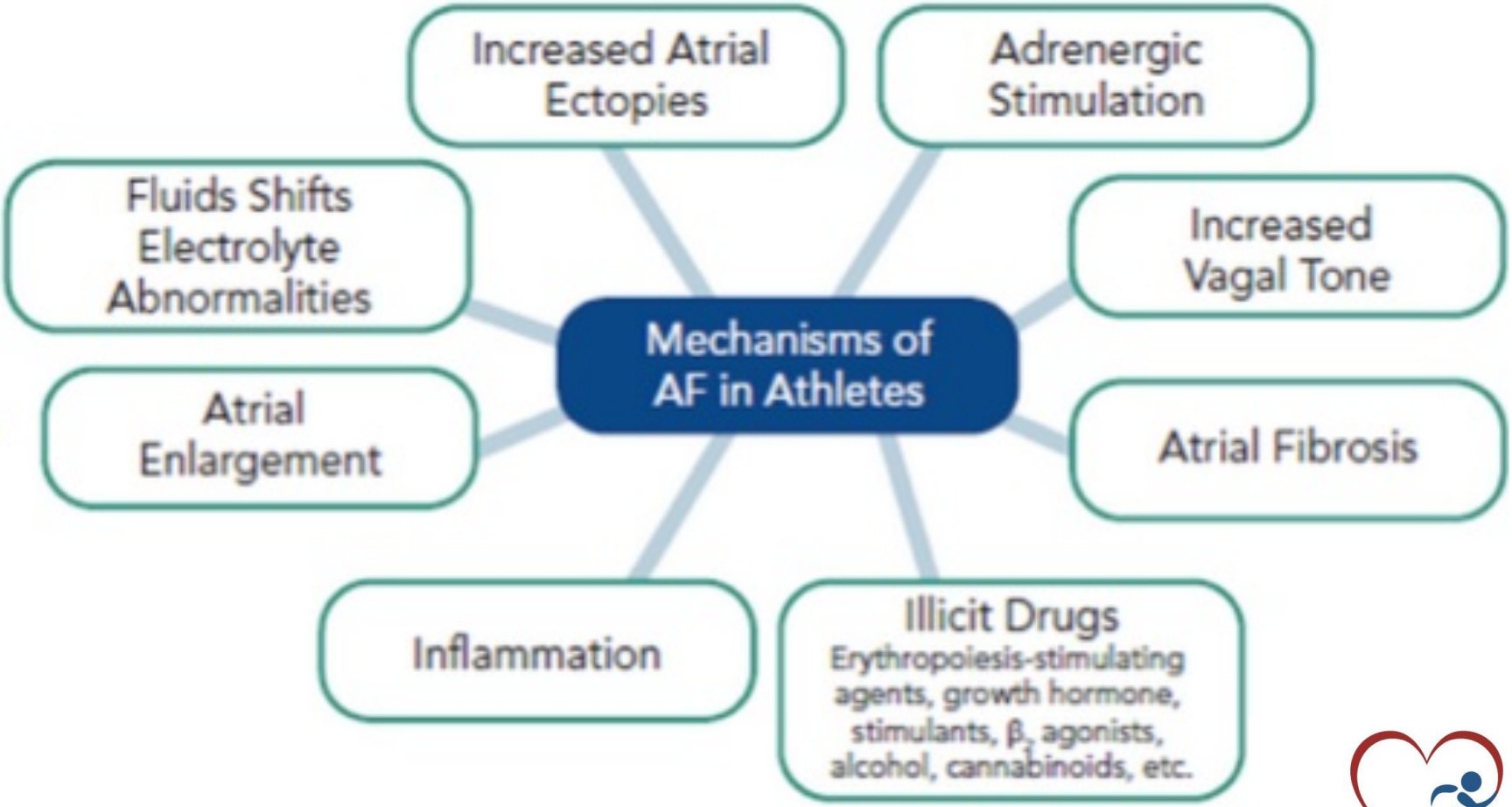
Time-Dependent Atrial Remodeling and Development of AF



Factors affecting development of AF



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U-Shaped Curve?

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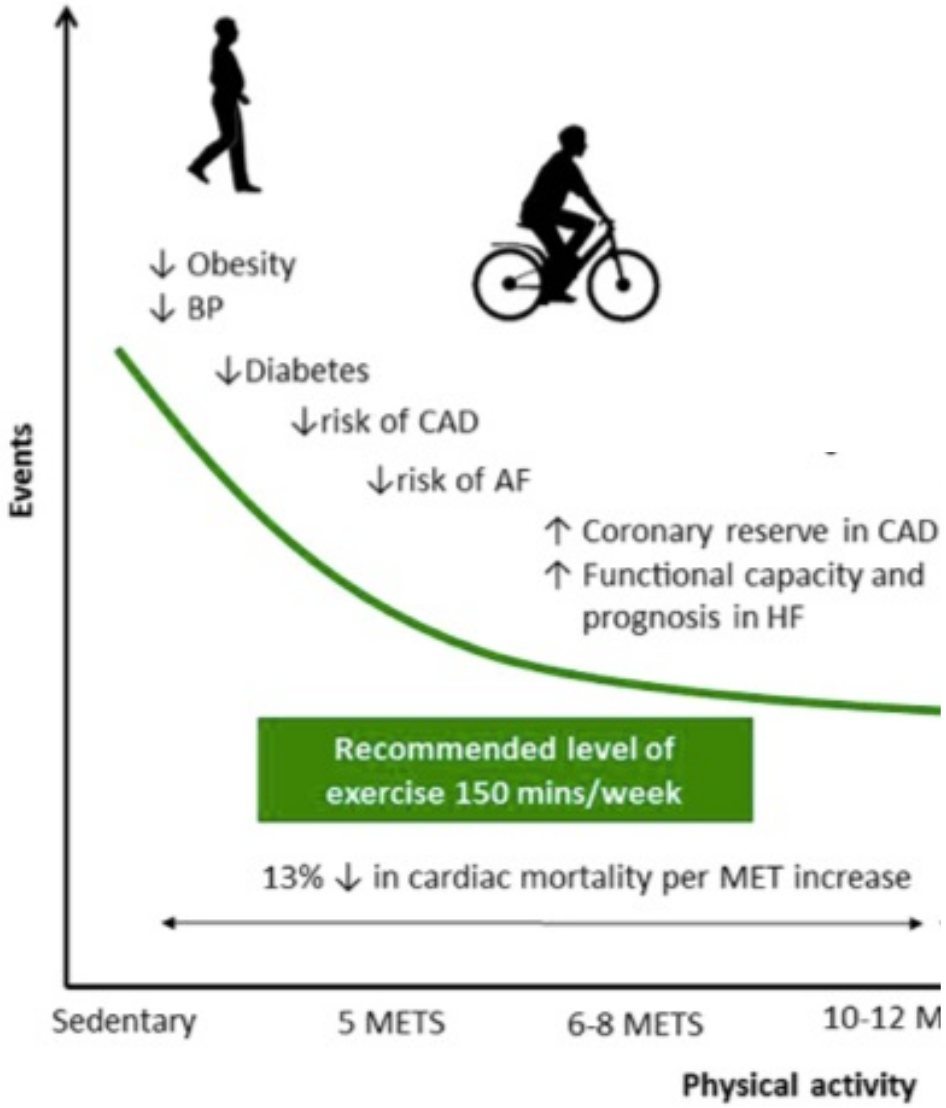
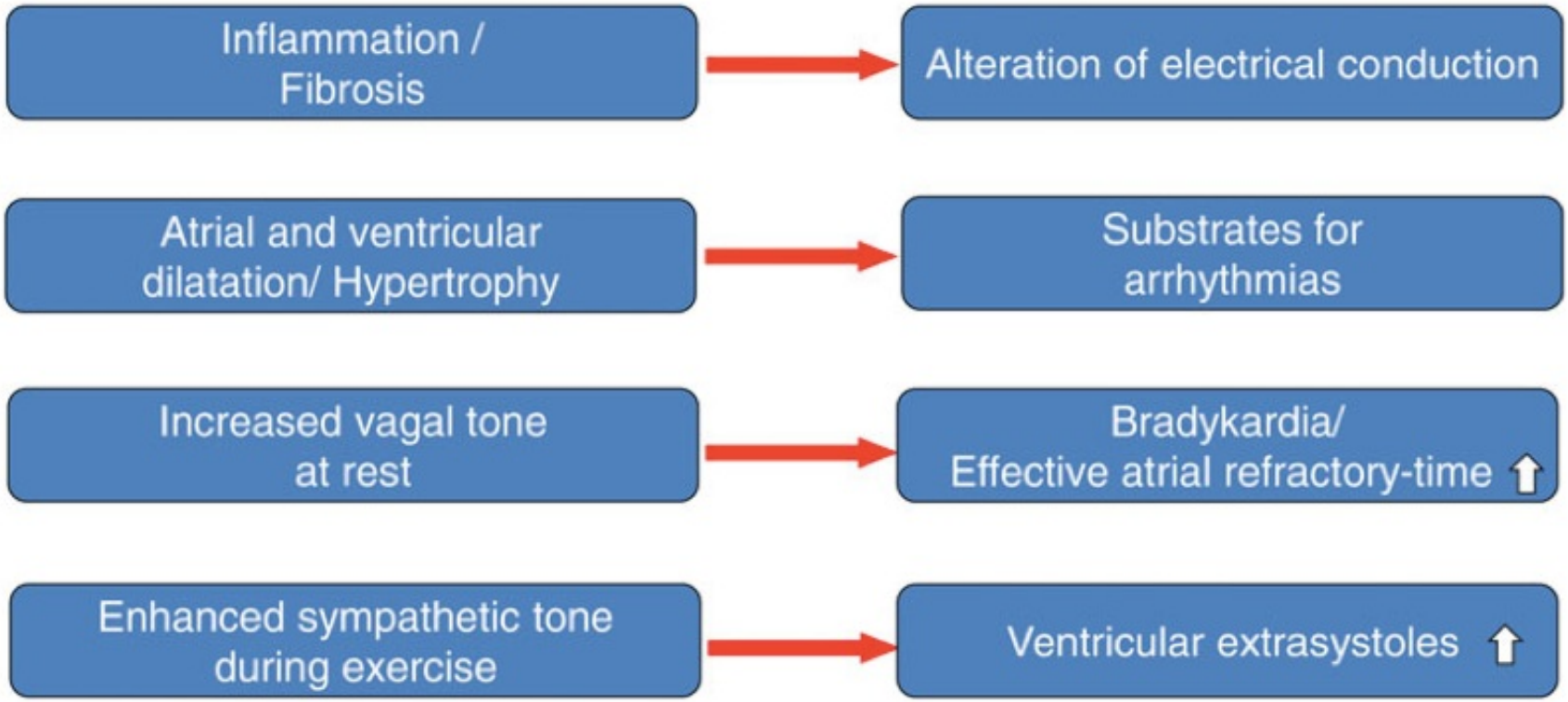


Potential mechanisms for atrial fibrillation induced by high-intensity-endurance sports



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PACs as a trigger

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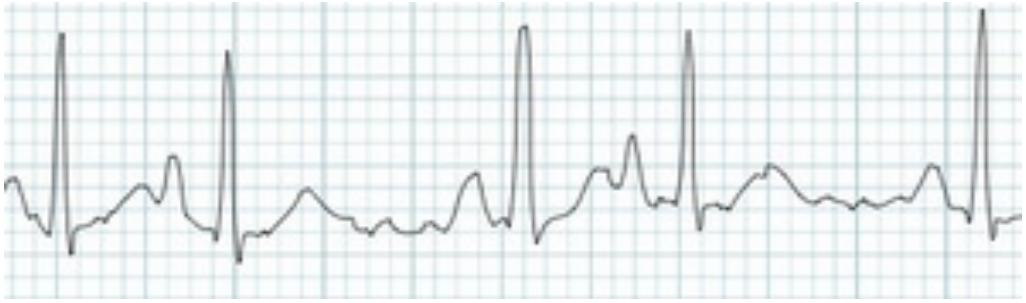

- PACs increased modestly with increased endurance exercise
- More PACs with more training hours
- More PACs with more marathons completed

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Evolution of Physical Activity

Evolution of Physical Activity

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Differences between AF in athletes and non-athletes

Differences between atrial fibrillation in athletes and the normal population

	Athletes	Nonathletes
Type	Vagal mediated	Adrenergic mediated
Presentation	Usually intermittent, paroxysmal	Paroxysmal, persistent, or permanent
Epidemiology	Variable, prevalence 0.2% to 60%	Mean prevalence of 0.5% to 5% (higher in older age group)
Clinical features	Palpitations are more common, chest discomfort, shortness of breath, diaphoresis, syncope	Palpitations, chest discomfort, shortness of breath, diaphoresis, syncope
Causes	Autonomic changes, cardiac adaptability, inflammation, fluid shifts, illicit drugs	Hypertension, valvular heart disease, myocardial infarction, pulmonary disease, hyperthyroidism, alcohol
Treatments	Sports abstinence, antiarrhythmic drugs, antiplatelet, ablation, anticoagulation (not preferred)	Rate-control medications, antiarrhythmic drugs, anticoagulation, ablation
Prognosis	Favorable for lone AF in the absence of underlying structural heart disease or risk factors	Not very favorable; risk for stroke and heart failure

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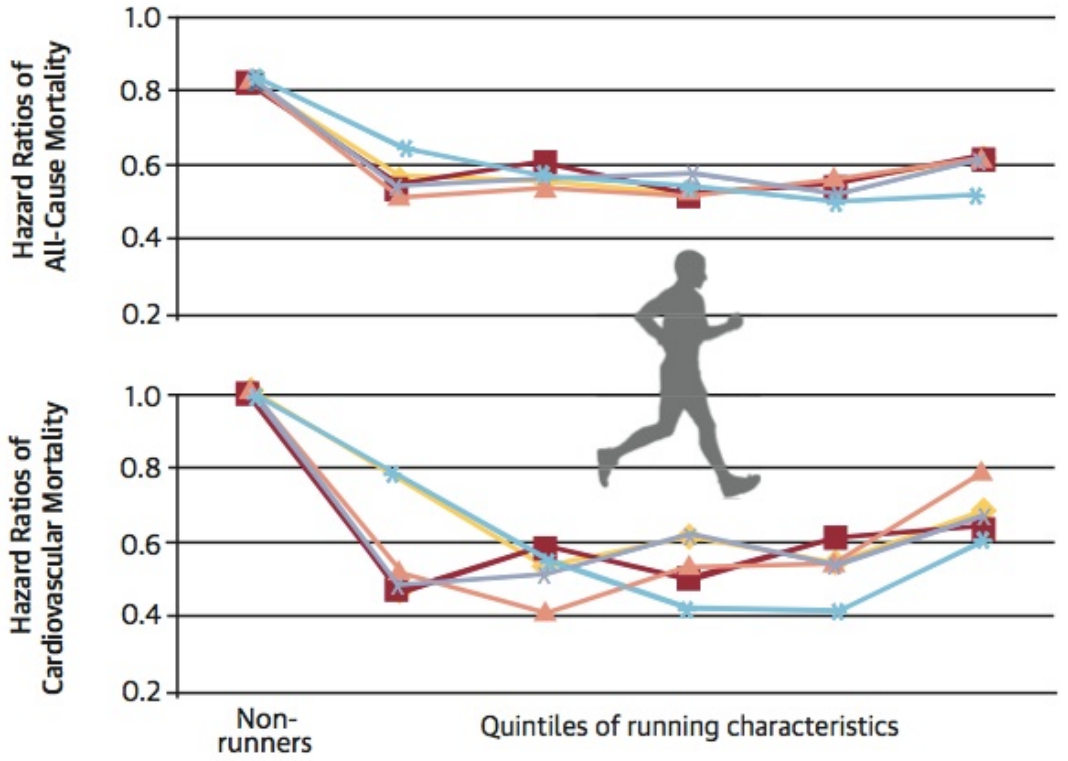
Is leisure time running good for you?

Runners vs. non-runners

30% ↓ all-cause mortality

45% ↓ CV mortality



Time (min/wk)	0	<51	51-80	81-119	120-175	≥176
Distance (miles/wk)	0	<6	6-8	9-12	13-19	≥20
Frequency (times/wk)	0	1-2	3	4	5	≥6
Total amount (MET-min/wk)	0	<506	506-812	813-1199	1200-1839	≥1840
Speed (mph)	0	<6.0	6.0-6.6	6.7-7.0	7.1-7.5	≥7.6

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