31st Annual CCSU Sports Medicine Symposium

Turning Negatives Into Positives:

A New Approach to Eccentric Training

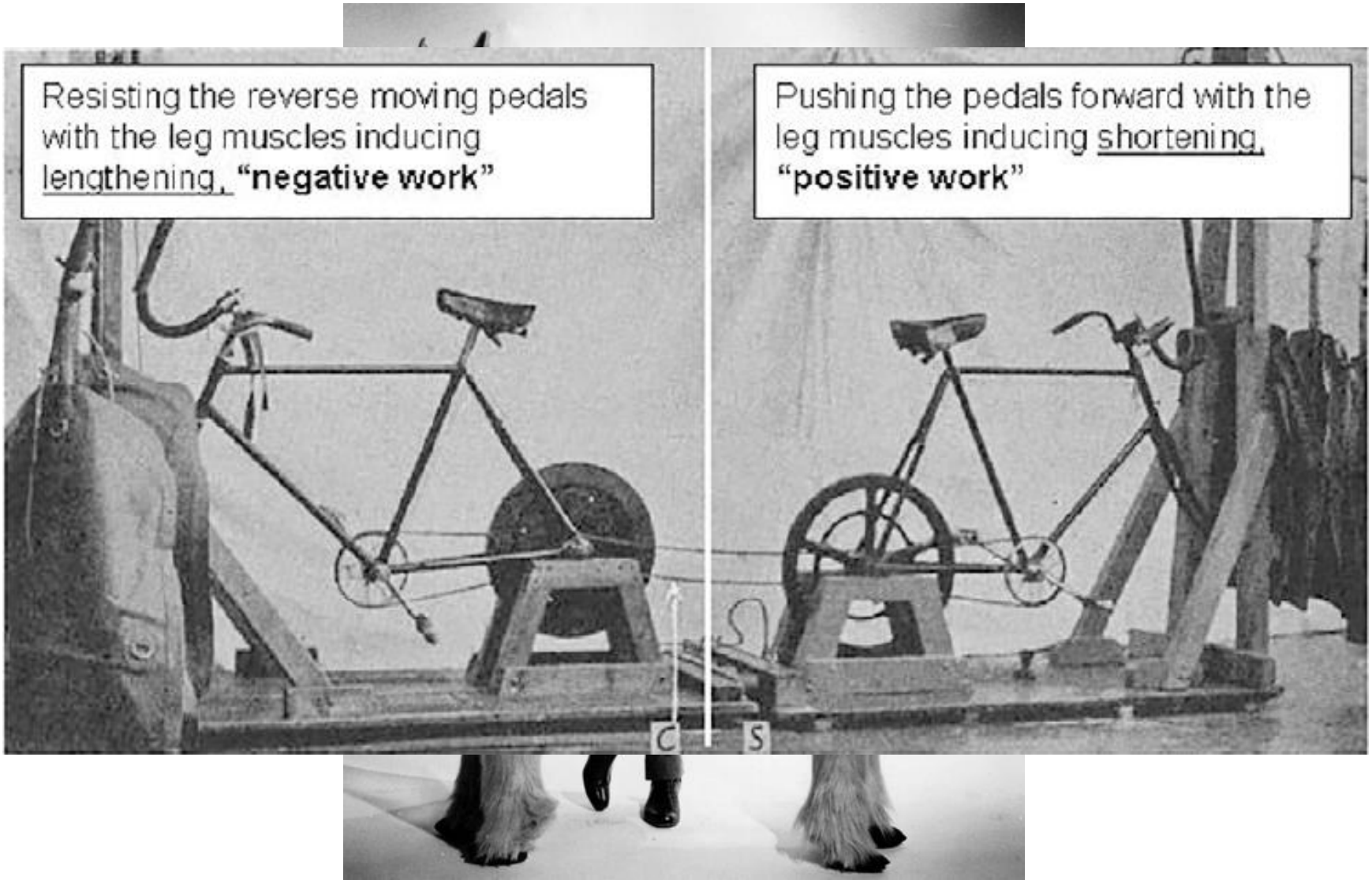
Disclosure & Conflict of Interest

- The presenter has no conflicts of interest or financial relationships to disclose.

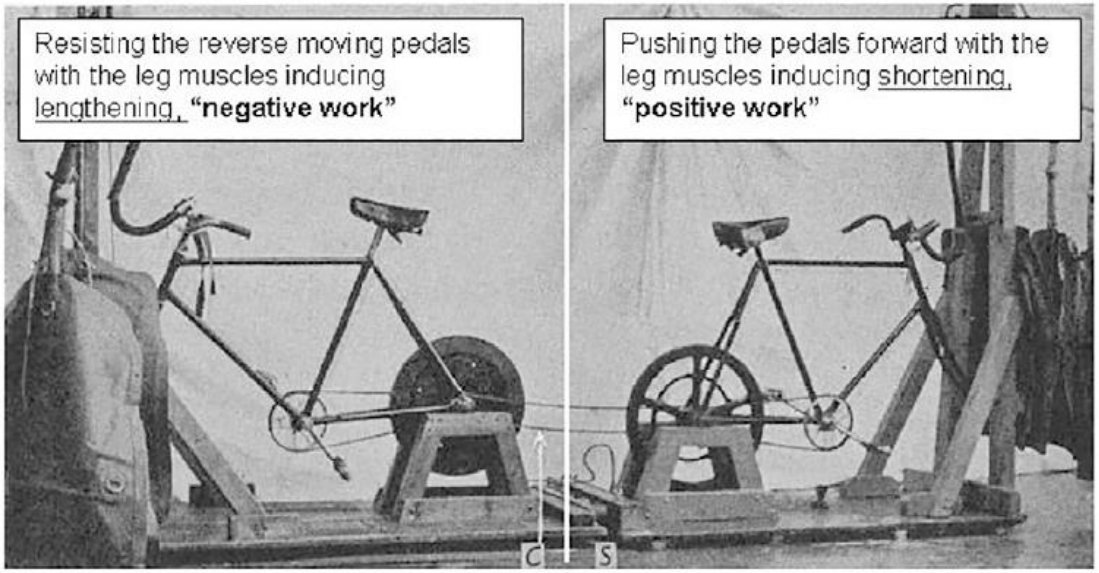
Eccentric Exercise

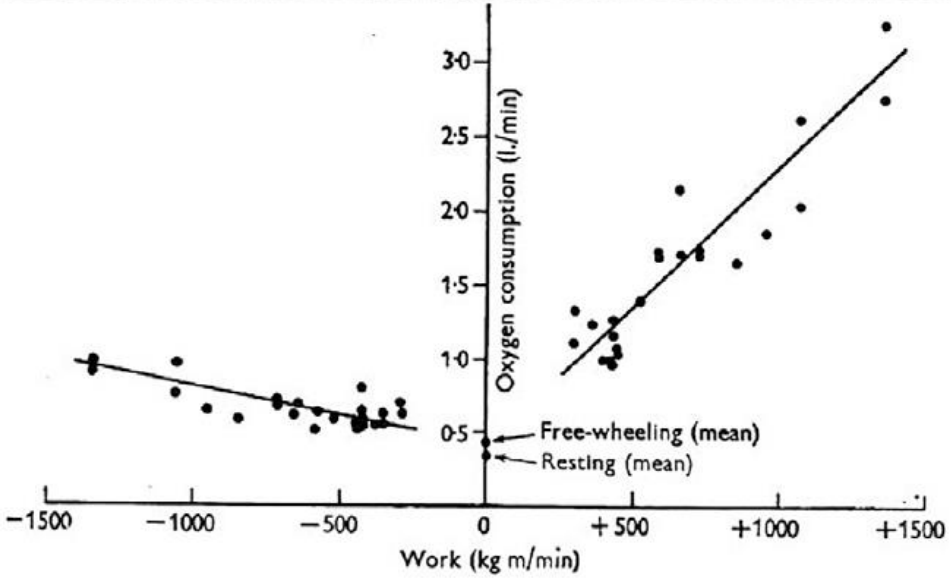
- Historical perspective
- Eccentric muscle mechanics
- Fallacies vs. Facts
  - Injury/Damage vs. Rehab/Benefits
- Safety, Feasibility & Application
  - Contribution to Injury, Prevention, Rehabilitation & Sport Performance

Push Me, Pull You



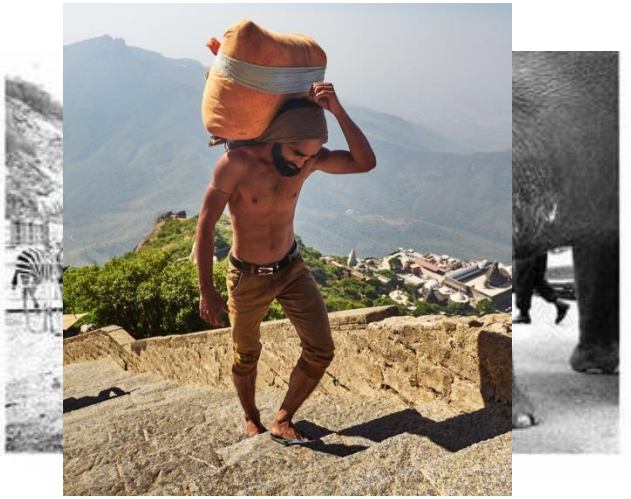
Two Bikes, One Chain – Abbott, Bigland & Ritchie (1952)





What is the COST of WORK?

- Energy cost of doing work
  - Fenn Effect (1924)
  - Energy required for force production is increased when muscles shorten



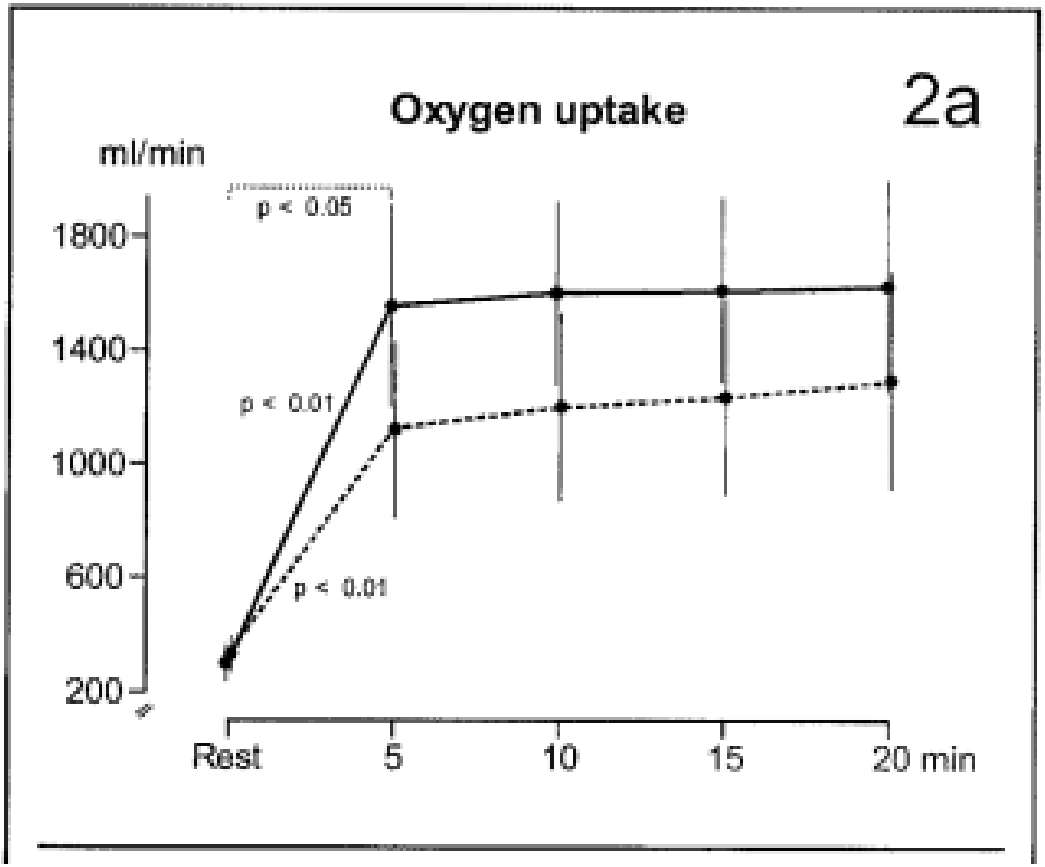
Positive Work

  - Negative Fenn Effect
  - Energy liberated is reduced when muscle is stretched while contracting

Negative Work

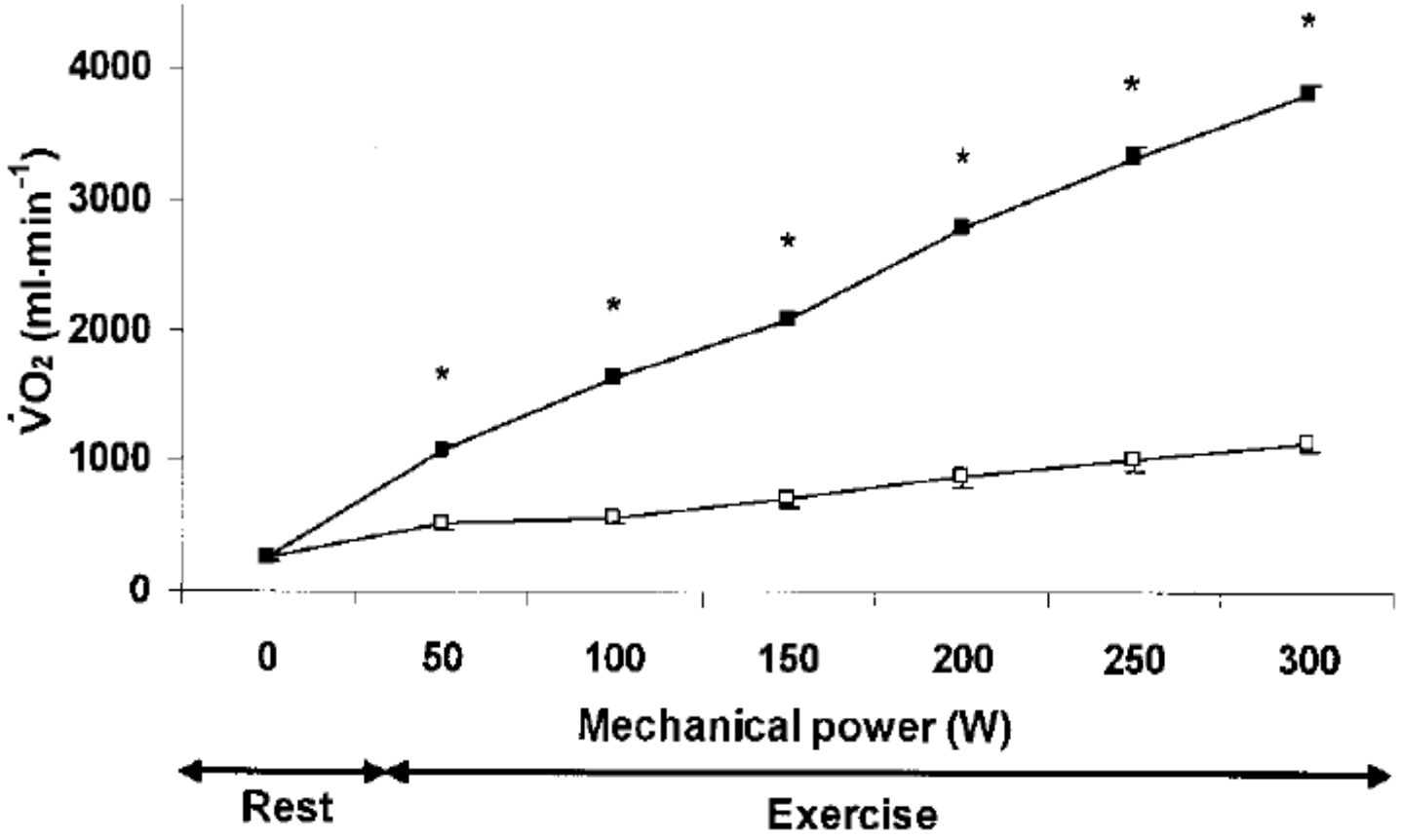
Why would Con exercise elicit a greater RPE than Ecc exercise?

- Metabolic Cost



Meyer et al. (2003) *MSSE*

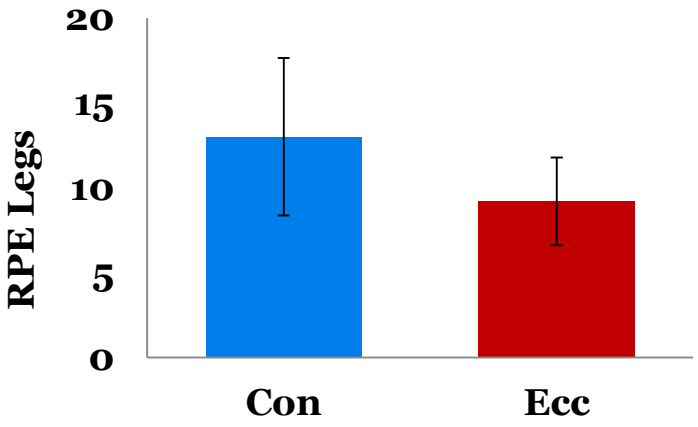
Lower Metabolic Demand for Ecc Ex

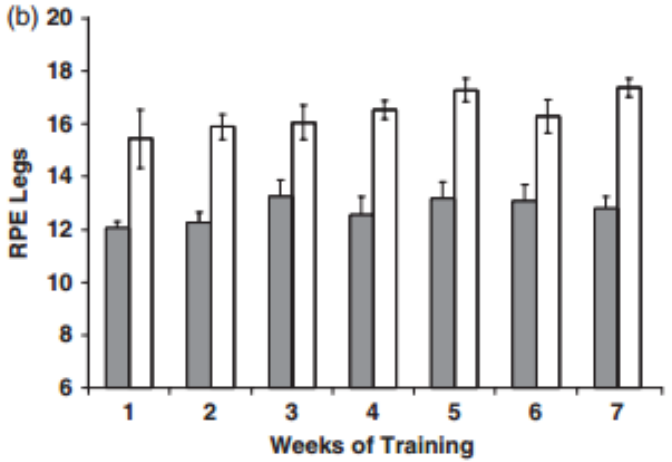


Dufour et al. (2004) *Med Sci Sports Exerc*

Responses to Con vs. Ecc Exercise

- Rating of Perceived Exertion

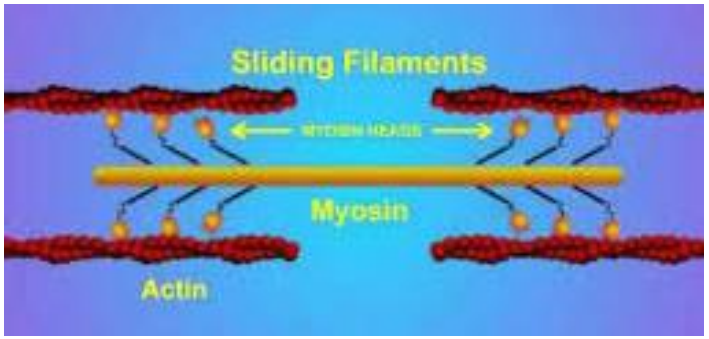




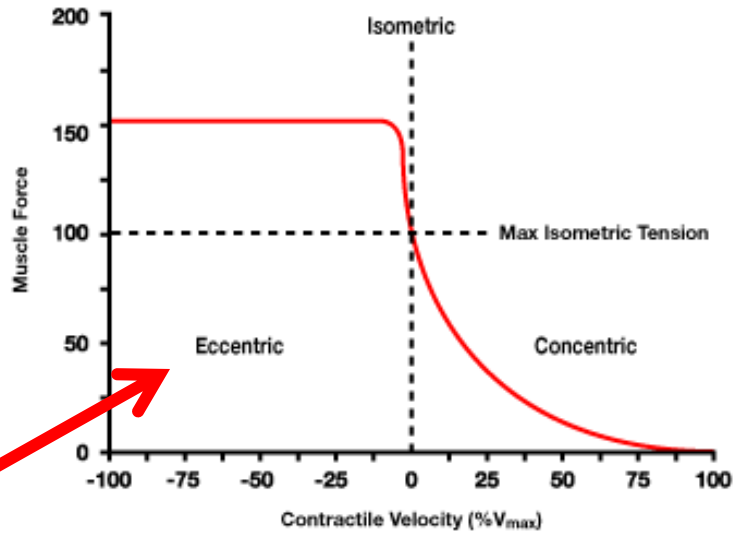
EXS 216 Kinesiology (2015)

Elmer et al. (2012) *Scan J Med Sc Sports*

Actin-Myosin Bonds???



- Chemical reactions that consume ATP are not simply reversed during lengthening contractions
- Speculation that actin-myosin bonds are disrupted mechanically
- Thomas McMahon (1995)



Muscle Force-Velocity Curve

Two Defining Properties!!!

- Force production is uniquely high
- Energy cost to produce force is uniquely low

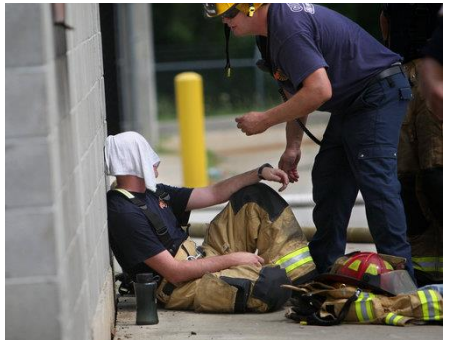
LaStayo et al. (2014) *JAP*

Fallacies vs. Facts of Eccentric Muscle Contraction

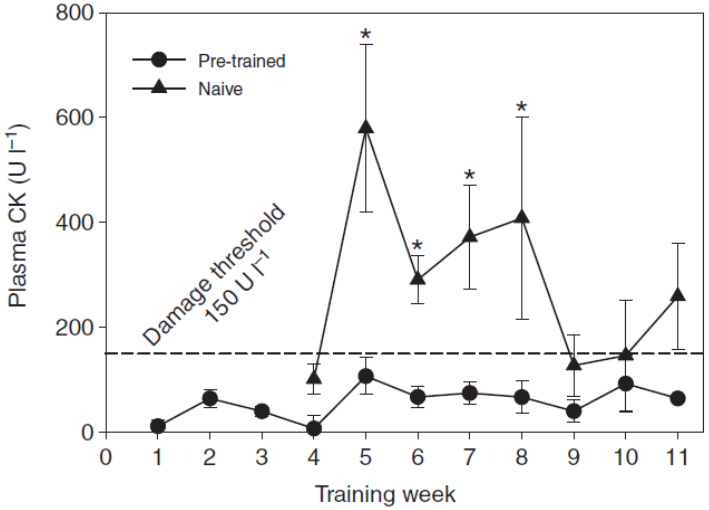
- Injury/Damage vs. Rehab/Benefits
  - 1000 vs. 50 citations
  - Delay Onset of Muscle Soreness
  - No Pain, No Gain???

Eccentric Training – CAUTION!!!

- Rhabdomyolysis
  - Condition in which damaged skeletal muscle (myoglobin) breaks down.
  - Myoglobin released into the bloodstream
  - Kidney failure
  - Symptoms
    - Muscle pain
    - Vomiting
    - Confusion



No Pain, No Gain?



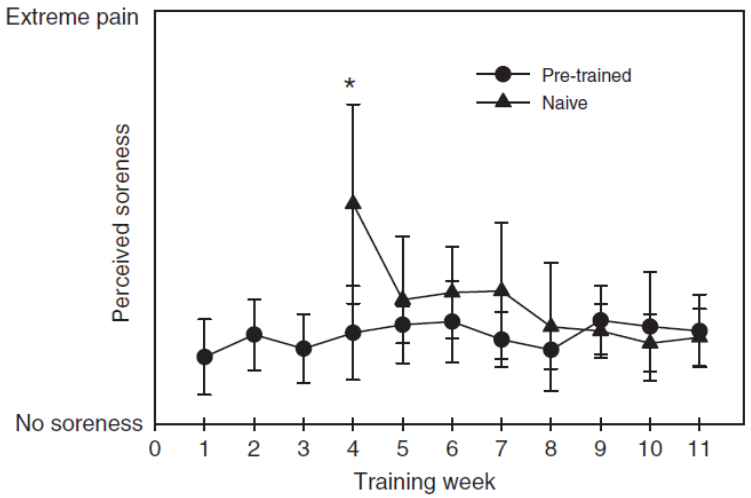
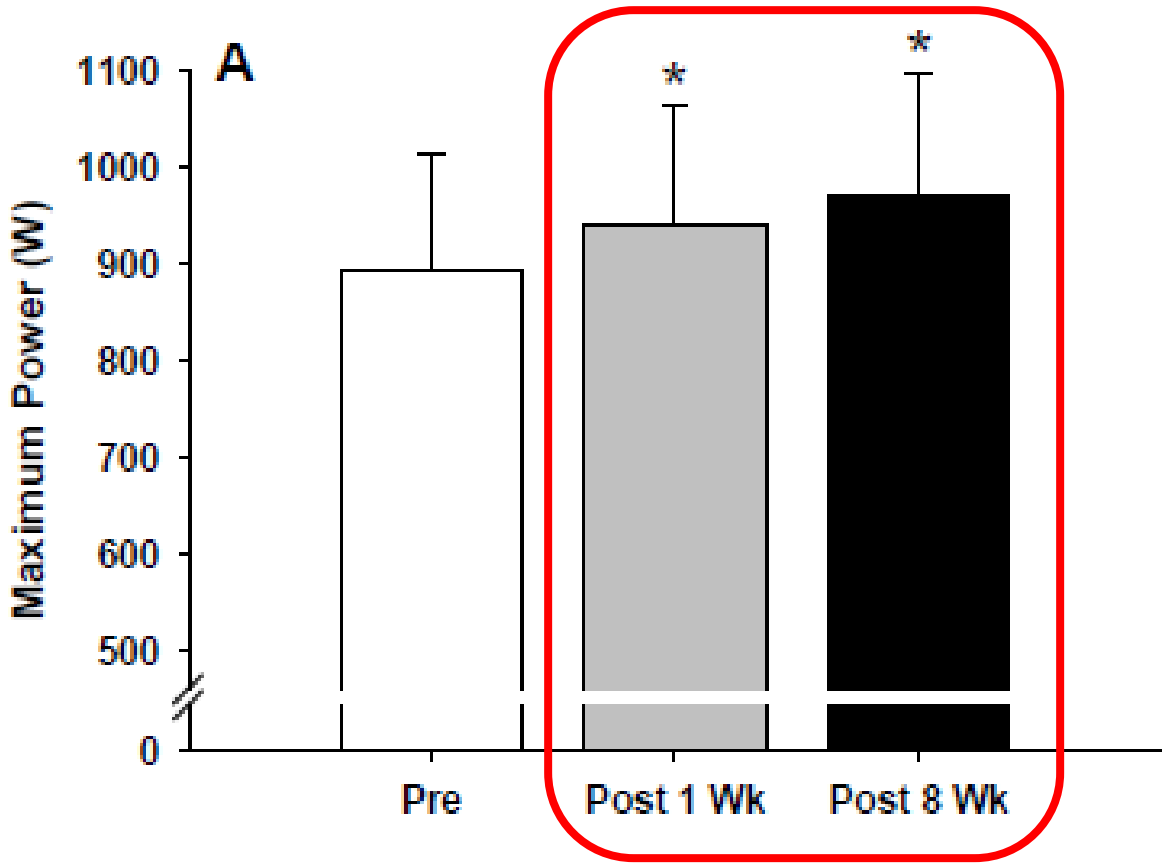


Table 2. Quadriceps muscle volume and isometric strength

	Pre-trained group (PT)			Naive group (NA)		
	Pre-training	Post-training	%Δ	Pre-training	Post-training	%Δ
Quadriceps volume (cm^3)	1651±145	1751±141	6.5*	1906±175	2041±176	7.5*
Quadriceps strength (N)	104.5±64.5	130.5±28.5	24.8*	108.4±81	136.4±118.6	25.8*

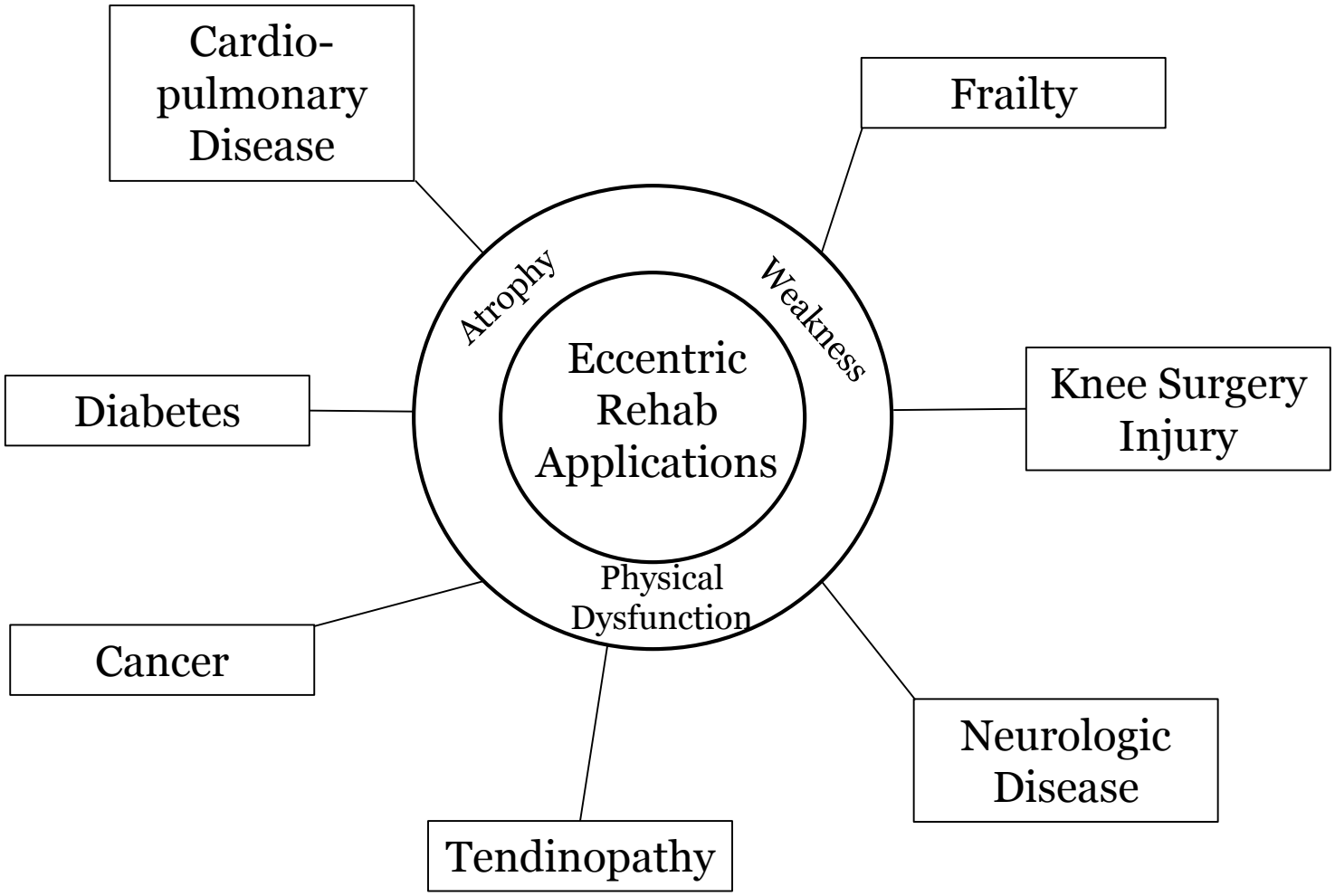
Mean values (N=14, ±s.e.m.) of the PT and NA groups before and after the 12-week resistance training. *Significant difference (P<0.05) was seen within the groups for pre- and post-cross volume values as well as pre- and post-strength results. No statistical difference (P>0.05), however, was present between the NA and PT groups for either muscle volume or strength.

Flann et al. (2011) ***J Exp Bio***



Leong et al. (2013) *IJSM*

Safety & Feasibility in Rehab



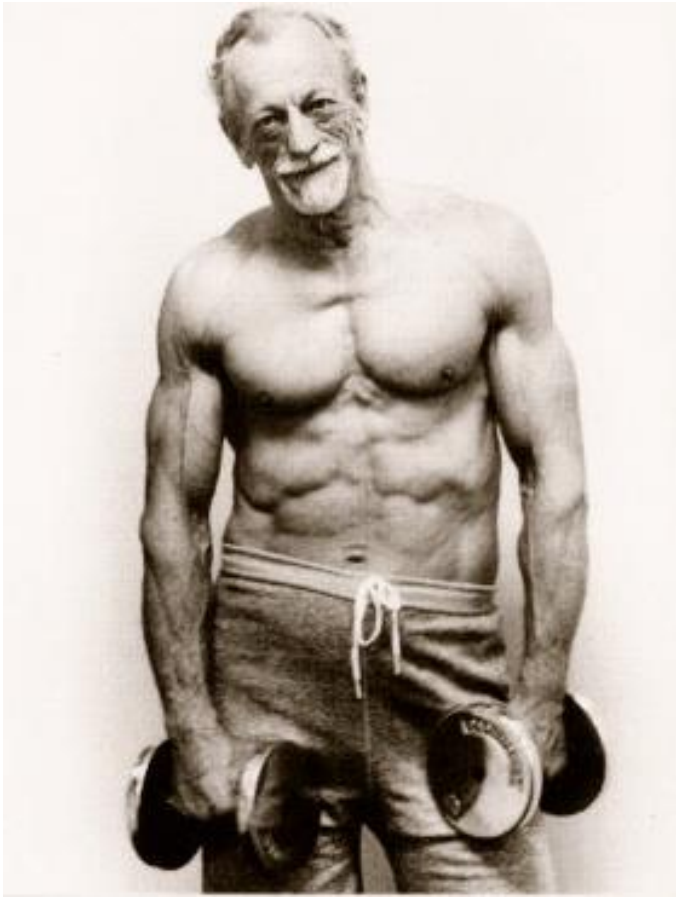
LaStayo et al. (2014) *JAP*
Andres et al. (2008) *Clin Orthop Relat Res*

Improvements in Muscular & Multi-Joint Function

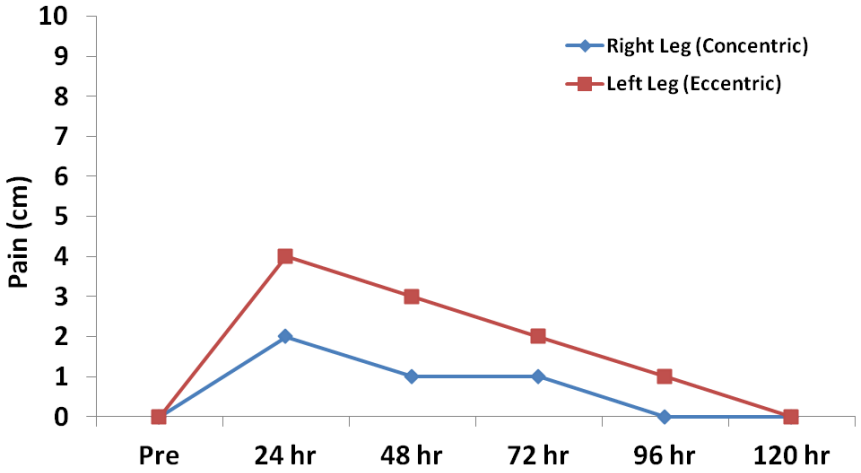
- Muscle Size
- Muscular Function
- Mobility

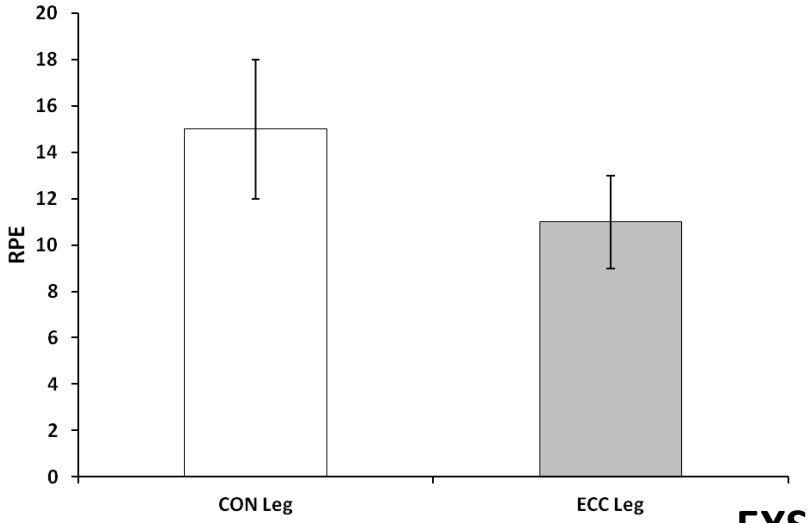
Application of Eccentric Training

- Progression
- Mode



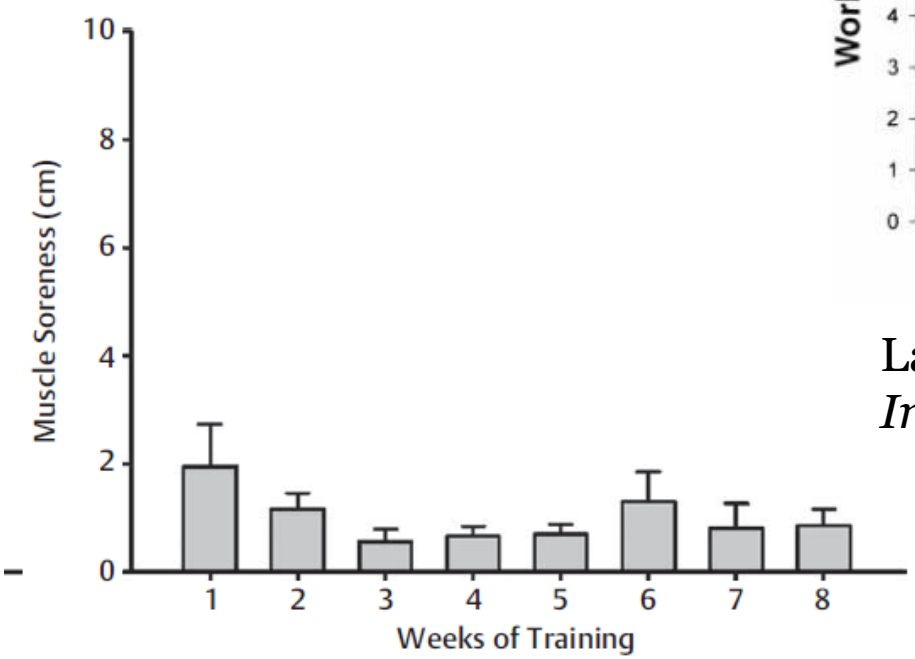
Acute Responses to Ecc Exercise



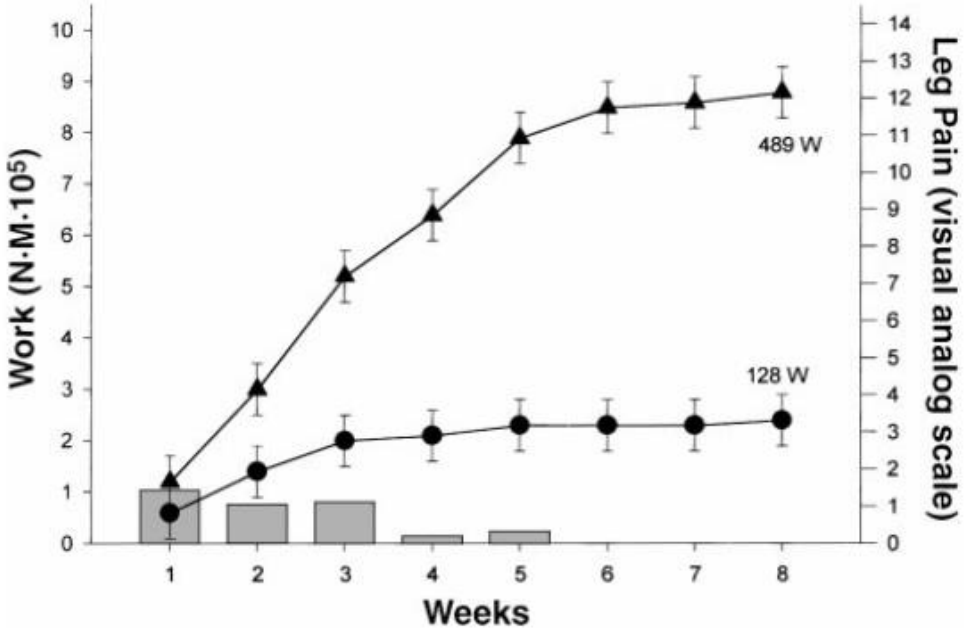


Responses to Chronic Eccentric Training

- Muscle Soreness



Leong et al. (2013) *IJSM*



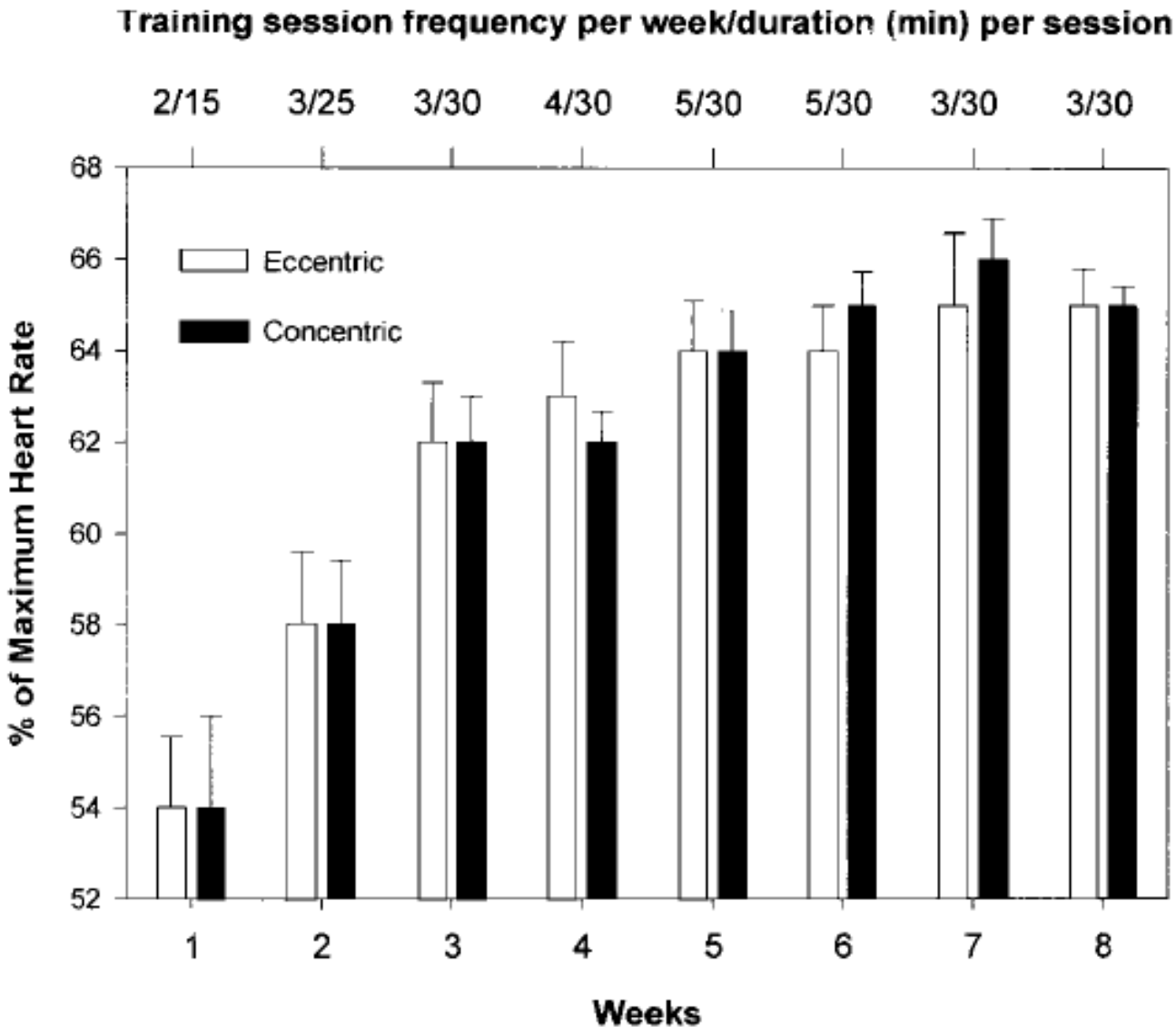
LaStayo et al. (2000) *Am J Physiol Regul Integr Comp Physiol*

Table 2. Progression of eccentric cycling training intensity and duration. Note that all training was performed at 60 rpm.

Weeks of Training	% Baseline P_{max}	Duration (min)
1	20	5
2	25	6
3	30	7
4	35	8
5	40	9
6	45	9.5
7	50	10
8	55	10.5

P_{max}: Maximum concentric cycling power.

Leong et al. (2013) *IJSM*



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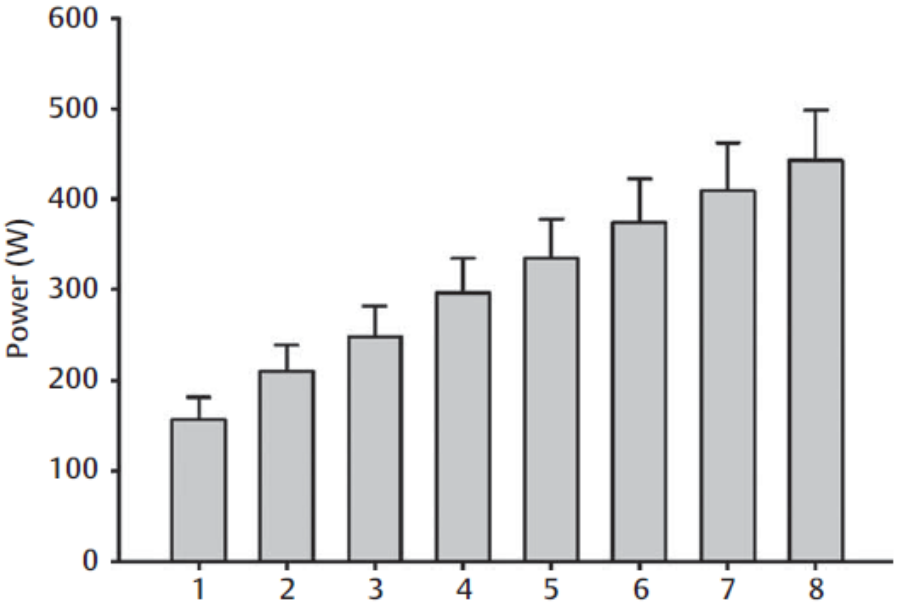
Eccentric Training Intensity



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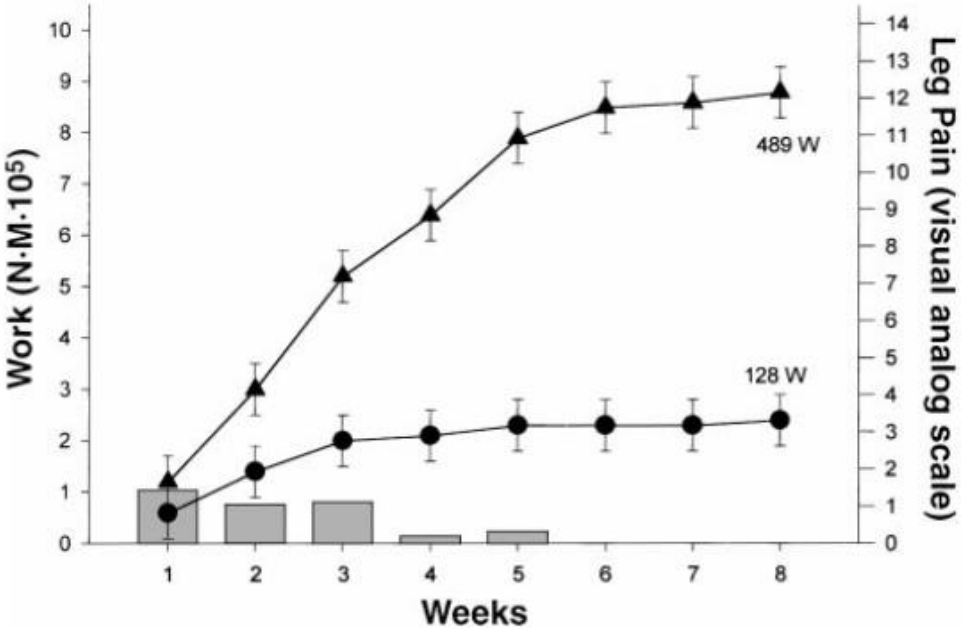

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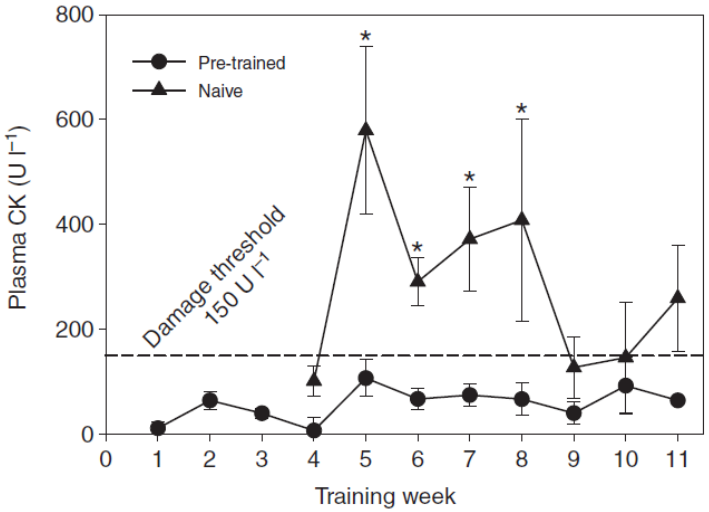
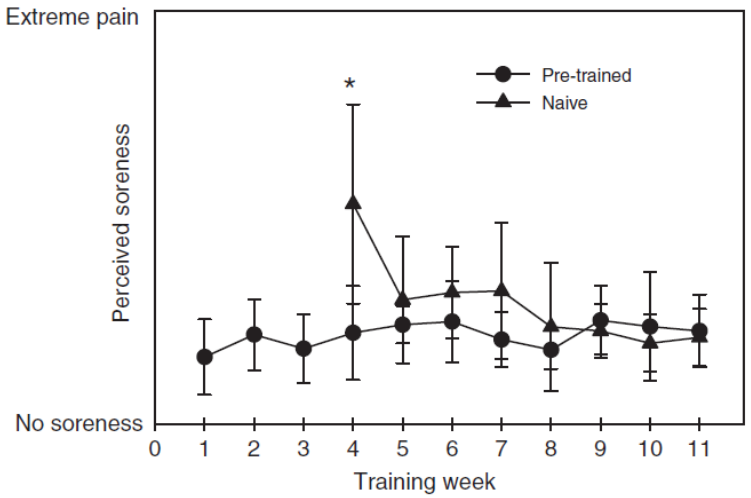
No Pain, No Gain?





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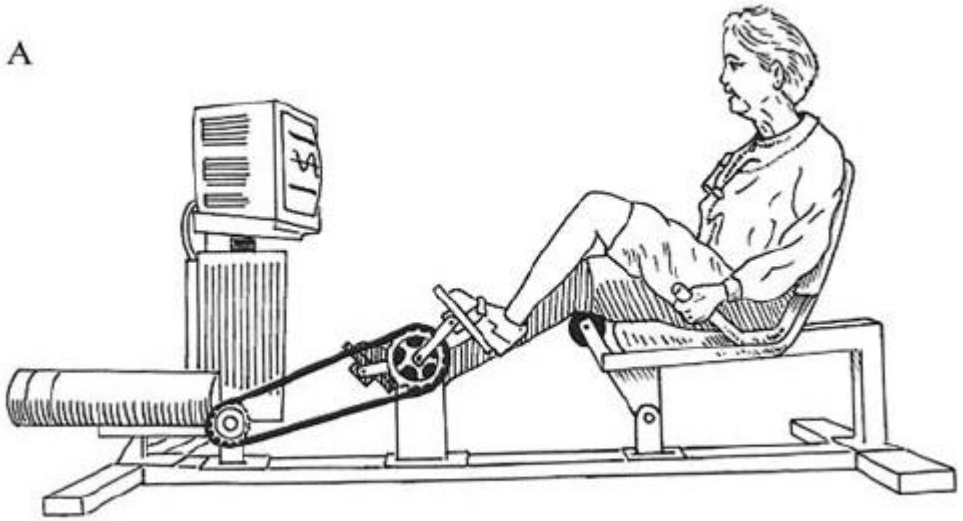
Flann et al. (2011) ***J Exp Bio***

Eccentric Training

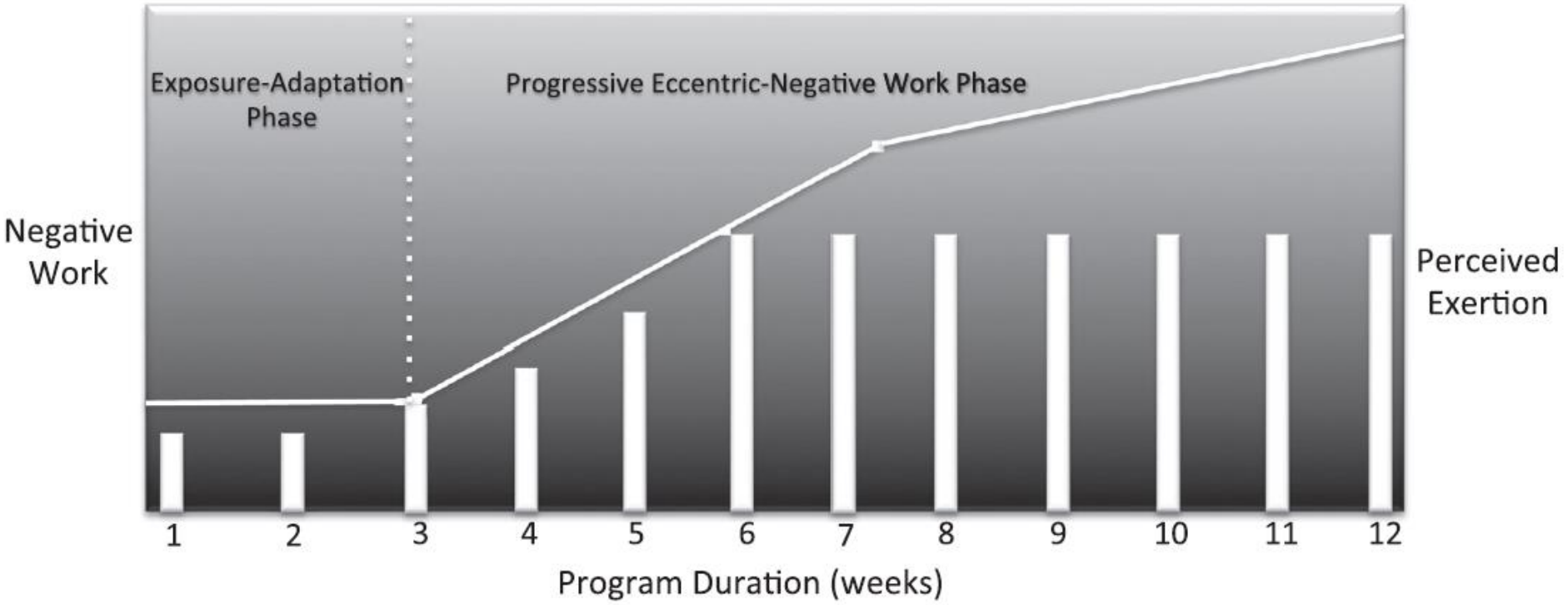
Frail elderly adult patients, mean age of 80.2 years



"…maintained 216 W for 15 minutes, and the least frail maintained a workload in excess of 400 W for 20 minutes…"

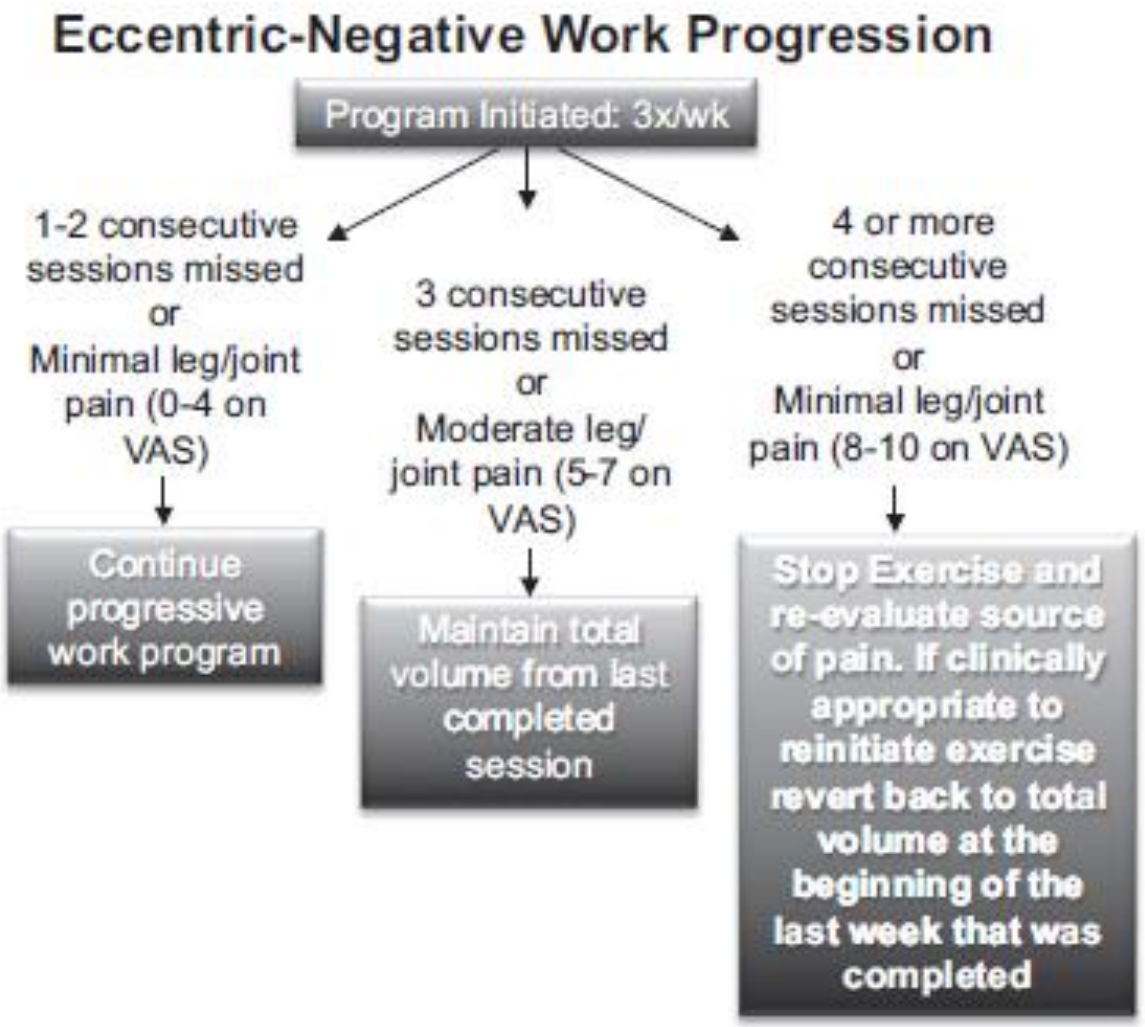
LaStayo et al. (2003) *J Gerntol*

12 week Progression



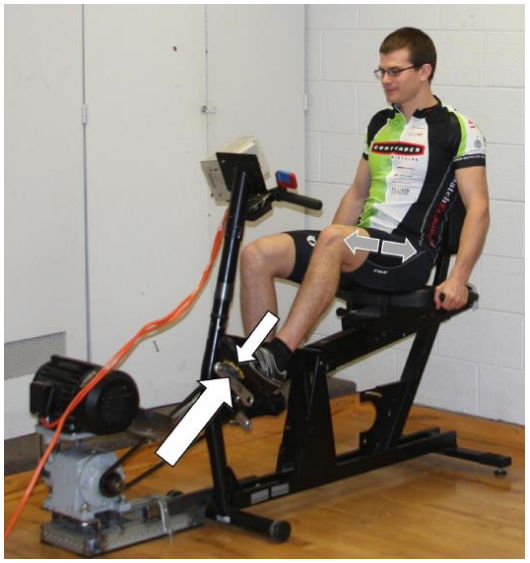
LaStayo et al. (2014) *JAP*

Algorithm for temporary pain, adverse reactions & missed sessions



How do we perform Ecc Training?

- Modes of Ecc Ex
  - Be Justin Bieber?
  - Agaton
  - Isokinetic Dynamometer
  - Eccentric Cycle Ergometer



Eccentric Cycle Ergometer

Elmer & Martin (2012) *J Appl Biomech*

Eccentric cycling is a potent stimulus for improving muscular function in:

- ✓Young healthy individuals
- ✓Athletes
- ✓Patients with tendinopathies
- ✓Frail and elderly
- ✓ACL patients
- ✓Parkinson's disease patients
- ✓Cancer survivors
- ✓Total knee replacement patients

???? Astronauts & Patients with low bone mass

LaStayo et al. (2003) *J Gerntol*
Dibble et al. (2006) *Mov Discord*
Gerber et al. (2009) *Phys Therp*
LaStayo et al. (2010) *J Geriatr Phys Ther*
Gross et al. (2010) *Int J Sports Med*
Elmer et al. (2011) *Scand J Med Sci Sports*

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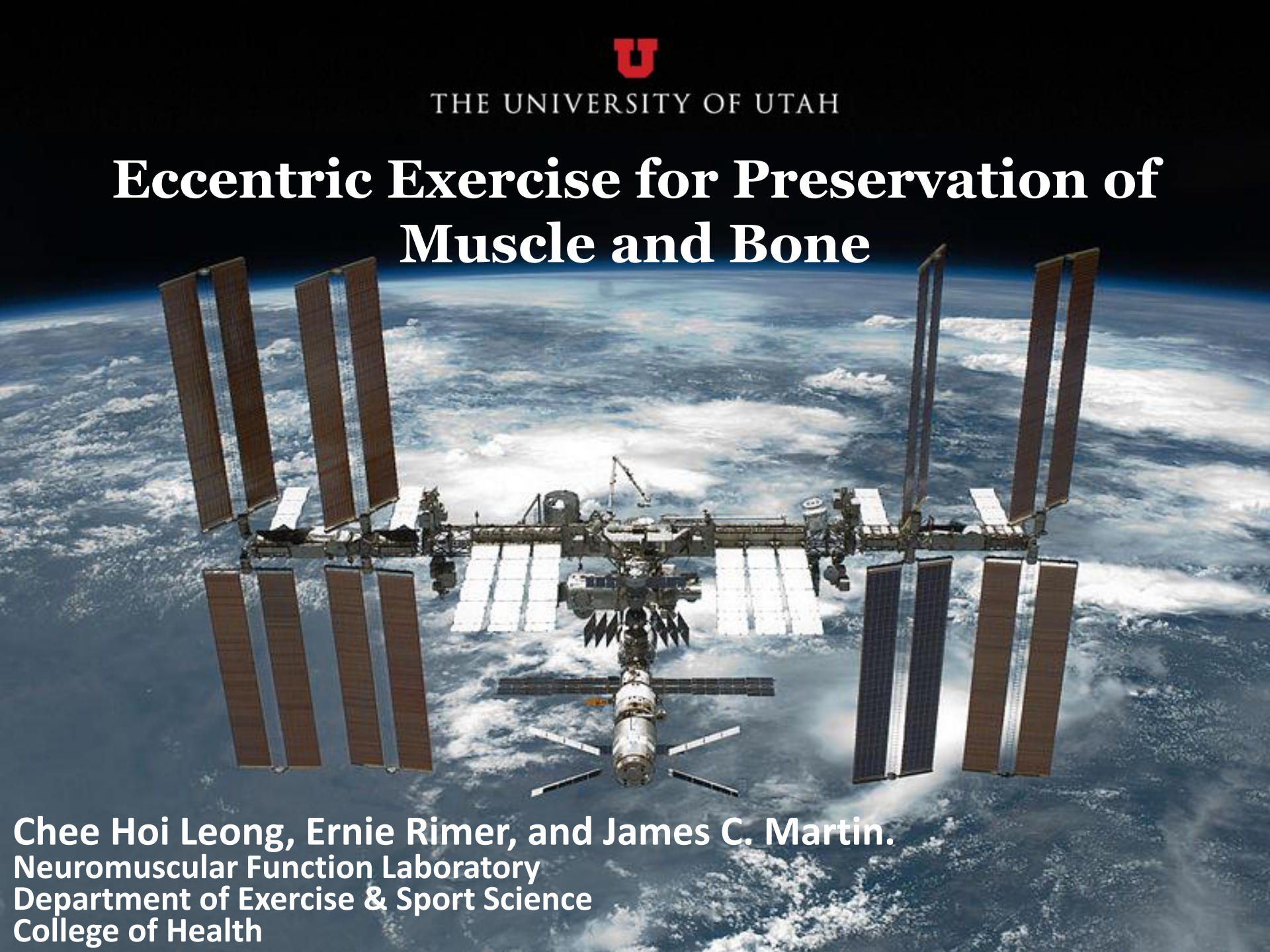
Eccentric Exercise for Preservation of Muscle and Bone



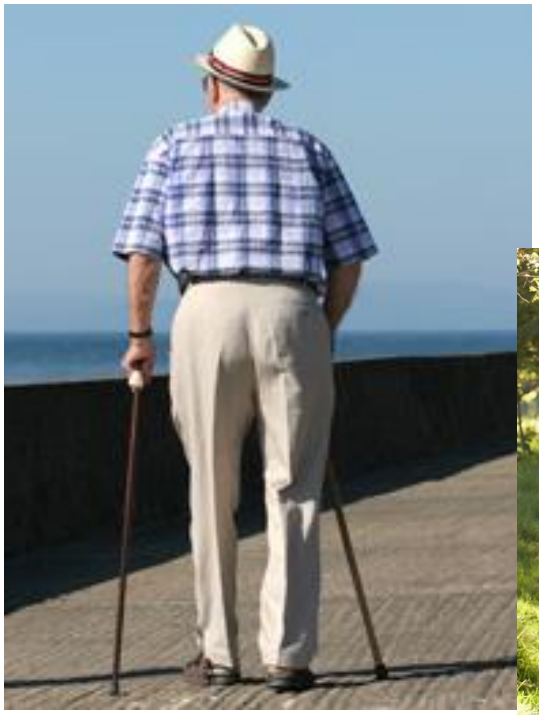
Chee Hoi Leong, Ernie Rimer, and James C. Martin.
Neuromuscular Function Laboratory
Department of Exercise & Sport Science
College of Health

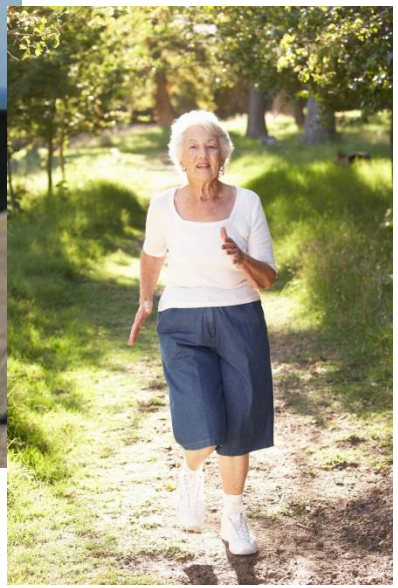
Exposure to Microgravity

Reduced Muscle Mass and Function

&

Reduced Bone Mineral Density





Summary

- Intervention geared toward individuals with:
  - Low muscle mass reserves and quality
  - High mobility impairments
  - Dwindling self-independence
- Few countermeasures are superior to traditional resistance exercise
  - Hypertrophy and attenuate muscular decline
- Safety, Feasibility & Clinical Benefits of Eccentric Exercise becoming more apparent
- Further development of parameters to optimize:
  1. Intensity
  2. Duration
  3. Modes

Thank You!!!

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