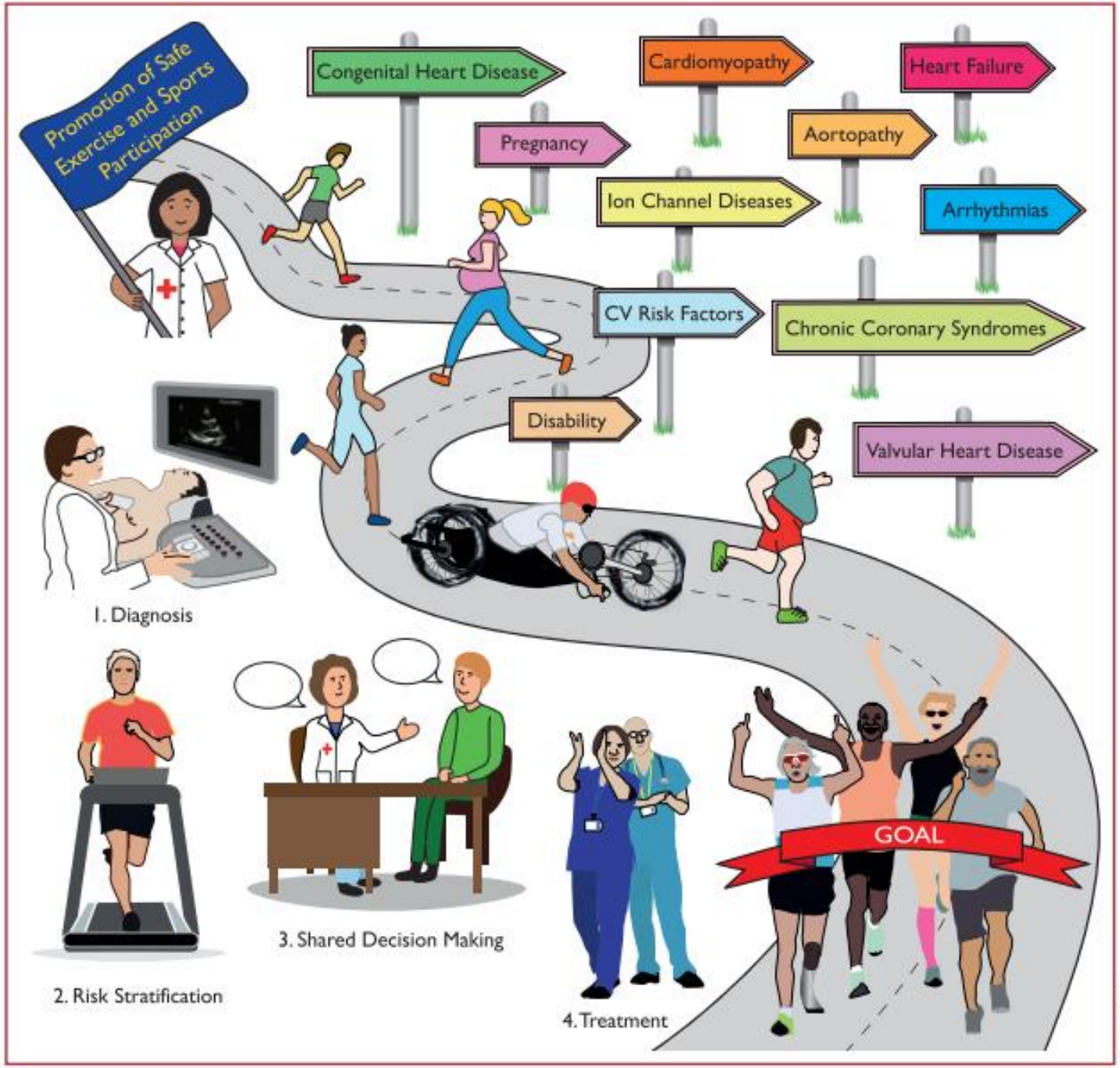
SPORCU KALBİ VE DAYANIKLILIK ANTRENMANLARI, MAX VO2 KAVRAMI

Antrenör Gelişim ve Vize Yenileme Semineri
5-6 Kasım 2022, Ankara

Dr. Deniz AYTEKİN
Kardiyoloji Uzmanı
Egzersiz Fizyolojisi Doktoru (PhD)


Promotion of Safe Exercise and Sports Participation
Congenital Heart Disease
Cardiomyopathy
Heart Failure
Pregnancy
Aortopathy
Ion Channel Diseases
Arrhythmias
CV Risk Factors
Chronic Coronary Syndromes
Disability
Valvular Heart Disease
1. Diagnosis
2. Risk Stratification
3. Shared Decision Making
4. Treatment
GOAL
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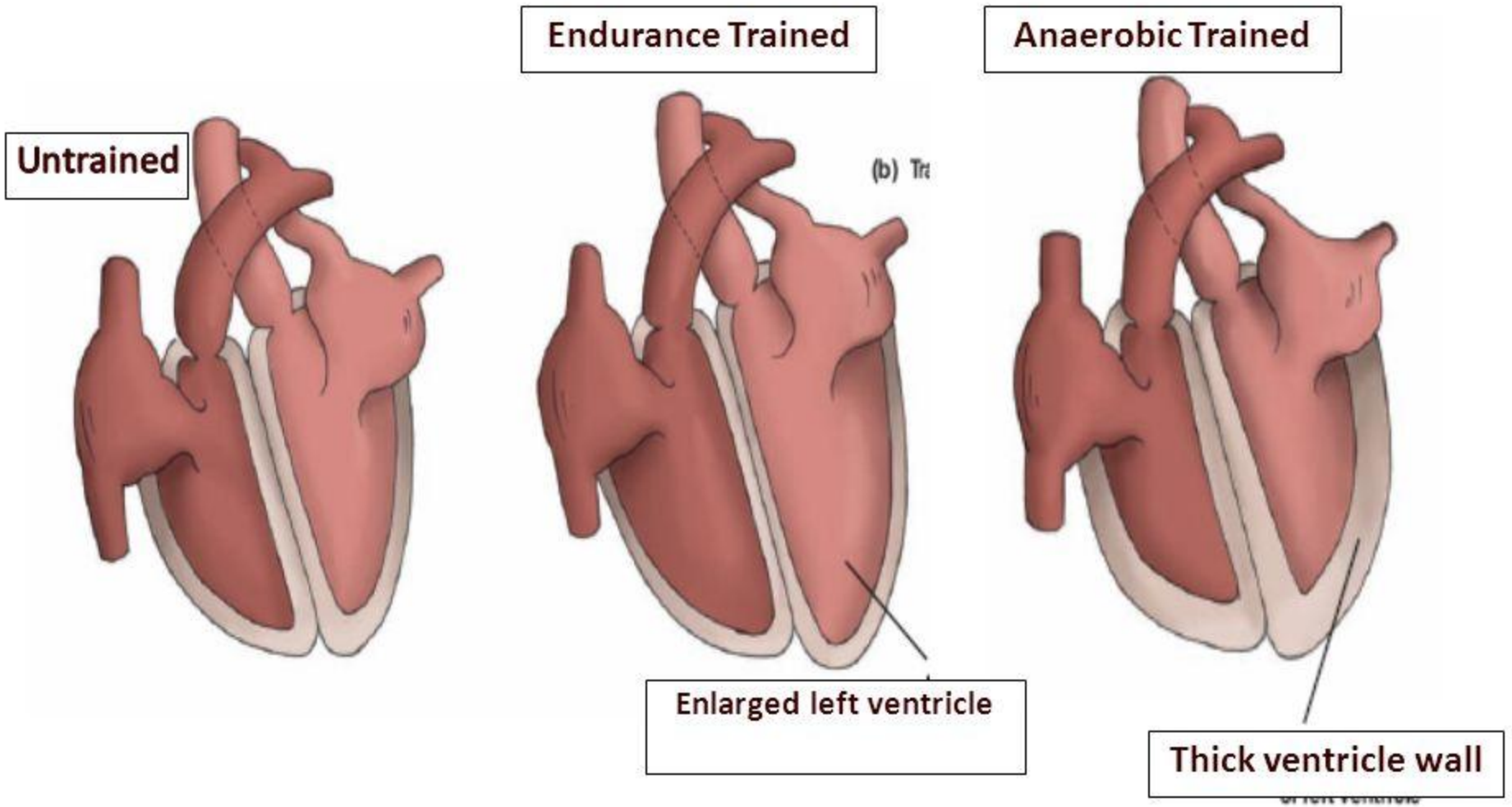
Dayanıklılık sporlarının kalp sağlığı üzerine etkileri.

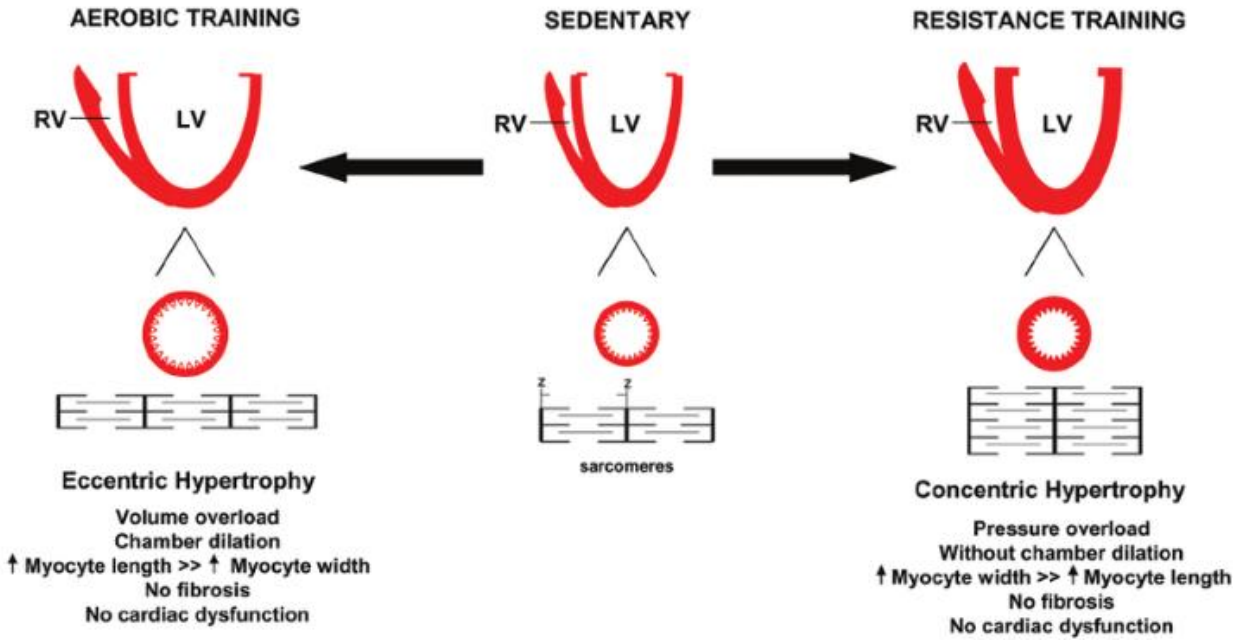
Sporcu Kalbi

Cardiac Hypertrophy

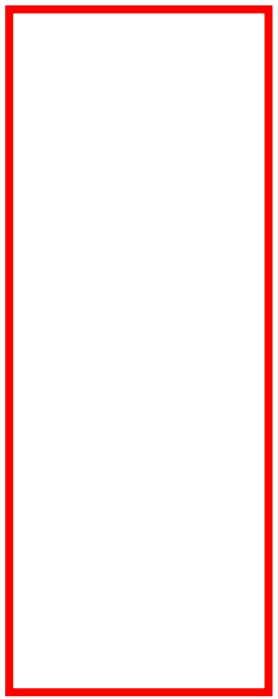


Endurans Antrenman KV etkileri

- Kalp istirahat nabzı,
- Periferik damar direnci azalır,
- Tansiyon düzene girer,
- Kalp atım hacmi (stroke volüm),
- Kardiyak debi,
- Kan hacmi,
- Oksijen kullanabilme becerimiz, VO2max artar.



Pelliccia, A., Sharma, S., Gati, S.,ve arkd. ESC Scientific Document Group (2021). 2020 ESC Guidelines on sports cardiology and exercise in patients with cardiovascular disease. *European heart journal*, *42*(1), 17–96.



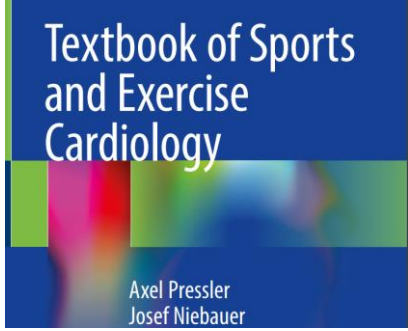


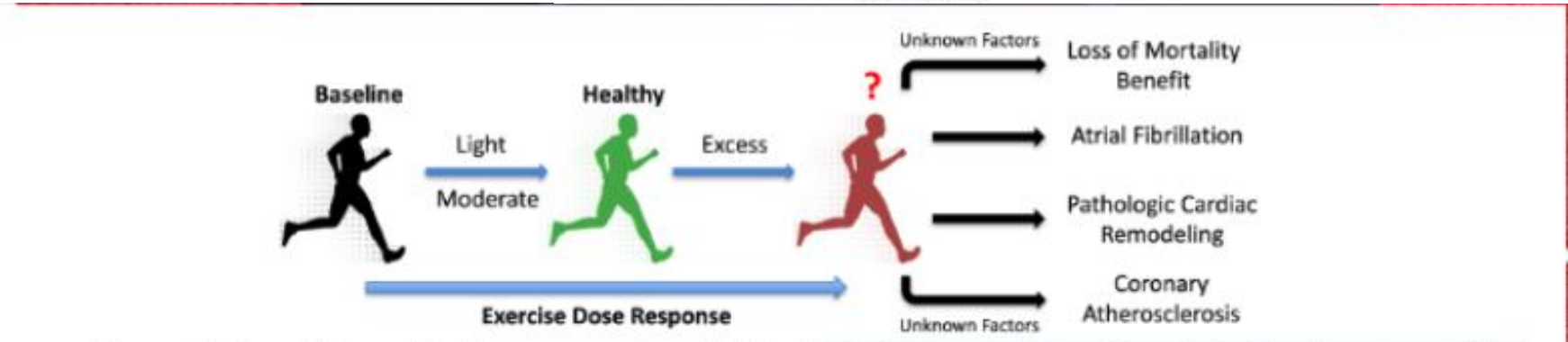
Table 4.1 Left ventricular size and type of sport (adapted from Pelliccia et al. [10])

Sport	Athletes	Males	Females	Age (years)	BSA (m^2)	Left ventricular measures		
						LVEDD (mm)	MWT (mm)	Mass index (g/m^2)
Rowing	95	92	3	21 ± 4	2.04 ± 0.1	56.0 ± 3	11.3 ± 1.3	121 ± 22
Track	89	66	23	26 ± 4	1.79 ± 0.1	51.4 ± 4	9.8 ± 1.2	101 ± 24
Cycling	64	49	15	20 ± 3	1.86 ± 0.1	54.8 ± 5	10.4 ± 1.1	115 ± 23
Soccer	62	62	0	24 ± 4	1.95 ± 0.1	54.9 ± 4	9.9 ± 0.7	105 ± 17
Canoeing	60	52	8	20 ± 3	1.92 ± 0.1	54.5 ± 3	10.5 ± 1.5	110 ± 21
Roller-skating	58	32	26	19 ± 2	1.73 ± 0.1	49.0 ± 4	9.0 ± 1.0	85 ± 17
Swimming	54	26	28	19 ± 3	1.81 ± 0.1	53.0 ± 4	9.3 ± 1.2	98 ± 23
Volleyball	51	36	15	20 ± 4	2.08 ± 0.1	53.7 ± 3	9.4 ± 1.0	88 ± 14
Pentathlon	50	36	14	19 ± 4	1.77 ± 0.1	52.4 ± 4	9.2 ± 0.9	98 ± 18
Tennis	47	32	15	17 ± 2	1.76 ± 0.1	50.0 ± 3	9.1 ± 1.0	88 ± 16
Fencing	42	31	11	22 ± 3	1.85 ± 0.1	51.7 ± 5	9.2 ± 1.3	92 ± 23
Alpine skiing	32	24	8	21 + 2	1.89 ± 0.1	52.0 ± 3	8.9 ± 0.9	87 ± 15
Cross-country skiing	31	24	7	24 ± 4	1.77 ± 0.1	54.5 ± 4	9.6 ± 0.8	107 ± 19
Equestrianism	28	23	5	28 ± 6	1.78 ± 0.1	50.4 ± 3	9.0 ± 0.8	87 ± 14
Team handball	26	9	17	22 ± 2	1.86 ± 0.1	51.8 ± 4	8.5 ± 0.9	80 ± 13
Yachting	24	20	4	27 ± 4	1.88 ± 0.1	51.2 ± 4	9.0 ± 0.8	85 ± 15
Roller hockey	23	23	0	22 ± 2	1.92 ± 0.1	53.4 ± 3	9.7 ± 0.9	99 ± 17
Water polo	21	21	0	24 ± 2	2.03 ± 0.1	54.7 ± 3	10.7 ± 0.6	110 ± 15
Tae kwon do	17	14	3	21 ± 2	1.76 ± 0.1	50.6 ± 4	8.7 ± 1.2	85 ± 17
Wrestling and judo	16	14	2	24 ± 3	1.93 ± 0.2	52.6 ± 5	10.2 ± 0.9	100 ± 14
Bobsledding	16	16	0	26 ± 3	2.08 ± 0.1	55.1 ± 2	9.6 ± 0.5	96 ± 7
Boxing	14	14	0	22 ± 4	1.85 ± 0.2	52.5 ± 3	9.8 ± 1.0	101 ± 16
Diving	11	7	4	23 ± 3	1.71 ± 0.1	49.6 ± 3	8.7 ± 1.1	83 ± 15
Field weight events	9	8	1	24 ± 3	2.26 ± 0.1	55.5 ± 4	10.0 ± 0.5	91 ± 8
Weightlifting	7	7	0	24 ± 2	1.96 ± 0.1	53.2 ± 3	10.4 ± 0.7	100 ± 9

BSA body surface area, *LVEDD* left ventricular end-diastolic diameter, *MWT* maximal wall thickness

Spora Bağlı Olası Riskler?

- Faydanın bitip zararın başladığı bir nokta var mı?
- Kalp büyümesi?
- Kalp kasında nedbe/skar gelişimi?
- Damarlarda kireçlenme?
- Ritim bozuklukları?
- Ani ölüm?



Representation of the exercise dose response from light/moderate to excess and possible pathologic outcomes associated with high levels of exercise.

Contents lists available at ScienceDirect

Progress in Cardiovascular Diseases

journal homepage: www.onlinepcd.com

Cross-country skiing and running's association with cardiovascular events and all-cause mortality: A review of the evidence☆

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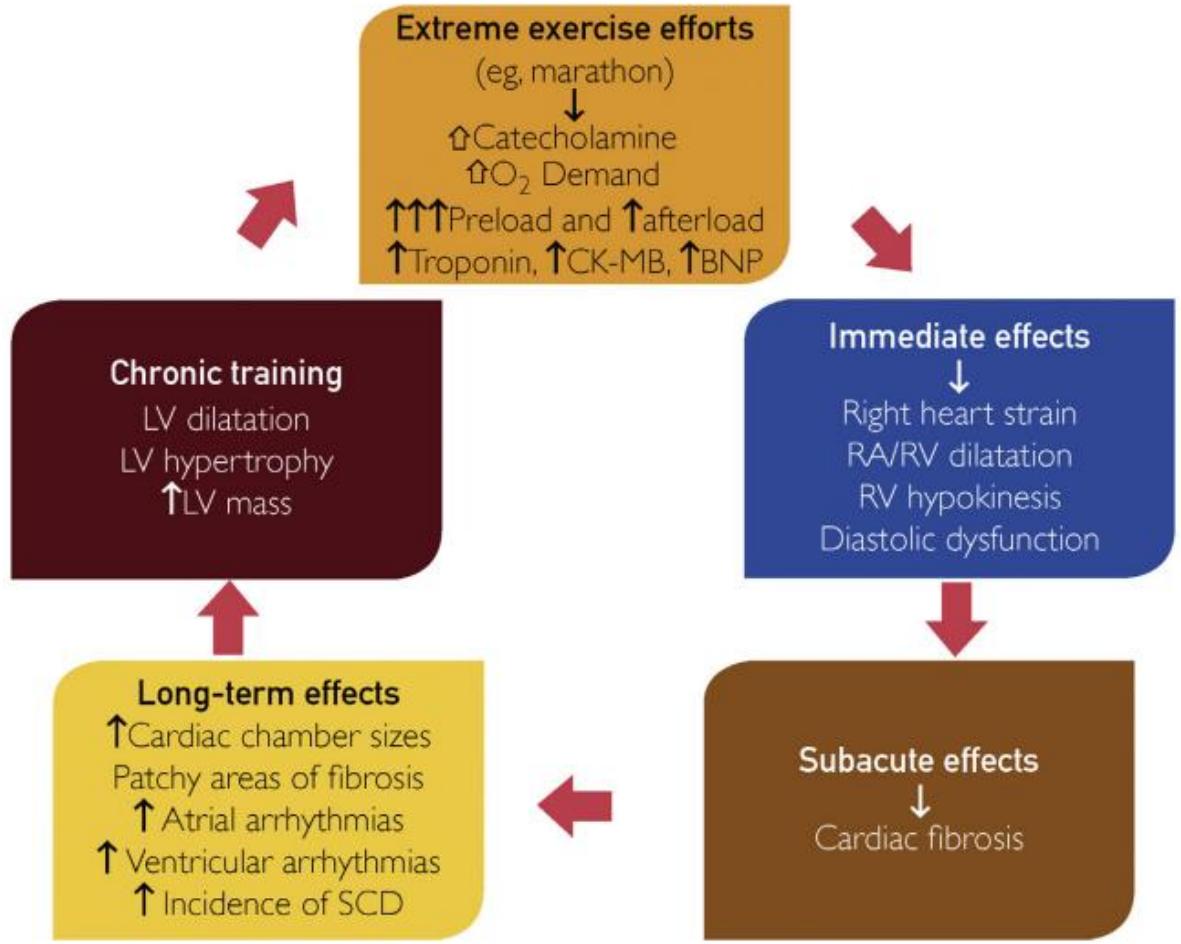


Fig Proposed pathogenesis of cardiomyopathy in endurance athletes. *Abbreviations*: BNP = B-type natriuretic peptide; CK-MB = creatine kinase MB; LV = left ventricle; RA = right atrium; RV = right ventricle; SCD = sudden cardiac death.
Reproduced with permission from Mayo Clin Proc 2012. Reproduced with permission from Mayo Clin Proc O'Keefe JH et al.[70]

Atrial flutter

- 31% vs. 8% are endurance athletes

*Claessen, La Gerche, Heidbuchel *Heart* 2011

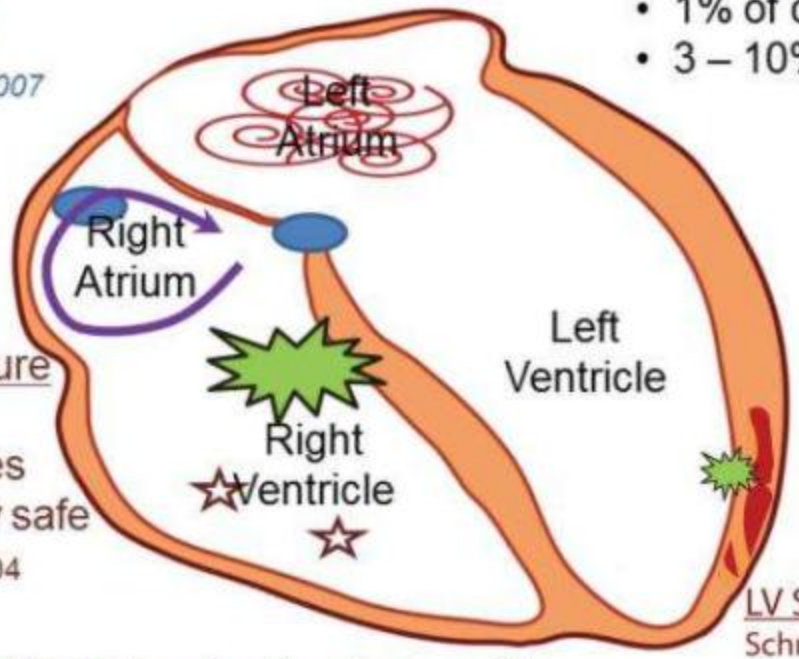
Heart block

PPM in 3% athletes
vs. 0% non-athletes

*Baldesberger et al EHJ 2007
*Stein et al JACC 2002

Atrial fibrillation

- 1% of community
- 3 – 10% athletes



Ventricular premature beats (ectopics)

Common in athletes
Usually completely safe

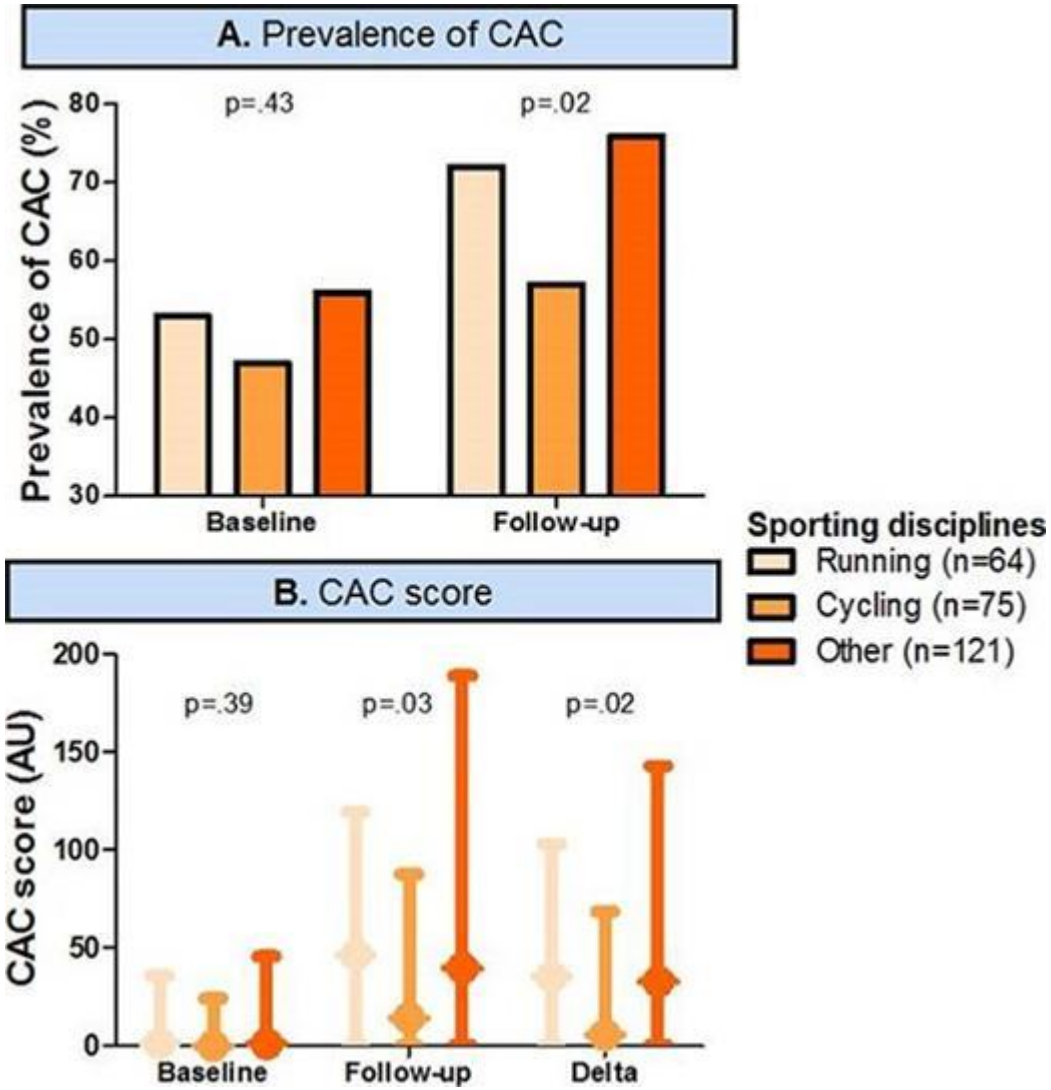
*Biffi *JACC* 2004

LV Scar / arrhythmias

Schnell et al. *BJSM* 2015

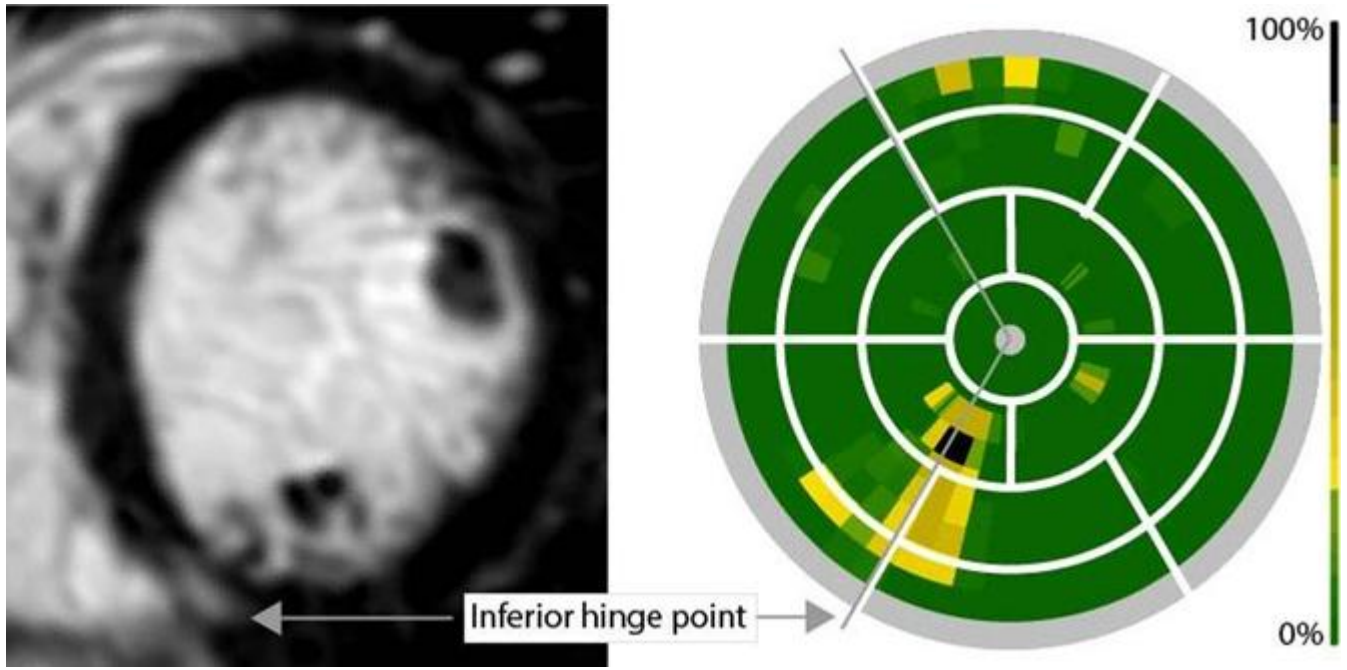
Ventricular tachycardia

Rare. Potentially serious
Most often of RV origin
??? More common in athletes *Heidbuchel, Hoogsteen et al. EHJ 2003

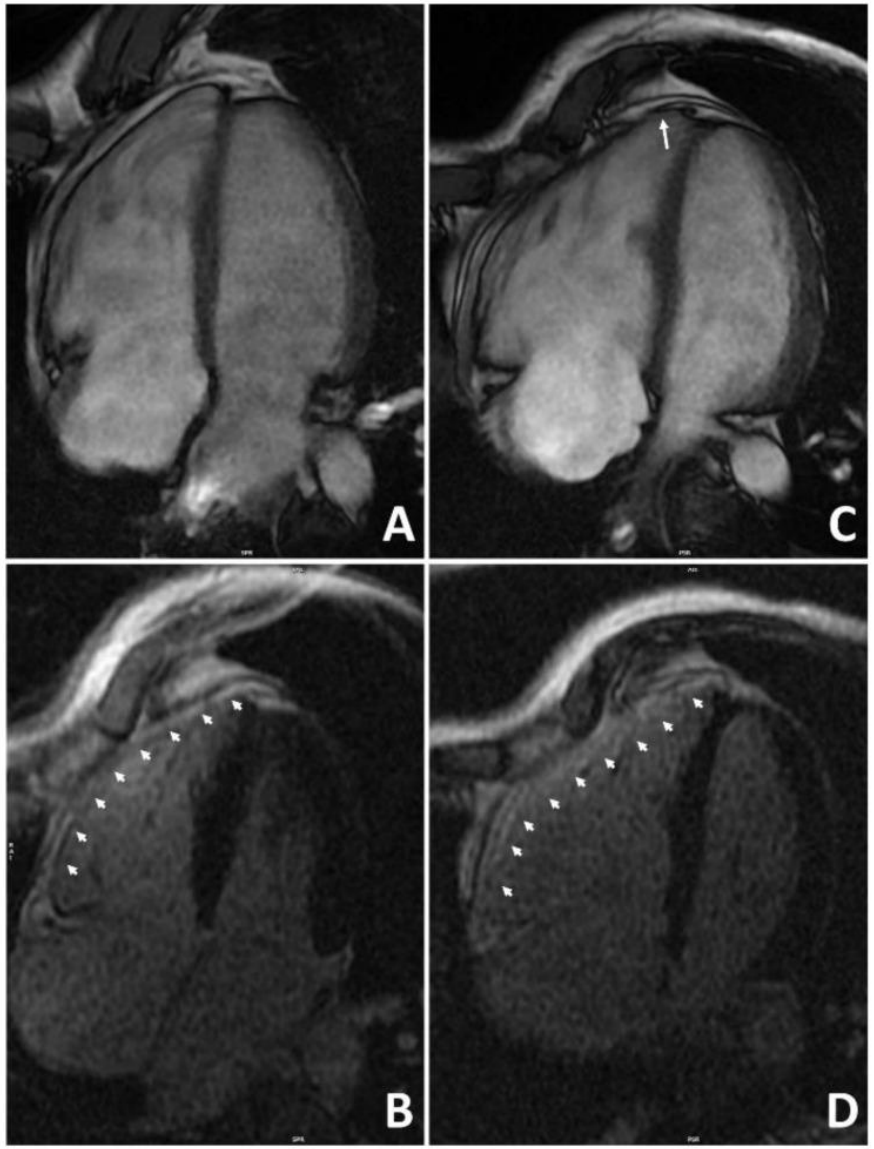


Conclusion

Cyclists have a lower incidence and less progression of CAC during 6 years of follow-up compared with runners and individuals performing other sports (e.g. water polo, tennis, hockey, etc.).


Inferior hinge point
100%
0%


TÜRKİYE SUTOPU
FEDERASYONU


A
C
B
D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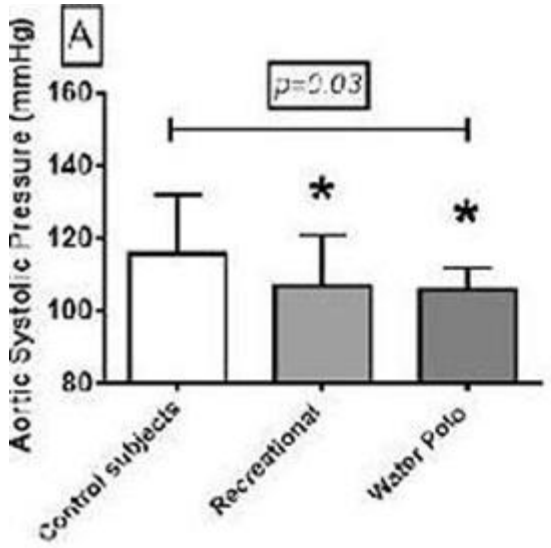

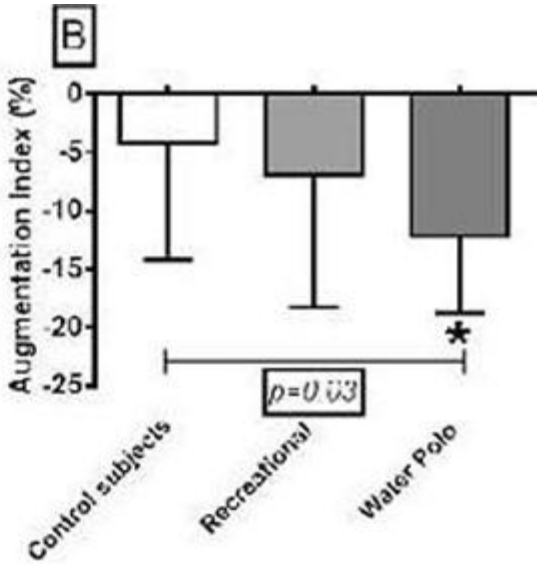

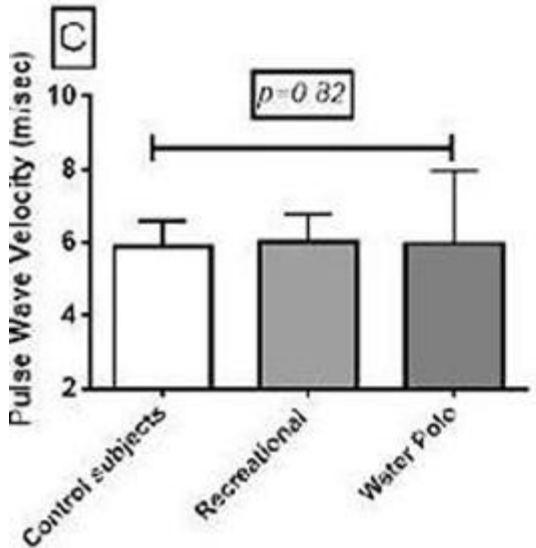

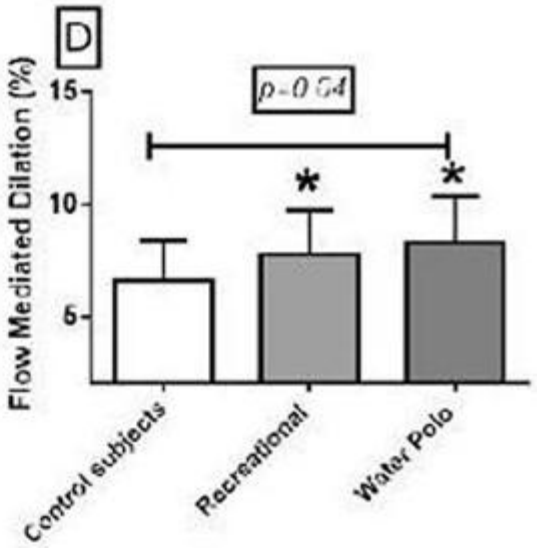

Conclusions

In young WP Olympic team players intense mixed endurance and strength training has no adverse impact on arterial wall properties and endothelial function with a parallel improvement in central hemodynamics.

These findings highlight that there are no definitive data to support on any adverse vascular related impact of ultra-endurance training while mixed endurance and strength training may be associated with a favorable vascular profile.

SPORLA İLİŞKİLİ ANİ ÖLÜM

Circulation
Volume 119, Issue 8, 3 March 2009; Pages 1085-1092
https://doi.org/10.1161/CIRCULATIONAHA.108.804617

ARRHYTHMIA/ELECTROPHYSIOLOGY

Sudden Deaths in Young Competitive Athletes

Analysis of 1866 Deaths in the United States, 1980–2006

Barry J. Maron, MD, Joseph J. Doerer, BS, Tammy S. Haas, RN, David M. Tierney, MD, and Frederick O. Mueller, PhD

Table. Demographics of Sudden Death in Young Athletes

Sport	No. (%)	Age, y	Male, n (%)	Female, n (%)	Race, n			Survivors, n (%)	Cause of Death, n (%)		
					White	Black	Other*		Trauma Injury	Commotio Cordis	CV Diseases†
Football	565 (30)	17±4	564 (99.8)	1 (0.2)	280	205	80	13 (2)	140 (25)	12 (2)	281 (50)
Basketball	405 (22)	17±4	364 (90)	41 (10)	142	243	20	30 (7)	4 (1.0)	0	349 (86)
Soccer	115 (6)	16±4	93 (81)	22 (19)	81	14	20	7 (6)	11 (10)	4 (4)	80 (70)
Baseball	111 (6)	16±4	111 (100)	0	95	5	11	14 (13)	16 (14)	30 (27)	54 (49)
Motor vehicle racing‡	104 (6)	28±8	103 (99)	1 (1)	102	0	2	0	97 (93)	0	5 (5)
Track and field	96 (5)	17±4	74 (77)	22 (23)	62	22	12	3 (3)	25 (26)	0	61 (64)
Wrestling	69 (4)	22±8	69 (100)	0	56	4	9	2 (3)	7 (10)	1 (1.4)	37 (54)
Boxing	56 (3)	25±6	55 (98)	1 (2)	21	19	16	0	42 (75)	0	11 (1.8)
Swimming§	46 (2)	17±4	30 (65)	16 (35)	43	1	2	1 (2)	0	0	35 (76)
Cross country	38 (2)	17±4	29 (76)	9 (24)	30	6	2	2 (5)	0	0	29 (76)
Hockey	29 (1.5)	18±5	29 (100)	0	28	1	0	3 (10)	4 (14)	7 (24)	11 (38)
Horse riding‖	27 (1.4)	27±8	17 (63)	10 (37)	21	1	5	0	24 (89)	0	2 (7)
Softball	22 (1.2)	19±6	6 (27)	16 (73)	19	0	3	2 (9)	3 (14)	1 (5)	12 (55)
Marathon	20 (1.1)	28±7	15 (75)	5 (25)	16	0	4	3 (15)	0	0	13 (65)
Lacrosse	19 (1.0)	18±2	19 (100)	0	18	1	0	2 (11)	1 (5)	8 (42)	9 (47)
Skiing¶	19 (1.0)	25±8	14 (74)	5 (26)	19	0	0	0	15 (79)	0	1 (5)
Triathlon	17 (0.9)	32±5	15 (88)	2 (12)	16	0	1	0	3 (18)	0	8 (47)
Rugby	16 (0.9)	21±3	16 (100)	0	13	2	1	0	3 (19)	0	7 (44)
Martial arts	15 (0.8)	23±7	14 (93)	1 (7)	12	3	0	0	5 (33)	2 (13)	2 (13)
Others#	14 (0.8)	26±9	12 (86)	2 (14)	14	0	0	2 (14)	3 (21)	0	5 (36)
Rowing	11 (0.6)	22±6	8 (73)	3 (27)	10	0	1	0	0	0	9 (82)
Cycling	10 (0.5)	29±8	8 (80)	2 (20)	7	2	1	0	7 (70)	0	3 (30)
Tennis	10 (0.5)	19±4	8 (80)	2 (20)	8	0	2	0	0	0	8 (80)
Volleyball	10 (0.5)	18±5	1 (10)	9 (90)	5	3	2	1 (10)	0	0	10 (100)
Gymnastics	9 (0.5)	15±3	5 (56)	4 (44)	6	0	3	0	4 (44)	0	3 (33)
Surfing	9 (0.5)	23±8	9 (100)	0	7	0	2	0	2 (22)	0	1 (11)
Figure skating	2 (0.1)	24±6	2 (100)	0	2	0	0	0	0	0	1 (50)
Golf	2 (0.1)	18±0.7	2 (100)	0	2	0	0	0	0	0	2 (100)
Totals	1866	19±6	1692	174	1135	532	199	85	416	65	1049

CV indicates cardiovascular.

*Hispanic (n=103); Asian (n=20); Native American (n=5); Pacific Islander (n=5); Middle Eastern (n=3); Indian (n=1); Japanese (n=1); mixed (n=6); unknown (n=55).

†Documented by autopsy and/or clinical findings.

‡Includes automobile (n=63) and motorcycle (n=41) racing.

§Swimming (n=40); water polo (n=6).

‖Jockey (n=16); equestrian (n=11).

¶Skiing (n=12); snowboarding (n=5); ski-jumping (n=2).

#Skateboarding (n=5); jai-alai (n=4); field hockey (n=2); bobsledding (n=1); bowling (n=1); riflery (n=1).


TÜRKİYE SUTOPU
FEDERASYONU

Romanian water polo player, aged 23, died during game

March 26, 2022

The sad news came from Romania. A water polo player of Dinamo Bucharest, Andrei Drăghici, aged 23, died during the game against Rapid Bucharest today.

Russian water polo player Vladislav Timakov dies during training camp

Associated Press

Sep 7, 2015

MOSCOW -- A player for the Russian national water polo team has died of an apparent heart attack while in the pool.

Vladislav Timakov, 22, was in Bulgaria for preseason training with his club Sintez Kazan when he "died suddenly" Sunday, the Russian Water Polo Federation said.

Timakov was swimming during a training session when he began to drown, his teammate Ivan Nagaev told Russian agency Ves Sport. Players hauled Timakov out of the water and a doctor provided first aid, but Timakov died on the way to the hospital, Nagaev said, adding that he believed Timakov had suffered a heart attack.

Timakov, who played as a center, represented Russia at the world championships in Kazan in July, scoring one goal in three games as Russia missed out on the medals.


This is the moment karate instructor
Mark Kingsland suffers a cardiac arrest
during a training session


itv
HD
QATAR AIRWAYS
GOING PLACES TOGETHER
QATAR AIRWAYS
GOING PLACES T

TÜRKİYE SUTOPU FEDERASYONU

TAM ZAMANINDA DOĞRU YERDE

OED'NİN ZAMANINDA UYGULANMASI HAYATTA KALMA OLASILIĞINI %50-60 ORANINDA ARTTIRIR

X2 X3 X5

The findings in our study highlight the need for an increased availability of AEDs in sport facilities. Hopefully, it would push to follow this pattern in the general population. Recreational sport participation is increasing substantially over time which further justifies better knowledge of prevention and improved treatment strategies. The American Heart Association/American College of Cardiology (AHA/ ACC) guidelines for competitive sports recommend that all schools and other organizations hosting athletic events or providing training facilities for organized competitive athletic programmes should have an emergency action plan that incorporates BLS and AED use. The 2021 ERC guidelines also recommend to all sports and exercise facilities to undertake a medical risk assessment of the risk of SR-SCA. Sport activities with a raised chance of SR-SCA should put an emergency response planning in place including staff and members training in the recognition and management of cardiac arrest and direct provision of an AED or clear directions to the nearest public access AED

Yüksek Hacim Ve Şiddette Uzun Süreli Yapılan Sporun Sağlık Üzerine Etkileri

European Journal of Preventive Cardiology
ESC European Society of Cardiology

Original scientific paper

European Journal of Preventive Cardiology
2017, Vol. 24(12) 1328–1335

DOI: 10.1177/2047487317713326
journals.sagepub.com/home/ejpc
SAGE

Running multiple marathons is not a risk factor for premature subclinical vascular impairment

Axel Pressler[1], Christiane Suchy[1], Tasja Friedrichs[1], Sophia Dallinger[1], Viola Grabs[2], Bernhard Haller[3], Martin Halle[1,4,5] and Johannes Scherr[1]

Abstract

Background: In contrast to the well-accepted benefits of moderate exercise, recent research has suggested potential deleterious effects of repeated marathon running on the cardiovascular system. We thus performed a comprehensive analysis of markers of subclinical vascular damage in a cohort of runners having finished multiple marathon races successfully.

Design: This was a prospective, observational study.

Methods: A total of 97 healthy male Munich marathon participants (mean age 44 ± 10 years) underwent detailed training history, cardiopulmonary exercise testing for assessment of peak oxygen uptake, ultrasound for assessment of intima-media-thickness as well as non-invasive assessments of ankle-brachial index, augmentation index, pulse wave velocity and reactive hyperaemia index.

Results: Runners had previously completed a median of eight (range 1–500) half marathons, six (1–100) full marathons and three (1–40) ultramarathons; mean weekly and annual training volumes were 59 ± 23 and 1639 ± 979 km. Mean peak oxygen uptake was 50 ± 8 ml/min/kg, and the Munich marathon was finished in 3:45 ± 0:32 h. Runners showed normal mean values for intima-media-thickness (0.60 ± 0.14 mm), ankle-brachial index (1.2 ± 0.1), augmentation index (17 ± 13%), pulse wave velocity (8.7 ± 1.4 cm/s) and reactive hyperaemia index (1.96 ± 0.50). Age was significantly and independently associated with intima-media-thickness ($r = 0.531$; $p < 0.001$), augmentation index ($r = 0.593$; $p < 0.001$) and pulse wave velocity ($r = 0.357$; $p < 0.001$). However, no independent associations of peak oxygen uptake, marathon finishing time, number of completed races or weekly and annual training km with any of the vascular parameters were observed.

Conclusions: In this cohort of healthy male runners, running multiple marathon races did not pose an additional risk factor for premature subclinical vascular impairment beyond age.

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Cross-country skiing and running's association with cardiovascular events and all-cause mortality: A review of the evidence☆

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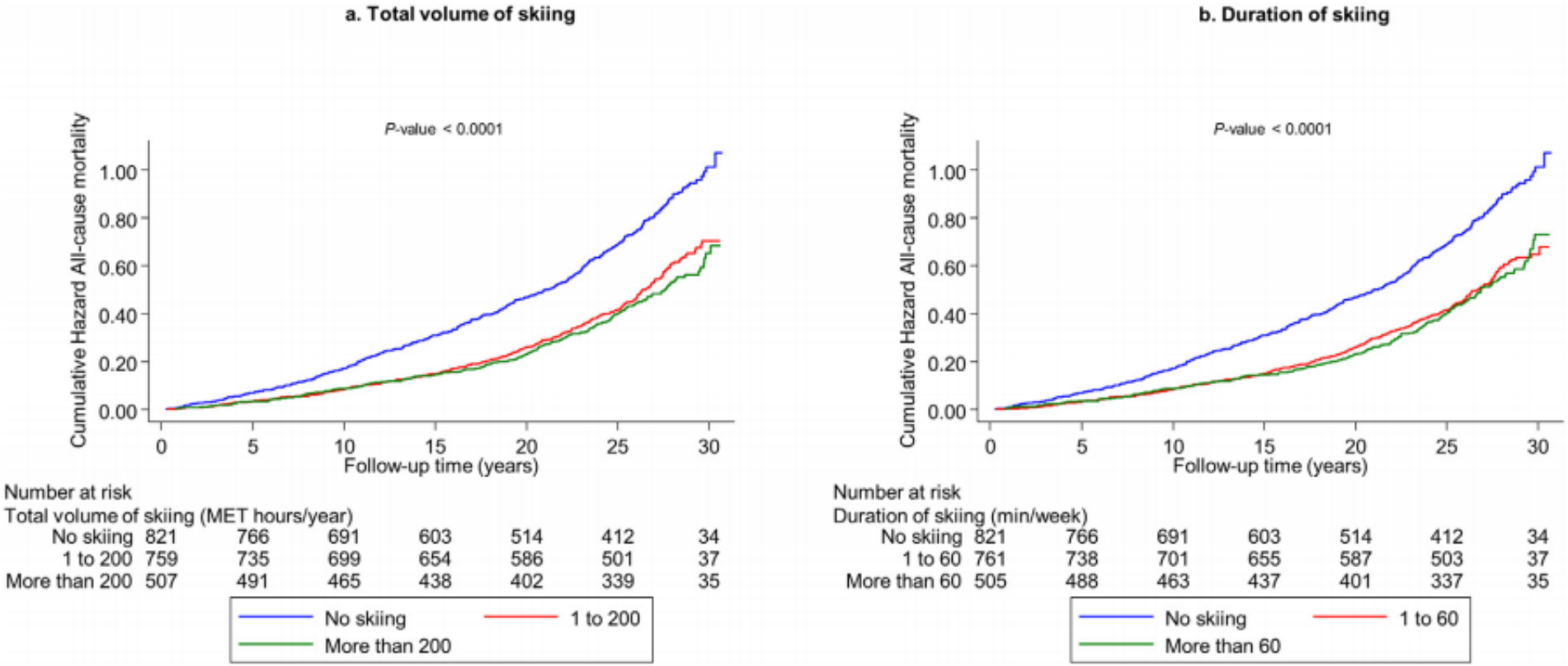

Fig Cumulative Kaplan-Meier curves for all-cause mortality during follow-up according to total volume and duration of cross-country skiing. Reproduced with permission from Scand J Med Sci Sports. 2018 Laukkanen et al.[25]

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Cross-country skiing and running's association with cardiovascular events and all-cause mortality: A review of the evidence☆

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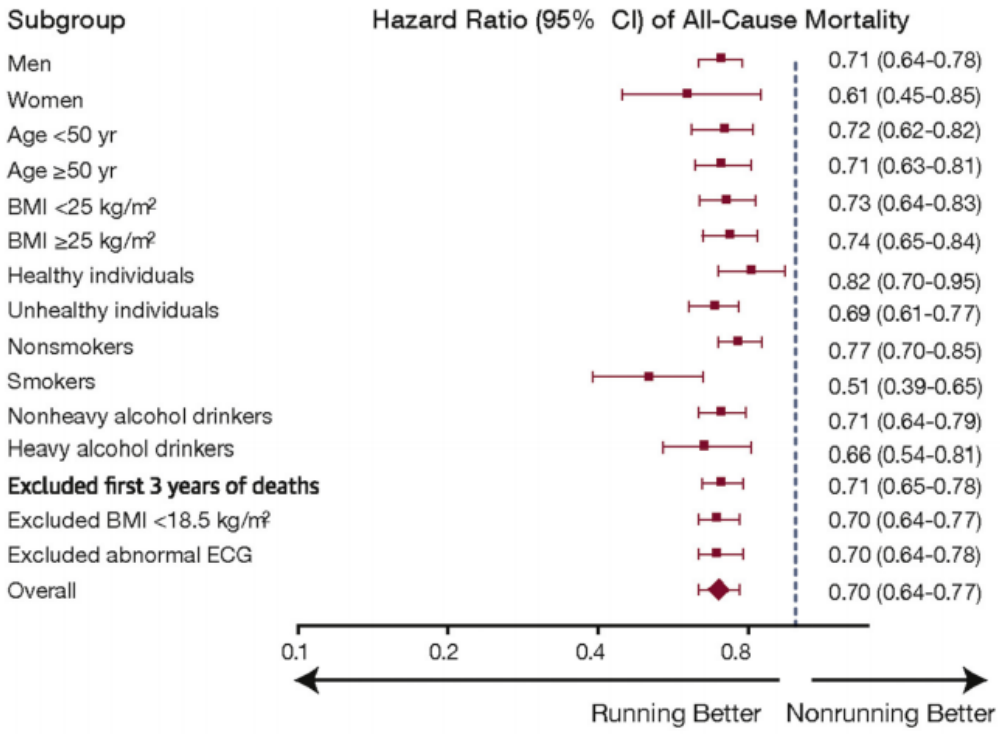

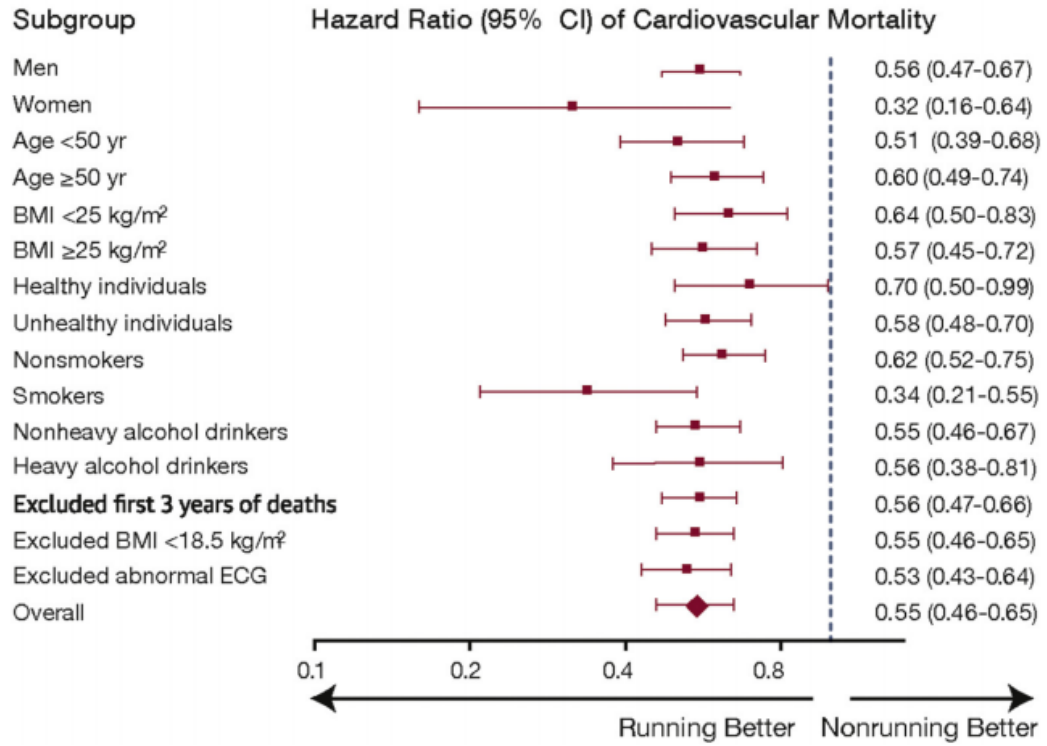

European Heart Journal (2013) **34**, 3145–3150
doi:10.1093/eurheartj/eht347

FASTTRACK CLINICAL RESEARCH
Sports cardiology

Mortality of French participants in the Tour de France (1947–2012)

Eloi Marijon[1,2,3,4]*, Muriel Tafflet[1,2,5], Juliana Antero-Jacquemin[1,5], Nour El Helou[1,5,6], Geoffroy Berthelot[1,5], David S. Celermajer[7], Wulfran Bougouin[1,2,4], Nicolas Combes[8], Olivier Hermine[1,9,12,13], Jean-Philippe Empana[1,2], Grégoire Rey[10], Jean-François Toussaint[1,5,11†], and Xavier Jouven[1,2,3,4†]

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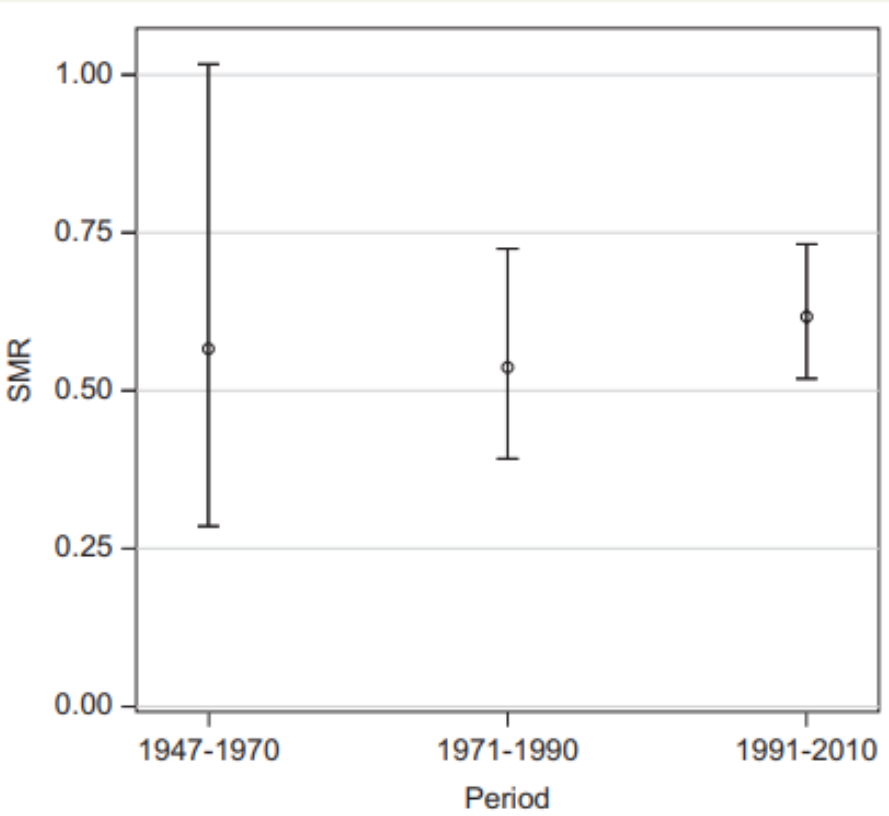


Figure 3 Standardized mortality ratio over time. We observed a lower mortality in the cyclists as compared to the male general population across the three time periods (1947–70, 1971–90, and 1991–2010), without any significant difference over time.

MAYO CLINIC

ORIGINAL ARTICLE

Elite Athletes Live Longer Than the General Population: A Meta-Analysis

Nuria Garatachea, PhD; Alejandro Santos-Lozano, PhD; Fabian Sanchis-Gomar, MD, PhD; Carmen Fiuza-Luces, PhD; Helios Pareja-Galeano, MSc; Enzo Emanuele, MD, PhD; and Alejandro Lucia, MD, PhD

Abstract

Objective: To perform a meta-analysis of cohort studies aimed at providing an accurate overview of mortality in elite athletes.

Patients and Methods: We reviewed English-language scientific articles available in Medline and Web of Science databases following the recommendations of the Meta-analyses Of Observational Studies in Epidemiology group. We searched for publications on *longevity* and *professional* or *elite athletes* (with no restriction on the starting date and up to March 31, 2014).

Results: Ten studies, including data from a total of 42,807 athletes (707 women), met all inclusion criteria. The all-cause pooled standard mortality ratio (SMR) was 0.67 (95% CI, 0.55-0.81; $P<.001$) with no evidence of publication bias ($P=.24$) but with significant heterogeneity among studies ($I^2=96\%$; $Q=224.46$; $P<.001$). Six studies provided data on cardiovascular disease (CVD) and 5 on cancer (in a total of 35,920 and 12,119 athletes, respectively). When only CVD was considered as a cause of mortality, the pooled SMR was 0.73 (95% CI, 0.65-0.82; $P<.001$) with no evidence of bias ($P=.68$) or heterogenity among studies ($I^2=38\%$; $Q=8.07$; $P=.15$). The SMR for cancer was 0.60 (95% CI, 0.38-0.94; $P=.03$) with no evidence of bias ($P=.20$) despite a significant heterogeneity ($I^2=91\%$; $Q=44.21$; $P<.001$).

Conclusion: The evidence available indicates that top-level athletes live longer than the general population and have a lower risk of 2 major causes of mortality, namely, CVD and cancer.

Sports Medicine (2021) 51:289–301
https://doi.org/10.1007/s40279-020-01379-5

SYSTEMATIC REVIEW

Health Consequences of an Elite Sporting Career: Long-Term Detriment or Long-Term Gain? A Meta-Analysis of 165,000 Former Athletes

Adam Runacres[1] · Kelly A. Mackintosh[1] · Melitta A. McNarry[1]

Accepted: 23 October 2020 / Published online: 24 December 2020

Abstract

Introduction Exercise is widely accepted to improve health, reducing the risk of premature mortality, cardiovascular disease (CVD) and cancer. However, several epidemiological studies suggest that the exercise-longevity relationship may be 'J' shaped; with elite athlete's likely training above these intensity and volume thresholds. Therefore, the aim of this meta-analysis was to examine this relationship in former elite athletes.

Methods 38,047 English language articles were retrieved from Web of Science, PubMed and SportDiscus databases published after 1970, of which 44 and 24 were included in the systematic review and meta-analysis, respectively. Athletes were split into three groups depending on primary sport: Endurance (END), Mixed/Team, or power (POW). Standard mortality ratio's (SMR) and standard proportionate mortality ratio (SPMR) were obtained, or calculated, and combined for the meta-analysis.

Results Athletes lived significantly longer than the general population (male SMR 0.69 [95% CI 0.61–0.78]; female SMR 0.51 [95% CI 0.40–0.65]; both $p < 0.01$). There was no survival benefit for male POW athletes compared to the general population (SMR 1.04 [95% CI 0.91–1.12]). Although male athlete's CVD (SMR 0.73 [95% CI 0.62–0.85]) and cancer mortality (SMR 0.75 [95% CI 0.63–0.89]), were significantly reduced compared to the general population, there was no risk-reduction for POW athletes CVD mortality (SMR 1.10 [0.86–1.40]) or END athletes cancer mortality (SMR 0.73 [0.50–1.07]). There was insufficient data to calculate female sport-specific SMR's.

Discussion Overall, athletes live longer and have a reduced incidence of both CVD and cancer mortality compared to the general population, refuting the 'J' shape hypothesis. However, different health risks may be apparent according to sports classification, and between sexes, warranting further investigation.

Trial registration PROSPERO (registration number: CRD42019130688).

Key Points

- Elite athletes live longer than the general population.
- Sport-specific differences in mortality, and disease, risk may be evident.
- More research is needed to examine the impact of an elite sporting career in female athletes with a minimum follow-up period of 30 years.

Conclusions

The main conclusions from this review are: (1) overall, male and female athletes' all-cause mortality is significantly lower than the general population; (2) sub-group analyses revealed END and team sport athletes, but not POW athletes, had a reduced all-cause mortality; (3) POW athletes were at a similar risk of CVD mortality compared to the general population, and; (4) END athletes cancer mortality was not significantly different to the general population. However, more research is warranted in female and power athletes, with a follow-up of ≥ 30 years, to ascertain the long-term benefits/consequences of chronic intensive exercise training in these populations.

VO2max Kavramı

Oxygen

Maximum

Volume

VO_2max

Maximal volume of oxygen your body can utilise

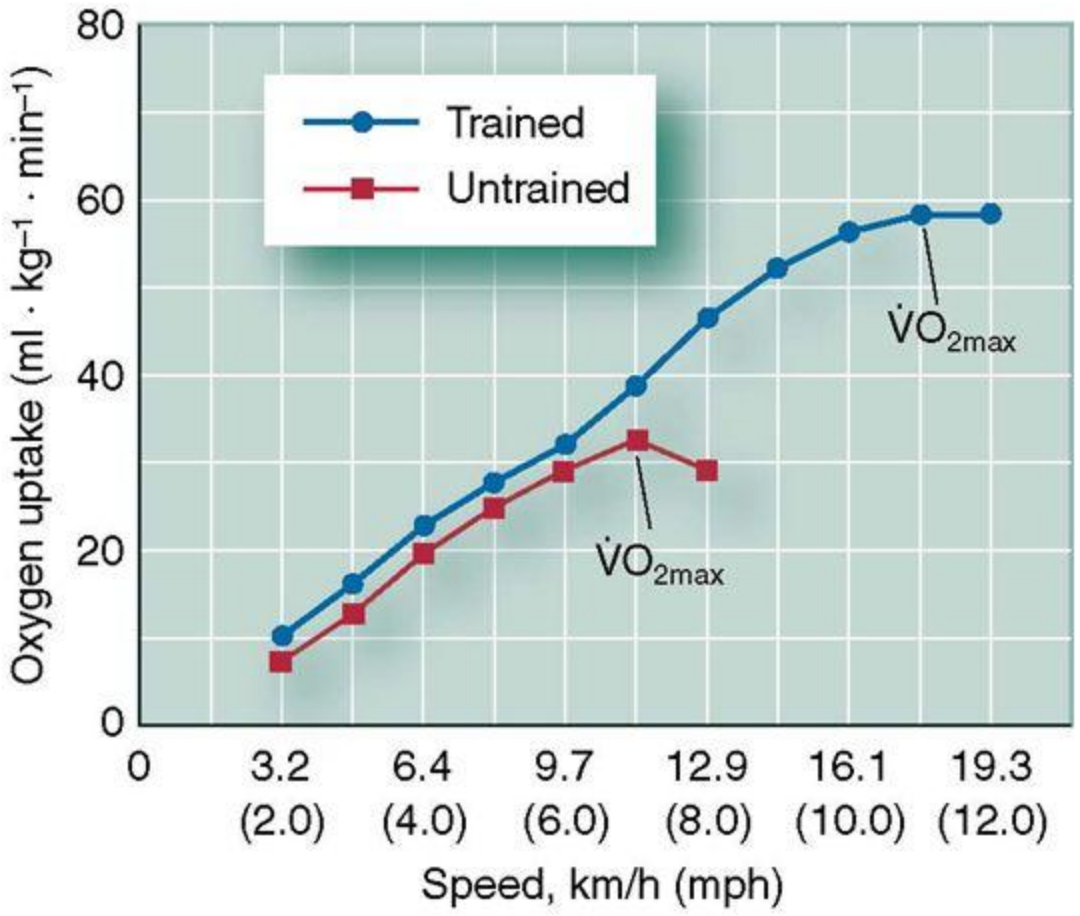
VO2max Kavramı

- Hareket=Oksijen Tüketimi
- Oksijen tüketimi, dakikada vücut ağırlığımızın her kilogramı başına mililitre olarak ifade edilir (**ml/kg/dk**)
- Dinlenme anında 3.5 ml/kg/dk yani 1 MET (metabolik eşdeğer)
- Maksimum enerjiyi üretebilmek, maksimum oksijen kullanabilme becerisi ile mümkündür ve **VO2max** olarak ifade edilir (*V= hacim O2=Oksijen Max=Maksimum*).
- Aerobik dayanıklılığı ifade eder

VO2max;

- 18-22 yaş kızlarda 38-42 ml/kg/dk, erkeklerde 44-50 ml/kg/dk iken
- Artan yaş ile beraber (>25 yaş) her yıl %1 azalır
- Düzenli antrenman ile VO2max artar
- Elit dayanıklılık atletlerinde 80-85 ml/kg/dk gibi değerler saptanabilir
- **En yüksek VO2max değeri 97.5 ml/kg/dk** ile Oskar Nikolai Birger Svendsen isimli Norveçli bisikletçiye aittir.

Relationship Between Exercise Intensity and Oxygen Uptake in Trained and Untrained Man



REVIEW ARTICLE

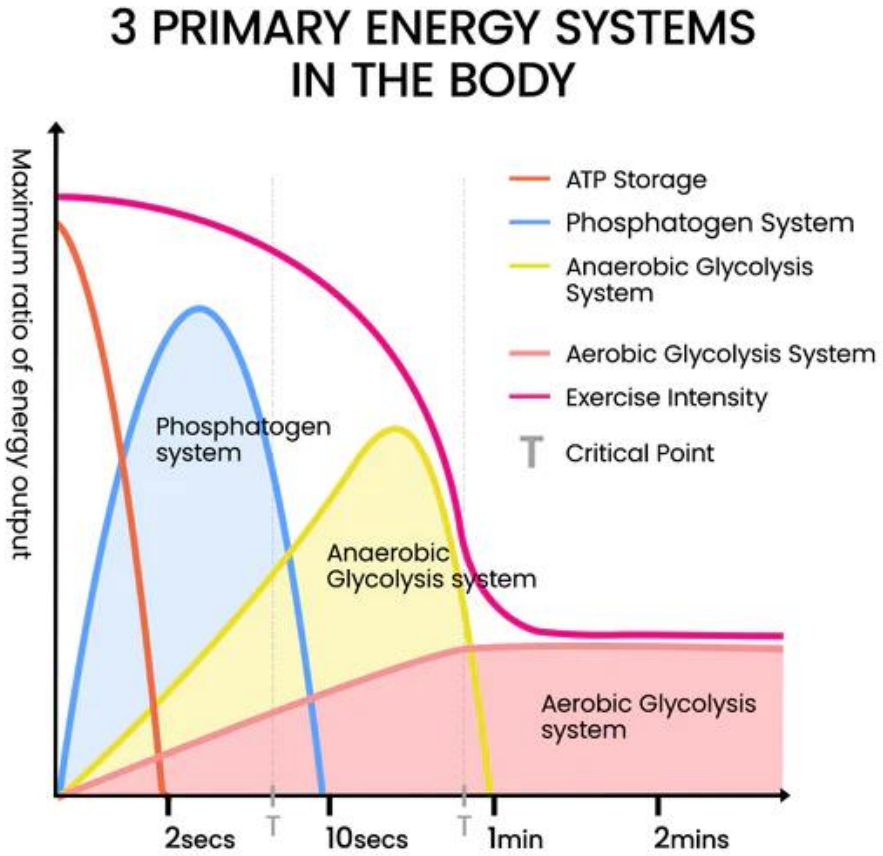
Sports Med 1998 Nov; 26 (5): 317-334
0112-1642/98/0011-0317/$09.00/0

Applied Physiology of Water Polo

Heather K. Smith

Department of Sport and Exercise Science, The University of Auckland, Auckland, New Zealand

Examination of the existing evidence suggests that there are moderate demands on all 3 energy systems (aerobic, anaerobic alactic and anaerobic glycolytic) during match play. The game is intermittent in nature, requiring multiple series of brief intervals (<15 seconds) of high intensity work. These work intervals are interspersed by intervals (<20 seconds) of lower intensity work which are of insufficient duration for full recovery, and with occasional longer rest periods (i.e. between quarters). These characteristics of water polo, the heart rate and blood lactate responses during games, and the physiological characteristics of elite players, suggest a dependence upon all of the metabolic systems for the provision of energy during play. On this initial basis, I suggest that the aerobic system provides for approximately 50 to 60%, the anaerobic (alactic) system 30 to 35% and the anaerobic (glycolytic) system 10 to 15% of the energy requirements during high level, competitive water polo games.



3 ENERGY SYSTEMS			
	ATP/PC SYSTEM	ANAEROBIC GLYCOLYSIS (Lactic acid system)	AEROBIC ENERGY SYSTEM
O2 Required	No	No	Yes
Speed of energy supply	Very fast	Fast	Slow
Fuel Source	Creatine Phosphate	Carbohydrates	Carbohydrates &fats (protein in extremes)
Amount of ATP Production	Limited	Limited	Unlimited
By Products	None	Lactic acid	CO2 ,H2O & Heat
Duration	0-10sec	Up to 2min	Forever
Cause of fatigue	Limited supply ATP/PC	Lactic acid production	Unlimited
Activity	Power based activities	Sprint endurance	Long duration

Original Paper DOI: 10.5604/20831862.1083277 Biol. Sport 2014;31:33-38

RELATIONSHIPS BETWEEN HEART RATE AND PHYSIOLOGICAL PARAMETERS OF PERFORMANCE IN TOP-LEVEL WATER POLO PLAYERS

Accepted for publication 03.11.2013

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ABSTRACT: The aim of this study was to measure the heart rate (HR) response of eight elite water polo players during the four 7-min quarters of the game and to check for relationships with the physiological parameters of performance ($\dot{V}O_2$max, $Th1_{vent}$, $Th2_{vent}$). Each athlete performed a $\dot{V}O_2$max treadmill test and played a water polo game wearing a heart rate monitor. The game fatigue index was calculated as the ratio of the fourth-quarter HR to the first-quarter HR: HR4/HR1. The results showed a slight decrease in fourth-quarter HR compared with the first quarter, with the mean four-quarter HR equal to 79.9 ± 4.2% of HRmax. Stepwise multiple regression analysis showed $\dot{V}O_2$max to be the main explanatory factor of game intensity, i.e. game HR expressed in $\%HR_{reserve}$ ($R=0.88$, $P<0.01$). We observed that higher aerobic capacity resulted in higher game intensity. We also observed a decrease in the playing intensity in the fourth quarter compared with the first, likely due to very high game involvement. We concluded that high aerobic capacity seems necessary to ensure high game intensity in water polo. This suggests that coaches should encourage their athletes to reach a minimum level of $\dot{V}O_2$max and that HR monitoring could be of great interest in the control of water polo training sessions.

CONCLUSIONS

To summarise, it seems that in water polo, the higher the player's aerobic capacity, the higher the game intensity. As a result of the very high game involvement, players slightly reduce their game intensity in the fourth quarter with respect to the first. This decline in HR is significantly linked to $\dot{V}O_2$max. As water polo game HR seems to be correlated with the classic physiological variables, this finding emphasises the importance of developing aerobic capacity in training programmes for water polo players.


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Table Indices of exercise intensity for endurance sports from maximal exercise testing and training zones

Intensity	VO_2max (%)	HRmax (%)	HRR (%)	RPE Scale	Training Zone
Low intensity, light exercise[a]	<40	<55	<40	10–11	Aerobic
Moderate intensity exercise[a]	40–69	55–74	40–69	12–13	Aerobic
High intensity[a]	70–85	75–90	70–85	14–16	Aerobic + lactate
Very high intense exercise[a]	>85	>90	>85	17–19	Aerobic + lactate + anaerobic

HR_{max} = maximum heart rate; HRR = heart rate reserve; RPE = rate of perceived exertion; VO_{2max} = maximum oxygen consumption.

[a]Adapted from refs [84,85] using training zones related to aerobic and anaerobic thresholds. Low-intensity exercise is below the aerobic threshold; moderate is above the aerobic threshold but not reaching the anaerobic zone; high intensity is close to the anaerobic zone; and very intense exercise is above the anaerobic threshold. The duration of exercise will also largely influence this division in intensity.


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SCANDINAVIAN JOURNAL OF
MEDICINE & SCIENCE IN SPORTS

ORIGINAL ARTICLE | Open Access

Aerobic High-Intensity Intervals are Superior to Improve $\dot{V}O_{2max}$ Compared to Sprint Intervals in Well-Trained Men

Håkon Hov, Eivind Wang, Yi Rui Lim, Glenn Trane, Magnus Hemmingsen, Jan Hoff, Jan Helgerud

First published: 31 October 2022 | https://doi.org/10.1111/sms.14251

In conclusion, HIIT 4x4min is superior for increasing $\dot{V}O_{2max}$ compared to SIT protocols, carried out as 8x20sec and 10x30sec. Despite a lower overall intensity during HIIT 4x4min than SIT, the aerobic intensity is higher during the former. HIIT should be the recommended interval format for aerobic performance.

- Kas içeresinde erken laktat birikimi veya fosfokreatin (PC) azalması, yorgunluğa ve dolayısıyla egzersiz performansında azalmaya sebep olur.
- Gelişmiş bir kardiyo-respiratuvar sistem ve dolayısıyla yüksek VO2max değeri, laktat temizlenmesini ve fosfokreatin (PC) yeniden üretilmesini kolaylaştırırarak, müsabaka içi ve müsabakalar arası toparlanmayı (recovery) hızlandırır.
- Bu nedenle gelişmiş kardiyo-respiratuvar sistem ve yüksek VO2max değeri, yüksek su topu performansı ile ilişkilidir

- Oyunun önemli bir kısmının orta-yüksek egzersiz şiddetlerinde ve yüksek kalp hızlarında geçmesi nedeniyle aerobik metabolizma, su topu branşında temel enerji kaynağı olarak izlenmektedir.
- Erkek su topu sporcularının (ulusal ve uluslararası düzeyde) VO2max değerleri bir çok çalışmada ortalama 4.5-4.7 L/kg veya 58-61 ml/kg/dk olarak bulunmuştur.
- Bu orta-yüksek aerobik güç (VO2max), ragbi, buz hokeyi, basketbol gibi diğer intermitant, kontakt, takım sporları ile benzerlik göstermektedir.

Aerobik güç, VO2max ölçülmesi


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ATOR

- Yapılan maç analizleri, su topu sporcularının, müsabaka zamanının %55-66.9 ‘unu dikey pozisyonda, eggbeater (yumurta çırpıcı) hareketi yaptığını göstermektedir.
- Su topu branşına özel bu eggbeater (yumurta çırpıcı) hareketinin temel alındığı ve bisiklet ergometresi ile karşılaştırıldığı bu çalışmada benzer VO2max değerleri saptanmıştır.
- Bu bulgular ışığında, su topu branşına spesifik bir yöntem olarak, gaz analizörü eşliğinde VO2max ölçümlerinde bu test spesifik ve geçerli bir yöntem olarak belirtilebilir.

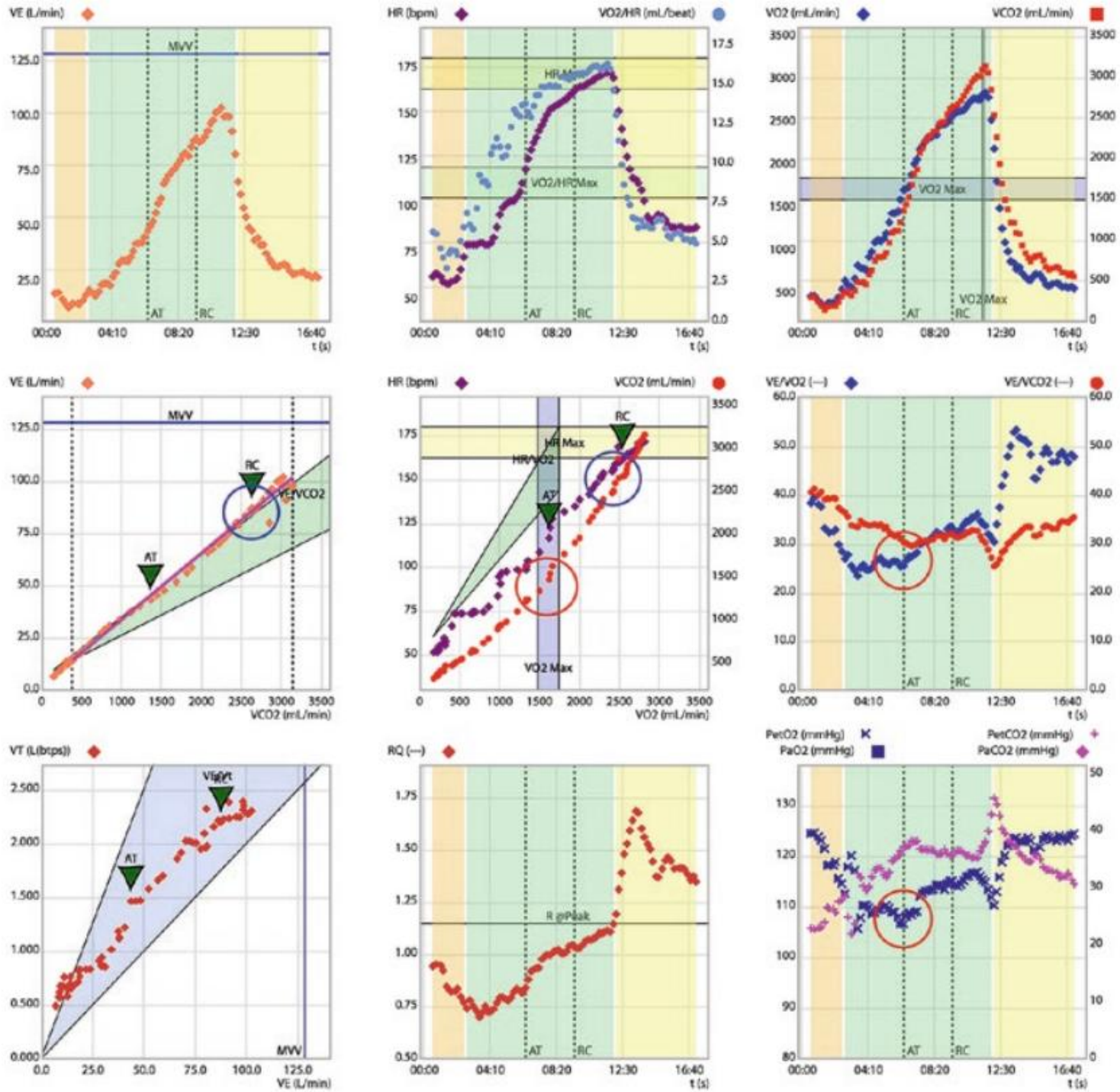
did not differ, and it presented agreement with the results obtained on land on the cycle ergometer.

- Therefore, it can be concluded that the eggbeater kick test is a specific and valid protocol to asses VO2 max in water polo players.

Sözün özü

- Yüksek hacim ve şiddette uzun süre yapılan spor dolaşım sistem ve kalpte bazı değişiklikler yapar. Bu değişikliklerin bir kısmı fizyolojik sınırı aşarak patolojik boyuta ulaşabilir. Bu sporcuların riskini önlemek için düzenli kontroller önemli.
- Ani kardiyak ölüm nadir ama önemli bir komplikasyon. Tüm sporcu ve antrenörlerin temel yaşam desteğini öğrenmesi gerekmekte. Spor yapılan yerlerde AED cihazlarının ulaşılabilir sayıda ve faal olarak bulundurulması uygundur.
- Su topu, yüksek egzersiz şiddetlerinde yapılan bir spor. Başarının mimarları olan siz antrenörlerin VO2max (aerobik gücü) arttırıcı planlamalar yapması başarıyı arttıracaktır.
- VO2max ölçüm ve takibinde saha ve laboratuvar testleri kullanılabilir.

Dikkatiniz için teşekkürler..



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