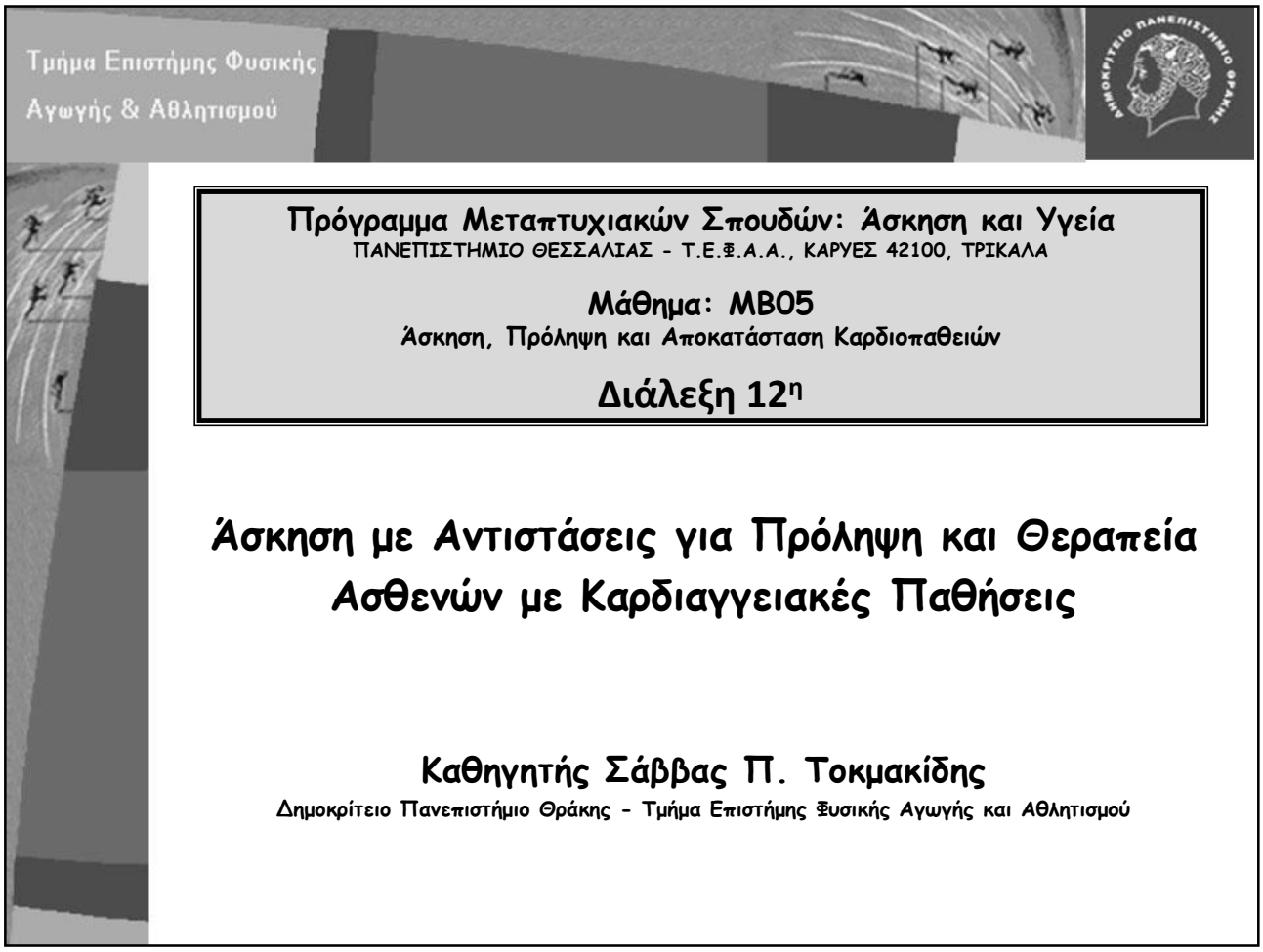


Πρόγραμμα Μεταπτυχιακών Σπουδών: Άσκηση και Υγεία

ΠΑΝΕΠΙΣΤΗΜΙΟ ΘΕΣΣΑΛΙΑΣ - Τ.Ε.Φ.Α.Α., ΚΑΡΥΕΣ 42100, ΤΡΙΚΑΛΑ

Μάθημα: MB05

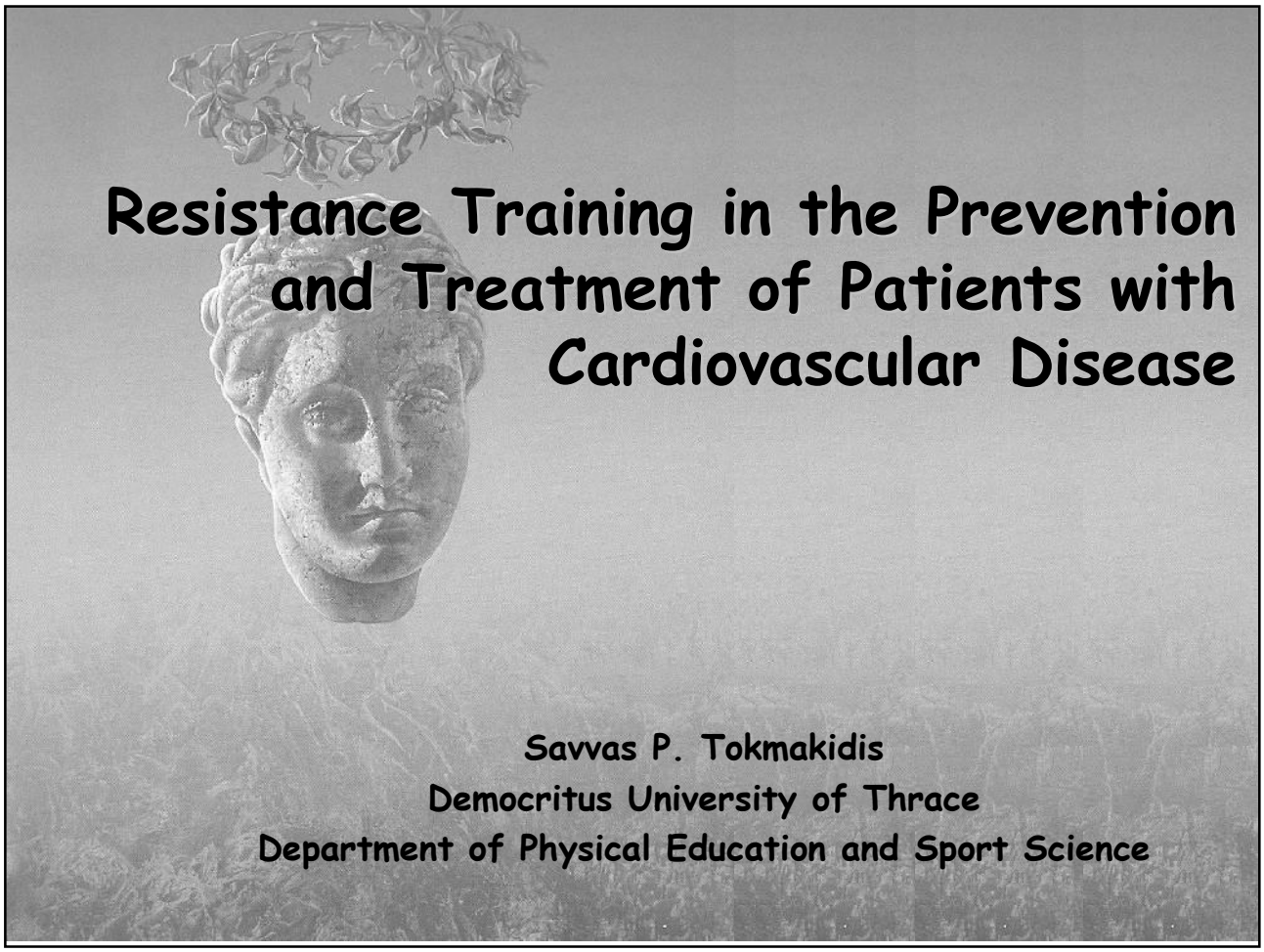
Άσκηση, Πρόληψη και Αποκατάσταση Καρδιοπαθειών

Διάλεξη 12η

Άσκηση με Αντιστάσεις για Πρόληψη και Θεραπεία Ασθενών με Καρδιαγγειακές Παθήσεις

Καθηγητής Σάββας Π. Τοκμακίδης

Δημοκρίτειο Πανεπιστήμιο Θράκης - Τμήμα Επιστήμης Φυσικής Αγωγής και Αθλητισμού



Resistance Training in the Prevention and Treatment of Patients with Cardiovascular Disease

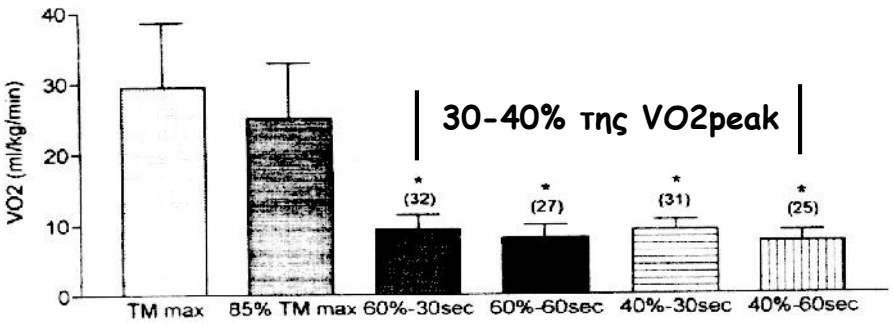
Savvas P. Tokmakidis
Democritus University of Thrace
Department of Physical Education and Sport Science

Historical background

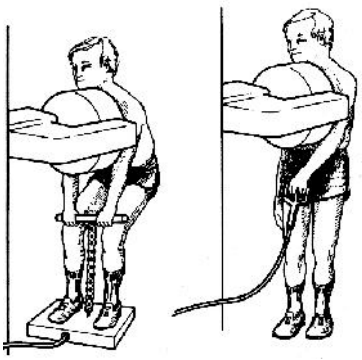
- Until 1950 exercise focused on cardiovascular health
- After 1950 resistance protocols were introduced in the rehabilitation programs of veterans in order to improve muscle mass and strength
- 1980-2000 resistance training was widely used in the prevention and rehabilitation of many chronic diseases including cardiovascular disease
- >2000 first guidelines published from ACSM, AHA, ADA

Safety Aspects of Resistance Exercise in Patients with Cardiovascular Disease

Resistance Exercise, Oxygen Cost and Left Ventricular Function

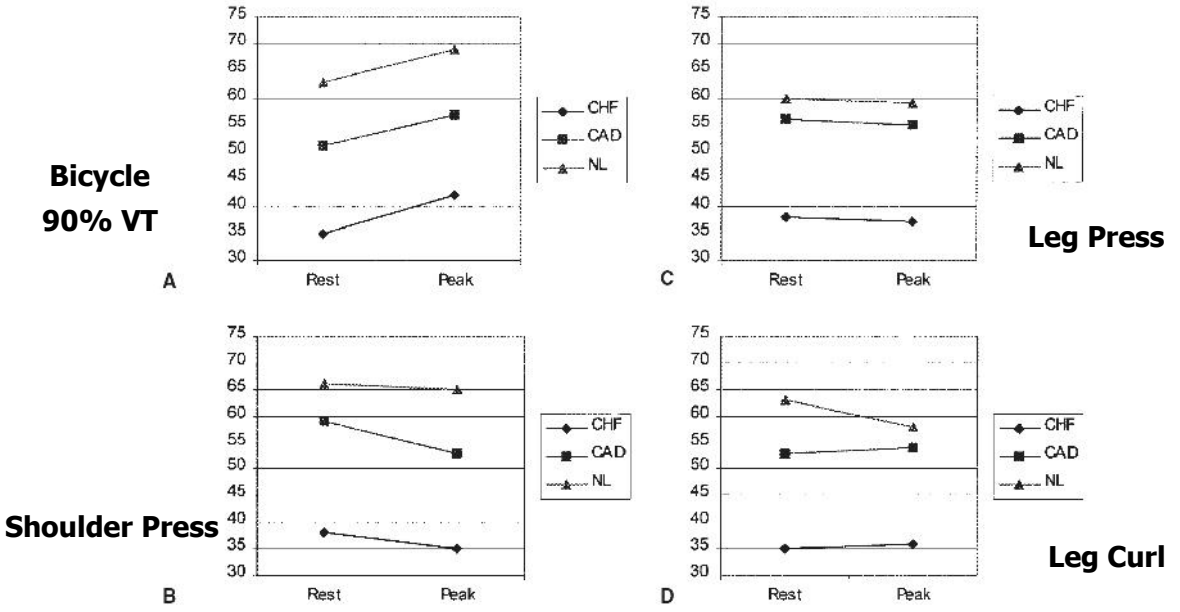


De Groot et al. (1998). J Cardiopulm Rehabil; 18: 145-152



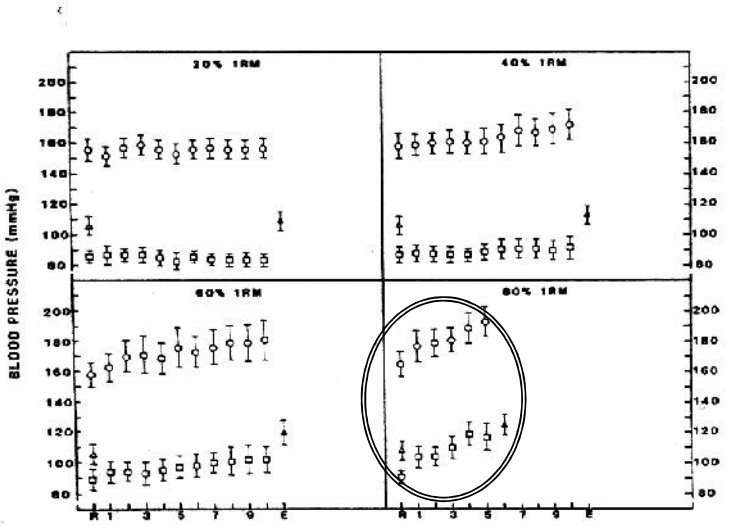
Sagiv et al. (1985). Am J Cardiol; 58: 785-790

Changes in Left Ventricular Ejection Fraction during Resistance Exercise in Cardiac Patients



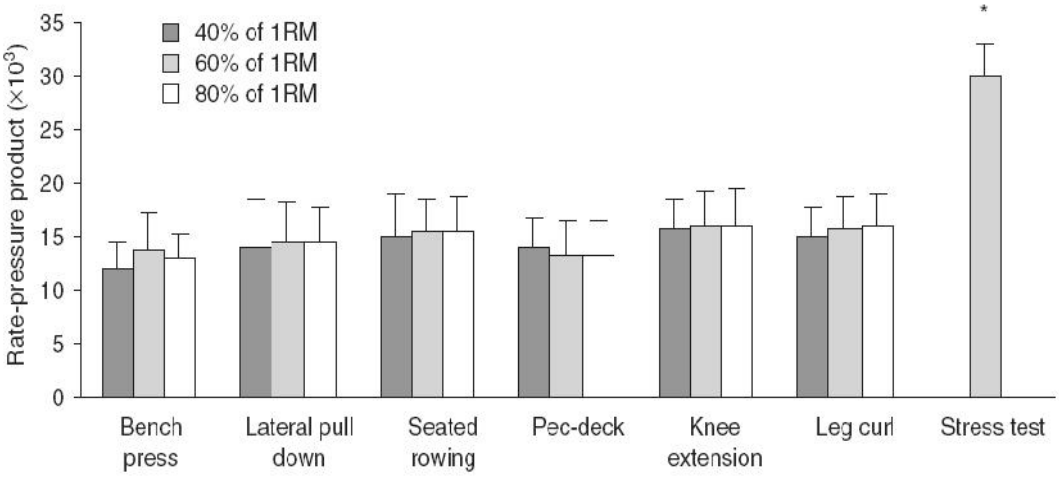
Karlsdottir et al. (2002). J Cardiopulm Rehabil; 22: 170-177

Systolic and Diastolic Pressure Alterations during Resistance Exercise of Different Intensities

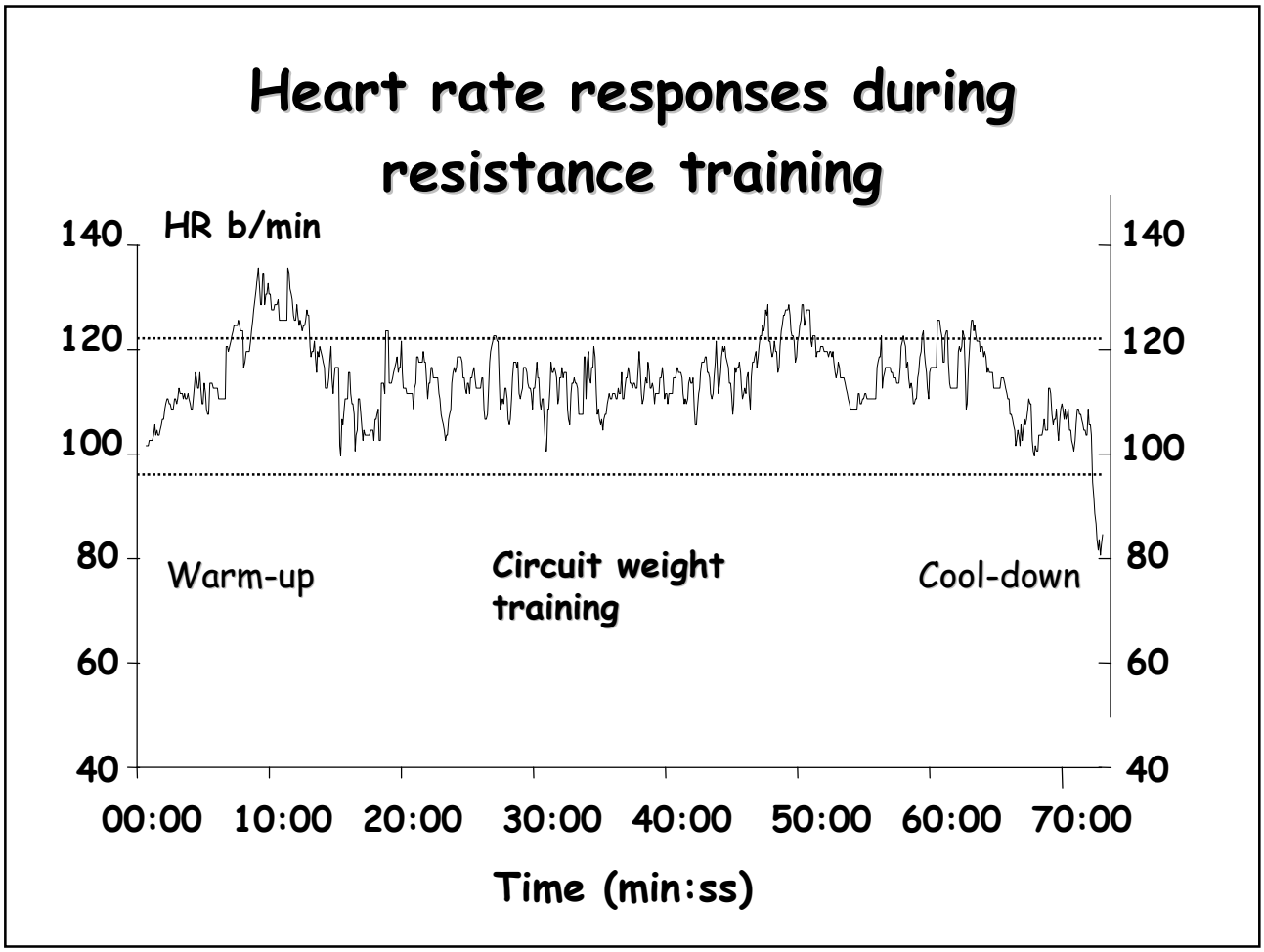


Haslam et al. (1988). J Cardiopulm Rehabil; 8: 213-215

Rate Pressure Product during Resistance Exercise in Patients with CAD



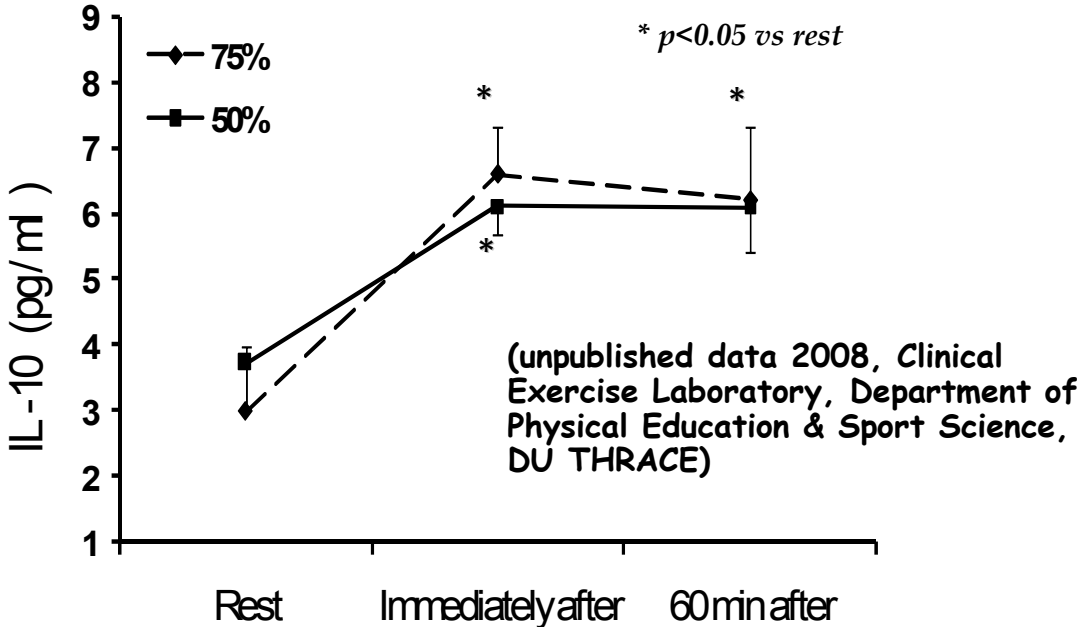
Volaklis & Tokmakidis (2005), Sports Med 35(12): 1085-1103


Heart rate responses during resistance training
HR b/min
140
120
100
80
60
40
Warm-up
Circuit weight training
Cool-down
00:00
10:00
20:00
30:00
40:00
50:00
60:00
70:00
Time (min:ss)

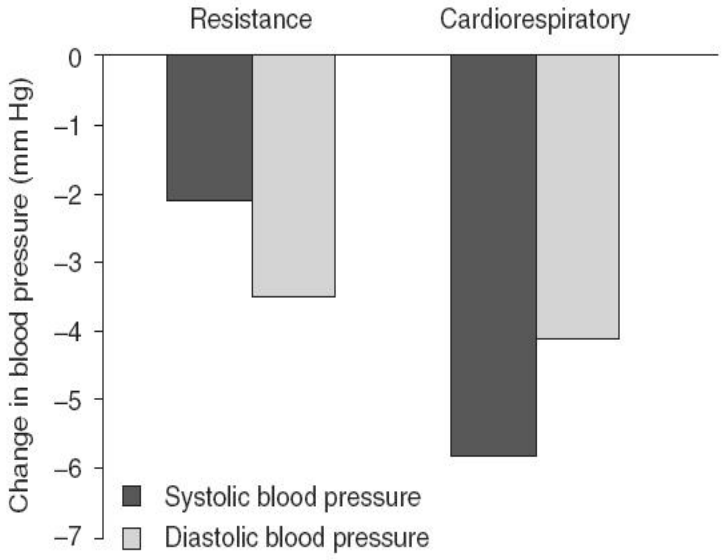
Anti-inflammatory Responses after Resistance Protocols in Patients with CAD

Inflammatory Responses after Resistance Exercise

- TNF-α, INF-γ, IL-6 : NS alterations
- IL-10 : Significant alterations

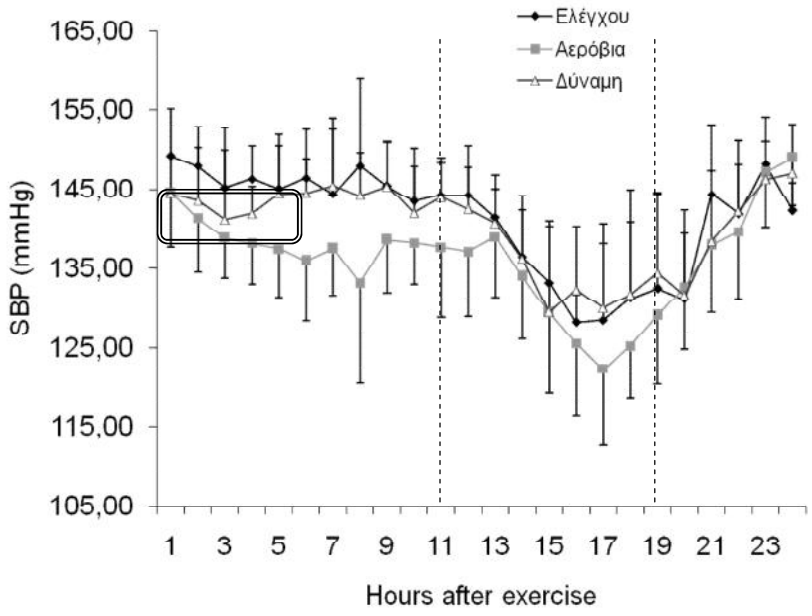


Long-term Blood Pressure Adaptations after Resistance and Aerobic Training



Wallace et al. (2003), Sports Med 33: 585-598

24-h Ambulatory Systolic Pressure Records after a Single Resistance & Aerobic Exercise Session in Patients with Stage I Hypertension



(unpublished data 2009, Clinical Exercise Laboratory, Department of Physical Education & Sport Science, DU THRACE)

Μεταβολή του διπλού γινόμενου με την προπόνηση με βάρη

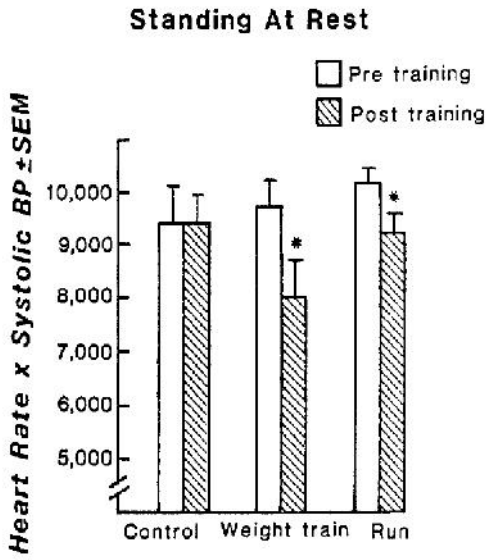


Figure 1. Resting rate pressure product ±*SEM* before and after 16 weeks among the 3 groups. *$p \leq 0.05$

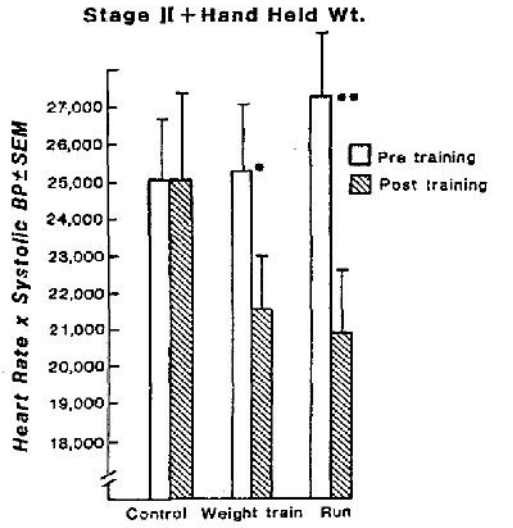


Figure 4. Rate pressure product ±*SEM* during mixed exercise (treadmill walking at 2.5 mph at 12% grade) while carrying a 9.07-kg weight before and after 16 weeks among the 3 groups. *$p < 0.05$; **$p < 0.01$

Τρέξιμο: **20 – 45 min στο 85% HRmax, 3 φορές την εβδομάδα, 16 εβδομάδες**
Βάρη: **8 ασκήσεις, 3 x 3-8 επαναλήψεις, 2 min διάλειμμα, 3 φορές την εβδομάδα, 16 εβδομάδες**
Υγιείς άνδρες ηλικίας 37 ± 4 χρόνων

Goldberg et al. *J. Strength and Cond. Res. 8*(4): 219-224, 1994.

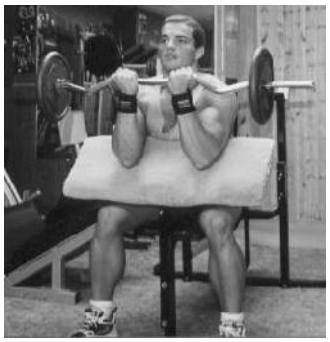
Συχνότητα Εμφράγματος σε Υπερτασικά και Νορμοτασικά Άτομα ανάλογα με τη Φυσική Δραστηριότητα

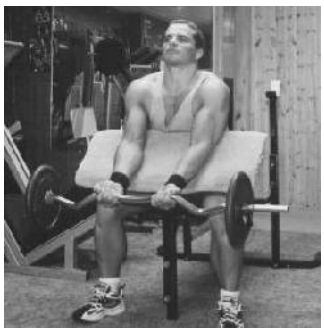
Shaper et al. (1994). J Hum Hypertens; 8: 3-10

Isometric versus Dynamic Resistance Exercise Protocols

Resistance exercise or weight lifting

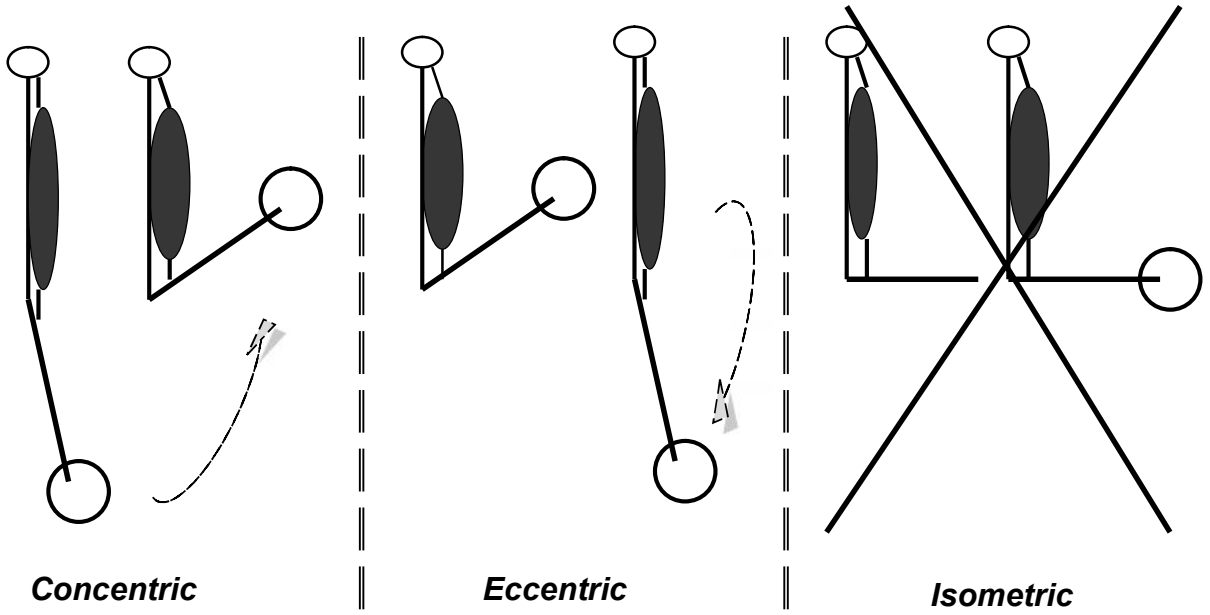
(combination of dynamic and static contraction)

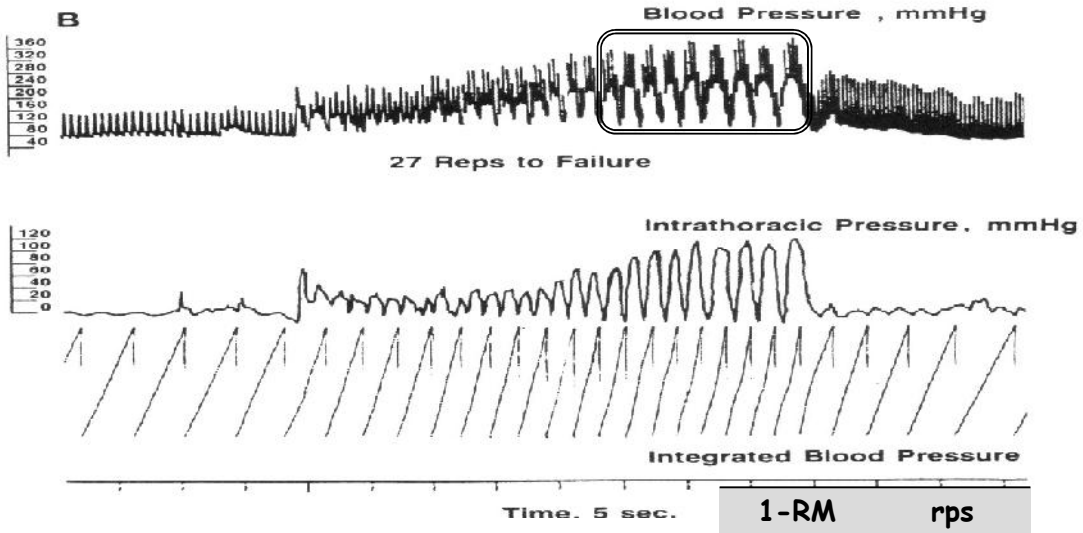




- Start lifting: static (isometric) contraction
- Raise the weight: dynamic, concentric (shortening)
- Lower the weight: dynamic, eccentric (lengthening)
- Relaxation phase: varies between successive lifts

Types of Muscle Activation during Resistance Exercise





Intra-thoracic and Intra-arterial Pressure during Leg Press Resistance Exercise

MacDougall et al. 1992

1-RM	rps
100	1
95	2 – 3
90	4 – 5
85	6 – 8
80	8 – 10
75	10 – 12
70	12 – 14
65	14 – 16
60	17 – 20

Muscular Strength as a Predictor of Mortality

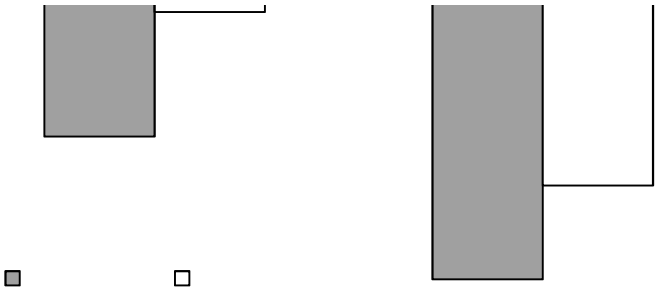
Epidemiological Data

Several studies during the last decade demonstrated that muscular strength is inversely and independently associated with death from cardiovascular disease, even after adjusting for cardiorespiratory fitness

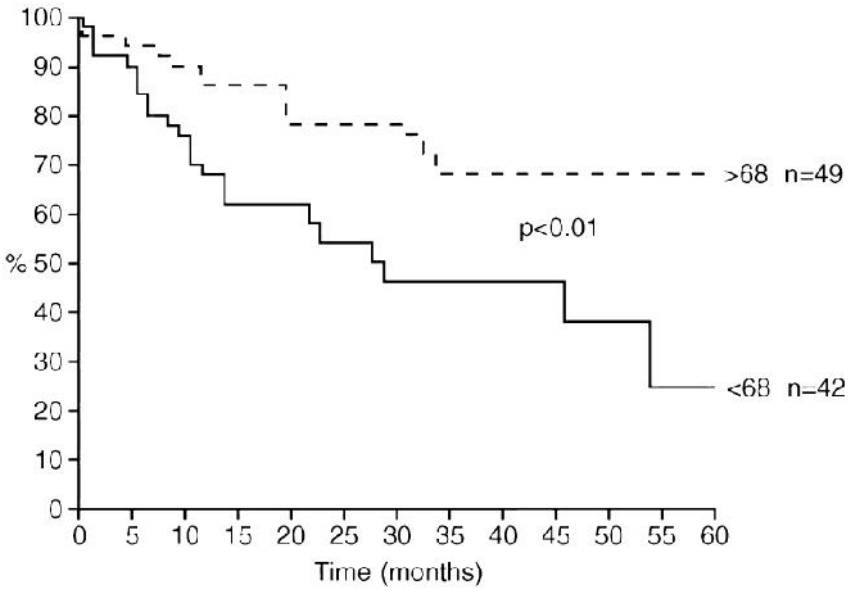
Ruiz et al. (2008). Br Med J; 337: 92-95
Sasaki et al. (2007). Am J Med; 120: 337-342
Gale et al. (2007). Int J Epidemiol; 36: 228-235
Metter et al. (2002). Med Sci Sports Exerc; 36: B359-365
Tanasescu et al. (2002). JAMA; 288: 1994-2000

Relative Risk of Coronary Heart Disease Associated with Resistance Training

n=8205, 25-69 yrs, 1977-1995
Tanasescu et al. (2002); *JAMA* 288: 1994-2000



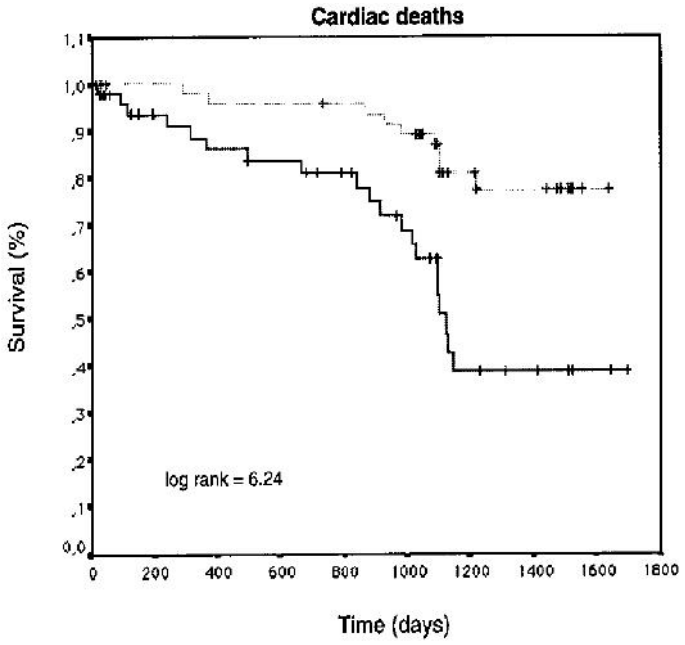
Association between Muscular Strength and Survival in Patients with Heart Failure



Huelschman et al. Eur J Heart Fail 2004; 6: 101-107

Άσκηση με Βάρη σε Ασθενείς με Καρδιακή Ανεπάρκεια

Μείωση θανάτων μετά από άσκηση σε ασθενείς με καρδιακή ανεπάρκεια

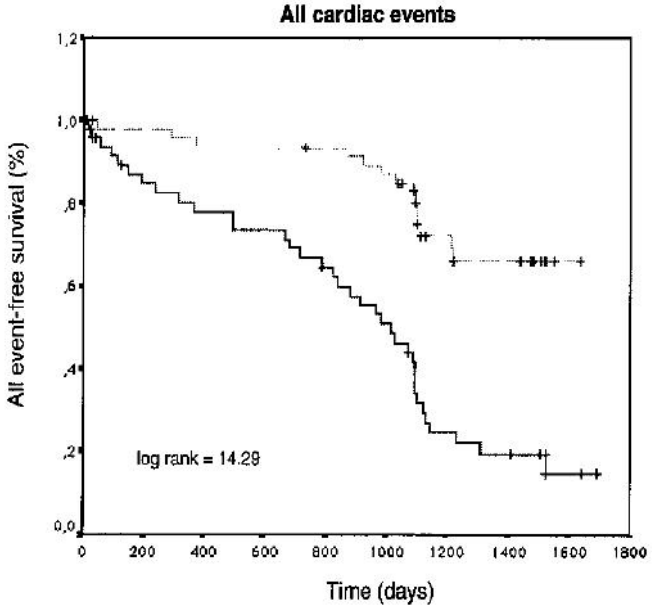


Exercise

Control

Belardinelli et al. (1999), *Circulation* 342: 454-460

Μείωση καρδιαγγειακών επεισοδίων μετά από άσκηση σε ασθενείς με καρδιακή ανεπάρκεια

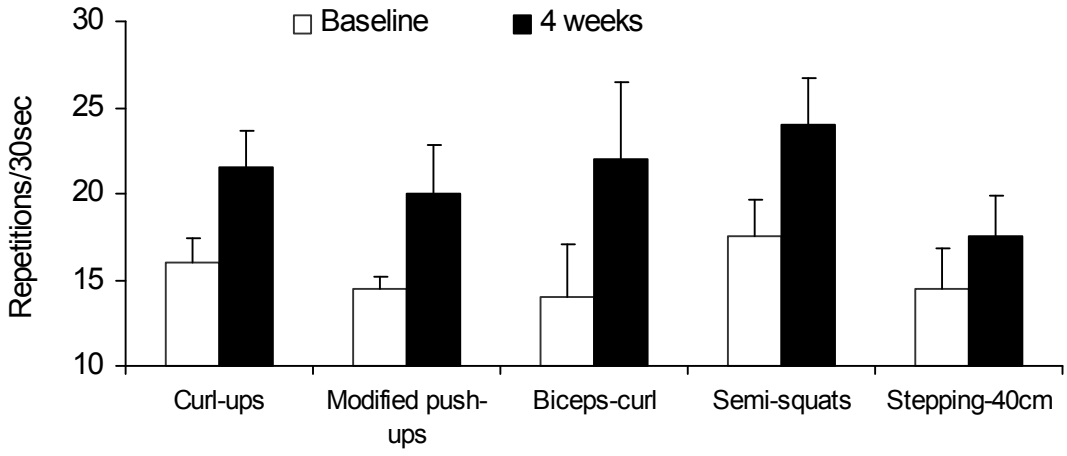


Exercise

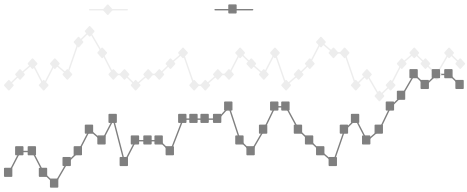
Control

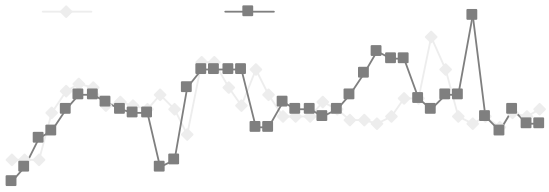
Belardinelli et al. (1999), *Circulation* 342: 454-460

Improvement of muscular strength in patients with heart failure

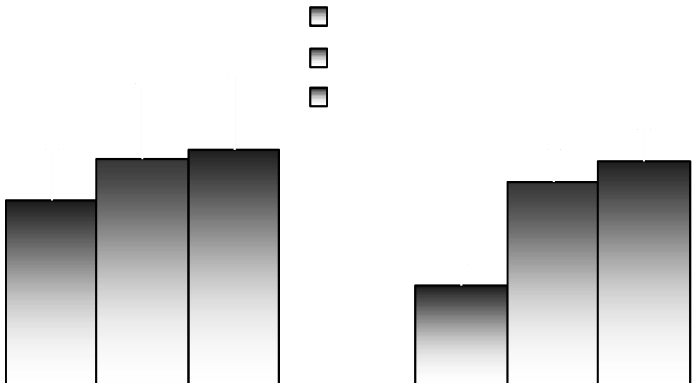


Heart rate responses in patients with heart failure



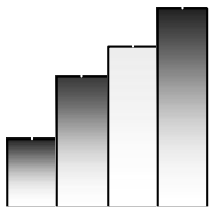


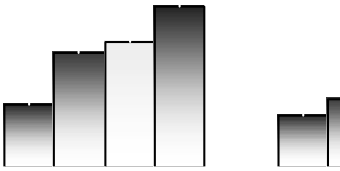
Muscular Strength Improvements after 14 weeks of a Combined Program in patients with HF

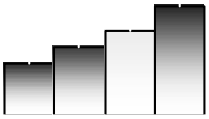


(unpublished data 2004, Clinical Exercise Laboratory, Department of Physical Education & Sport Science, DU THRACE)

Βελτίωση μυϊκής αντοχής







Comparison of the Effects of Aerobic to Resistance Training on Health and Fitness Variables

Variable	Aerobic Exercise	Resistance Exercise
Bone mineral density	↑	↑ ↑ ↑
Body composition		
Fat mass	↓ ↓	↓
Muscle mass	↔	↑ ↑
Strength	↔	↑ ↑ ↑
Glucose metabolism		
Insulin response to glucose challenge	↓ ↓	↓ ↓
Basal insulin levels	↓	↓
Insulin sensitivity	↑ ↑	↑ ↑
Serum lipids		
High-density lipoprotein	↑ ↔	↑ ↔
Low-density lipoprotein	↓ ↔	↓ ↔
Resting heart rate	↓ ↓	↔
Blood pressure at rest		
Systolic	↓ ↓	↓
Diastolic	↓ ↓	↓
Physical endurance	↑ ↑ ↑	↑ ↑
Basal metabolism	↑	↑ ↑

Braith et al. (2006), Circulation 113: 2642-2650

Resistance Exercise in the Treatment of Cardiovascular Disease

Guidelines for Training

AHA Scientific Statement

Resistance Exercise in Individuals With and Without Cardiovascular Disease: 2007 Update

A Scientific Statement From the American Heart Association Council on Clinical Cardiology and Council on Nutrition, Physical Activity, and Metabolism

Mark A. Williams, PhD, Co-Chair; William L. Haskell, PhD, FAHA, Co-Chair; Philip A. Ades, MD; Ezra A. Amsterdam, MD; Vera Bittner, MD; Barry A. Franklin, PhD; Meg Gulanick, RN, PhD; Susan T. Laing, MD; Kerry J. Stewart, EdD

Abstract—Prescribed and supervised resistance training (RT) enhances muscular strength and endurance, functional capacity and independence, and quality of life while reducing disability in persons with and without cardiovascular disease. These benefits have made RT an accepted component of programs for health and fitness. The American Heart Association recommendations describing the rationale for participation in and considerations for prescribing RT were published in 2000. This update provides current information regarding the (1) health benefits of RT, (2) impact of RT on the cardiovascular system structure and function, (3) role of RT in modifying cardiovascular disease risk factors, (4) benefits in selected populations, (5) process of medical evaluation for participation in RT, and (6) prescriptive methods. The purpose of this update is to provide clinicians with recommendations to facilitate the use of this valuable modality. (*Circulation*. 2007;116:572-584.)

Absolute and Relative Contraindications to Resistance Training in Cardiac Patients

Williams et al. (2007), Circulation 116: 572-584

Absolute
Unstable CHD
Decompensated HF
Uncontrolled arrhythmias
Severe pulmonary hypertension (mean pulmonary arterial pressure >55 mm Hg)
Severe and symptomatic aortic stenosis
Acute myocarditis, endocarditis, or pericarditis
Uncontrolled hypertension (>180/110 mm Hg)
Aortic dissection
Marfan syndrome
High-intensity RT (80% to 100% of 1-RM) in patients with active proliferative retinopathy or moderate or worse nonproliferative diabetic retinopathy
Relative (should consult a physician before participation)
Major risk factors for CHD
Diabetes at any age
Uncontrolled hypertension (>160/>100 mm Hg)
Low functional capacity (<4 METs)
Musculoskeletal limitations
Individuals who have implanted pacemakers or defibrillators

Requirements for Participation in Resistance Exercise Programs

- Ejection fraction > 45%
- Functional capacity > 7 METs
- Appropriate HR and BP responses during cardiopulmonary stress testing
- No angina during exercise
- Absence of arrhythmias
- Participation in aerobic training for 8 weeks

ACSM 1998

Termination Criteria for Resistance Exercise in Patients with CAD

- Moderate to severe angina
- Drop of heart rate > (> 10 b/min)
- Drop of blood pressure >10 mmHg from baseline BP
- Hypertensive response (SP >220, DP >110 mmHg)
- Increasing nervous system symptoms
- Signs of poor perfusion

ACSM 1998

Cardiac Rehabilitation Resistance Training Guidelines by Diagnosis

Diagnosis	Guidelines from the American Association of Cardiovascular and Pulmonary Rehabilitation	Guidelines from the American College of Sports Medicine
Myocardial infarction	1- to 3-lb hand weights on cardiac rehabilitation program entry; traditional resistance training at 5 weeks if 4 weeks of supervised endurance training have been completed	Traditional resistance training at 3 months; 1- to 3-lb hand weights 2 weeks after myocardial infarction
Percutaneous coronary intervention	1- to 3-lb hand weights on cardiac rehabilitation program entry; traditional resistance training at 3 weeks if 2 weeks of supervised endurance training have been completed	2 weeks of aerobic exercise prior to traditional resistance training

ACSM 2000, AACPR 2004

Forces Required to Perform 32 Activities of Daily Living in CAD patients

Activity*	Force lbs
Lifting 1-lb dumbbell	2
Lifting 3-lb dumbbell	4
Lifting 5-lb dumbbell	6
Lifting 10-lb dumbbell	12.5
Pushing open door to cardiac rehabilitation	15.5
Pulling open door to leave cardiac rehabilitation	22
Pushing open cardiac rehabilitation bathroom door	12.5
Pulling open door to leave cardiac rehabilitation bathroom	11
Pushing door to exit cardiac rehabilitation building	13
Pulling door to enter cardiac rehabilitation building	13.5
Opening door to enter Baylor University Medical Center	15
Pushing door to exit Baylor University Medical Center	22.5
Pulling open door at doctor's office	14.5
Pushing doctor's office door to leave	15.5
Pushing door to enter hospital room	6.5
Pushing IV pole with full drip bag across carpet	6.5
Hold elevator door from closing	14.5
Opening refrigerator	9
Opening refrigerator freezer	10.5
Pulling 1 gallon of milk from refrigerator	10.5
Lifting 1 gallon of milk	10.5
Closing microwave door	6.5
Pulling open oven door	6.5
Pulling out full dishwasher rack	5
Lifting full laundry hamper	21.5
Pushing vacuum cleaner	7.5
Pulling vacuum cleaner	8.5
Flushing industrial toilet	13.5
Lifting purse	7.5
Pulling full file drawer	10
Lifting copy machine lid	6
Lifting full coffee pot	6.5
Pushing with aid of right arm to rise off bench	27.5
Pulling chair across linoleum floor	5
Opening car door	12.5
Lifting a Dallas phone book	4.5

Adams et al. (2006), Am J Cardiology 97: 281-286

Summary of Exercise Programming Recommendations for Stroke Survivors

Mode of Exercise	Major Goals	Intensity/Frequency/Duration
Aerobic		
• Large-muscle activities (eg, walking, treadmill, stationary cycle, combined arm-leg ergometry, arm ergometry, seated stepper)	• Increase independence in ADLs • Increase walking speed/efficiency • Improve tolerance for prolonged physical activity • Reduce risk of cardiovascular disease	• 40%–70% peak oxygen uptake; 40%–70% heart rate reserve; 50%–80% maximal heart rate; RPE 11–14 (6–20 scale) • 3–7 d/wk • 20–60 min/session (or multiple 10-min sessions)
Strength		
• Circuit training • Weight machines • Free weights • Isometric exercise	• Increase independence in ADLs	• 1–3 sets of 10–15 repetitions of 8–10 exercises involving the major muscle groups • 2–3 d/wk
Flexibility		
• Stretching	• Increase ROM of involved extremities • Prevent contractures	• 2–3 d/wk (before or after aerobic or strength training) • Hold each stretch for 10–30 seconds
Neuromuscular		
• Coordination and balance activities	• Improve level of safety during ADLs	• 2–3 d/wk (consider performing on same day as strength activities)

Gordon et al. Circulation 2004; 109: 2031-2041

Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION

American Heart Association®

AHA Scientific Statement

Exercise Standards for Testing and Training

A Scientific Statement From the American Heart Association

Gerald F. Fletcher, MD, FAHA, Chair; Philip A. Ades, MD, Co-Chair; Paul Kligfield, MD, FAHA, Co-Chair; Ross Arena, PhD, PT, FAHA; Gary J. Balady, MD, FAHA; Vera A. Bittner, MD, MSPH, FAHA; Lola A. Coke, PhD, ACNS, FAHA; Jerome L. Fleg, MD; Daniel E. Forman, MD, FAHA; Thomas C. Gerber, MD, PhD, FAHA; Martha Gulati, MD, MS, FAHA; Kushal Madan, PhD, PT; Jonathan Rhodes, MD; Paul D. Thompson, MD; Mark A. Williams, PhD; on behalf of the American Heart Association Exercise, Cardiac Rehabilitation, and Prevention Committee of the Council on Clinical Cardiology, Council on Nutrition, Physical Activity and Metabolism, Council on Cardiovascular and Stroke Nursing, and Council on Epidemiology and Prevention

Circulation. 2013;128:873-934; originally published online July 22, 2013;

Table 7. General Guidelines for Endurance and Resistance Training

Endurance training	
Frequency	≥5 d/wk
Intensity	55%–90% maximum predicted HR* or 40%–80% $\dot{V}o_2$max or HR reserve RPE 12–16
Modality	Walking, treadmill, cycling, etc
Duration	30–60 min
Resistance training	
Frequency	2–3 d/wk
Intensity	50%–80% of 1-RM or RPE 12–16 1–3 sets of 8–15 repetitions per exercise
Modality	Lower extremity: leg extensions, leg curls, leg press. Upper extremity: bench press, lateral pulldowns, biceps curl, triceps extension
Duration	30–45 min

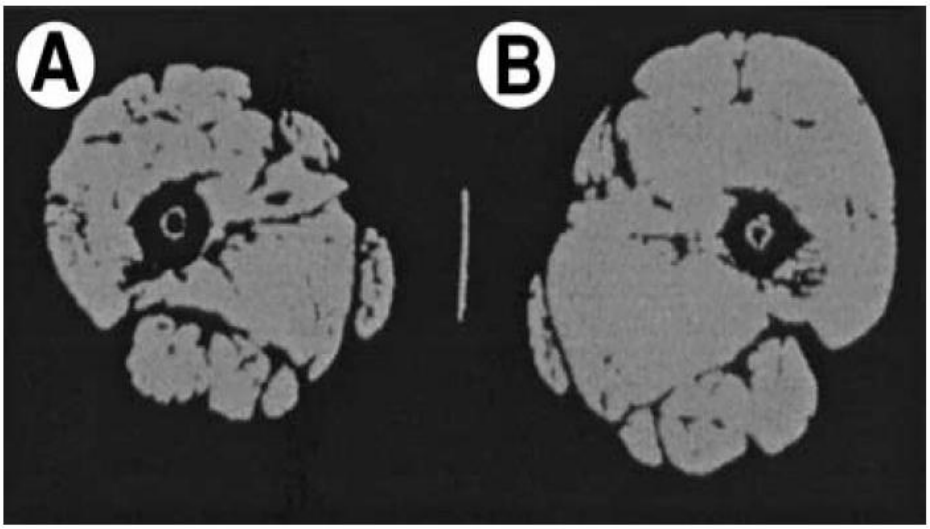
American Heart Association®

Circulation. 2013;128:873-934;

Resistance Training in the Treatment of Cardiovascular Disease

Chronic Adaptations

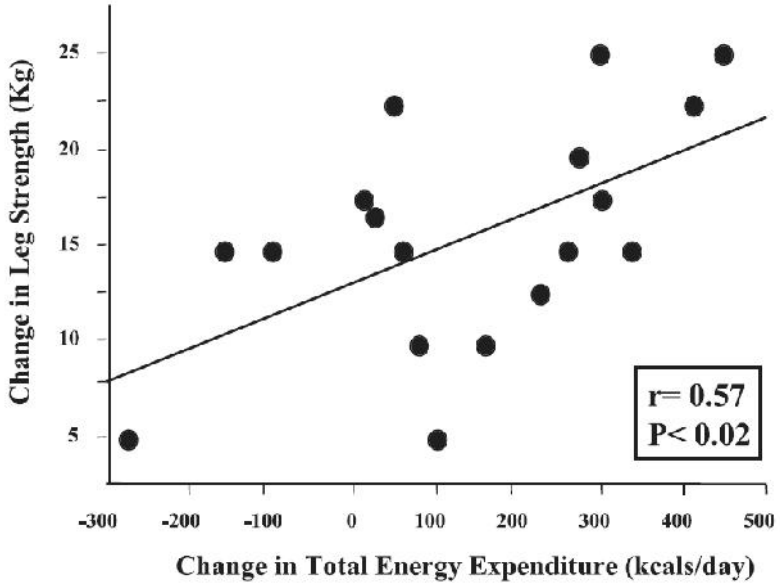
Cross Sectional Area after 40 Sessions of Resistance Training in a Patient with Heart Failure



Feiereisen et al. (2004). Eur J Cardiovasc Prev Rehabil 11: 35-39

Association between Muscular Strength and RMR after Exercise in patients with CAD

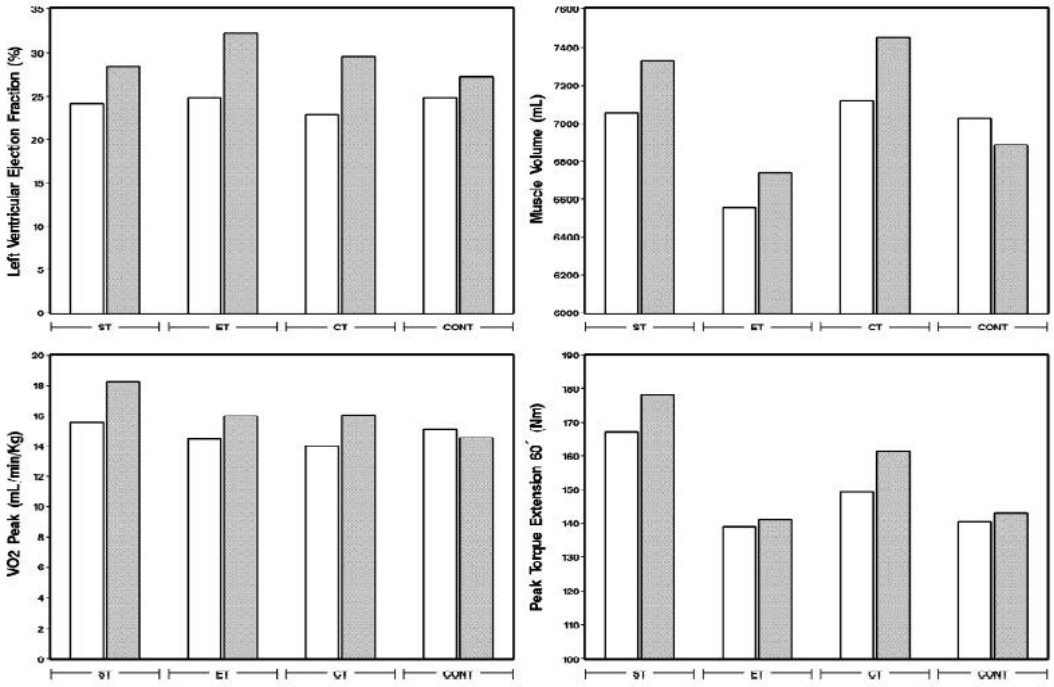
Βελτίωση μεταξύ της μυϊκής δύναμης και αερόβιας άσκησης σε γυναίκες ασθενείς διαβήτη τύπου 2



Ades et al. J Appl Physiol 2005; 98: 1280-1285

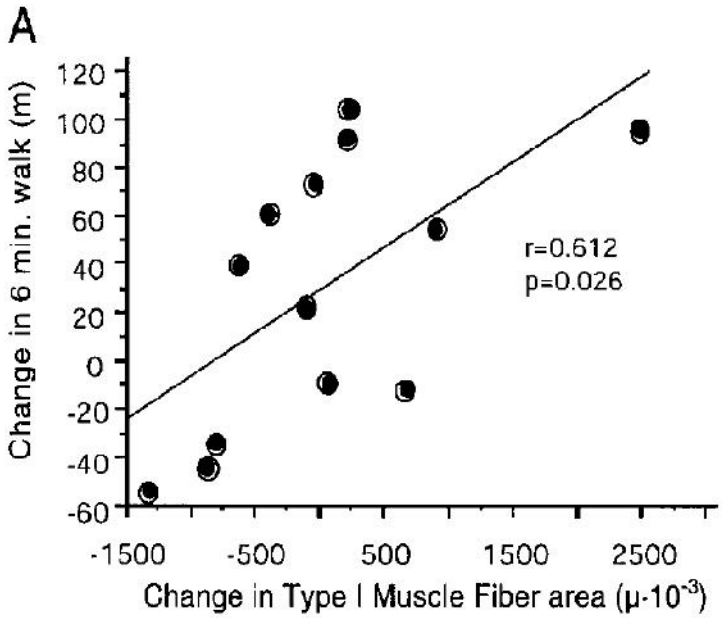
Tokmakidis et al. Eur J Appl Physiol 2006; 97: 437-442

Physiological Adaptations after Three Different Training Modalities in Patients with HF



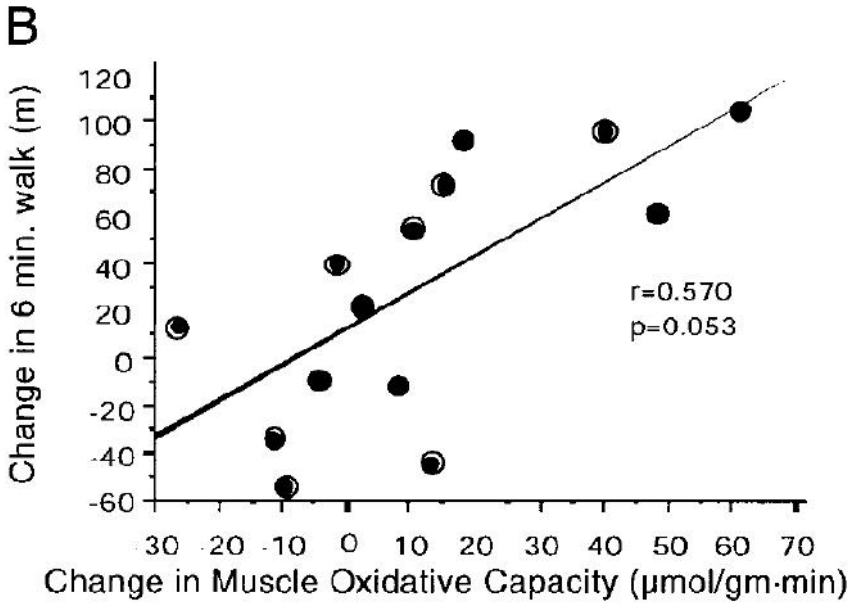
Feiereisen et al. (2007). Med Sci Sports Exerc; 11: 1910-1917

Change in Type I Muscle Fiber Area after Resistance Training in Patients with Heart Failure



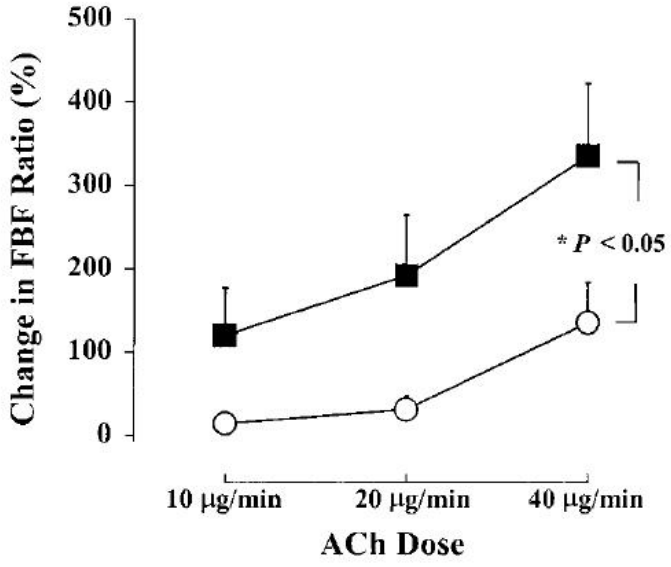
Pu et al. (2001), J Appl Physiol 342: 454-460

Change in Muscle Oxidative Capacity after Resistance Training in Patients with Heart Failure



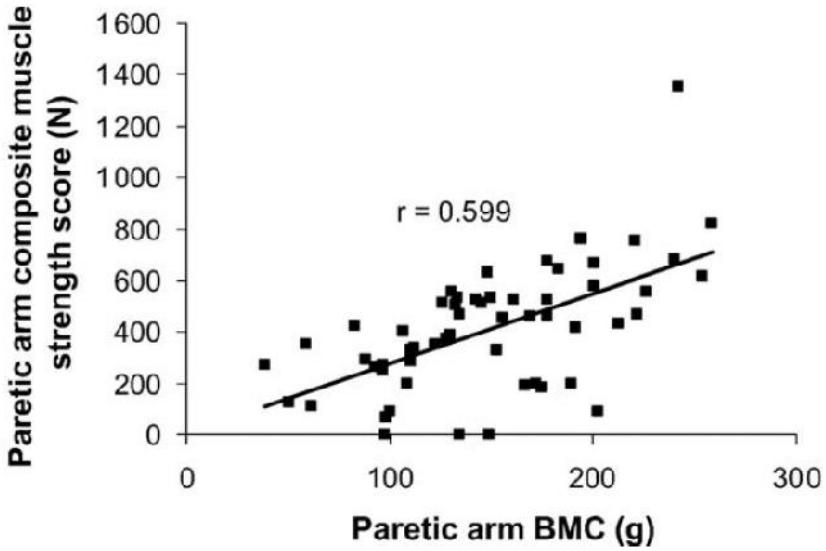
Pu et al. (2001), J Appl Physiol 342: 454-460

Forearm Blood Flow Response after 8 Weeks of Circuit Weight Training in Patients with HF



Maiorana et al. (2000), Am J Physiol Heart Circ Physiol 279: H19999-H2005

Association between Muscular Strength and BMC after Exercise in Patients with Stroke



Marco et al. (2005). Bone 37: 103-111

Χαρακτηριστικά Άσκησης με Βάρη

Cirquit weight training
(κυκλική προπόνηση με αντιστάσεις)

Χαρακτηριστικά Άσκησης με Βάρη σε Ασθενείς με Χρόνιες Παθήσεις

Προϋποθέσεις ασφαλούς συμμετοχής

- **Κλάσμα εξώθησης > 45%**
- **Λειτουργική ικανότητα > 7 METs**
- **Απουσία υποτασικής ή υπερτασικής απάντησης στην κόπωση**
- **Έλλειψη στηθαγχικών συμπτωμάτων κατά την άσκηση**
- **Απουσία κοιλιακών αρρυθμιών**
- **Συμμετοχή σε αερόβια άσκηση για 8 εβδομάδες**

ACSM 1998, AHA 2007

Άσκηση με Βάρη σε Ασθενείς με Στεφανιαία Νόσο

- **Επίσημες συστάσεις από την Αμερικανική Καρδιολογική Εταιρεία για εφαρμογή της άσκησης με βάρη στα προγράμματα άσκησης καρδιοπαθών**

Fletcher et al. *Circulation* 1995; 91: 580-615

Pollock et al. *Circulation* 2000; 101: 828-833

Williams et al. Circulation 2007; 116: 572-584

Training program
(Exercise prescription)

AEROBIC EXERCISE
(2 days per week)

- **60-80% of HRmax**
- **5 min warm-up**
- **45 min treadmill or**
- **aerobic activities**
- **5 min cool-down**
  (stretching exercises)

RESISTANCE EXERCISE
(2 days per week)

- **40-60% of 1 RM**
- **8 exercises**
- **12 repetitions, 3 sets**
- **Circuit weight training**
- **5 min cool-down**
  (stretching exercises)

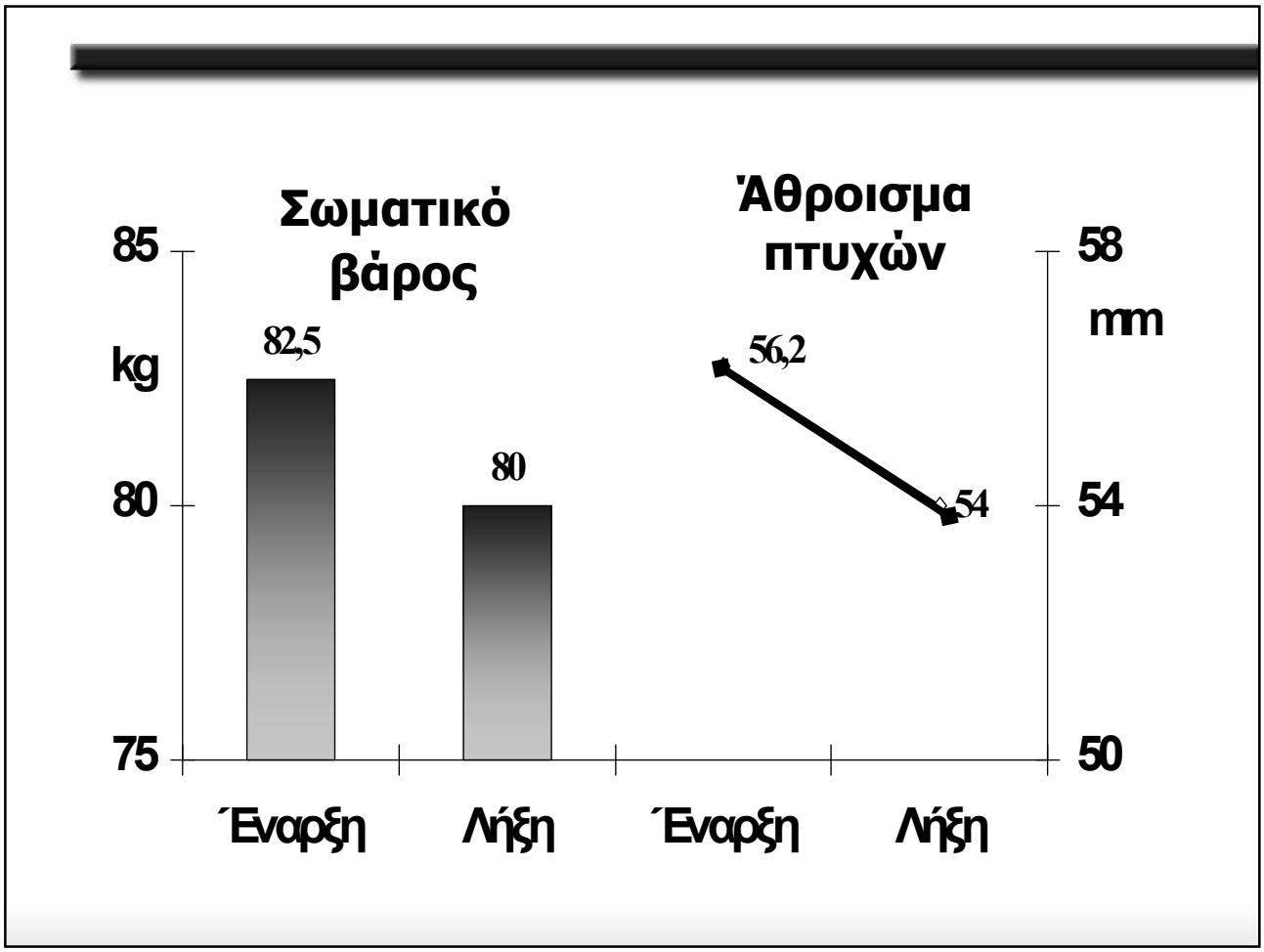
Exercise training programs in patients with coronary artery disease

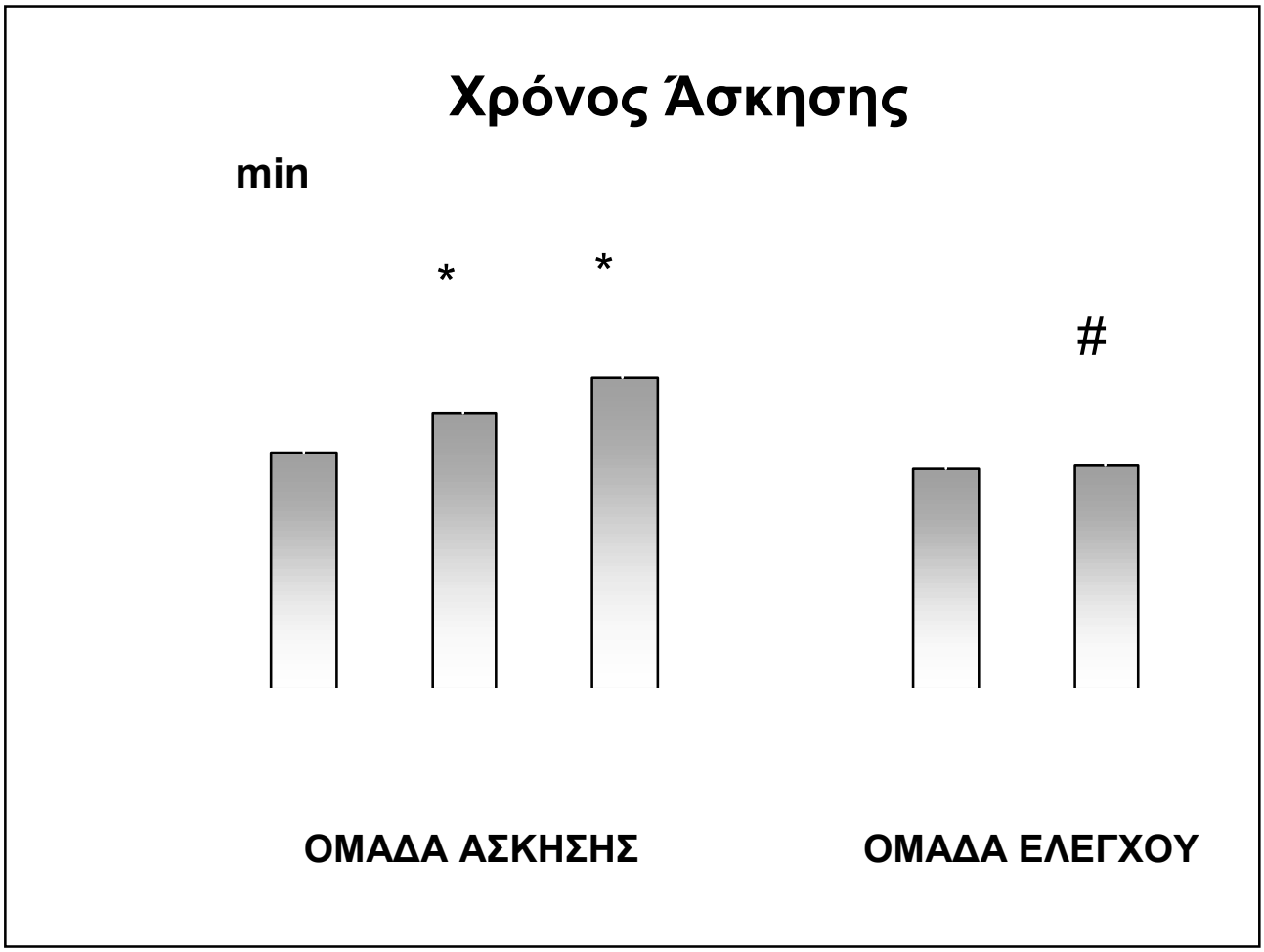
Results after a combined strength and aerobic exercise training program

(Duration: 8 months)

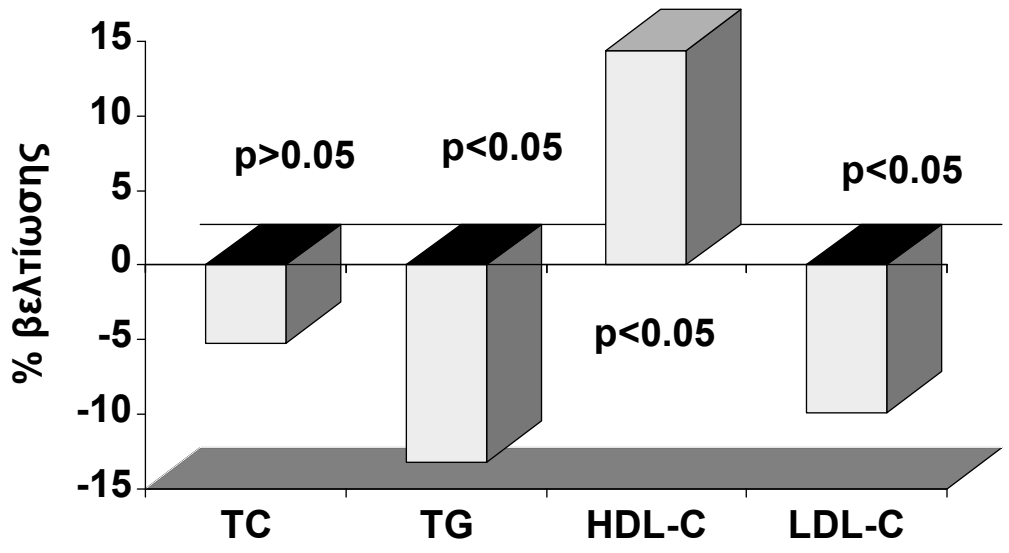
2 days per week

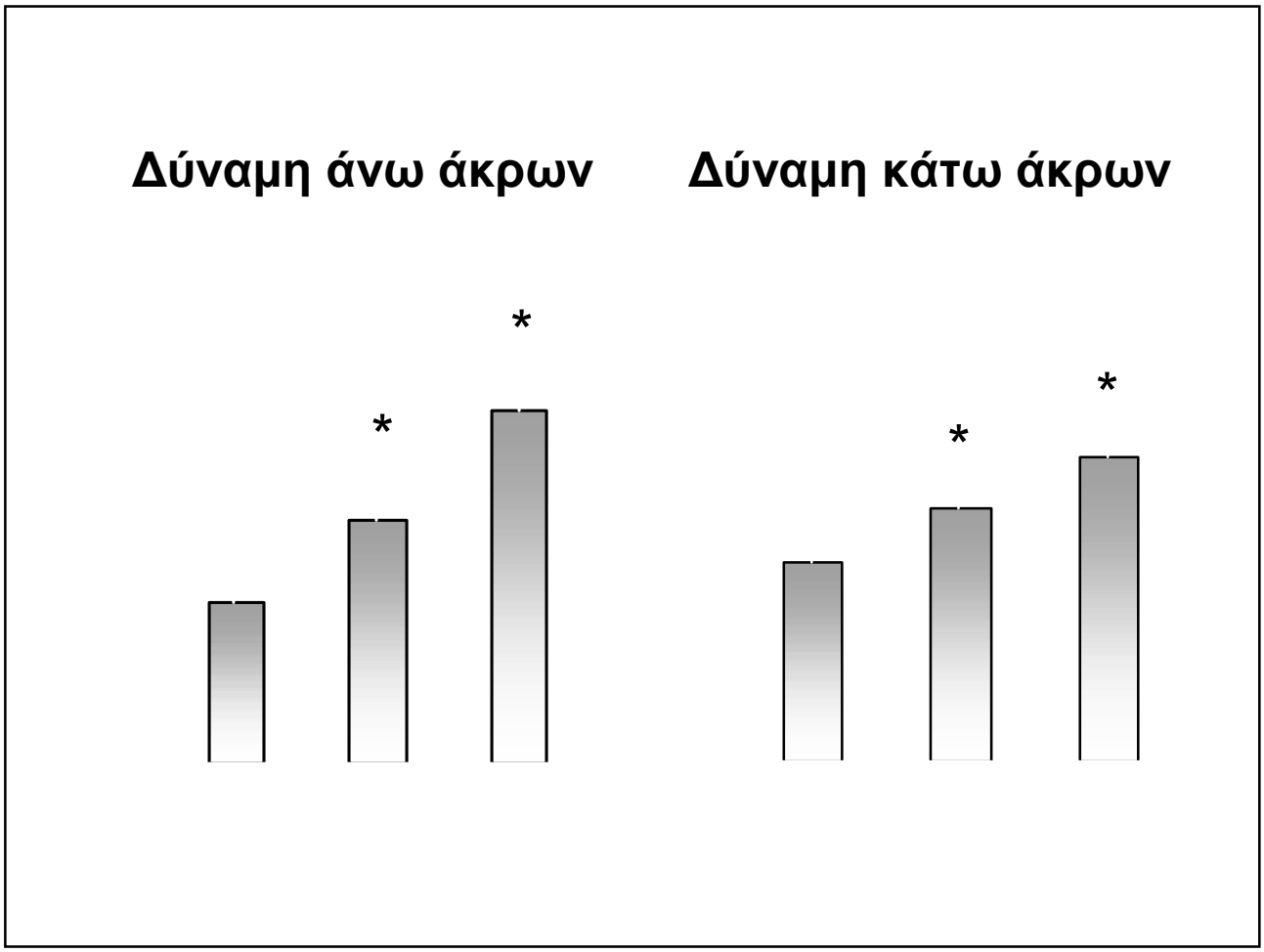
2 days per week


Σωματικό βάρος
Άθροισμα πτυχών
85
kg
80
75
58
mm
54
50
82,5
80
56,2
54
Έναρξη
Λήξη
Έναρξη
Λήξη

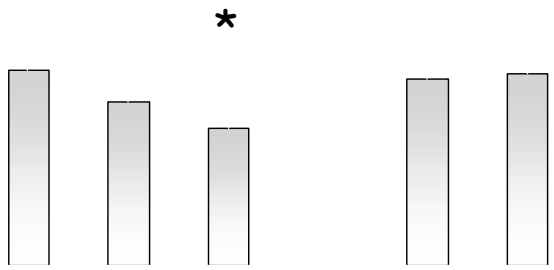

Χρόνος Άσκησης
min
*
*
#
ΟΜΑΔΑ ΑΣΚΗΣΗΣ
ΟΜΑΔΑ ΕΛΕΓΧΟΥ

Αιματολογικές παράμετροι



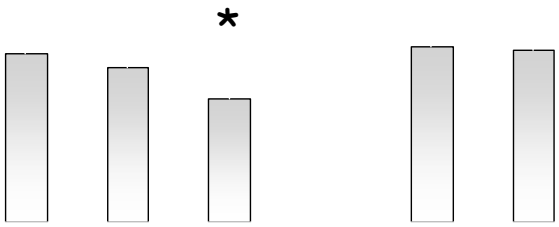

Δύναμη άνω άκρων
Δύναμη κάτω άκρων
*
*
*
*
*

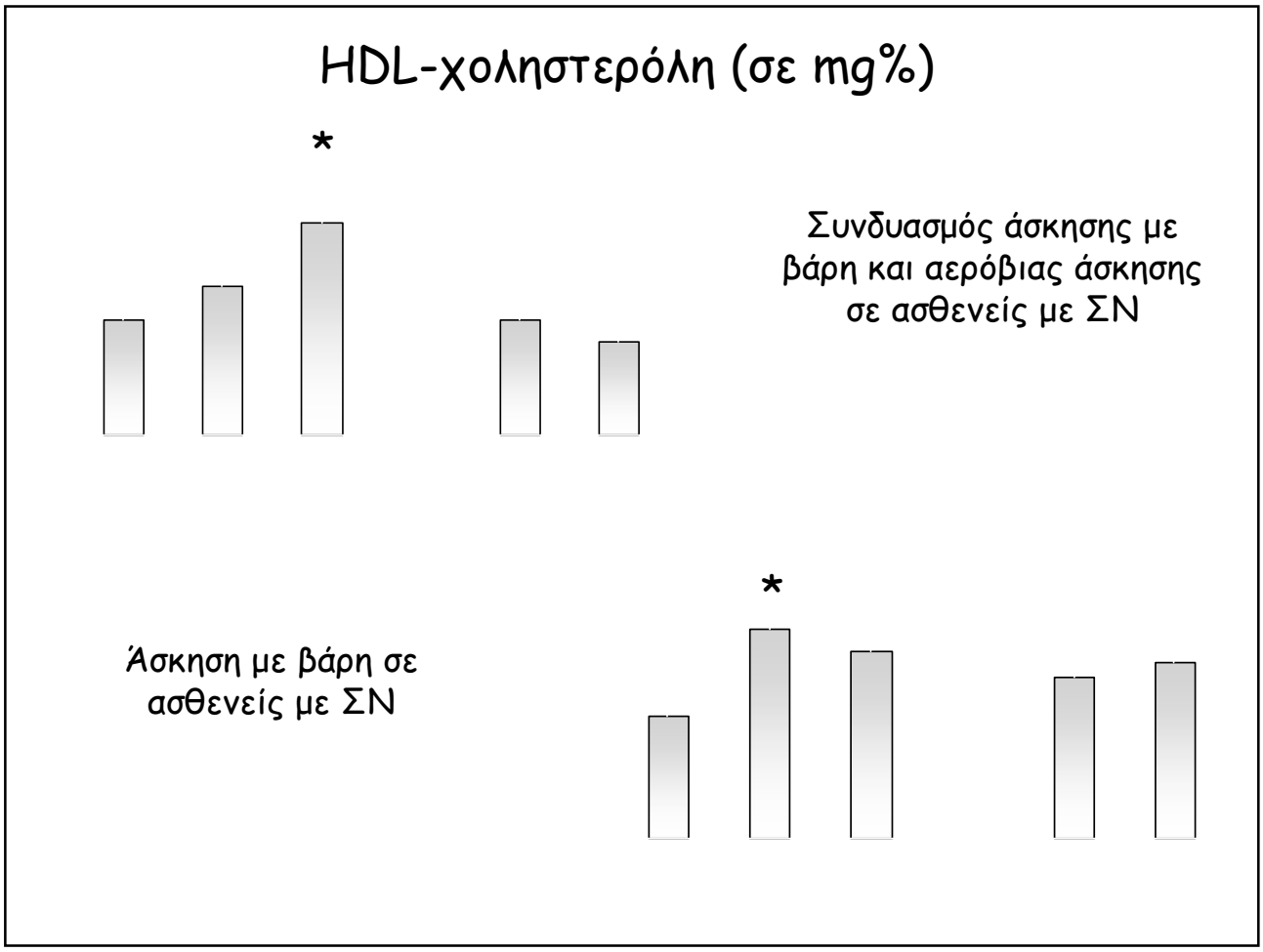
Ολική χοληστερόλη (σε mg%)

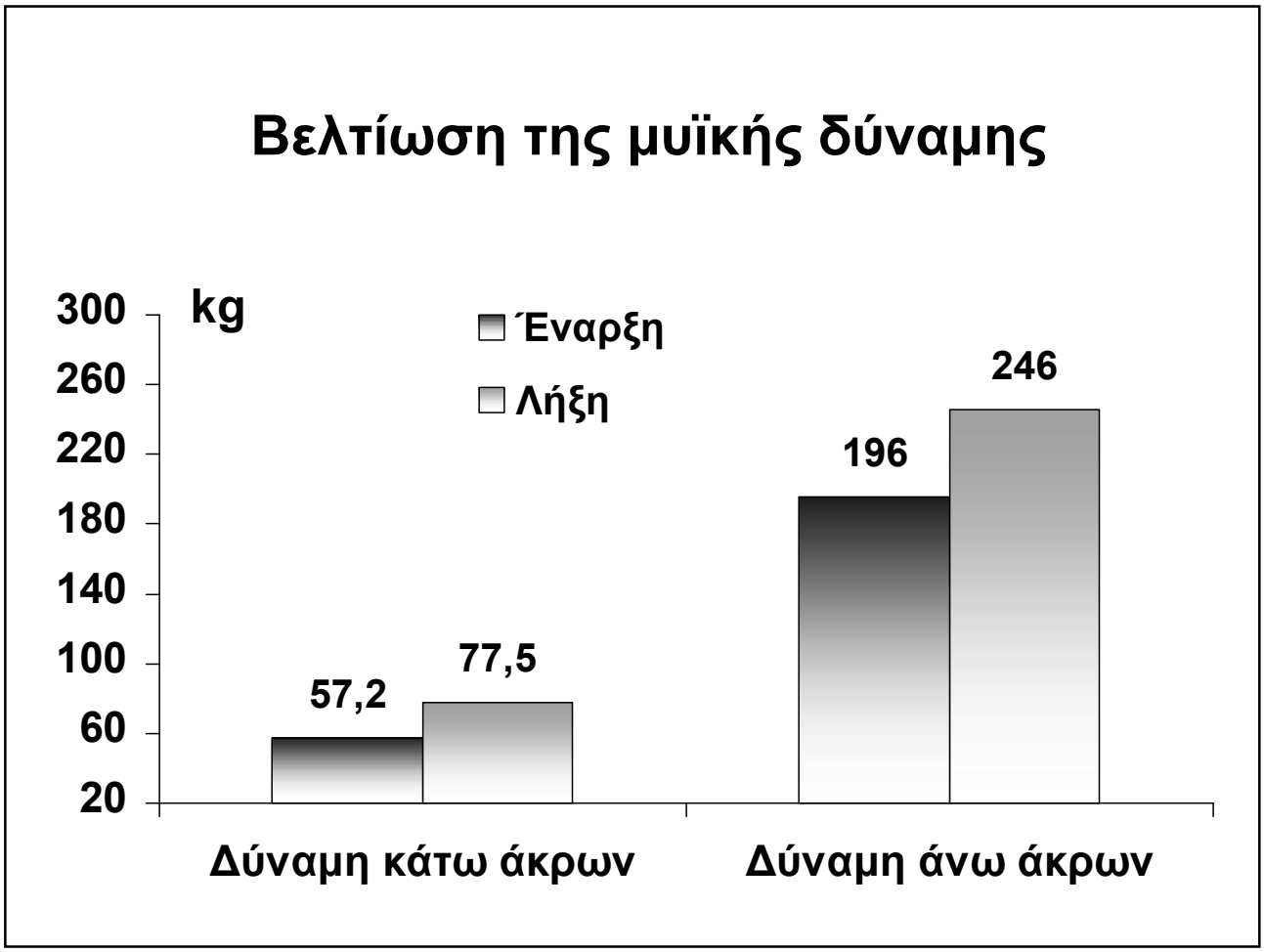


Συνδυασμός άσκησης με βάρη και αερόβιας άσκησης σε ασθενείς με ΣΝ

Άσκηση με βάρη σε ασθενείς με ΣΝ




HDL-χοληστερόλη (σε mg%)
*
Συνδυασμός άσκησης με βάρη και αερόβιας άσκησης σε ασθενείς με ΣΝ
Άσκηση με βάρη σε ασθενείς με ΣΝ
*


Βελτίωση της μυϊκής δύναμης
300
260
220
180
140
100
60
20
kg
Έναρξη
Λήξη
57,2
77,5
196
246
Δύναμη κάτω άκρων
Δύναμη άνω άκρων

Resistance Exercise Protocols
Different intensity – Similar volume
Acute inflammatory responses

Submaximal Intensity – Muscular Hypertrophy

3 sets x 8 repetitions x 75% 1 RM, 90 sec rest

Moderate Intensity – Muscular Endurance

2 sets x 18 repetitions x 50% 1 RM, 90 sec rest

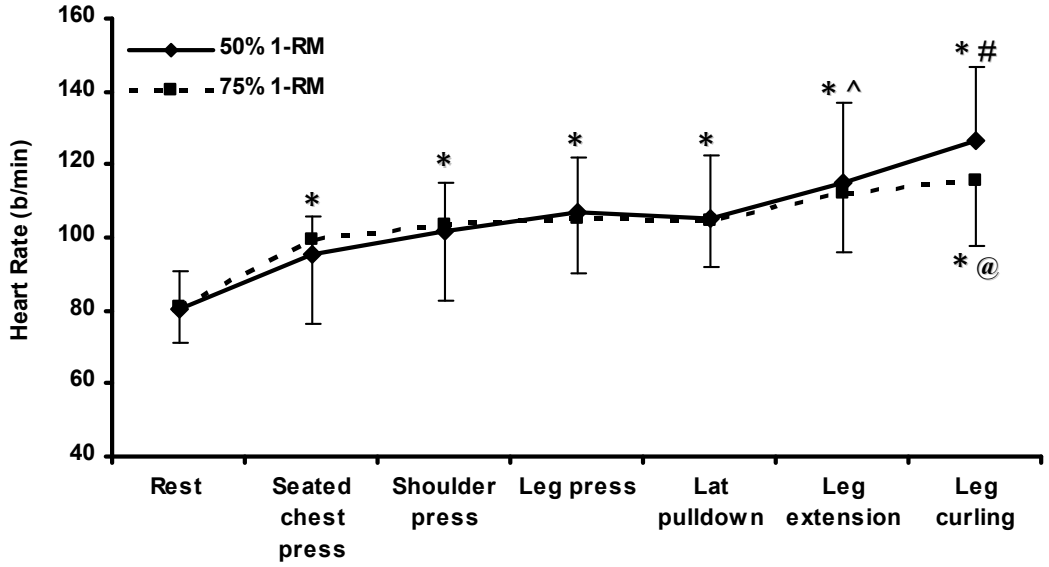
Exercises

Seated chest press, Shoulder press,

Leg press, Lateral pulldown,

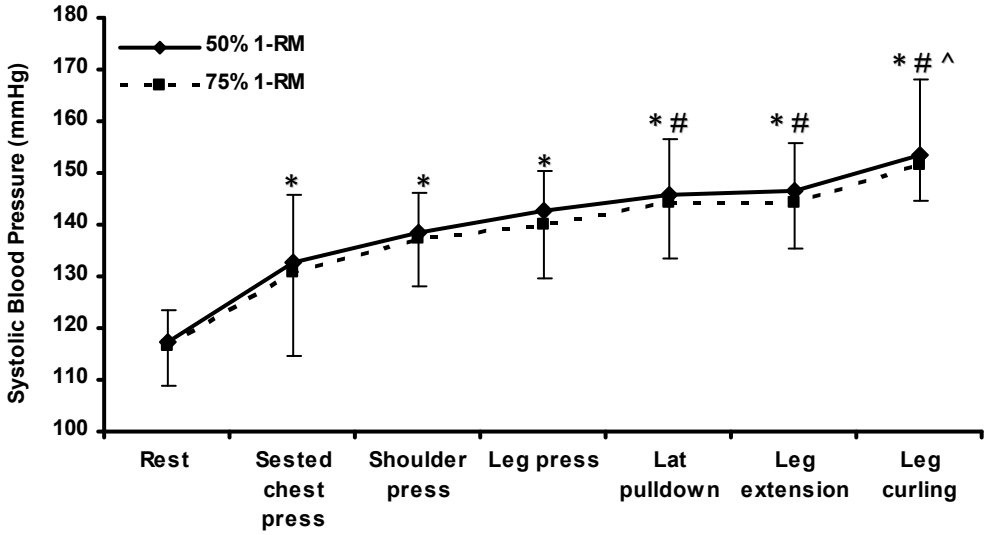
Leg extension, Leg flexion

Heart rate



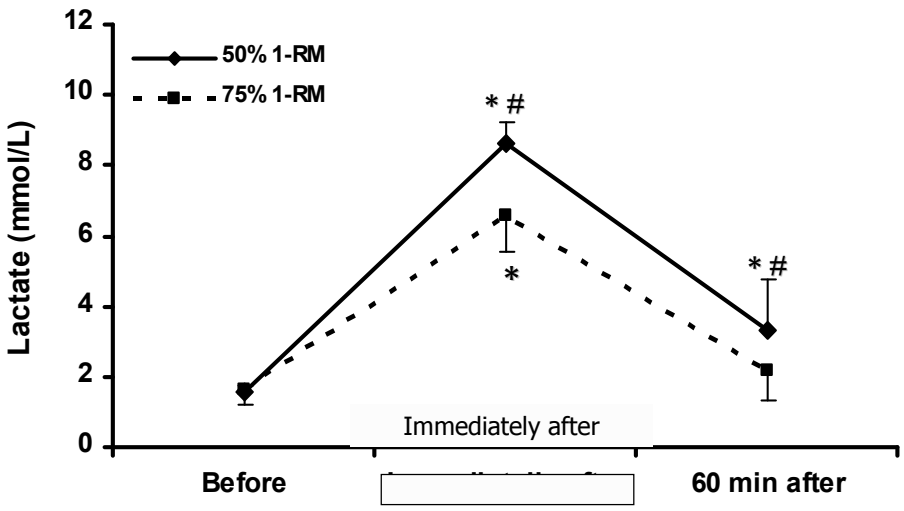
** p<0.05 from rest, @ p<0.05 from the first exercise,*
^ p<0.05 from 1st and 2nd exercise, # p<0.05 from the first four exercises

Systolic Blood Pressure



** p<0.05 from rest, # p<0.05 from the 1st exercise, ^ p<0.05 from the 2nd exercise*

Blood Lactate



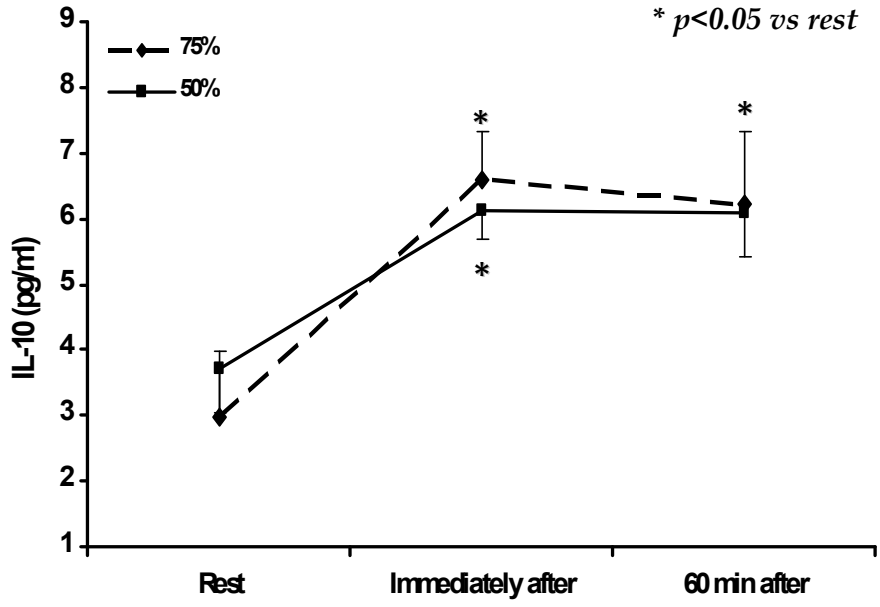
- *p<0.05 from before exercise value*
- *# p<0.05 from corresponding value with 75% 1-RM*

Inflammatory responses after resistance exercise

- TNF-α : NS alterations
- INF-γ : NS alterations
- IL-6 : NS alterations

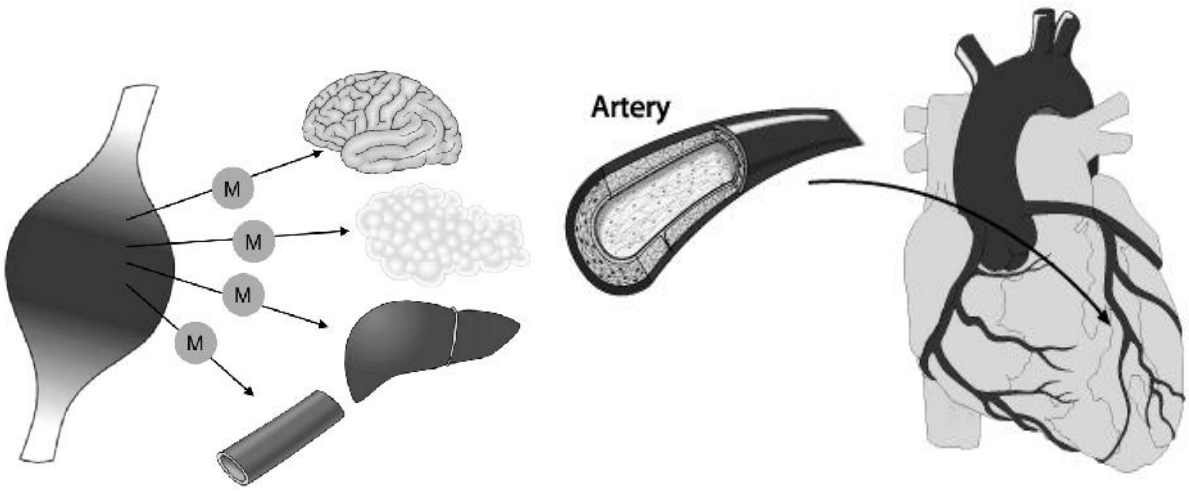
IL-10 : Significant alterations

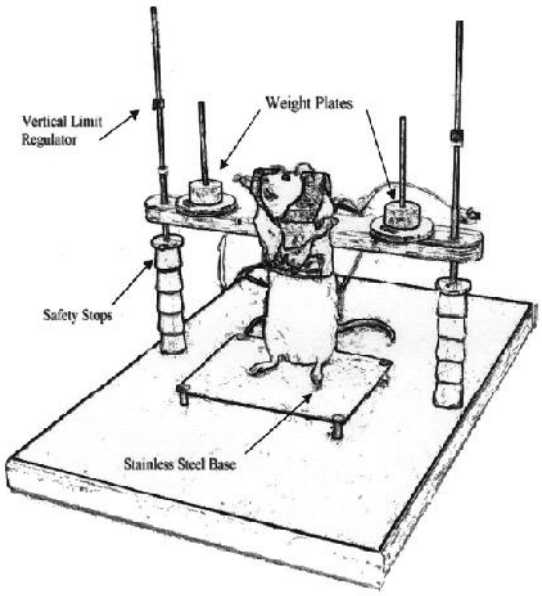
Thus, no inflammation occurs during resistance training at different intensities.

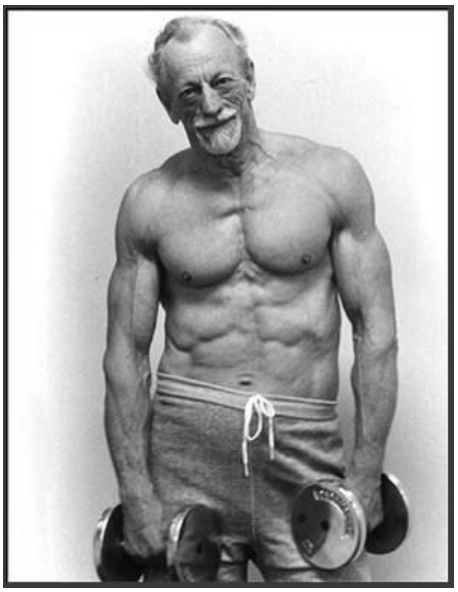


Muscle as an Endocrine Organ

Pedersen et al. 2008; Physiol Rev 88: 1379-1406




Vertical Limit
Regulator
Weight Plates
Safety Stops
Stainless Steel Base



Thank you