RESISTANCE TRAINING IN CARDIAC REHABILITATION

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OUTLINE

- Definition and Types of Resistance training (RT)
- Physiologic adaptation of RT
- Role of RT in Cardiac patient
- Indication and contraindication
- Exercise prescription of RT

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RESISTANCE TRAINING (RT)

Definition: Active exercise (a dynamic or static muscular contraction) in which muscle contraction is resisted by an outside force. This outside force may be manual or mechanical.

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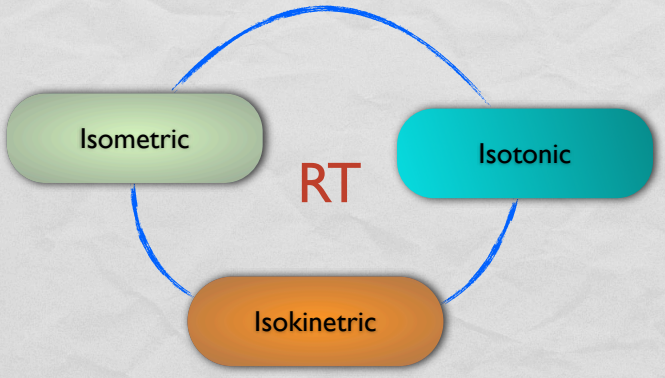
Types of RT



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PHYSIOLOGIC ADAPTATION IN RT

Adaptation : - Neuromuscular

- Connective tissue
- Endocrine
- Metabolic
- Cardiovascular
- Immune system

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PHYSIOLOGIC ADAPTATION IN RT

Neuromuscular Adaptation :

Early -phase adaptation → Increase in neural factor and quality protein change

(greater potential to recruit fast twitch motor)

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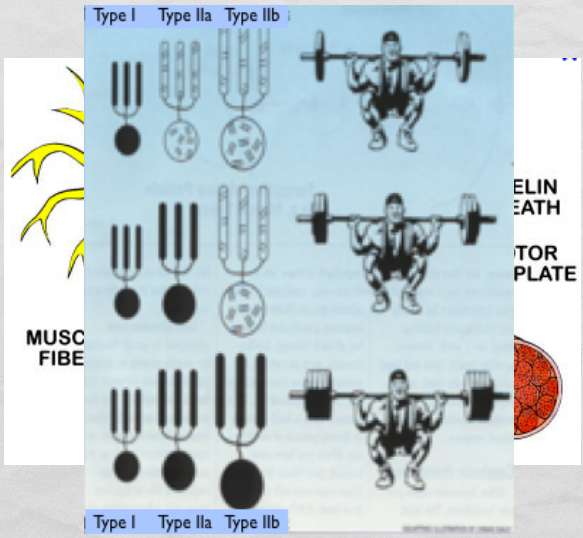

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PHYSIOLOGIC ADAPTATION IN RT

Neuromuscular Adaptation :

Late -phase adaptation → Increase of muscle hypertrophy

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Muscle

- Increase of the cross sectional area of the muscle due to
  - Increase myofibril per muscle fiber
  - fibers splitting
  - Increase number of muscle fiber
- Increase protein content of the muscle fiber.
- Increase energy source necessary to fuel muscle contraction and increase levels of ATP, and creatine phosphate.

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PHYSIOLOGIC ADAPTATION IN RT

Connective tissue Adaptation :

- Alter tendon and ligament structure make them larger stronger and more resistance to injury
- Increase tensile strength of tendon and ligament

Bone:

- Improve and maintain bone density.

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Variable	Strength Training Adaptations	Endurance Training Adaptations
Skeletal muscle structure	Hypertrophy of muscle fibers; greater in type II fibers Hyperplasia (possibly) of muscle fibers Fiber type composition: remodeling of type IIB to type IIA; no change in type I to type II distribution (i.e., no conversion) Capillary bed density: ↓ or no change Mitochondrial density and volume: ↓	Hypertrophy: minimal or no change Capillary bed density: ↑ Mitochondrial density and volume: ↑
Neural system	Motor unit recruitment: ↑ # motor units firing Rate of firing: ↑ (↓ twitch contraction time) Synchronization of firing: ↑	
Metabolic system	ATP and CP storage: ↑ Myoglobin storage: ↑ Stored triglycerides: not known	ATP and CP storage: ↑ Myoglobin storage: ↑ Stored triglycerides: ↑
Enzymes	Creatine phosphokinase: ↑ Myokinase: ↑	Similar ↑ Similar ↑
Body composition	Lean body (fat-free) mass: ↑ % body fat: ↓	Lean body (fat-free) mass: no change % body fat: ↓
Connective tissue	Tensile strength of tendons, ligaments, and connective tissue in muscle: ↑ Bone: ↑ bone mineral density; no change or possible ↑ in bone mass	Tensile strength of tendons, ligaments, and connective tissue in muscle: ↑ Bone: ↑ mineralization with weight-bearing activities

Kisner C. Therapeutic Exercise: Foundations and Techniques. 5th ed. Philadelphia, Pa: FA Davis Co; 2007.

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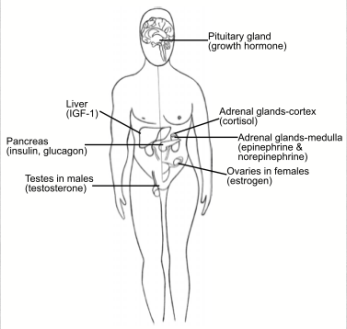
PHYSIOLOGIC ADAPTATION IN RT

Endocrine Adaptation :



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Hormone	Acute response to RE	Chronic Resting Adaptations	Chronic changes to acute response
Testosterone	May! , ↔ ," , is likely with high intensity, short rest interval, high-volume	Typically ↔ unless there are substantial changes in volume and intensity	May! slightly if individual can train at high level
GH	! or ↔ with low intensity, low - volume ! when high intensity and volume programs with short rest	↔ ; however, overnight "bursts" may ! if workout is strenuous	Acute ! can be higher when individuals train harder over time
Insulin	↔ ,response related to diet or plasma volume "	↔	↔
IGF-1	Delayed response base on GH secretion pattern	Related to GH changes, ↔ or ! IGF-1 in muscle !	Related to GH
Cortisol	! or ↔ with low intensity, low - volume ! when high intensity and volume programs with short rest	↔;" ; may ! with overtraining	May not change
Catecholamine	! during workout and before in anticipation	↔	↔

American College of Sport Medicine. Resource Manual for Guidelines for Exercise Testing and Prescription 6th ed.Pheiladelphia,Lippincott Williams&Wilkins; 2010

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PHYSIOLOGICAL ADAPTATIONS TO RESISTIVE EXERCISE

Cardiovascular system

- Increase cardiac output
- Increase stroke volume
- Increase maximal oxygen consumption
- Decreased diastolic blood pressure.

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Aerobic Vs. Resistance

Variable	Aerobic Exercise	Resistance Exercise
Bone mineral density	↑ ↑	↑ ↑
Body composition		
% Fat	↓ ↓	↓
LBM	↔	↑ ↑
Strength	↔	↑ ↑ ↑
Glucose metabolism		
Insulin response to glucose challenge	↓ ↓	↓ ↓
Basal insulin levels	↓	↓
Insulin sensitivity	↑ ↑	↑ ↑
Serum lipids		
HDL	↑ ↔	↑ ↔
LDL	↓ ↔	↓ ↔
Resting heart rate	↓ ↓	↔
Stroke volume, resting and maximal	↑ ↑	↔
Blood pressure at rest		
Systolic	↓ ↔	↔
Diastolic	↓ ↔	↓ ↔
$\dot{V}o_2max$	↑ ↑ ↑	↑ ↔
Submaximal and maximal endurance time	↑ ↑ ↑	↑ ↑
Basal metabolism	↑	↑ ↑

Pollock ML, Franklin BA, Balady GJResistance exercise in individuals with and without cardiovascular disease: benefits, rationale, safety, and prescription, Circulation

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Purpose of RT for Patients with Cardiac diseases

- Improved muscle strength and endurance
- Improved self confidence
- Increase ability to perform activities of ADL
- Maintain independence
- Decrease cardiac demands of muscle work(⇓ RPP) during daily activity
- Decrease development of other disease(osteoporosis, Type II DM and obesity)
- Slow age - and disease- related decline of muscle strength and mass

American College of Sport Medicine. Guidelines for Exercise Testing and Prescription , 8 th ed.Pheiladelphia,Lippincott Williams&Wilkins; 2010

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RT IN HT

- Moderate intensities of exercise is recommence due to arterial stiffness
- Net change of diastolic blood pressure of 3.5 mmHg

	Baseline		Net change		
Variable	*n*	Mean	*n*	Mean (95% CL)	*P* value
Blood pressure (mmHg)					
Systolic	12	131.0	12	−3.2 (−7.1, +0.7)	0.10
Diastolic	12	81.1	12	−3.5 (−6.1, −0.9)	< 0.01
VO_{2max} (mL/min per kg)	9	24.7	6	+2.6 (+0.3, +4.8)	< 0.05
Heart rate (b.p.m.)	10	70.7	8	+1.0 (−1.7, +3.7)	NS
Weight (kg)	8	76.4	4	+0.33 (−2.7, +3.4)	NS
Body fat (%)	6	30.1	4	−0.94 (−1.6, −0.25)	< 0.01

R. H. Fagard, Exercise is good for your blood pressure: effects of endurance training and resistance training,Clinical and Experimental Pharmacology and Physiology, vol. 33, no. 9, pp. 853–856, 2006

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RT AND ATERIAL STIFFNESS

Search Jan 1980 - Apr 2011
on PubMed and SPORTDiscus

12 relevant abstracts accepted for full text review

4 excluded after full text review
- 3 non RCT
- 1 outcome except PWV or Carotid ß

8 included in meta-analysis

Data Extraction
- subjects characteristics
-training program
-amount of changes in stiffness

Miyachi M. Effects of resistance training on arterial stiffness: a meta-analysis. Br J Sports Med. 2012 Jan 20.

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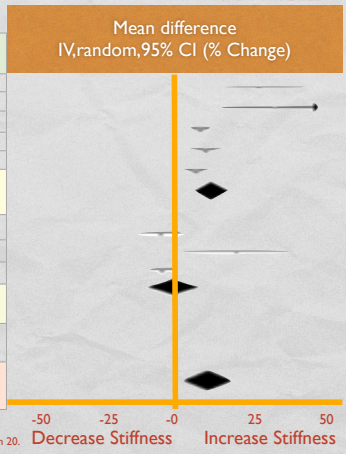
RT AND ATERIAL STIFFNESS

	Authors	Training Intensity	Outcome
Young(<40 yrs)	Miyachi 2004	High	Carotid ß
	Kawano 2006	Moderate	Carotid ß
	Okamoto 2006	High	baPWV
	Okamoto 2009-2	High	baPWV
	Okamoto 2009-1	High	baPWV
	Subtotal (95%CI)		
Middle-aged(>40yrs)	Cortez-2008	Moderate	cfPWV
	Collier 2008	Moderate	cfPWV
	Yoshizawa 2009	Moderate	cfPWV
	Subtotal (95%CI)		
	Total (95%CI)		



Miyachi M. Effects of resistance training on arterial stiffness: a meta-analysis. Br J Sports Med. 2012 Jan 20.

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RT IN DM

- Light or moderate intensities are effective for controlling blood glucose in T2DM
- Increased glucose uptake observed after RT solely to the increase in muscle mass
- RT can effectively alter body composition in both men and women.
- Increase total FFM, muscular strength, and RMR, as well as reduce total FM with the preferential mobilization of VAT and SAT in the abdominal region

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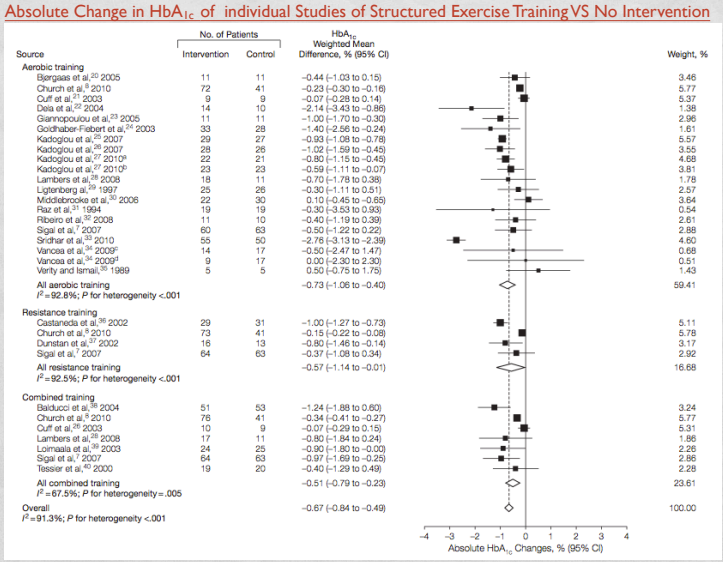
Absolute Change in HbA_{1c} of individual Studies of Structured Exercise Training VS No Intervention



Umpierre D, Ribeiro PA, Kramer CK, Leitao CB, Zucatti AT, Azevedo MJ, et al. Physical activity advice only or structured exercise training and association with HbA1c levels in type 2 diabetes: a systematic review and meta-analysis. JAMA. 2011 May 4;305(17):1790-9.

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RT IN METABOLIC SYNDROME

Changes in primary and secondary outcomes for studies included in meta-analysis

Variable	N	X̄(95% CI)	Q (p)	I^2
Primary outcomes (mg/dl)				
- TC	30	−5.5 (−9.4, −1.6)*	102.6 (<0.001)**	71.7
- HDL-C	28	0.7 (−1.2, 2.6)	211.5 (<0.001)**	87.2
- TC/HDL-C	14	−0.5 (−0.9, −0.2)*	96.7 (<0.001)**	86.6
- Non-HDL-C	26	−8.7 (−14.1, −3.3)*	234.2 (<0.001)**	89.3
- LDL-C	23	−6.1 (−11.2, −1.0)*	152.2 (<0.0001)**	85.5
- TG	26	−8.1 (−14.5, −1.8)*	89.4 (<0.001)**	72.0
Secondary outcomes				
- Body weight (kg)	21	0.003 (−0.4, 0.4)	8.2 (0.99)	<0.0001
- BMI (kg/m^2)	14	−0.2 (−0.2, 0.1)	14.5 (0.34)	10.6
- Body fat (%)	15	−1.8 (−2.5, −1.1)*	30.6 (0.006)**	54.2
- LBM (kg)	15	1.0 (0.4, 1.5)*	25.1 (0.03)**	44.1

Kelley GA, Kelley KS. Impact of progressive resistance training on lipids and lipoproteins in adults: a meta-analysis of randomized controlled trials. Prev Med. 2009 Jan;48(1):9-19.

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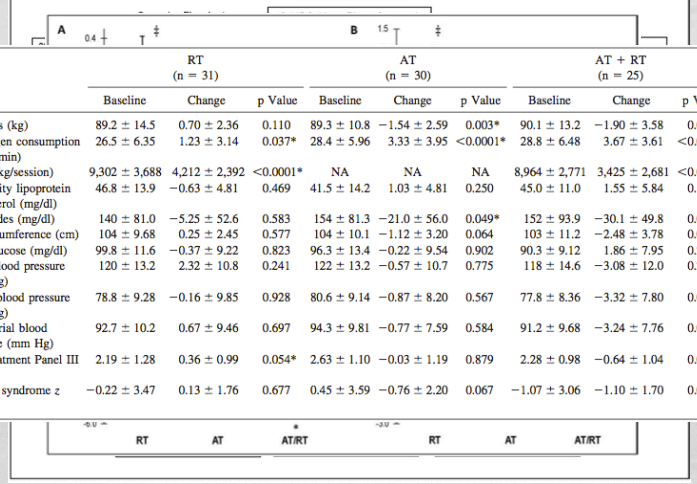
RT IN METABOLIC SYNDROME



Variable	RT (n = 31)			AT (n = 30)			AT + RT (n = 25)		
	Baseline	Change	p Value	Baseline	Change	p Value	Baseline	Change	p Value
Body mass (kg)	89.2 ± 14.5	0.70 ± 2.36	0.110	89.3 ± 10.8	−1.54 ± 2.59	0.003*	90.1 ± 13.2	−1.90 ± 3.58	0.014*
Peak oxygen consumption (ml/kg/min)	26.5 ± 6.35	1.23 ± 3.14	0.037*	28.4 ± 5.96	3.33 ± 3.95	<0.0001*	28.8 ± 6.48	3.67 ± 3.61	<0.0001*
Strength (kg/session)	9,302 ± 3,688	4,212 ± 2,392	<0.0001*	NA	NA	NA	8,964 ± 2,771	3,425 ± 2,681	<0.0001*
High-density lipoprotein cholesterol (mg/dl)	46.8 ± 13.9	−0.63 ± 4.81	0.469	41.5 ± 14.2	1.03 ± 4.81	0.250	45.0 ± 11.0	1.55 ± 5.84	0.197
Triglycerides (mg/dl)	140 ± 81.0	−5.25 ± 52.6	0.583	154 ± 81.3	−21.0 ± 56.0	0.049*	152 ± 93.9	−30.1 ± 49.8	0.006*
Waist circumference (cm)	104 ± 9.68	0.25 ± 2.45	0.577	104 ± 10.1	−1.12 ± 3.20	0.064	103 ± 11.2	−2.48 ± 3.78	0.003*
Fasting glucose (mg/dl)	99.8 ± 11.6	−0.37 ± 9.22	0.823	96.3 ± 13.4	−0.22 ± 9.54	0.902	90.3 ± 9.12	1.86 ± 7.95	0.253
Systolic blood pressure (mm Hg)	120 ± 13.2	2.32 ± 10.8	0.241	122 ± 13.2	−0.57 ± 10.7	0.775	118 ± 14.6	−3.08 ± 12.0	0.210
Diastolic blood pressure (mm Hg)	78.8 ± 9.28	−0.16 ± 9.85	0.928	80.6 ± 9.14	−0.87 ± 8.20	0.567	77.8 ± 8.36	−3.32 ± 7.80	0.044*
Mean arterial blood pressure (mm Hg)	92.7 ± 10.2	0.67 ± 9.46	0.697	94.3 ± 9.81	−0.77 ± 7.59	0.584	91.2 ± 9.68	−3.24 ± 7.76	0.048*
Adult Treatment Panel III score	2.19 ± 1.28	0.36 ± 0.99	0.054*	2.63 ± 1.10	−0.03 ± 1.19	0.879	2.28 ± 0.98	−0.64 ± 1.04	0.005*
Metabolic syndrome z score	−0.22 ± 3.47	0.13 ± 1.76	0.677	0.45 ± 3.59	−0.76 ± 2.20	0.067	−1.07 ± 3.06	−1.10 ± 1.70	0.004*

Lori AB, Cris AS, Leslie HW, et al. Comparison of Aerobic Versus Resistance Exercise Training Effects on Metabolic Syndrome (from the Studies of a Targeted Risk Reduction Intervention Through Defined Exercise - STRRIDE-AT/RT) Am J Cardiol 2011;108:838–844

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RT IN METABOLIC SYNDROME

- Improvement in lipid profiles after RT➜ Not-clear
- RT combined with aerobic exercise may be more efficacious
- RT increases muscle mass by a minimum of 1 -2 kg (1 kg in muscle mass should result in an REE increase 21 kcal/kg of new muscle.)[1]
- Reduction visceral fat
- Effect in high-quantity strength training (Completed 4 to 7 hours of strength training each week) [2]

1 Braith RW, Stewart KJ. Resistance exercise training: its role in the prevention of cardiovascular disease. Circulation. 2006 Jun 6;113(22):2642-50.

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HEART FAILURE

- " Central " = Reduced exercise capacity [VO2peak] is a major contributor of poor quality of life and is an indepen- dent predictor of rehospitalization and mortality in patients with CHF
- "Peripheral" = changes in the periphery (skeletal muscle); this is known as the "muscle hypothesis"

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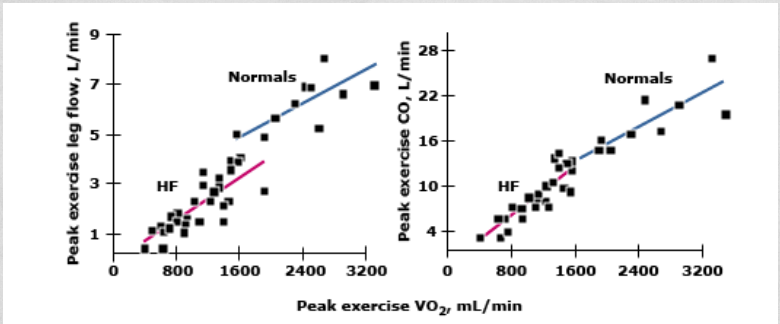
Plots of the relations of peak exercise Vo2 to blood and cardiac single leg flow (PanelA) and cardiac output (Panel B) inpatients with chronic heart failure



Sullivan MJ, Knight JD, Higginbotham MB, Cobb FR; Relation between central and peripheral hemodynamics during exercise in patients with chronic heart failure. Muscle blood flow is reduced with maintenance of arterial perfusion pressure, Circulation 80 1989 769-781

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EFFECTS OF AT, RT AND COMBINE IN CHF

	AT	RT	AT+RT
Exercise capacity			
Peak VO_2	↑↑	↑↔	↑↑
Cardiac function			
Peak cardiac output	↑↔	↔	
Peak stroke volume	↑	↔	
Ejection fraction	↑↔	↔	↑↔
End-systolic volume	↑	↔	↔
End-diastolic volume	↑	↔	↔
Vascular function			
Endothelial function	↑↑	↑	↑
Arterial remodeling	↑	↑↑	?
Skeletal muscle function			
Muscle strength	↔↑	↑↑↑	↑
Muscle endurance	↑	↑↑	↑
Oxidative enzymes	↑	↑	↑

Mandic S, Myers J, Selig SE, Levinger I. Resistance versus aerobic exercise training in chronic heart failure.

Curr Heart Fail Rep. 2012 Mar;9(1):57-64.

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CLINICAL IMPORTANT BENEFITS OF RT IN CHF

Guideline	Recommendation	Outcome	Relative difference	Study design
Aerobic exercise: Bicycle ergometer	Grade A Grade A Grade A Grade A	Vo_2 max Dyspnea Work Capacity Left ventricular function	18%;255;19% 56% 54%;24% 16%	3 RCT (N =166)
Resistance training	Grade A Grade A Grade A Grade A	Left ventricular function Peak lactate levels Muscle strength Muscle endurance	29%;23% 27% 44% 64%	3 RCT (N =47)

Bartlo P. Evidence-based application of aerobic and resistance training in patients with congestive heart failure. J Cardiopulm Rehabil Prev. 2007 Nov-Dec;27(6):368-75.

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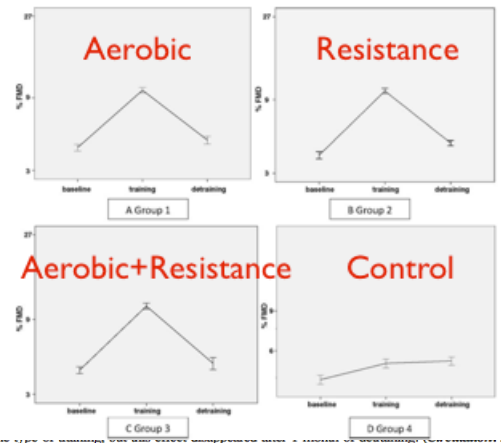
Effects of
Detrainir



owed by
Patients

Background—In co
little is known abc
the effect of differ
Methods and Result
of detraining by n
randomized into 4
training (n=53); a
in group 2, 4.4±4
in group 1, 10.1±
4 but to a much
decreased by 169
flow-mediated dil
Conclusion—In pat
independently of th

helial function, but
spectively evaluate
ardial infarction.
and after 1 month
ET. Patients were
stance plus aerobic
oup 1, 4.01±1.6%
eased to 9.9±2.5%
increased in group
ctor level after ET
Detraining returned

ndothelial function
09;119:1601-1608.)

Vona M, Codeluppi GM, Iannino T, Ferrari E, Bogousslavsky J, von Segesser LK. Effects of different types of exercise training followed by detraining on endothelium-dependent dilation in patients with recent myocardial infarction. Circulation. 2009 Mar 31;119(12):1601-8.

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HEMODYNAMIC MEASURES DURING DIFFERENT MODALITIES OF EXERCISE IN HF EFFECT OF TREATMENT WITH ß-BLOCKER

Parameter	Baseline	Upper Limb (Biceps Curl)	Lower Limb (Dual-Leg Press)	Submaximal Recumbent Cycle	Peak Recumbent Cycle
$\dot{V}O_2$ ml·kg^{-1}·min^{-1}					
β-Blockade	3.3 ± 0.2	4.0 ± 0.2	6.1 ± 0.4	9.3 ± 0.4	11.6 ± 0.9
No β-blockade	3.9 ± 0.3	5.0 ± 0.5	7.0 ± 0.5	10.2 ± 0.3	13.7 ± 1.0
CO, l/min					
β-Blockade	5.3 ± 0.5	5.4 ± 0.5	5.4 ± 0.4	5.9 ± 0.6	6.5 ± 0.6
No β-blockade	5.3 ± 0.5	5.5 ± 0.6	5.1 ± 0.3	5.6 ± 0.4	6.4 ± 0.8
HR, beats/min					
β-Blockade	68 ± 5	74 ± 5	84 ± 6	91 ± 6	101 ± 7
No β-blockade	73 ± 3	84 ± 6	89 ± 7	96 ± 7	113 ± 9
SV, ml/beat					
β-Blockade	81 ± 9	77 ± 9	68 ± 8	69 ± 11	66 ± 10
No β-blockade	74 ± 8	68 ± 10	59 ± 5	60 ± 8	60 ± 11
MAP, mmHg					
β-Blockade	84 ± 3	94 ± 4	99 ± 5	96 ± 4	102 ± 2
No β-blockade	79 ± 2	96 ± 6	97 ± 7	95 ± 7	105 ± 10
MPAP, mmHg					
β-Blockade	30 ± 3	31 ± 3	48 ± 6	48 ± 4	52 ± 5
No β-blockade	29 ± 3	30 ± 4	37 ± 4	40 ± 5	43 ± 6
PAWP, mmHg					
β-Blockade	17 ± 2	21 ± 3	36 ± 5	34 ± 3	38 ± 4
No β-blockade	17 ± 2	19 ± 3	25 ± 5	24 ± 4	26 ± 4
CVP, mmHg					
β-Blockade	9 ± 2	9 ± 2	18 ± 3	17 ± 2	19 ± 2
No β-Blockade	8 ± 2	11 ± 3	16 ± 3	16 ± 3	19 ± 3
SVR, dyn·s·cm^{-5}					
β-Blockade	1,148 ± 107	1,131 ± 127	1,167 ± 121	1,225 ± 172	1,184 ± 165
No β-blockade	1,159 ± 113	1,308 ± 184	1,291 ± 176	1,212 ± 210	1,193 ± 241

Cheetham C, Green D, Collis J, Dembo L, O'Driscoll G. Effect of aerobic and resistance exercise on central hemodynamic responses in severe chronic heart failure. J Appl Physiol. 2002 Jul;93(1):175-80.

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SAFETY OF RT

Acute cardiac autonomic responses after a bout of resistance exercise

Réponse du système nerveux autonome après exercice en résistance

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KEYWORDS
Heart rate variability;
Resistance exercise;
Maximal aerobic exercise;
Submaximal aerobic exercise

Summary
Objective. – The aim of this study was to analyze the heart rate variability (HRV) after a session of resistance exercise and compare the responses to those obtained in a series of maximal and submaximal aerobic exercises.
Methods. – Ten male volunteers with previous experience with resistance training were recruited. The participants underwent three exercise protocols, including a session of resistance exercise composed of 10 exercises. In different days, participants performed a progressive maximal intermittent test (30-15$_{IFT}$) and a continuous submaximal test at an intensity of 45% of the final velocity attained in the maximal test (45%V$_{IFT}$). The autonomic responses were analyzed during the 10 min following exercise, by HRV analysis and vagal reactivation indices.
Results. – The time domain indices were lower for maximal aerobic exercise, followed by resistance exercise and by the submaximal aerobic exercise (standard deviation of RR intervals (SDNN): 32 ± 15.4, 11 ± 3.7, 45.5 ± 15.3, $P < 0.05$; root-mean-square difference of successive normal RR intervals (RMSSD): 17 ± 8.3, 5.6 ± 2.7; 30.0 ± 11.0, $P < 0.05$, respectively). These responses showed the same pattern while analyzing the frequency domain indices, presented in natural logarithm (low frequency band (LF): 5.5 ± 1.0, 3.1 ± 0.9, 6.1 ± 0.9, $P < 0.05$; high frequency band (HF): 4.0 ± 1.0, 1.0 ± 0.7, 4.3 ± 0.9, $P < 0.05$; and LF + HF: 5.7 ± 1.1, 3.2 ± 0.8, 6.3 ± 0.9, $P < 0.05$, respectively). However, for vagal reactivation index (T30) there was no difference between maximal aerobic exercise and resistance exercise ($P > 0.05$), and they were both slower than submaximal exercise ($P < 0.05$).

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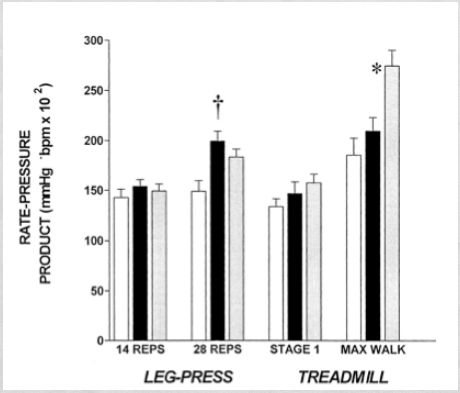
Rate–pressure product during single leg-press (SLP) weight lifting and treadmill exercise in heart transplant recipients who are early (G1, open bars, n54), intermediate (G2, solid bars, n55) and late (G3, shaded bars, n59) post transplant.



Oliver D, Pflugfelder PW, McCartney N, McKelvie RS, Suskin N, Kostuk WJ. Acute cardiovascular responses to leg-press resistance exercise in heart transplant recipients. Int J Cardiol. 2001 Nov;81(1):61-74.

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INDICATION OF RT

- Low to moderate - risk patients
- High - risk patients with supervision

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ACSM RISK STRATIFICATION CATEGORIES FOR ATHEROSCLEROTIC CARDIOVASCULAR DISEASE	
Low risk	Asymtomatic men and women who have# 1 CVD risk factor*
Moderate risk	Asymtomatic men and women who have $ 2 CVD risk factor*
High risk	Individuals who have known cardiovascular,pulmonary,or metabolic disease or one or more signs and symptoms listed **

* table A
** table B

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TABLE A : ATHEROSCLEROTIC CARDIOVASCULAR DISEASE(CVD) RISK FACTOR THRESHOLDSS FOR USE WITH ACSM RISK STRATIFICATION

Positive risk factor	Defining Criteria
Age	Men $ 45 yr;Women $ 55 yr
Family history	MI, Coronary revascularization sudden dath before 55 yr of age in father or other male 1st degree relative, or before 65 yr of age in mother or female 1st degree relative
Smoking	Current cigarette smoker or quit within the previous 6 months or expose toacco smoke
Sedentary life style	Not participate in at least 30 min of moderate intensity PA on at least 3 days of the week fir at least 3 month
Hypertension	SBP$ 140 mmHg , DBP $ 90 mmHg
Dyslipidemia	LDL-C $ 130 , HDL-C # 40 , Chol $ 200
Obesity	BMI $ 30 ,Waist girth $ 40 inches in men, $ 35 inches inwomen
Prediabetes	IFG = FBS $ 100 < 126

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TABLE B : MAJOR SIGNS OR SYMPTOMS SUGGESTIVE OF CARDIOVASCULAR , PULMONARY, OR METABOLIC DISEASE

Sign or symptom
Pain and discomfort in chest, neck, Jaw, arms,or other areas that may result from ischemia
Shortness of breath at rest or with mild exerction
Dizziness or syncope
Orthopnea or PND
Ankle edema
Palpitation or tachycardia
Intermittent claudication
Known heart murmur
Unusual fatigue or SOB with usual activities

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CONTRAINDICATION OF RT

Absolute :

- Unstable CHD
- Decompensated HF
- Uncontrolled arrhythmias
- Severe pulmonary hypertension

(mean pulmonary arterial pressure> 55 mmHg)

- Severe and symptomatic aortic stenosis
- Acute myocarditis, Endocarditis, or pericarditis
- Uncontrolled hypertension (> 180/110 mmHg) (160/100 mmHg)*
- Aortic Dissection
- Marfan syndrome
- High - Intensity RT (80 -100% of 1 RM) in patient with active proliferation retinopathy or moderate or worse non-proliferative diabetic retinopathy

* American Association of Cardiovascular and Pulmonary Rehabilitation.Guidelines for Cardiac Rehabilitation and Secondary Prevention Programs 4th ed.Champaign,IL: Human Kinetics; 2004

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CONTRAINDICATION OF RT

Relative:

- Major risk factors of CHD
- Diabetics at any age
- Uncontrolled hypertension (>160/>100 mmHg)
- Low functional capacity(< 4 METs)
-Musculoskeletal limitations
-Individuals who have implanted pacemakers or defibrillators

M.A.Williams, et al., Resistance exercise in individuals with and without cardiovascular dis- ease: 2007 update: a scientific statement from the American Heart Association Council on Clinical Cardiology and Council on Nutrition, Physical Activity, and Metabolism, Circulation, vol. 116, no. 5, pp. 572–584, 2007.

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CONTRAINDICATION OF RT IN CHF

Absolute	Relative
- NYHA IV Obstruction of left ventricular outflow - Decompensated CHF - Therapeutic arrhythmias - Exercise capacity ≦3 METs - Moderated to severe aortic stenosis - Uncontrolled diabetic	- Unstable agina - New onset of AF - Severe pulmonary hypertension - Complex ventricular arrhythmias at rest - Arrhythmias which increase in severity/frequency - Significant exercise - induce ischemias (>3)mmST depression

Braith RW, Beck DT. Resistance exercise: training adaptations and developing a safe exercise prescription. Heart Fail Rev. 2008 Feb;13(1):69-79.

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RESISTANCE EXERCISE PRESCRIPTION

F : Frequency

I : Intensity

T : Time

T : Type

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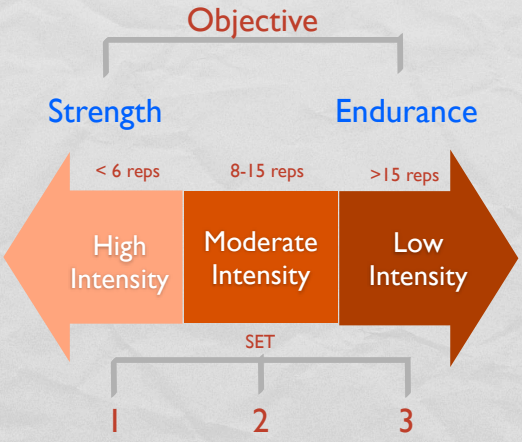
INTENSITY



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RESISTANCE TRAINING MODALITIES

- Free weights/dumbbells
- Elastic bands
- Pulleys
- Strength training machines

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Population	Resistance Training: Sets; Reps	Resistance Training: Stations/Devices*	Flexibility Training: Frequency	Flexibility Training: Goal
Healthy/sedentary adults				
2007 AHA Scientific Statement	1 set; 8–12 reps for persons <50–60 y of age; 10–15 reps at reduced levels of resistance for persons 50–60 y of age	8–10 exercises	2–3 d/wk	Stretching the major muscle or tendon groups, 2–3 d/wk
2006 ACSM Guidelines[110]	1 set; 8–12 reps (range, 3–20 reps) performed at a moderate rep duration (≈3 s concentric, ≈3 s eccentric)	8–10 exercises	2-3 nonconsecutive d/wk	Static stretching, major muscle tendon units a minimum of 2–3 d/wk; stretch to the ROM at a point of tightness, 15–30 s/stretch, 2–4 reps/stretch
Elderly persons				
2001 American Geriatrics Society[121]	Low: 40% 1-RM; 10–15 reps Moderate: 40%–60% 1-RM; 8–10 reps High: >60% 1-RM; 6–8 reps	Not specified	2–3 d/wk	3–5 stretches/key muscle group; hold for 20–30 s; 3–5 d/wk
Cardiac patients				
2007 AHA Scientific Statement	1 set; 10–15 reps	8–10 exercises	2–3 d/wk	Stretching the major muscle or tendon groups, 2–3 d/wk
2004 AACVPR guidelines[111]	1 set; 12–15 reps	6–8 exercises	2–3 d/wk	
2006 ACSM guidelines[110]	1 set; 10–15 reps	8–10 exercises	2–3 d/wk	

M.A.Williams, et al., Resistance exercise in individuals with and without cardiovascular dis- ease: 2007 update: a scientific statement from the American Heart Association Council on Clinical Cardiology and Council on Nutrition, Physical Activity, and Metabolism, Circulation, vol. 116, no. 5, pp. 572–584, 2007.

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RESISTANCE EXERCISE PRESCRIPTION BY DISEASE

Diagnosis	Guidelines from American Association of cardiovascular and Pulmonary Rehabilitation (AACVP) *	Guidelines from American College of sport medicine (ACSM)**
Myocardial infraction (MI) or Cardiac surgery	1-3 lb, in … of ons… participa…	…te of …ipation …ogram
Percutaneous coronary intervention (PCI)	1-3 lb, initiate a minimum 3 wks after transcatheter procedure including 2 wks of consistent participation in a supervised CR endurance training program	1-3 lb, initiate a minimum 2-3 wks after transcatheter procedure including 2 wks of consistent participation in a supervised CR endurance training program
Pacemaker or ICD Implantation	No specific guidelines	Do not raise arm on affected side above shoulder for 2 weeks

Avoid traditional upper-body RT exercises, Lifting weights 50% of MVC, 8 - 12 weeks

* American Association of Cardiovascular and Pulmonary Rehabilitation.Guidelines for Cardiac Rehabilitation and Secondary Prevention Programs 4th ed.Champaign,IL: Human Kinetics; 2004
** American College of Sport Medicine. Guidelines for Exercise Testing and Prescription , 8 th ed.Pheiladelphia,Lippincott Williams&Wilkins; 2010

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RESISTANCE EXERCISE PRESCRIPTION IN HF

Resistance training	Training Type and stimulus			
	Training objectives	Stress form	Intensity	Repetitions
Step I-Pre-training	-To learn and practice the correct implementation to learn perception to improve intramuscular co-ordination	Dynamic	<30% 1RM RPE <12	5-10
Step II - Resistance / Endurance training	- To improve local aerobic endurance and intramuscular co -ordination	Dynamic	30-40% 1 RM RPE < 12-13	12-25
Step III - strength training, Muscle build up training	- To increase muscle mass to improve intramuscular co-ordination	Dynamic	40-60% 1 RM RPE < 15	8-15

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FORCES REQUIRED TO PERFORM ADL

Activity	Force pounds
Lift 1 lb dumbbell	2
Lift 3 lb dumbbell	4
Lift 5 lb dumbbell	6
Lift 10 lb dumbbell	12.5
Pushing open the door to CR	15.5
Pulling open door to leave CR	22
Lifting full laundry hamper	21.5
Hold elevator door from closing	14.5
open refrigerator	9
Pulling 1 gallon of milk from refrigerator	10.5
Closed microwave door	6.5
Pushing vacuum cleaner	7.5
Pulling vacuum cleaner	8.5
Flushing industrial toilet	13.5
Lifting purse	7.5
Lifting full coffee pot	6.5
Opening car door	15.5

Adams J, Cline MJ, Hubbard M, McCullough T, Hartman J. A new paradigm for post-cardiac event resistance exercise guidelines. Am J Cardiol. 2006;97:281–286.

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PROPER TECHNIQUE FOR RT

- Slow controlled movement through the full range of motion
- Regular breathing pattern
- Avoid strain, tight grip
- RPE 11-13 from scale 6-20
- Initial load 12-15 rep 30-40 % of 1 RM x UE
  50-60% of 1 RM x LE
- Progressive increase load 2-5 lb /wk for UE
  5 - 10 lb/wk for LE

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PROPER TECHNIQUE FOR RT

- A rest period of 30–120 seconds between sets is recommended
- RPE 11-13 from scale 6-20
- Monitored for symptoms such as dizziness, palpitations or shortness of breath

Modifier from American College of Sport Medicine. Guidelines for Exercise Testing and Prescription , 8 th ed.Pheiladelphia,Lippincott Williams&Wilkins; 2010 and Wise FM, Patrick JM. Resistance exercise in cardiac rehabilitation. Clin Rehabil. 2011 Dec;25(12):1059-65.

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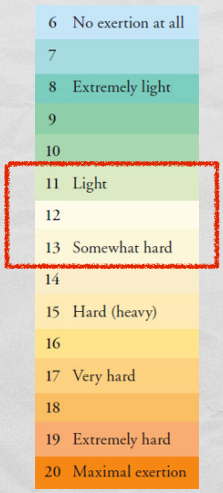
Rate of Perceived- exertion scale



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SUMMARY

- Right = Technique
- Right = Time
- Right = Persons

"Combine both Aerobic and Resistance"

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