

WHAT ARE THE *LONG- TERM*
CARDIAC IMPLICATIONS OF
PARTICIPATING IN HIGH
INTENSITY SPORT?



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Athlete`s heart:physiological?

- ◆ Skey 1867,London times
- ◆ Henschen 1899,Uppsala/Jena
- ◆ McCann GP 2000, Editorial EHJ
- ◆ Coumel J 2002 , -----"-----
- ◆ Thompson PD 2006, --"---
Circulation

Senior (ex)athletes

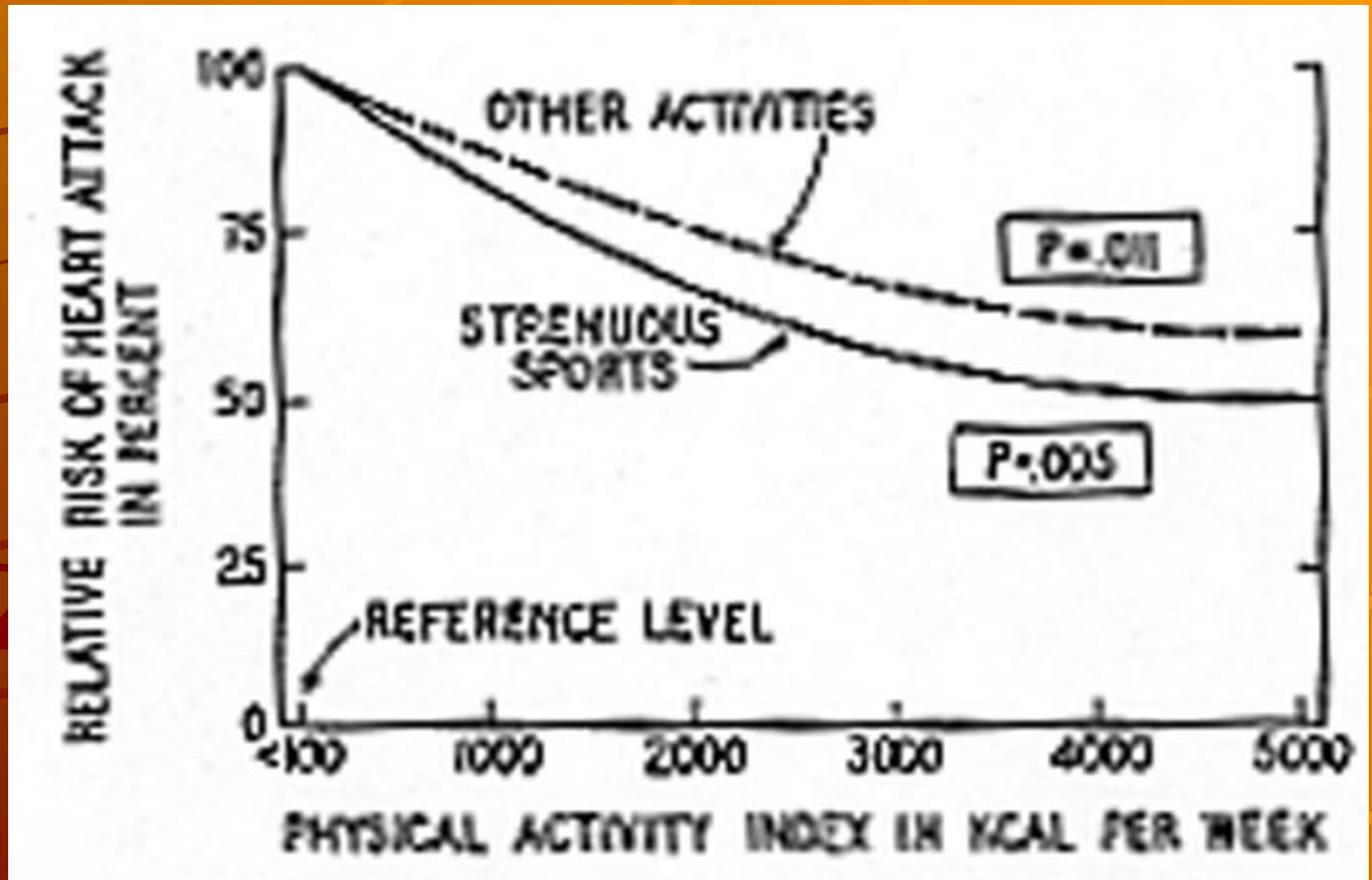
- ◆ ***Ex top athletes***, stopped hard training
- ◆ Ex top athletes, stopped all training
- ◆ Ex top athletes, still hard training
- ◆ ***Master athletes*** (usually not ex top athletes)
- ◆ Master athletes, stopped training



Life expectancy in ex athletes

- ◆ Still training: ↑ (Paffenbarger-1978, Karvonen 1979, Roskamm 1964)
- ◆ Training not specified: ↑, risk factors ↓ (Kujala 2003)
- ◆ Stopped training:
 - (>50)/↑(<50) (Schnohr 1971)
 - ↓ in major a. (Polednak 1972)
 - (Rook 1954, Beaglehole 1983)
 - (Baladesberger 2008, some training)

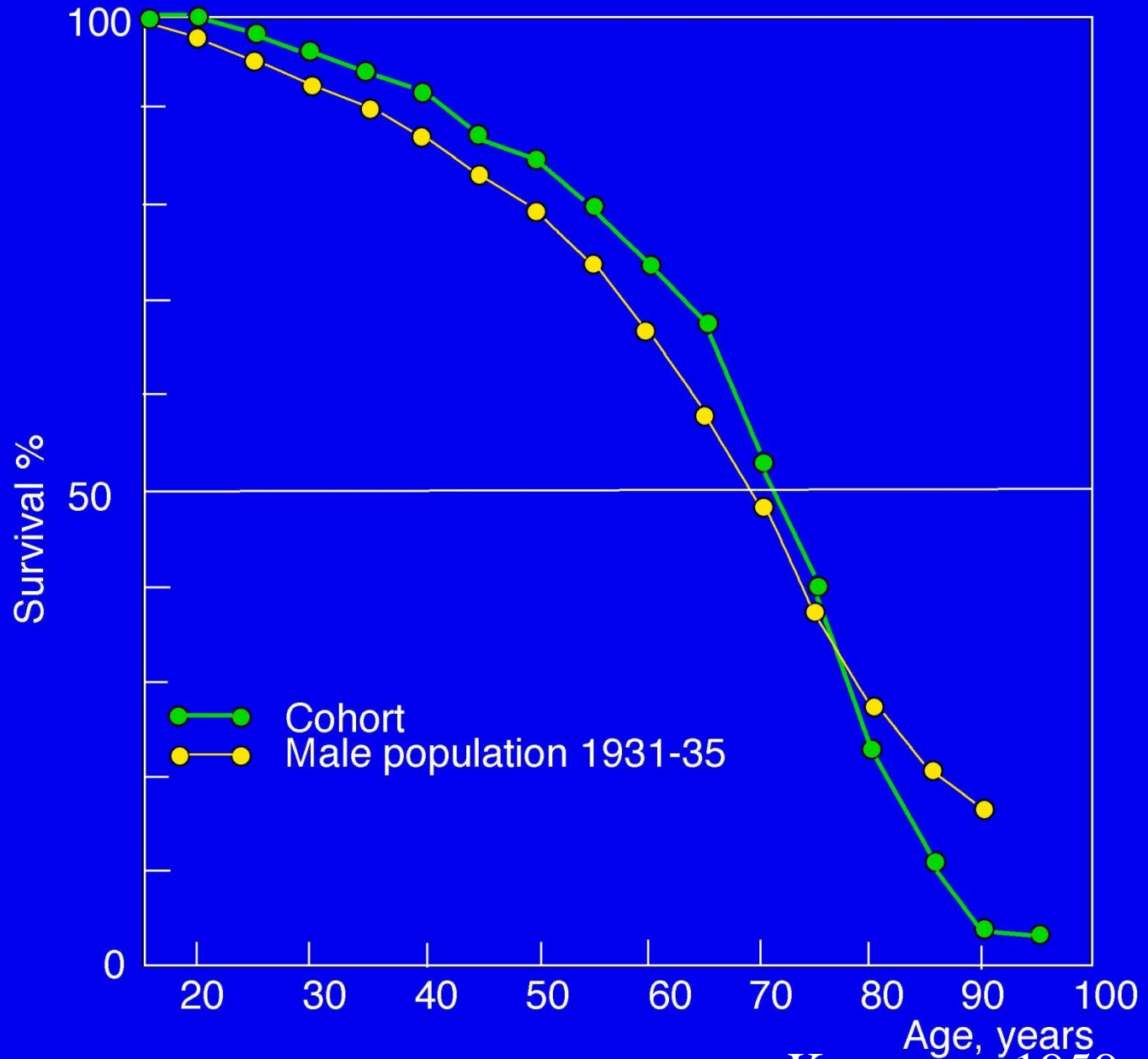
ATHLETIC ACTIVITY IN COLLEGE: NO PROTECTION IN HARVARD ALUMNIS UNLESS STILL TRAINING



(6-10 years follow up)

Paffenbarger R. Am J Epid 1981

LONGEVITY OF CROSS COUNTRY SKIERS



Karvonen 1959

MORGEDAL, Telemark, Norway

1860

Site of
Winter
Olympic
Fire

1952-94



MASTER ATHLETES

150 år Aftenposten

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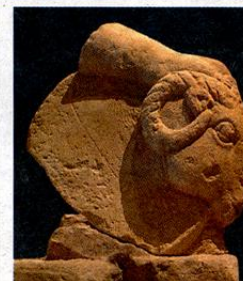
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Ble nesten drapsmann

Etter 22 år møtte han sitt offer igjen. Og i vinter ble Arild Knutsen kåret til årets Osloborger.



Fantastiske funn

Restene av Cæsars koloni i Arles er funnet på bunnen av elven Rhône.



Da mor var ung...

Hva skal foreldre svare når tenåringsne spør om de aldri gjorde noe galt?

– VERNER FORELDRENE

Barnevernbarnas leder mener foreldre får for mange sjanser av barnevernet. Hun er rystet over saken om de to Vestfold-brødrene som Aftenposten omtalte i går. Les hele deres historie.

DEL 1 • side 2 og 3
og A-magasinet

REDDE FOR Å SNAKKE

Akademikere ved Høgskolen i Oslo blir stemplet som «ekstremt illojale» fordi de uttaler seg om høyskolen i pressen. Ansatte Aftenposten har snakket med, opplever situasjonen som svært ubehagelig.

KULTUR • side 7

DET KOKER I HELLAS

Frustrerte grekere lammet Hellas i en ny storstreik i går. Frustrasjonen mot regjeringens lønnskutt og skatteheving er stigende i et land som økonomisk er nede i knestående.

DEL 1 • side 14 og 15

Trener på seg hjerte-trøbbel

Farlig hardtrening. Birkebeinere har mye høyere risiko for hjerteflimmer enn folk flest, viser en undersøkelse. Harald Sjølhagen har diagnosen. Han trener til sitt 39. birkebeinerrenn, men lar seg ikke skremme.

DEL 1 • side 22 og 23



FOTO: DMV PETER NEEGAARD



Master athletes: Left ventricle

STUDY *n* *age* *Left ventr.*

Nishimura 1980 29 45 LVM↑EF, Diast.f.↓
(cyclists) (vs ctr and young cycl)

Northcote 1990 20 56 LVM↑, EF→ vs ctr

Hood 1999 20 55/67 53% sept>12

Jungblut 2000 12 69 LVMI↑, diast.f.→ vs ctr

Bouvier 2001 10 73 Syst and diast.f.↑

Mont 2002 32 44 ↑ vs ctr

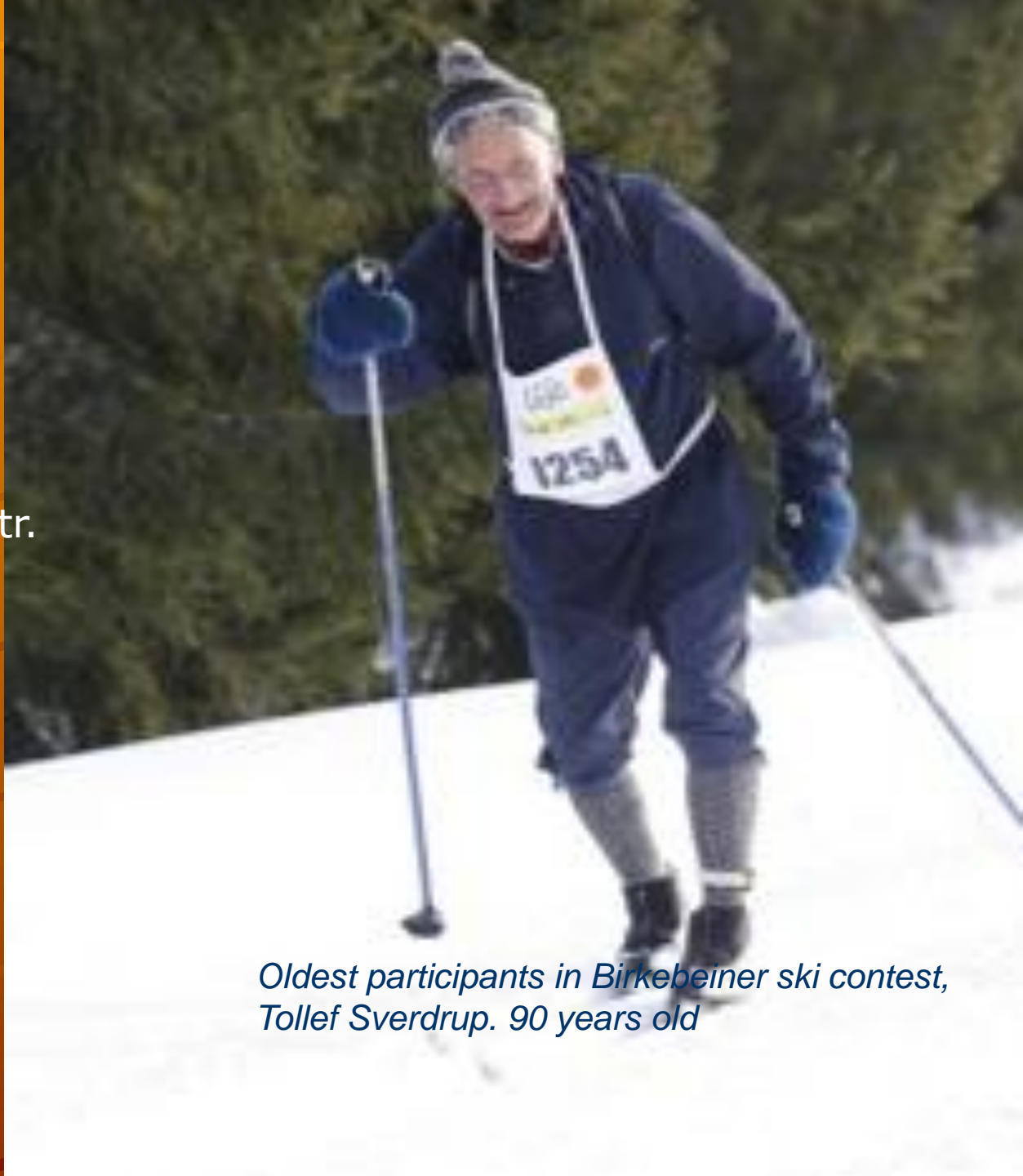
Gates 2003 12 68 LVM↑, diast.function→ vs ctr

TRONDHEIM STUDY:

Sed. young before/after tr.

Sed. 72 years "

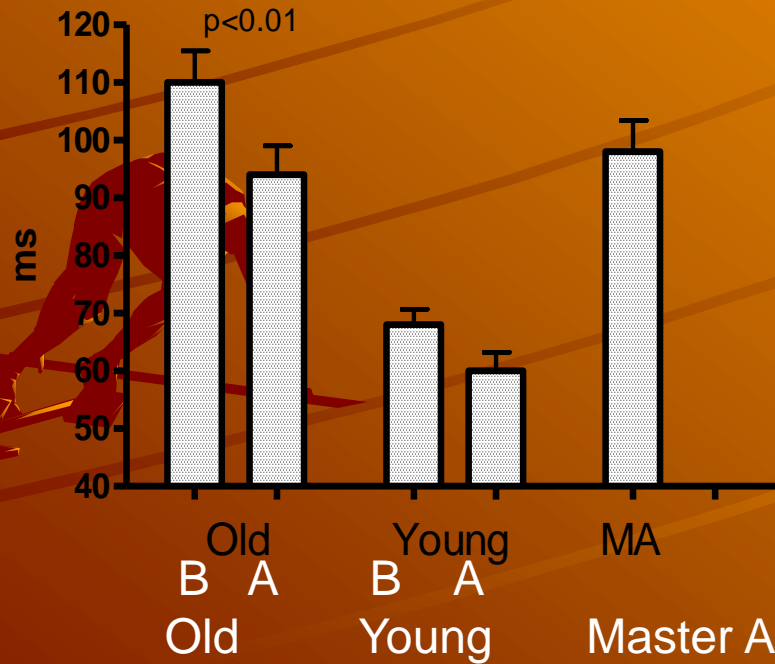
Birkebeiner skiers 74 y



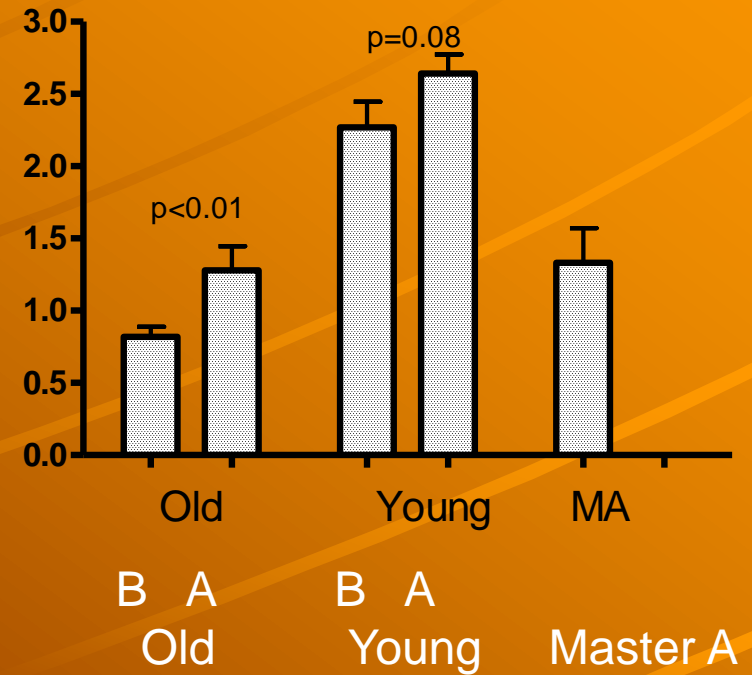
*Oldest participants in Birkebeiner ski contest,
Tollef Sverdrup. 90 years old*

IVRT and E/A ratio

IVRT



E/A ratio



Master athletes:Atrial fibrillation

<i>STUDY</i>	<i>n</i>	<i>age</i>	<i>Atr.fib./(%)</i>
Karjalainen1998 (<i>orienteering runners</i>)	228	57	↑ vs normal (5,6 vs 1)
Hood 1999 (<i>runners</i>)	20	55/67	5%,stable
Mont 2002 (<i>mixed</i>)	32	44	↑ (4 vs 0,7)
Grimsmo 2010 (<i>cross country skiers</i>)	78	70	↑ (17 vs 6,6)

Master athletes: Other arrhythmias

Jensen-Urstad 1998:

↑ ventricular arrhythmias, ↑ bradyarrhythmias
in 11 runners 73 years old

Hood 1999:

20 runners 55 years, followed next 12 years. 2
pacemaker implantations

53% ventricular couplets on follow up

Master athletes: Coronary heart disease (Møhlenkamp EHJ 2008)

- ✦ Risk factors reduced
- ✦ Coronary calcification score (SCS) *not* reduced
- ✦ CSC inversely correlated to exercise capacity and HR recovery
- ✦ (108 marathon runners > 50 years vs ctr. Late gadolinium enhancement proportional to number of marathons)
- ✦ ***Editorial (A.Schmermund): Selection bias?***

EX ATHLETES

Gjermund Eggen



M-gullet var sikret i 1966, var stemningen så høy at



Slik så han ut, Norges



Gjermund x 2. Engerdal har hedret sin store sønn med e

Gullmedaljene og skiene er viktige elementer i Gjermund Eggen's liv. Eggen skiene ble produsert på Engerdal skifabrikk i årene 1968-1983. Fabrikken var i flere år produsent av verdenscupskiene.

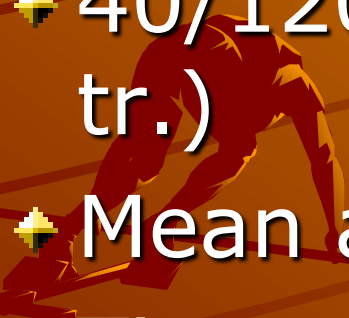
Ex-athletes: Left ventricular volume/hypertrophy

STUDY	n	Age	LVEDd	Vol /hyp
Roskamm 64 *	92	53		↑ vs ctr
Grimby 66 *	33	41		↑ vs ctr (Xray)
Pyorala 67 *	61	58		--"--, BP↓ vs ctr
Reindell 85	33	50	55	-----"----- (60% active)
Vollmer-Larsen* 89	8	43	57	(Ctr 52) LVvol→ diast.f.→vs ctr
Murayama 76	12	37		EKGhyp↓
Dickhut 85 active	20	50	55,8	↑ LVM vs ctr
" not active	13	49	54,2	→ " vs ctr (LVEDd 52,8)
Høglund 86*	13	66	52	LA↑,LVEDd,IVSd→ vs ctr
Sivertssen 94	27	52	>56: 10%	EKGhyp↓
Pelliccia 02	40	30	61→57	→/↓LVEDd
Luthi 08*	63	66	51	↑ LA,LVEDd, →LVM vs ctr
Bjørnstad 09	30	39	54,6	LVEDVindex→

(*: not baseline data)

RIGHT VENTRICLE:NO BASELINE DATA

Follow up of athletes with LVH- Pelliccia 2002

- ◆ 280/3000 male athl, sept > 12, LVDd > 60
 - ◆ 120/280 stopped training > 1 year
 - ◆ 40/120 willing to participate (25 light tr.)
 - ◆ Mean age 33
 - ◆ Time since competition: 5,6 yrs
 - ◆ LVEDd 61 → 57, sept 12 → 10,1
- 

Master athletes and ex athletes:left ventricular internal diameter

- ◆ 8 Veteran cyclists 41-51 years
- ◆ 8 Ex-cyclists(not elite)
- ◆ Controls

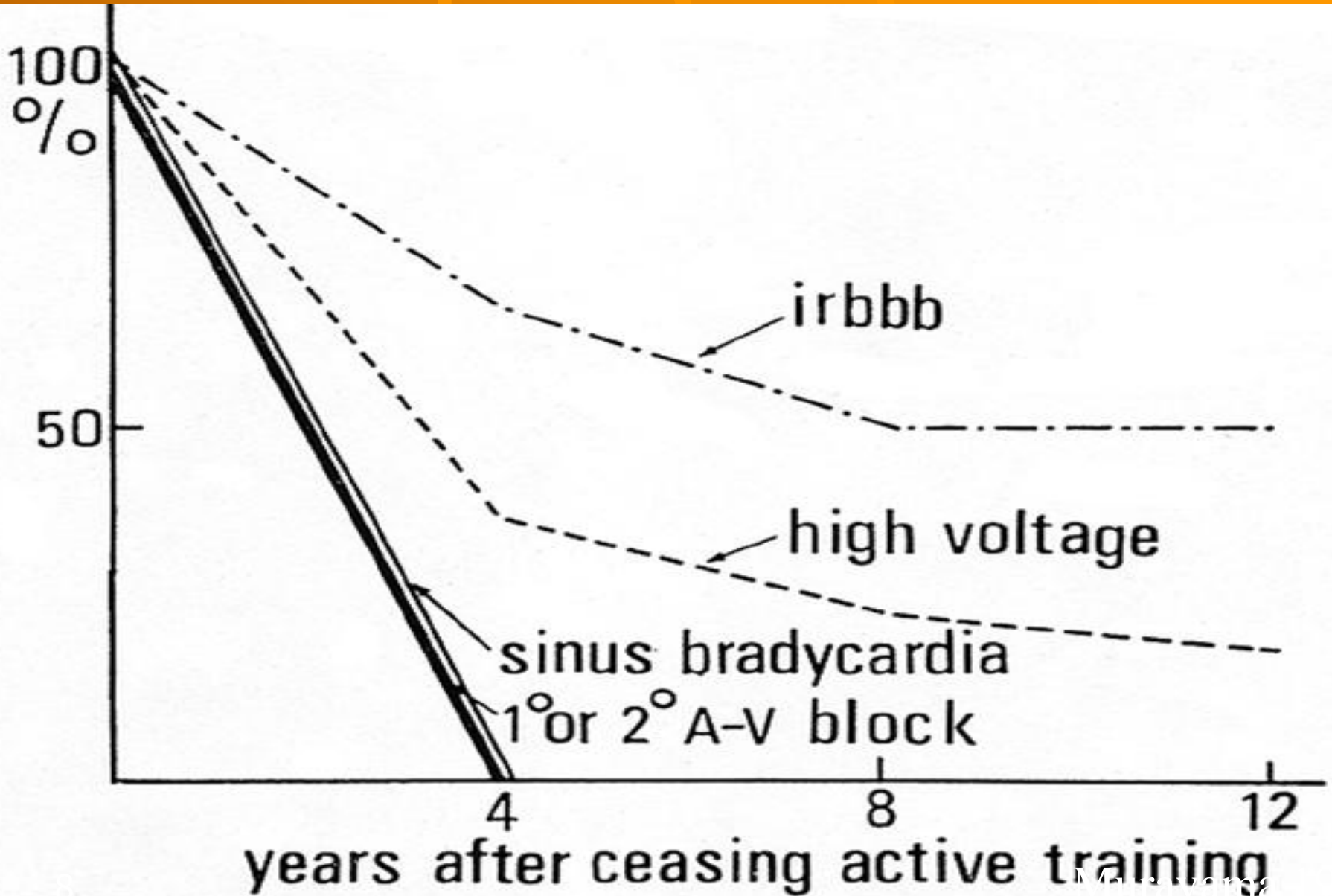
Veteran cyclists:LVEDd↑ vs ctr

Ex- cyclists LVEDd → vs ctr



Vollmer-Larsen A
Acta Physiol Scand 1989

ECG IN OLYMPIC ATHLETES (TOKYO 1964) (Murayama 1980)



Ex-athletes: Heart rate&rhythm

<i>STUDY</i>	<i>n</i>	<i>Age</i>	<i>Brad/block</i>
Murayama 76	12	37	Brad↓ AVbl↓
Sivertssen 94	27	52	HR →
<i>Baldesberger 08*</i>	62	62	blocks,a.fib,,VT↑ vs ctr
Bjørnstad 09	30	39	Blocks ↓, HR→

(*: *not baseline data*)



Long-Term Assessment of Electrocardiographic and Echocardiographic Findings in Norwegian Elite Endurance Athletes

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Exercise and Cardiac Rehabilitation

Cardiology 1994;84:42–50

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Ambulatory Electrocardiographic Findings in Top Athletes, Athletic Students and Control Subjects

Exercise and Cardiac Rehabilitation

Cardiology 1993;82:66–74

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The Norwegian College of

Electrocardiographic and Echocardiographic Findings in Top Athletes, Athletic Students and Sedentary Controls

MATERIAL & METHODS

- ◆ 30 TOP ENDURANCE ATHLETES (skiers, runners), 50% FEMALES (32 INVITED), MEAN AGE 25 YEARS, 12 INTERNATIONAL CHAMPIONS, 10 INTERNATIONAL LEVEL, 8 NATIONAL LEVEL (Start of systematic training at 13 years)
- ◆ 100% FOLLOW UP 15 YEARS (1 EXCLUDED FROM ECHO STATISTICS DUE TO PREGNANCY)
- ◆ Clin., ECG, 24h ECG, echo (also with doppler on follow up)

15 years follow up of Norwegian top endurance athletes: Results

- ◆ Weight 63→68 kg
 - ◆ Training hours/week: 11,6→4,2
(Males 12,7→5,0)
(Females 10,5→3,6)
- (All stopped competitions 5-12 years previously)



Table 1. Standard ECG at baseline (competing) and follow-up (retired from competitions) (n = 28)

	Baseline	Follow-up
Heart rate, bpm	53.5 ± 9.8	55.4 ± 11.4
PQ, s	0.168 ± 0.020	0.169 ± 0.023
QRS duration	0.088 ± 0.011	0.091 ± 0.091*
ST elevation, mm	1.8 ± 0.8	1.35 ± 0.6**
Sokolow Index, mm	28.6 ± 9.9	25.2 ± 7.6*

* p < 0.05, ** p < 0.01 baseline vs. follow-up.

Table 2. Holter ECG at baseline and follow-up (n = 28)

	Baseline	Follow-up
Highest heart rate, bpm	133.4 ± 17.3	126.5 ± 16.8*
Lowest heart rate, bpm	39.2 ± 5.0	40.0 ± 5.1
Mean heart rate, bpm	60.5 ± 9.0	62.5 ± 7.7
Ventricular ectopic beats, n/h	0.4 ± 0.8	3.8 ± 10

* p < 0.05 baseline vs. follow-up.

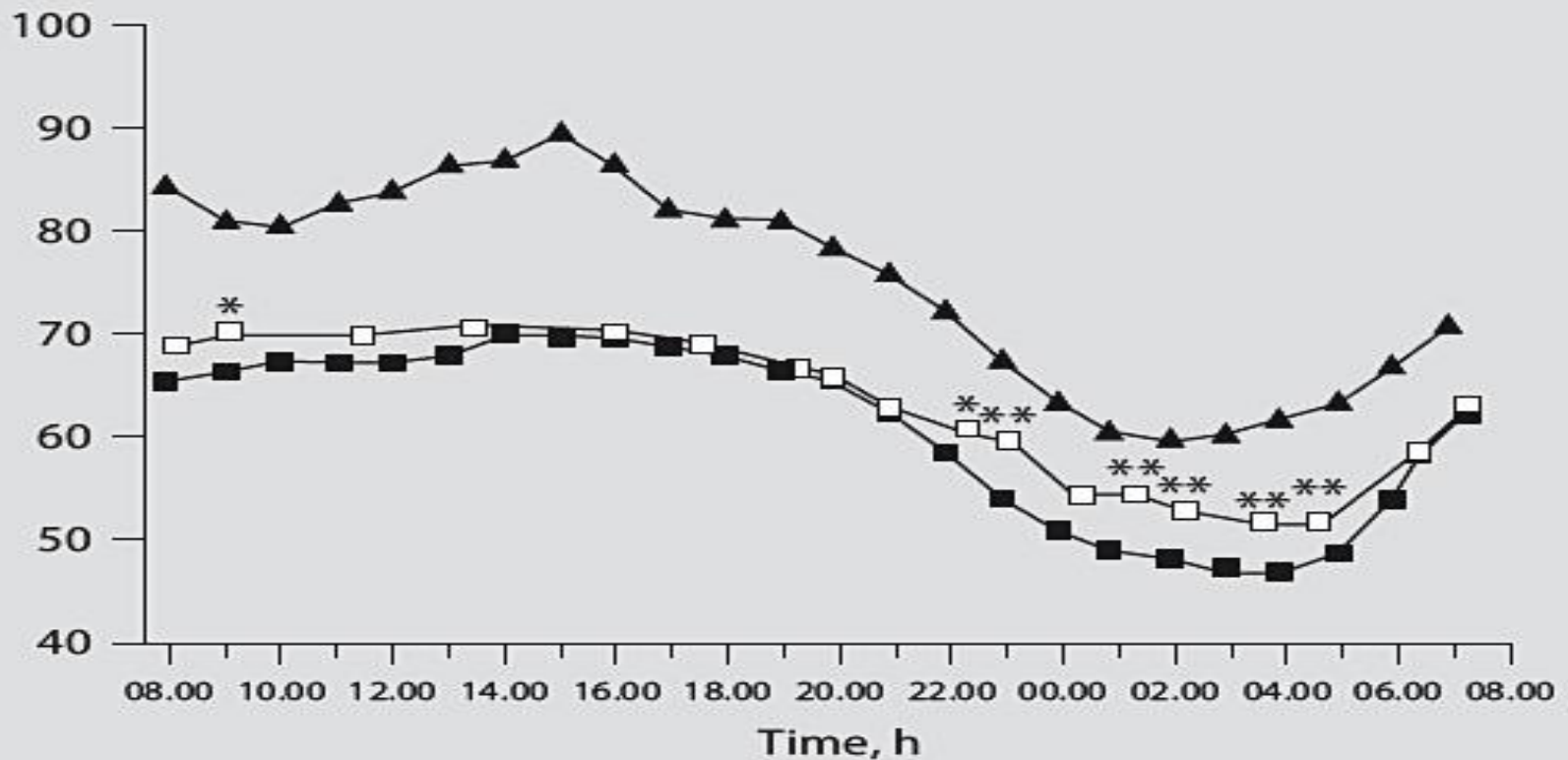


Fig. 1. Heart rate of top athletes in competing age (25 years) (■) (n = 30) and at 15 years' follow-up (□) (n = 29), and in sedentary control subjects 25 years of age (▲) (n = 30). * p < 0.05, ** p < 0.001, athletes at competing age vs. follow-up.

Follow up: SA/AV-blocks (6subj.)

✦ *BASELINE VS FOLLOW UP:*

✦ 2 subj. AV bl gr 2 (longest pause 2,4 sec)

✦ 1 " AV block grade 1 (PQ>0,22 sec)

✦ 3 " SA block longest pause 3,1 "

✦ **ALL REGRESSED** on follow up. (Most episodes of block at baseline occurred during night)

✦ *FOLLOW UP:* 1 *new subject* had a dropped beat (pause 2,1 sec) and 1 new subject one episode of SA block/nodal rhythm (pause 1,9 sec)

Norwegian athletes, follow up: Ventricular premature beats

- ✦ >10 VPBs/24h : 31% (Normal:13%)
- ✦ >100 ---"--- : 14% (" 4%)
- ✦ >1000 ---"-- : 3%
- ✦ VT:0
- ✦ >100 VPBs:LVM↑ vs <100 VPBs,but EF→

✦ ***Heart rate variability high compared to normal values***


Table 3. Echocardiographic parameters at baseline and at follow-up in total group (n = 29), males (15) and females (14)

	Total		Males		Females	
	baseline	follow-up	baseline	follow-up	baseline	follow-up
LVIDd, mm	52.0 ± 3.7	54.6 ± 2.6 ***	53.9 ± 3	55.5 ± 2	50.0 ± 4	53.6 ± 3***
IVSd, mm	9.7 ± 1.1	9.6 ± 1.5	10.3 ± 1	10.6 ± 1	9.1 ± 1	8.5 ± 1
LVPWd, mm	10.0 ± 1.4	9.3 ± 1.5**	10.8 ± 1	10.2 ± 1*	9.1 ± 1	8.4 ± 1*
MWT, mm	9.9 ± 1.2	9.5 ± 1.4*	10.6 ± 1	10.4 ± 1	9.1 ± 1	8.4 ± 1
RWT	0.38 ± 0.04	0.35 ± 0.05***	0.39 ± 0.1	0.38 ± 1	0.36 ± 0.04	0.32 ± 0.04**
LVEDV/m ² ·ml	68.1 ± 6.2	70.2 ± 6.7	67.8 ± 5.3	67.7 ± 5.9	68.4 ± 7.7	72.9 ± 7.7*
LVM/m ² , g	108.6 ± 19.4	106.9 ± 19.4	118.7 ± 3.1	116.5 ± 4.3	97.8 ± 7.3	96.6 ± 4.6
EF, %	60 ± 7	67 ± 6**	62 ± 8	70 ± 6***	59 ± 7	64 ± 4
IVRT, ms	74 ± 13	79 ± 11				

LVIDd = Left ventricular internal diameter; IVSd = interventricular septum; LVPWd = left ventricular wall. MWTd = mean wall thickness = (LVPWd + IVSd) × 0.5; RWT = relative wall thickness = 4 × MWTd:LVIDd. LVEDV = left ventricular and diastolic volume; LVEDV = left ventricular end-diastolic volume; LVM = left ventricular mass; EF = ejection fraction; d = diastolic; IVRT = isovolumetric relaxation time (baseline: by M-mode echo/phonocardiography, follow-up: by Doppler).

* p < 0.05, ** p < 0.01, *** p < 0.001 baseline vs. follow-up in total group, males and females.

Follow up data of Norwegian top level endurance athletes(not baseline data:



	Males	Females
◆ Left atr, cm	3,8(0,2)	3,1(0,8)
◆ " cm2	22,6(0,19)	20,1(0,5)
◆ Aorta, cm	3,6(0,7)	3,0(0,8)
◆ Bas.sept,cm/s	8,7(1,7)	7,5(1,8)
◆ Lat.wall "	10,2(4)	9,1(1,6)
◆ E/A ratio	1,7	

Norwegian ex athletes: Conclusions

- ✦ **LV volume unchanged**
- ✦ **LV ejection fraction increased**
- ✦ LV diastolic function normal*
- ✦ Left atrium slightly enlarged*
- ✦ Aortic root -----"-----*
- ✦ **Heart rate unchanged (increased at night)**
- ✦ **AV and SA blocks disappeared**
(High HRV *)
(**VPBs: unchanged****)

**) : Not baseline data **) : Different methods*

Norwegian 39 years old ex athletes: Conclusions on changes 6-12 years after stopping active career

- ◆ ***LV volume unchanged***
 - ◆ ***Relative wall thickness reduced***
 - ◆ ***LV ejection fraction increased***
 - ◆ ***LV diastolic function normal****
 - ◆ ***Left atrium slightly enlarged****
 - ◆ ***Aortic root -----"-----****
 - ◆ ***Heart rate sign. reduced only at night***
 - ◆ ***AV and SA blocks disappeared***
(High HRV *)
(VPBs: no significant change**)
- *) : Not baseline data **): Different methods***

CARDIOLOGY

Editorial Comment

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Cardiac Impact of Long-Term Endurance Training: Negligible or Negative?

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Follow up study: Baldesberger

- ✦ No baseline data
- ✦ 134 former professional cyclists
- ✦ 62 studied (age 62) vs 62 controls
- ✦ 71% used prohibited drugs in active career
- ✦ Increased a.fib./flutter (10% vs 0%, proportional to number of bicycle years), ventr.tach. (15% vs 3% , sinus n. disease (10% vs 2%))
- ✦ LV mass and LA volume correlated to total (lifelong) amount of training, but only LA and LVEDV sign. higher than ctr

Conclusions

- ◆ ***Master athletes:***

Increased left atrial volume and left ventricular volume and mass. Diastolic function slightly better than age-matched controls(?)

Increased atrial fibrillation, probably also SA blocks and ventricular arrhythmias

- ◆ ***Ex-top athletes:*** Increased left atrial and probably ventricular volumes. Increased arrhythmias?(Right ventricle: not baseline data)

- ◆ Reduced mortality by training.

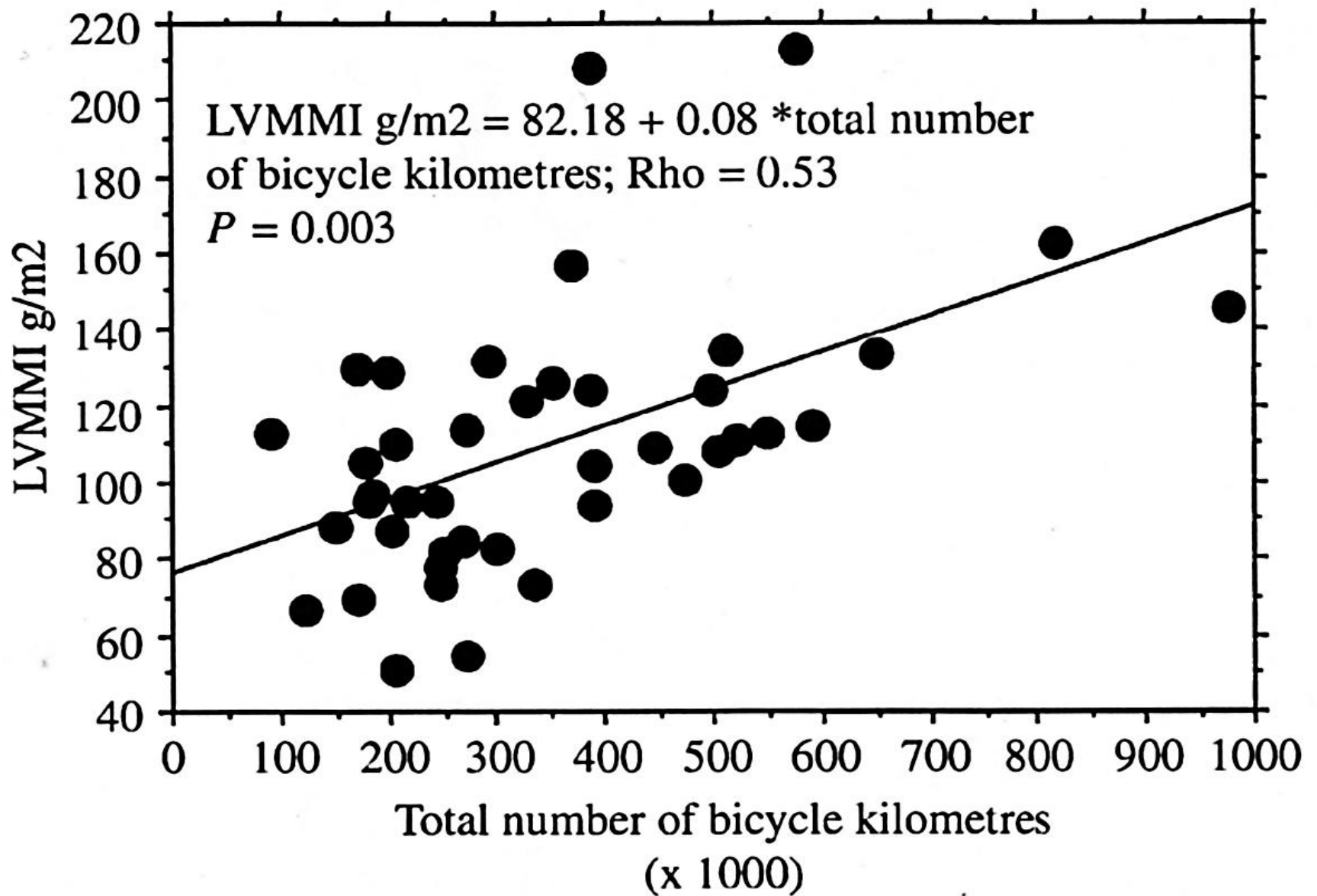


Table 5 Comparison of ventricular arrhythmias

	FAs (n = 62)	Controls (n = 62)	P-value
Number of subjects with VPCs, n (%)	28 (45)	22 (35)	0.12
Number of VPCs per 24 h			
Total	337 ± 1054	390 ± 1211	0.59 ^a
Median (range)	32 (0–7780)	67 (0–7792)	
None/rare VPCs	49	48	
Occasional VPCs	10	10	
Frequent VPCs	3	4	
Couplets of VPC			
Mean	12 ± 72	8 ± 33	0.70*
Median (range)	0 (0–569)	0 (0–222)	
Subjects with VT	9 (15%)	2 (3%)	0.05

FAs, former athletes VPCs; ventricular premature complexes; VT, ventricular tachycardia.

^aMann–Whitney test.

Table 4 Supraventricular arrhythmias

	FAs (n = 62)	Controls (n = 62)	P-value
Atrial premature complexes per 24 h			
Median (range)	18 (0–2616)	17 (1–6135)	0.35
Atrial premature complexes			
None < 1/h, n (%)	35 (56)	39 (63)	
Rare, n (%)	23 (37)	19 (31)	
Occasional, n (%)	3 (5)	2 (3)	
Frequent, n (%)	1 (2)	2 (3)	
Number of subjects with SVT, n (%)	21 (34)	19 (31)	0.82
Number of runs of SVT			
Mean	0.7 ± 1.3	0.7 ± 1.4	0.88
Median (range)	0 (0–7)	0 (0–7)	

FAs, former athletes; SVT, supraventricular tachycardia.



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CLINICAL RESEARCH

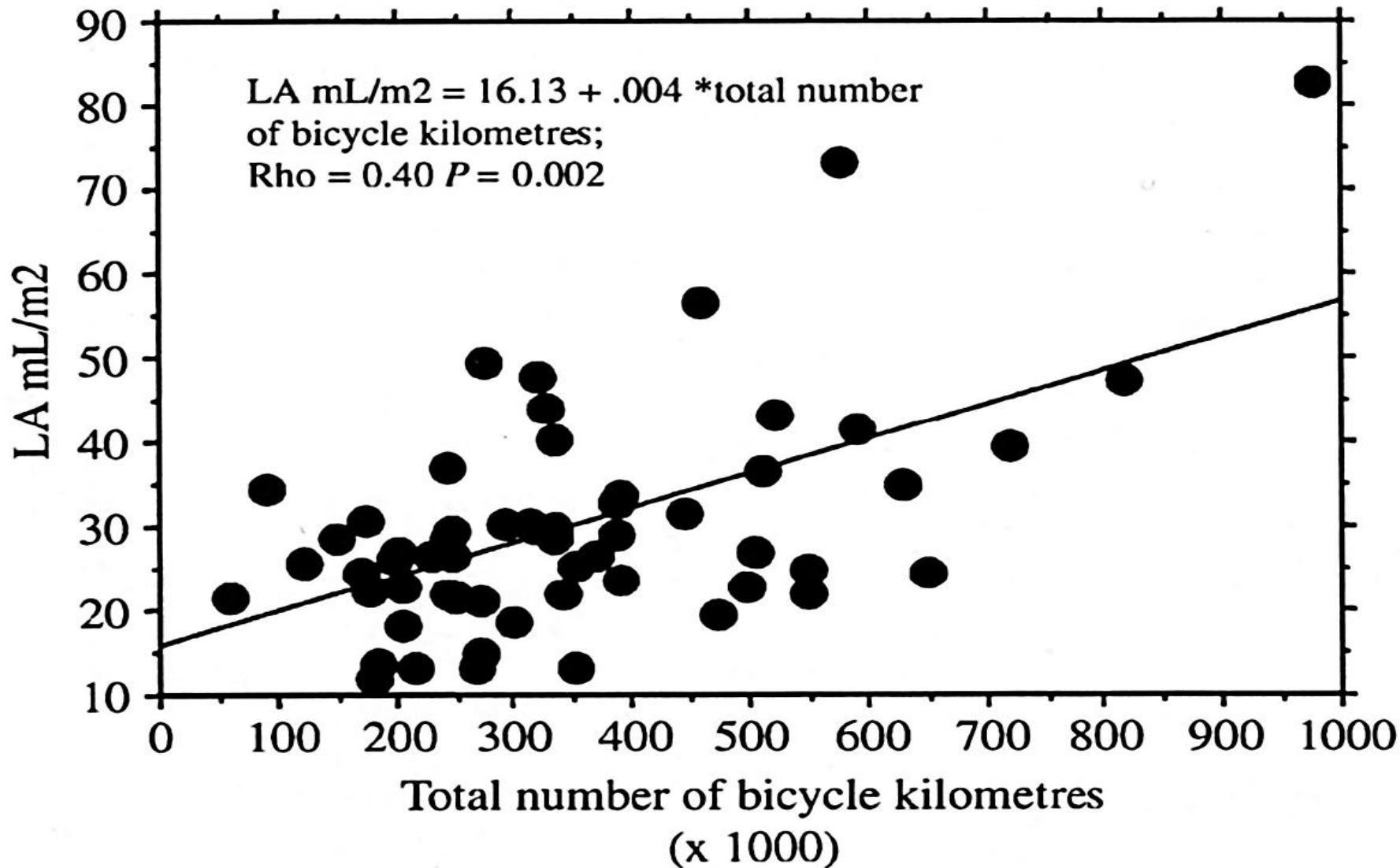
Arrhythmia/electrophysiology

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

Sylvette Baldesberger¹, Urs Bauersfeld², Reto Candinas¹, Burkhardt Seifert³, Michel Zuber⁴, Manfred Ritter⁵, Rolf Jenni⁶, Erwin Oechslin⁶, Pia Luthi¹, Christop Scharf¹, Bernhard Marti⁷, and Christine H. Attenhofer Jost^{1*}

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Atrial fibrillation in Norwegian veteran skiers



- ✦ 1976:122 (149 invited)
- ✦ 2006:78(refused/no rep.111,dead 33)
- ✦ 2006:

	<i>n</i>	<i>age</i>	<i>tr.years</i>	<i>*</i>	<i>a.fib(%)</i>
<i>Group I</i>	33	59	39		6(18)
<i>" II</i>	37	75			5 (14)
<i>" III</i>	8	89			2 (25)
<i>Total</i>	78	70	42		13(17)

*:mean 6,9 hours/week

(Grimsmo EJCP 2010)

Master athletes: Retirement

- ◆ Miki Am Heart J 1994:9 cyclists 49 years, stopped tr. 2 years
- ◆ Initial LVV and wall thickness increased vs sedentary ctr
- ◆ 2 yrs f.up: wall thickness →, HR ↑, E/A ↓

