Running and Heart:

Friends or Foes?

Josef VESELKA

Department of Cardiology, Motol University Hospital,
2nd Medical School, Charles University, Prague

KARDIOLOGICKÁ KLINIKA
2. LF UK a FN MOTOL

Why is a cardiologist interested in exercise?

Inactivity

- Physical inactivity causes 6% of the burden of disease from **coronary heart disease**, 7% (3.9–9.6) of **type 2 diabetes**, 10% (5.6–14.1) of **breast cancer**, and 10% (5·7–13·8) of **colon cancer.**
- Inactivity causes 5.3 million of the 57 million deaths that occurred worldwide in 2008.

- Elimination of physical inactivity would increase the life expectancy of the world's population by 0.68 (range 0.41–0.95) years.

Lee et al, Lancet 2012

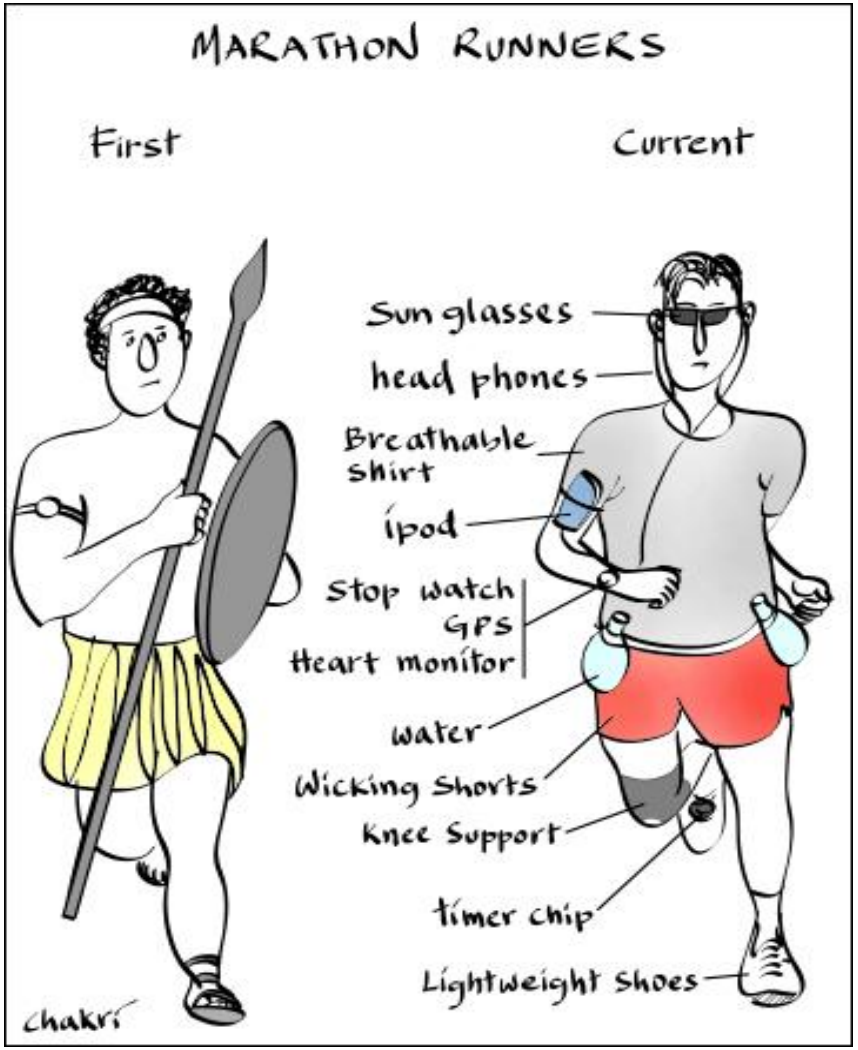
Rowe et al. Circulation 2014

Running

Marathon Run

September 12, 490 B.C.

Feidippides: Marathon - Athens



Troponin release

Marathon Running

- **Training (30-100 km a week)**
- **Fluid**
- **Fuel**
- **Acclimatisation**

- **Heat, humidity**
- **Fluid loss**
- **Hyponatremia**
- **Lactate**

HEART → **cTROPONIN**

Marathon Run in Amateurs

- **The lowest baseline VO2 max or marathon training the ↑ cTn release**
- Post-marathon CMR – edema, inflammation, segmental hypoperfusion.
- The whole finding is reversible

Neilan TG et al. Circulation 2006

Marathon running as a cause of troponin elevation:
a systematic review and meta-analysis

- The pooled incidence of a post-marathon cTn elevation was 51% of all runners.

- The available data demonstrate that **cTn** levels are frequently elevated after a marathon with **unclear cardiovascular significance**.
- This elevation of cTn appears to be consistent among a diverse runners population.

Regwan S. J Interv Cardiol 2010

Troponin Release after Exercise

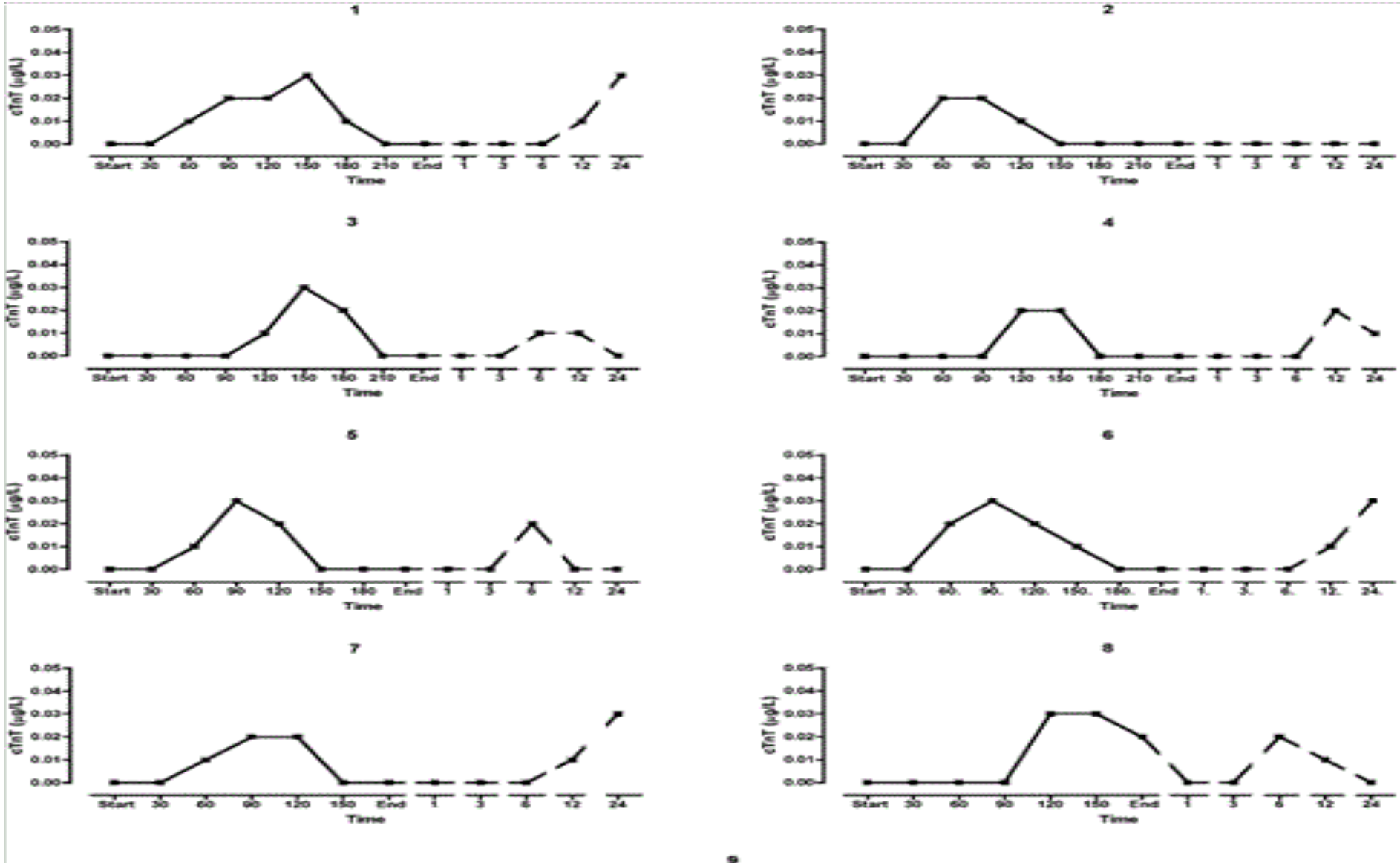
Until now, release of cTnT has been proposed as pathognomonic of cardiac necrosis.

Rather, it is possible that **post-exercise cTn release represents reversible cardiomyocyte membrane damage that may reflect part of a remodeling process**.

Although cTnT is diagnostic of ACS in the clinical setting, in a healthy exercising population, cTnT is routinely released in all persons after periods of increased myocardial demand.

Middleton N et al. JACC 2008

Troponin Release after Exercise



Troponin Release in Adolescents Playing Baskeball

- Serum cTnT and cTnI levels **in 10 male players** (age 15.0 ± 0.7 yr) were assessed immediately before and at 2, 4 and 24 h after a **pre-season basketball-training program**.
- At 4 h following the game, serum cTnT levels in four of the ten subjects were above the cutoff of 0.01 ng · ml^{-1} for myocardial injury. Two of these four subjects had values higher than the acute myocardial infarction cutoff of 0.05 ng · ml^{-1}. **In three of the four subjects, the serum cTnI was above the cutoff of 0.06 ng · ml^{-1} for myocardial injury.**
- Troponins at 24 h had returned to pre-exercise levels.
- These findings suggest that the physical stress encountered during intense, **intermittent-type sports could cause release of cardiac troponins in some adolescents at low risk for cardiac disease**.

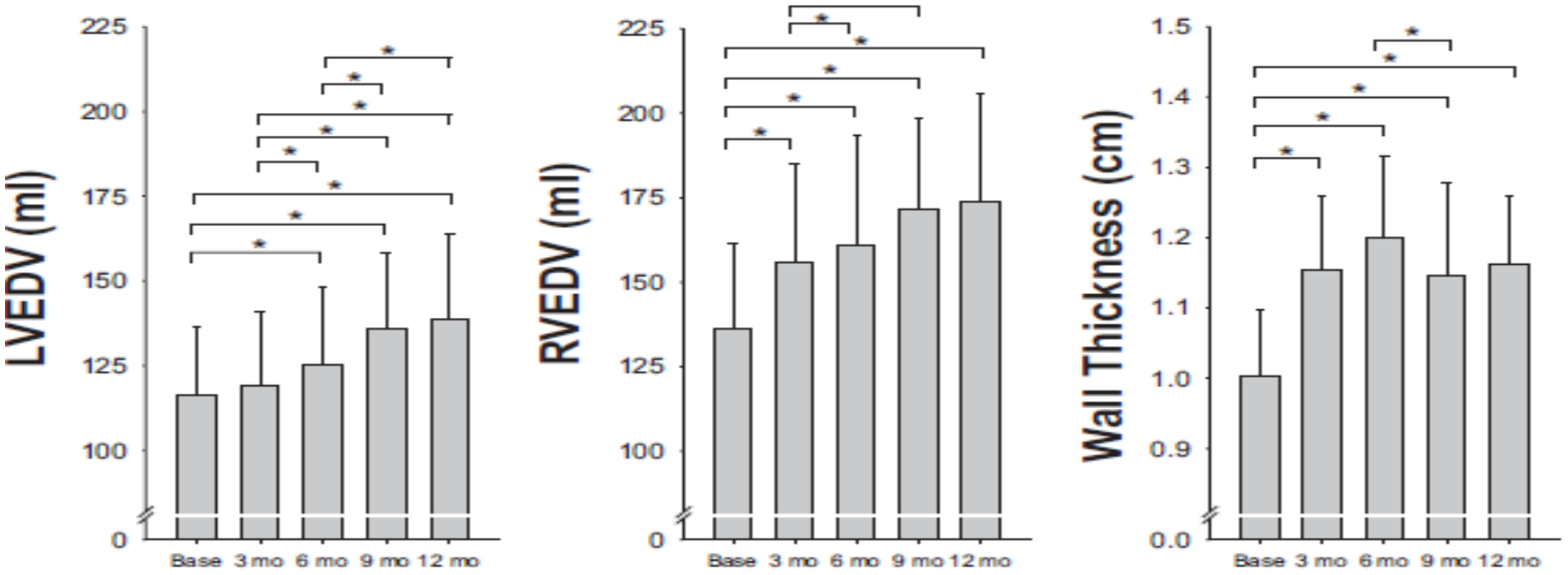
Nie J et al. Int J Sports Med 2008

Remodeling

LV/RV function

Cardiac Remodeling in Response to 1 Year of Intensive Endurance Training

Circulation. 2014;130:2152-2161.



Conclusions—One year of prolonged and intensive endurance training leads to cardiac morphological adaptations in previously sedentary young subjects similar to those observed in elite endurance athletes; however, it is not sufficient to achieve similar levels of cardiac compliance and performance. Contrary to conventional thinking, the left ventricle responds to exercise with initial concentric but not eccentric remodeling during the first 6 to 9 months after commencement of endurance training depending on the duration and intensity of exercise. Thereafter, the left ventricle dilates and restores the baseline mass-to-volume ratio. In contrast, the right ventricle responds to endurance training with eccentric remodeling at all levels of training. (*Circulation*. 2014;130:2152-2161.)

LV/RV Dysfunction in Elite Athletes

- 114 Olympic athletes; 2 or more Olympic games
  - No LV/RV dysfunction, no symptoms of HF, no CV events

    Pelliccia A et al. JACC 2010

- 40 athletes (endurance race 3-11 hours).
  - **cTnI level correlates with RV dysfunction; longer race = worse dysfunction, LV without dysfunction**
  - RV function normalized in 1 week

    La Gerche A et al. EHJ 2011

RV dysfunction following prolonged endurance exercise: meta-analysis

- 14 studies, 329 participants
- Slightly decreased RV systolic function, modest RV dilation, no LV changes
- Intense prolonged exercise is associated with a measurable **transient reduction in RV function while LV function is relatively unaffected.**

Alliott AD, La Gerche A. Br J Sports Med 2014

Exercise and survival

Survival of Runners vs Community Controls

21-year FU in California

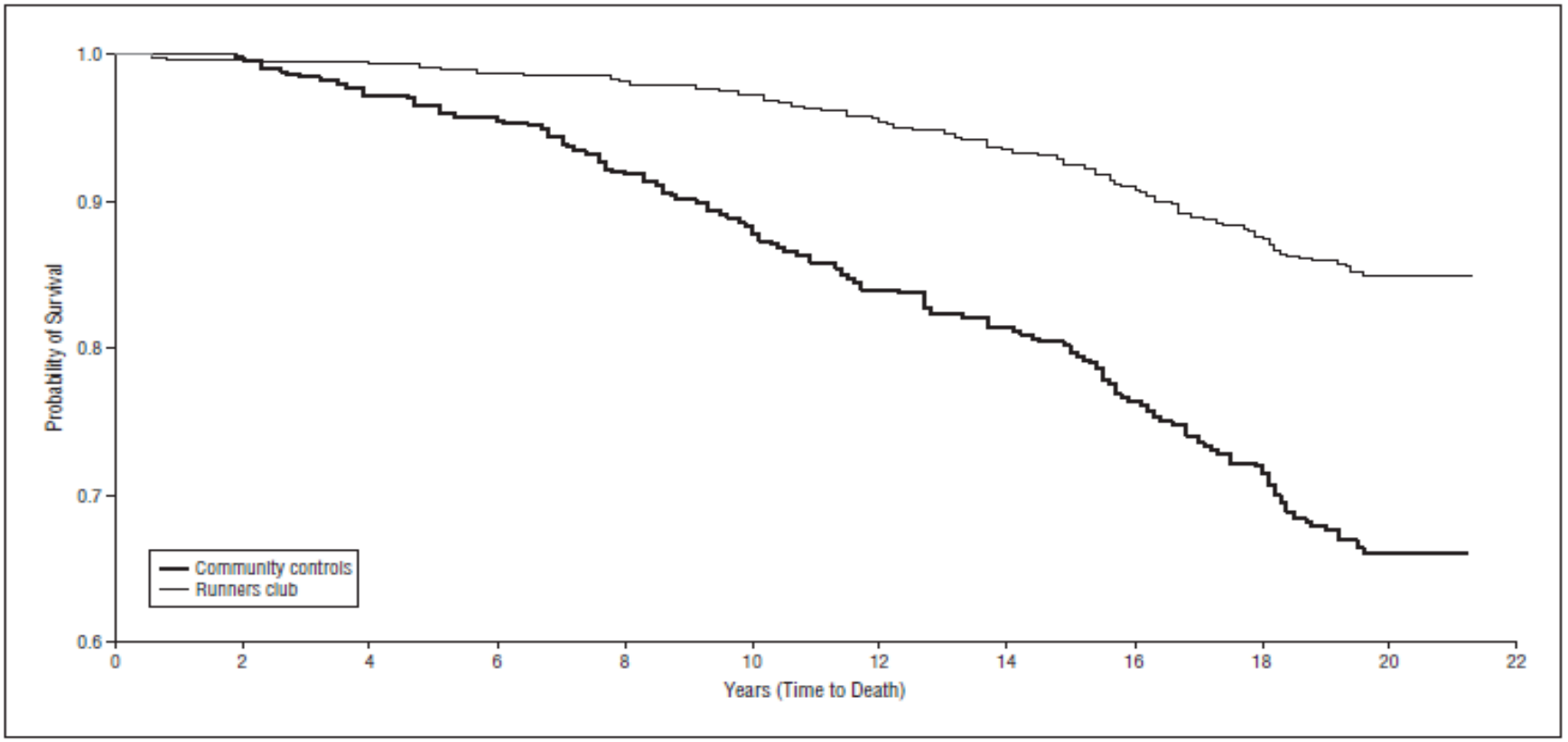
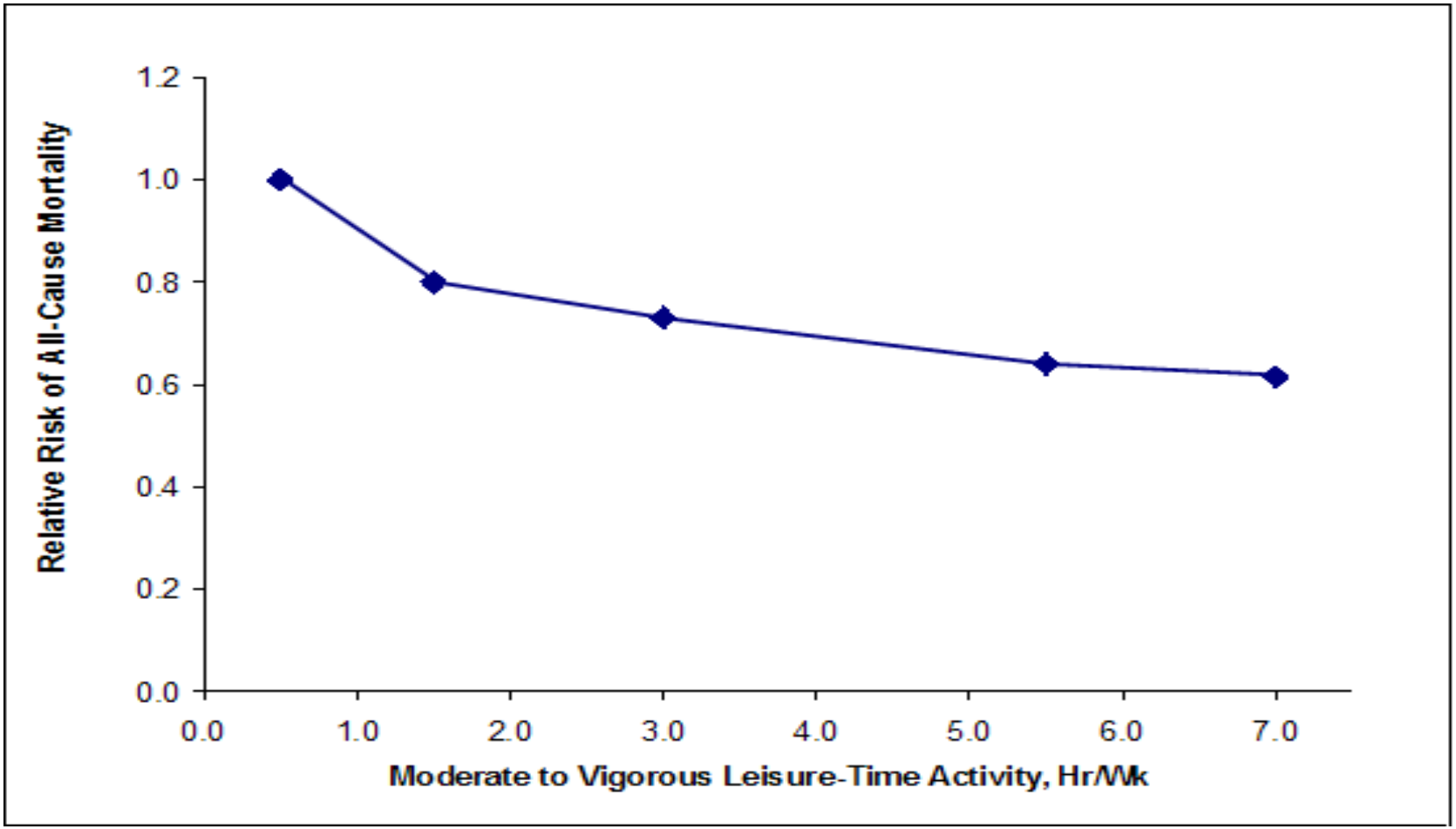


Figure 4. Kaplan-Meier unadjusted survival curves for all cause mortality in runners club members and community controls from study onset through 19 years of follow-up. All 941 subjects at study inception are included. The difference between groups remained significant ($P<.001$ by log rank test).

Conclusion: Vigorous exercise (running) at middle and older ages is associated with reduced disability in later life and a notable survival advantage.

Arch Intern Med. 2008;168(15):1638-1646

Exercise and Survival



US Department of Health and Human Services. Physical Activity and Health: A Report of the Surgeon General [Internet]. Atlanta (GA): US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion. 1999 [cited 2010 Oct 10]. 278 p

Relationship between type, frequency and duration of physical activity and CAD, CVD and TE

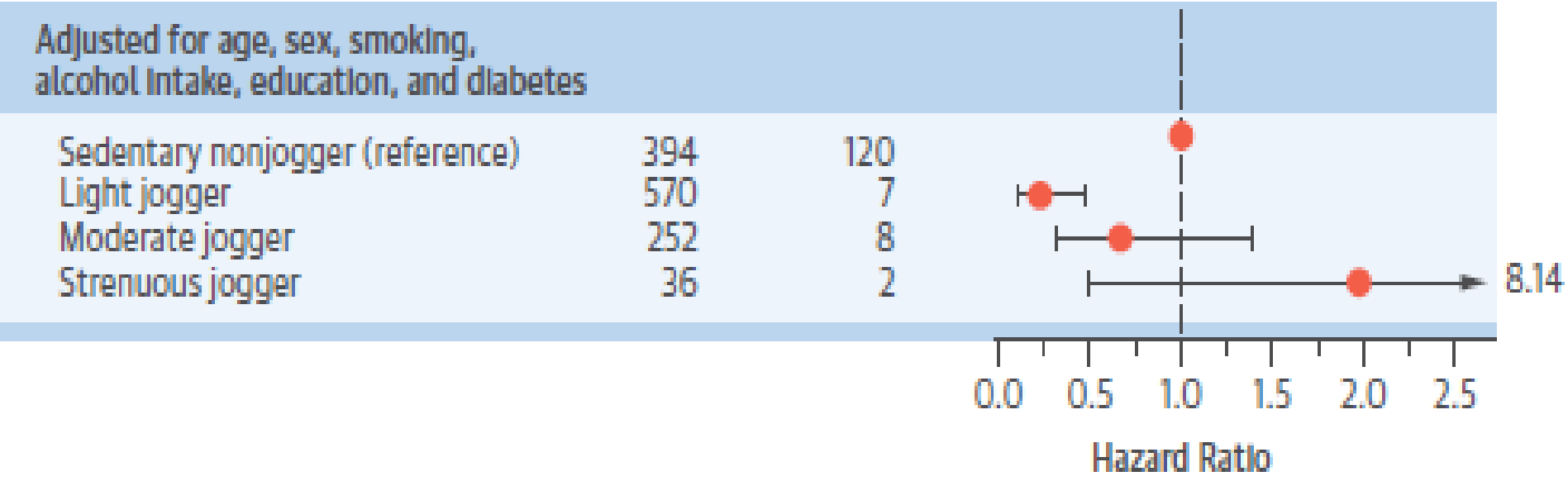
- 1.1 million women, median FU 9 years
- Moderately active vs inactive = lower risk in all
- Daily activity vs 2-3/w = higher risk in CVD, TE
- Daily **strenuous** activity vs 2-3/w = higher risk in all

- **Moderate 2-3/w activity is optimal**

Armstrong ME. Circulation 2015

Copenhagen City Heart Study

- 1098 joggers vs 3950 non-joggers, FU 12 yrs.
- U-shaped association between all-cause mortality and dose of jogging.
- **2-3 running days, 1-2.5 hours per week, at slow or average pace**.



Schnohr P et al. JACC 2015

Sport and sudden death

Prague Marathon Run

(10.000 runners)

What is the risk?

London Marathon – 32-year experience

802.000 Finishers – 32 cardiac arrests, 9 deaths

Incidence of SCD =1:89.000

Sharma S. ESC congress 2013

Who is at the highest risk of SD?

- Risk in relation to running times
  - Costumes 5+ hours – low risk
  - Middle age runners 3-4 hours – high risk
  - Elite club 2-3 hours – low risk

Sharma S. ESC congress 2013

Sudden Death

Symptoms, Previous Cardiac History

- Prodromal symptoms absent in 80%
- Previous cardiac history absent at all
- Relevant family history < 5%
- Over 50% have run at least 1 marathon

Sharma S. ESC congress 2013

Tod zweier Läufer bei Wachau-Halbmarathon

13. September 2015, 18:56

Ein 44-jähriger und ein 35-jähriger Mann starben im Spital nach Herzkreislaufstillstand

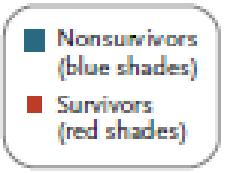
Krems – Der 18. Wachau-Marathon wurde durch den Tod zweier Läufer überschattet. Nach Angaben der Veranstalter erlitten ein 44-jähriger Niederösterreicher und ein 35-jähriger Wiener, die für den Halbmarathon genannt hatten, einen Herzkreislaufstillstand.

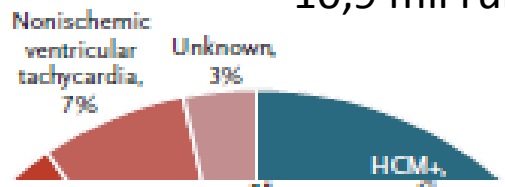
Bei beiden Männern wurde durch das Rote Kreuz eine Reanimation versucht, sie starben aber im Krankenhaus Krems trotz intensivmedizinischer Behandlung. (APA, 13.9.2015)

Sudden Death and (Half)Marathon Run

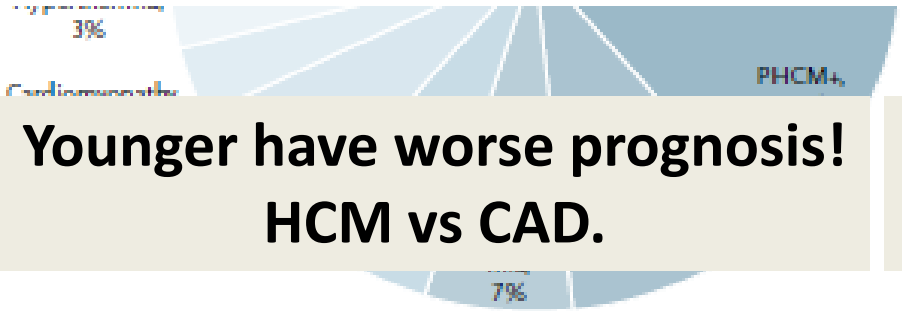
Kim JH et al. NEJM 2012

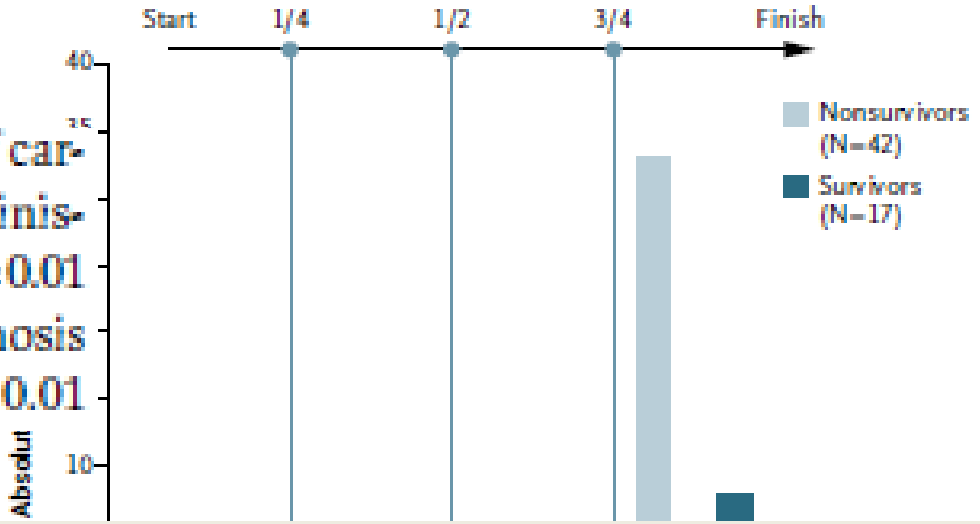
10,9 mil runners in USA (2000-2010); 59 cardiac arrests





arrest. The strongest predictors of survival of cardiac arrest were initiation of bystander-administered cardiopulmonary resuscitation (CPR) (P=0.01 by Fisher's exact test) and an underlying diagnosis other than hypertrophic cardiomyopathy (P=0.01





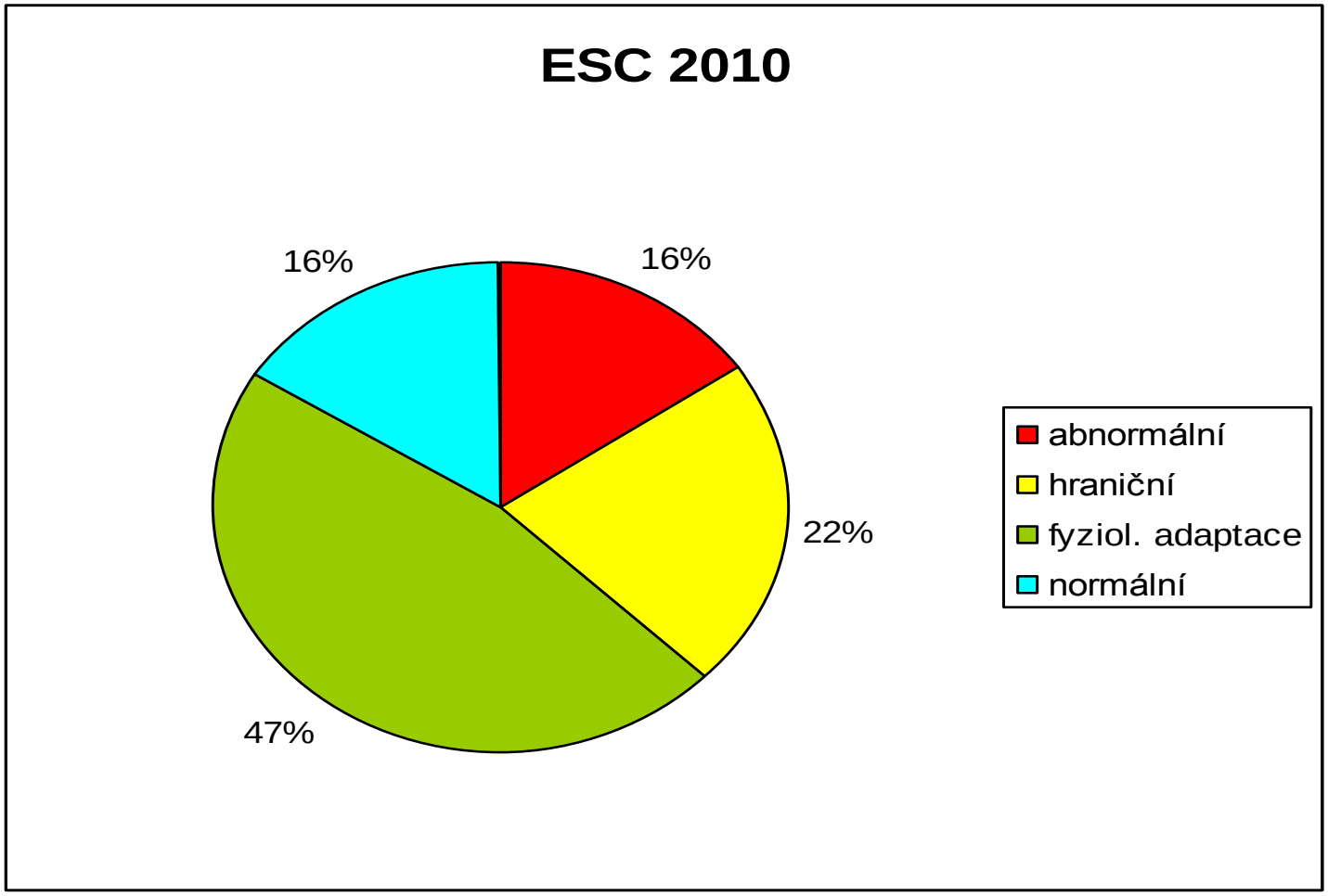
Younger have worse prognosis! HCM vs CAD.

Dangerous is NOT atherotrombosis, but ischemia!

Marathons and half-marathons are associated with a low overall risk of cardiac arrest and sudden death. Cardiac arrest, most commonly attributable to hypertrophic cardiomyopathy or atherosclerotic coronary disease, occurs primarily among male marathon participants; the incidence rate in this group increased during the past decade.

Pre-participation ECG

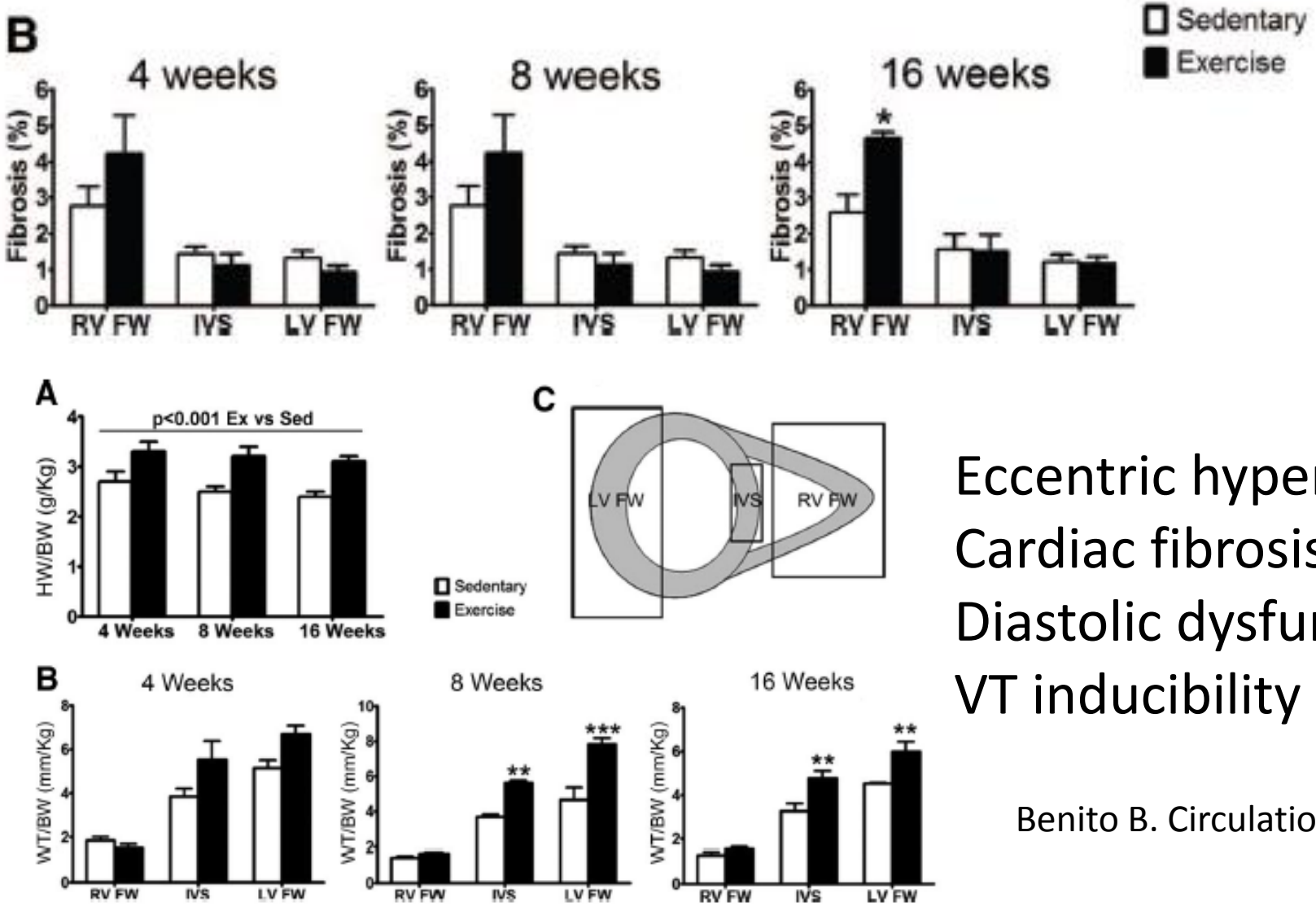
(Prague, Marathon run 2012; 186 runners)



Honěk J, CKS congress 2012

Sport and atrial fibrillation

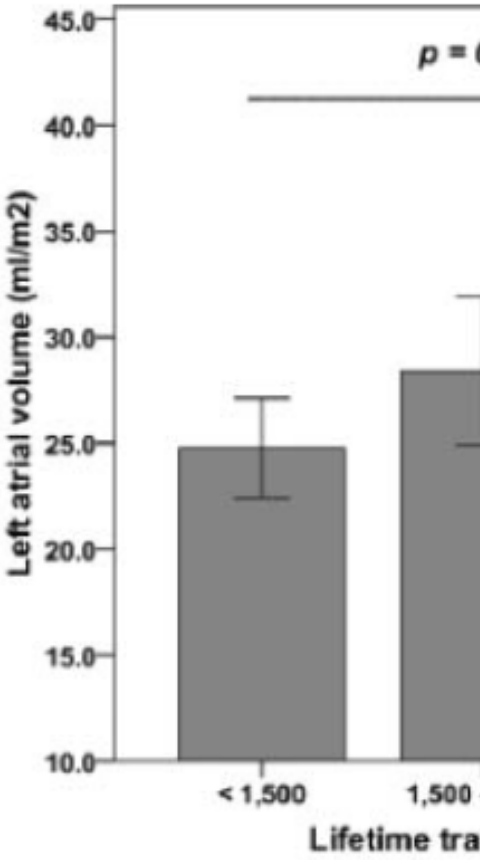
Rat Model of Exercise

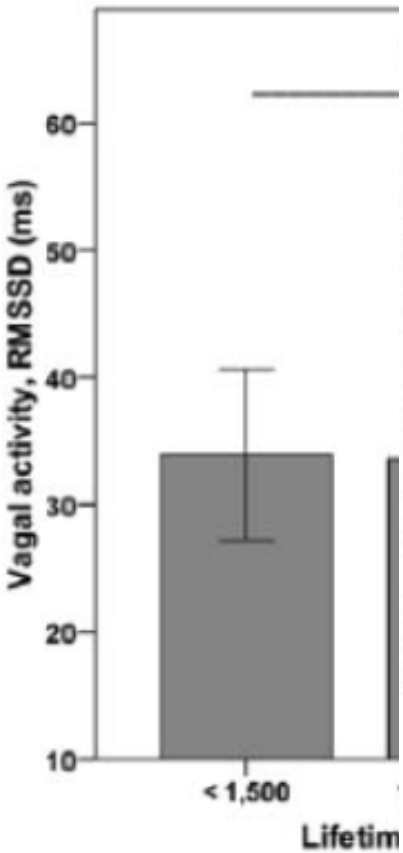


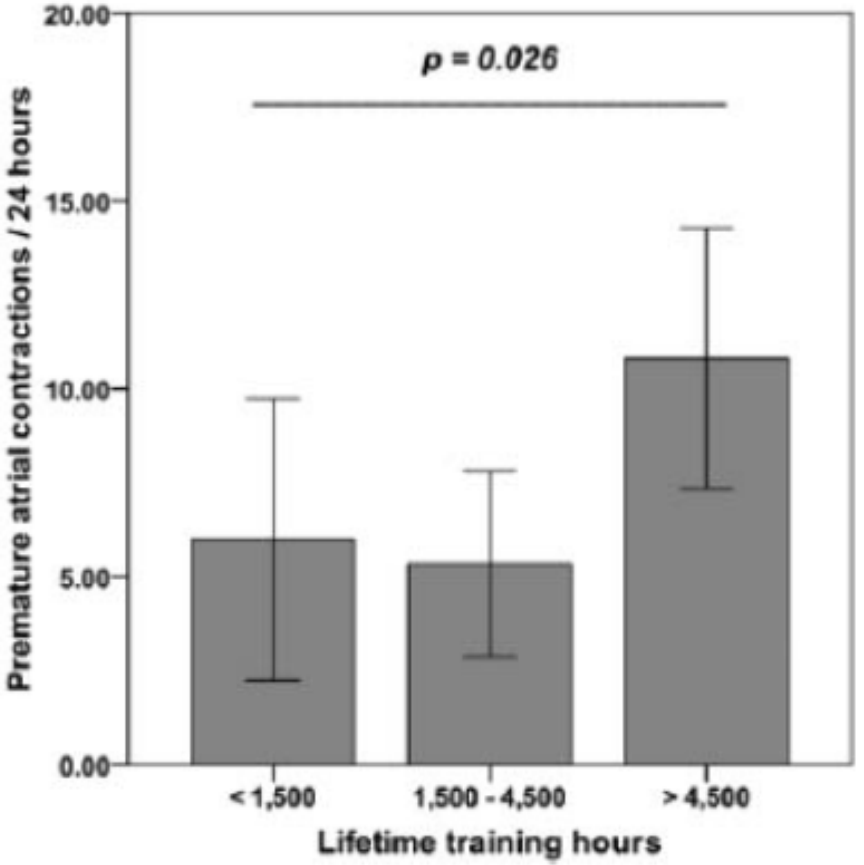
Eccentric hypertrophy
Cardiac fibrosis
Diastolic dysfunction
VT inducibility

Benito B. Circulation 2011

Pathophysiological mechanisms responsible for the increased risk of AF in endurance athletes



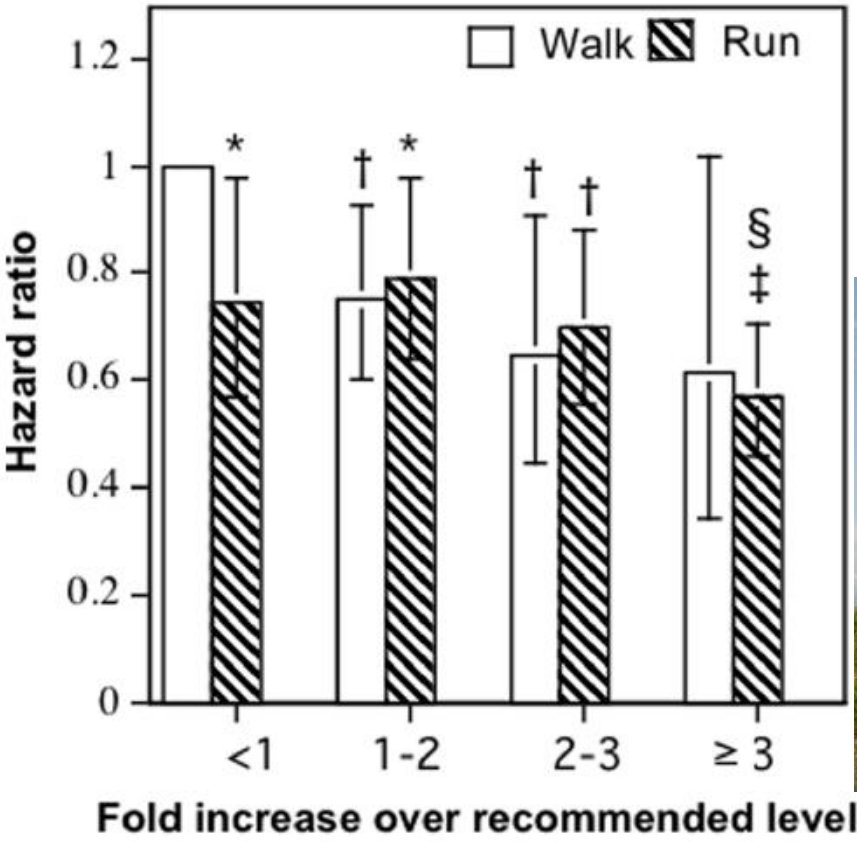




Calvo N. Br J Sports Med 2014

Running, Walking and AF

32.000 runners, 15.000 walkers
FU 6.2 years



In conclusion, these data suggest that walking and running affect the incidence of cardiac arrhythmias similarly, except for substantially higher risk in walkers who fail to meet contemporary physical activity guideline levels. Reduced AF may represent one of the mechanisms by which moderate physical activity, and walking in particular, reduces cardiovascular disease risk [35] and stroke [36]. Hypertension, high cholesterol, and diabetes are also reduced in association with walking distance [37]. Higher doses of

Williams PT. PloS ONE 2013

AF in Athletes

- **Atrial fibrillation**: most studies show that atrial fibrillation is more common in **competitive athletes**, particularly those participating in long-term endurance sports.

- Postulated mechanisms include morphologic changes such **as atrial dilatation, autonomic changes such as increased vagal tone**, or inflammatory changes due to sports participation.

- Treatment options include long-term antiarrhythmic agents, “pill in the pocket” medications, or radiofrequency ablation, a highly successful procedure in athletes.

Lampert R. Prog Cardiovasc Dis 2012

Take-home messages

- **Regular physical activities would probably increase the life expectancy** of the world's population and decrease incidence of CVDs.
- Running is the most natural movement and has beneficial effects (except for elite athletes).
- **Marathon run is associated with cTn release (50% of runners)**, potential short-term RV dysfunction and probably benign long-term effect.

Take-home messages

- There are rationales for higher incidence of AF in **elite endurance athletes**.
- There is **no evidence justifying inactivity**.