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

Neurological

Cardiovascular

Endocrine

Oncological

Musculoskeletal
### Marathon Finishers

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

Lepers AGE 2012
Marathon finishers

Lepers AGE 2012
## Marathon finishers

<table>
<thead>
<tr>
<th>Year</th>
<th>Women</th>
<th>Men</th>
<th>Masters (40 yrs+)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>10%</td>
<td>90%</td>
<td>26%</td>
</tr>
<tr>
<td>1995</td>
<td>26%</td>
<td>74%</td>
<td>41%</td>
</tr>
<tr>
<td>2000</td>
<td>38%</td>
<td>62%</td>
<td>44%</td>
</tr>
<tr>
<td>2005</td>
<td>41%</td>
<td>59%</td>
<td>44%</td>
</tr>
<tr>
<td>2010</td>
<td>41%</td>
<td>59%</td>
<td>44%</td>
</tr>
<tr>
<td>2011</td>
<td>41%</td>
<td>59%</td>
<td>46%</td>
</tr>
<tr>
<td>2012</td>
<td>42%</td>
<td>59%</td>
<td>46%</td>
</tr>
<tr>
<td>2013</td>
<td>43%</td>
<td>58%</td>
<td>46%</td>
</tr>
<tr>
<td>2014</td>
<td>43%</td>
<td>57%</td>
<td>47%</td>
</tr>
</tbody>
</table>

MORE Women participating in marathons

More MASTERS ATHLETES participating in marathons
Atrial Fibrillation
AF Prevalence

• 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 years

• 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

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. Quatrini, MD,* Cataldo Pisicchio, MD,* Alessandra Roselli, MD,* Stefano Caselli, MD,* Franco Culasso, PhD‡
AF Risk Factors

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

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

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

Emerging risk factors

- Subclinical atherosclerosis
- Borderline hypertension (between 120/80 mm Hg and 140/90 mm Hg)
- Chronic kidney disease
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- Elevated natriuretic peptides
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- **Excessive endurance exercise**
- Excessive alcohol intake
- Increased height
- Increased birth weight
- Smoking
- Caffeine intake
- Ethnicity
AF – why do we care so much?
Lone AF

• 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
Vagal AF

• >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
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
Mild activity = less AF incidence

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

<table>
<thead>
<tr>
<th>Walking distance, blocks/wk (n*)</th>
<th>No. of Events</th>
<th>Person-Years</th>
<th>Age- and Gender-Adjusted</th>
<th>Adjusted for Multiple Variables†</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–4 (n=1145)</td>
<td>272</td>
<td>8867</td>
<td>1.0 (Reference)</td>
<td>1.0 (Reference)</td>
</tr>
<tr>
<td>5–11 (n=855)</td>
<td>218</td>
<td>9188</td>
<td>0.78 (0.65–0.93)</td>
<td>0.78 (0.65–0.94)</td>
</tr>
<tr>
<td>12–23 (n=981)</td>
<td>212</td>
<td>9452</td>
<td>0.71 (0.59–0.86)</td>
<td>0.76 (0.63–0.91)</td>
</tr>
<tr>
<td>24–59 (n=1205)</td>
<td>191</td>
<td>9789</td>
<td>0.62 (0.51–0.75)</td>
<td>0.67 (0.55–0.81)</td>
</tr>
<tr>
<td>≥60 (n=1260)</td>
<td>168</td>
<td>9984</td>
<td>0.51 (0.42–0.63)</td>
<td>0.56 (0.45–0.69)</td>
</tr>
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Walking pace (n*)

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<tr>
<td>&lt;2 mph (n=1656)</td>
<td>527</td>
<td>16 805</td>
<td>1.0 (Reference)</td>
<td>1.0 (Reference)</td>
</tr>
<tr>
<td>2–3 mph (n=2314)</td>
<td>427</td>
<td>22 494</td>
<td>0.62 (0.55–0.71)</td>
<td>0.68 (0.59–0.77)</td>
</tr>
<tr>
<td>&gt;3 mph (n=1476)</td>
<td>107</td>
<td>7982</td>
<td>0.51 (0.41–0.63)</td>
<td>0.59 (0.48–0.74)</td>
</tr>
</tbody>
</table>

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

Lluís Mont¹*, David Tamborero¹, Roberto Elosua³, Irma Molina¹, Blanca Coll-Vinent², Marta Sitges¹, Bárbara Vidal¹, Andrea Scalise¹, Alejandro Tejeira¹, Antonio Berruezo¹, and Josep Brugada¹ on behalf of the GIRAFA (Grup Integrat de Recerca en Fibril-lació Auricular) Investigators

<table>
<thead>
<tr>
<th></th>
<th>Odds ratio (95% confidence interval)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cumulated moderate and heavy physical activity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–2077 h</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2078–9318 h</td>
<td>5.60 (1.59–19.75)</td>
<td>0.0075</td>
</tr>
<tr>
<td>≥9319 h</td>
<td>15.11 (3.75–60.83)</td>
<td>0.0001</td>
</tr>
<tr>
<td><strong>Height</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>155–164.9 cm</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>165–176.9 cm</td>
<td>13.54 (2.47–74.30)</td>
<td>0.0027</td>
</tr>
<tr>
<td>177–195 cm</td>
<td>23.23 (2.48–217.56)</td>
<td>0.0059</td>
</tr>
<tr>
<td><strong>Left atrial anteroposterior diameter (mm)</strong></td>
<td>1.40 (1.17–1.67)</td>
<td>0.0003</td>
</tr>
</tbody>
</table>
Who is more likely to get AF?

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

Sylvette Baldesberger¹, Urs Bauersfeld², Reto Candinas¹, Burkhardt Seifert³,
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

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

- Karjalainen et al. \(^8\):
  - OR (95% CI): 5.83 (1.29–26.38)
  - %Weight: 8.49

- Heidbuchel et al. \(^9\):
  - OR (95% CI): 4.67 (1.77–12.30)
  - %Weight: 18.94

- Elosua et al. \(^10\):
  - OR (95% CI): 2.86 (1.28–6.40)
  - %Weight: 28.38

- Molina et al. \(^11\):
  - OR (95% CI): 7.45 (1.59–34.87)
  - %Weight: 6.36

- Mont et al. \(^12\):
  - OR (95% CI): 6.54 (3.58–11.97)
  - %Weight: 35.89

- Baldesberger et al. \(^13\):
  - OR (95% CI): 14.38 (0.79–261.05)
  - %Weight: 1.94

Overall (95% CI):
- Test of OR = 1: \( P = 0.0001 \)
- Heterogeneity: \( P = 0.633; I^2 = 0\% \)

5-fold increase
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.
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

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.
Who is more likely to get AF?
Who is more likely to get AF?
Who is more likely to get AF?

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

Matthias Wilhelm, MD\textsuperscript{a,*}, Laurent Roten, MD\textsuperscript{b}, Hildegard Tanner, MD\textsuperscript{b}, Ilca Wilhelm, MD\textsuperscript{c}, Jean-Paul Schmid, MD\textsuperscript{a}, and Hugo Saner, MD\textsuperscript{a}

\textit{(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
U-shaped curve?

>5x jog/wk ➔ 53%↑ risk of AF
Natural history of AF in the athletes

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

Jan Hoogsteen\textsuperscript{a,*}, Goof Schep\textsuperscript{b}, Norbert M. van Hemel\textsuperscript{c}, Ernst E. van der Wall\textsuperscript{d}
Paroxysmal atrial fibrillation in male endurance athletes. A 9-year follow up

Mean age of AF onset 41.4
Paroxysmal atrial fibrillation in male endurance athletes. A 9-year follow up

Adrenergically and vagally induced atrial fibrillation in 1993 and 2002

Number of athletes

<table>
<thead>
<tr>
<th>Year</th>
<th>1993</th>
<th>2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>13</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

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

Vagally induced atrial fibrillation
1993

N=10

2002

PAF N=6
Chronic.AF N=2
no AF N=1
Death N=1

Adrenergically induced atrial fibrillation
1993

N=7

2002

PAF N=5
no AF N=1
Death N=1
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
AF - How much is too much?
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
Current and prolonged sport practice was associated with:
• **3x** higher prevalence of Lone AF
• **5x** times higher prevalence of vagal Lone AF

Age and hypertension adjusted
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)
AF mechanisms
Potential mechanisms for AF induced by endurance exercise

- Volume overload, repetitive episodes of atrial stretching
- Atrial enlargement, inflammation (?)
- Atrial remodeling with fibrosis
- Left ventricular hypertrophy, diastolic dysfunction
- Elevated blood pressure at rest and during exercise
- Premature atrial contractions
- Elevated vagal tone at rest

- Substrate
- Trigger
- Atrial fibrillation
- Hypertension

- Illicit drugs/anabolic steroids (?)
- Elevated adrenergic tone during exercise
AF mechanisms

**Triggers**
- Increased pulmonary vein ectopy

**Endurance sport practice**

**Modulators**
- Increased vagal tone:
  - Bradycardia
  - Shortening and dispersion of atrial refractory period
- Gastroesophageal reflux

**Substrate**
- Pressure and volume overload
- Atrial stretch
- Myocyte hypertrophy:
  - Atrial dilatation
  - Inflammatory response
  - Atrial fibrosis
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
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

Erythropoiesis-stimulating agents (erythropoietin, darbopoeitin)
Growth hormone, insulin-like growth factor–1
Stimulants (amphetamines, ephedrine, adrenaline, pseudoephedrine, methylphenidate, etc)
β₂ agonists (salbutamol, formoterol, and salmeterol)
Alcohol, cannabinoids, ketamine, cocaine, ecstasy
Diuretics (can cause electrolyte abnormalities causing AF)
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
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
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
Treatment options in the athlete with AF?

- Direct-current cardioversion
- Ablation strategies
  - ~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.
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
Exercise and AF

- Regular moderate exercise has TREMENDOUS health benefits
- High-performance endurance athletes and Olympic athletes live longer than the general population
Impact of CARDIOrespiratory FITness on Arrhythmia Recurrence in Obese Individuals With Atrial Fibrillation
The CARDIO-FIT Study

Rajeev K. Pathak, MBBS,* Adrian Elliott, PhD,* Melissa E. Middeldorp,* Megan Meredith,* Abhinav B. Mehta, M Act St,† Rajiv Mahajan, MD, PhD,* Jeroen M.L. Hendriks, PhD,* Darragh Twomey, MBBS,* Jonathan M. Kalman, MBBS, PhD,‡ Walter P. Abhayaratna, MBBS, PhD,§ Dennis H. Lau, MBBS, PhD,* Prashanthan Sanders, MBBS, PhD*
CARDIO-FIT study

**Graph A:** Ablation-Free Drug-Free AF Freedom over follow-up days for different predicted fitness levels:
- <85% Predicted
- 86%-100% Predicted
- >100% Predicted

**Graph B:** Total AF Freedom over follow-up days for different predicted fitness levels:
- <85% Predicted
- 86%-100% Predicted
- >100% Predicted

**Table:**

<table>
<thead>
<tr>
<th>Time (Days)</th>
<th>0</th>
<th>365</th>
<th>730</th>
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<th>1,460</th>
<th>1,825</th>
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<td>12</td>
<td>6</td>
</tr>
<tr>
<td>86%-100% Predicted</td>
<td>134</td>
<td>93</td>
<td>56</td>
<td>34</td>
<td>19</td>
<td>11</td>
</tr>
<tr>
<td>&gt;100% Predicted</td>
<td>79</td>
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<td>50</td>
<td>36</td>
<td>26</td>
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<td>21</td>
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CARDIO-FIT study

- Structured: Age and Ability Matched
- Frequency: 3 Days to 5 Days
- Intensity: Low to Moderate
- Time: 60 to 200 Minutes/Week
- Type: Aerobic and Strength Training
- Heart Rate: Monitor, 85% of 220 - Age

- Weight Loss
- Improved Glycemic Control
- Optimal BP Control
- Better Lipid Profile
- Reduced Inflammation

Incremental Effect of CRF gain With <10% Weight Loss on 5-Year AF Freedom Without Rhythm Control
- <2MET Gain: 13%
- ≥2MET Gain: 37%

Atrial Fibrillation Burden
- Incremental Effect of CRF gain With ≥10% Weight Loss on 5-Year AF Freedom Without Rhythm Control Strategies
- <2MET Gain: 44%
- ≥2MET Gain: 76%
Conclusions

• 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.
Survival of professional cyclists
Time-Dependent Atrial Remodeling and Development of AF
Factors affecting development of AF

- Increased Atrial Ectopies
- Adrenergic Stimulation
- Fluids Shifts, Electrolyte Abnormalities
- Atrial Enlargement
- Inflammation
- Illicit Drugs (Erythropoiesis-stimulating agents, growth hormone, stimulants, β-agonists, alcohol, cannabinoids, etc.)
- Increased Vagal Tone
- Atrial Fibrosis
U-Shaped Curve?

- Obesity ↓
- BP ↓
- Diabetes ↓
- Risk of CAD ↓
- Risk of AF ↓

- Coronary reserve in CAD ↑
- Functional capacity and prognosis in HF ↑

Recommended level of exercise 150 mins/week

13% ↓ in cardiac mortality per MET increase
Potential mechanisms for atrial fibrillation induced by high-intensity-endurance sports

- Inflammation / Fibrosis → Alteration of electrical conduction
- Atrial and ventricular dilatation/ Hypertrophy → Substrates for arrhythmias
- Increased vagal tone at rest → Bradykardia/ Effective atrial refractory-time
- Enhanced sympathetic tone during exercise → Ventricular extrasystoles
PACs as a trigger

- PACs increased modestly with increased endurance exercise
- More PACs with more training hours
- More PACs with more marathons completed
Evolution of Physical Activity
Evolution of Physical Activity
## Differences between AF in athletes and non-athletes

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

[SPORTSCARDIOLOGYBC]
Is leisure time running good for you?

**Runners vs. non-runners**

<table>
<thead>
<tr>
<th>Non-runners</th>
<th>Quintiles of running characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time (min/wk)</td>
</tr>
<tr>
<td>0</td>
<td>&lt;51</td>
</tr>
<tr>
<td>51-80</td>
<td>6-8</td>
</tr>
<tr>
<td>81-119</td>
<td>9-12</td>
</tr>
<tr>
<td>120-175</td>
<td>13-19</td>
</tr>
<tr>
<td>≥176</td>
<td>≥20</td>
</tr>
</tbody>
</table>

30% ↓ all-cause mortality

45% ↓ CV mortality