UNIVERSITY OF NORTH CAROLINA CHARLOTTE

Sarcopenia and How to Preserve Strength in the Aged

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"Exercise is the most effective way to improve health and lifespan, and that it can delay death and prevent physical and cognitive decline. "
Dr. Peter Attia

NCCRA | North Carolina Cardiopulmonary Rehabilitation Association

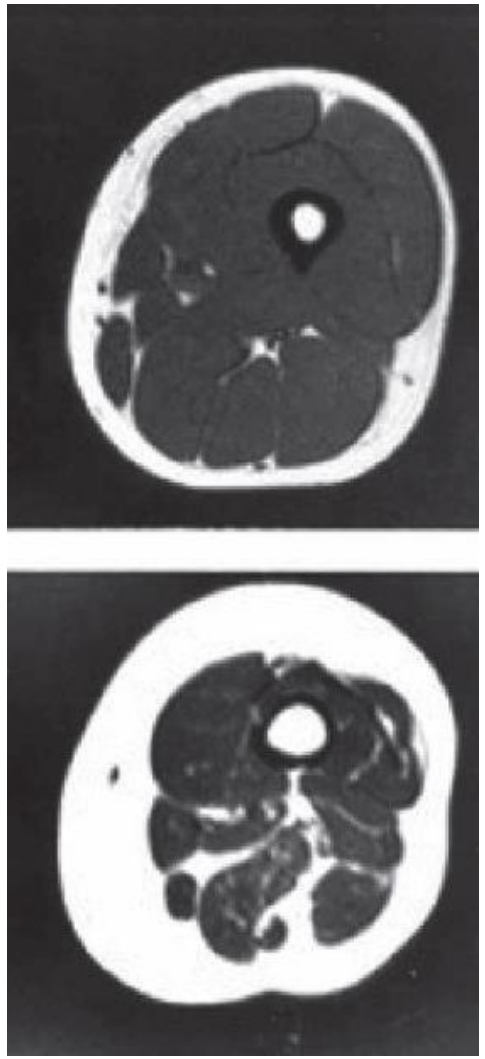
Sarcopenia and How to Preserve Strength in the Aged

Objectives

1. Describe the characteristics of an aged skeletal muscle.
2. Identify the diagnosis of Sarcopenia and it's effects on other diseases - including cardiopulmonary.
3. Explain the importance of exercise to the aged skeletal muscle.
4. Create a program (data on exercise and nutrition) to preserve muscle strength in the aged.

The Aged Skeletal Muscle: Defining Sarcopenia

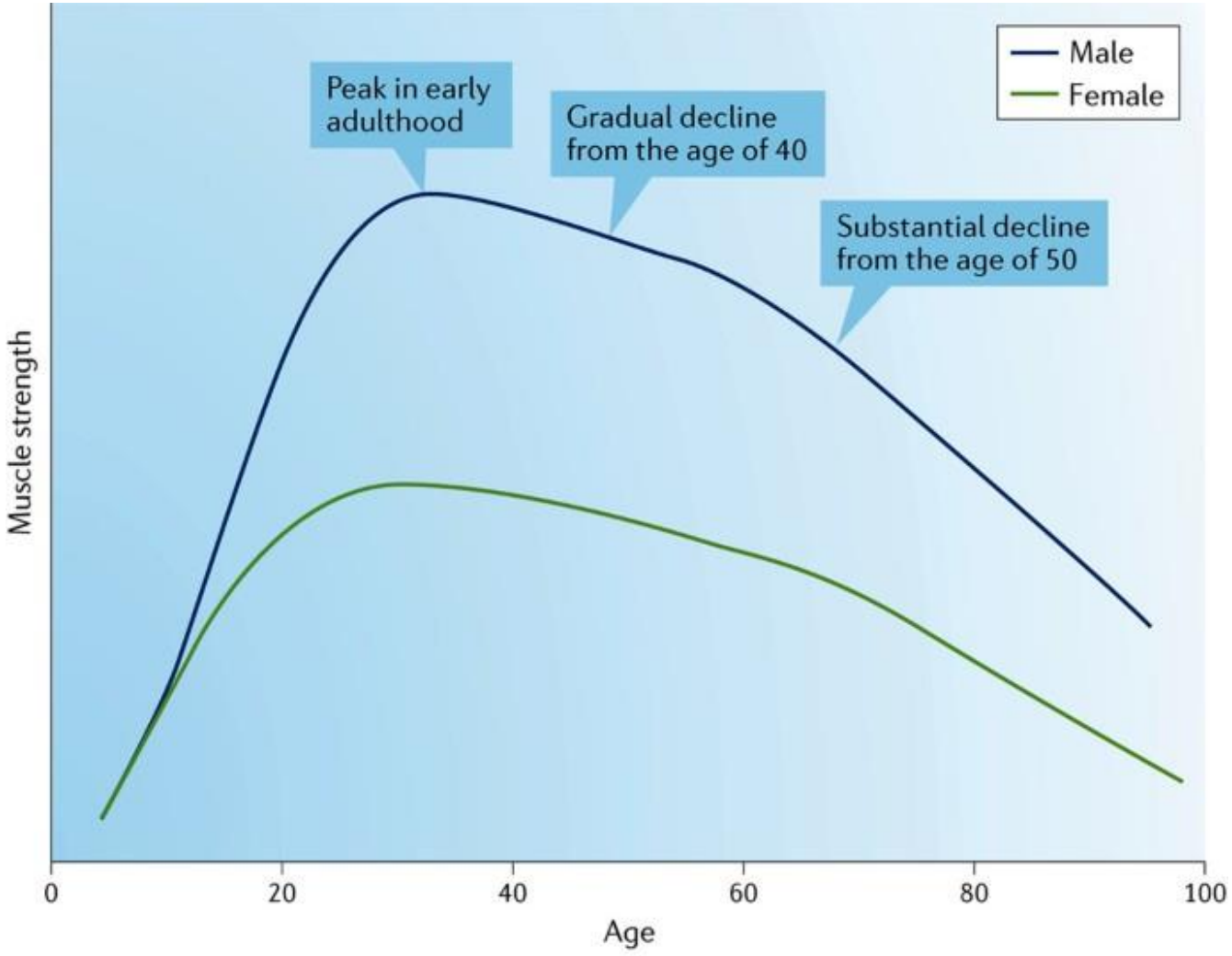
- ↓ Strength 2%-4%/ year starting at age of 50-60y.
- ↓ CSA by 40%
- ↑ intramuscular adipose tissue (30-50%).
- ↑ fibrosis between muscle fibers (~ 17%).



https://kaorukashima.com/2014/01/06/do-you-have-muscle/
Ramos, 2018

The Aged Skeletal Muscle: Defining Sarcopenia

- Risk Factors/Causes
  - Lifestyle
  - Disease
- Diagnosis
  - SARC-F
  - Functional tests
  - Imaging
- Formally recognized as a muscle disease in the International Classification of Disease (ICD-10: M62).



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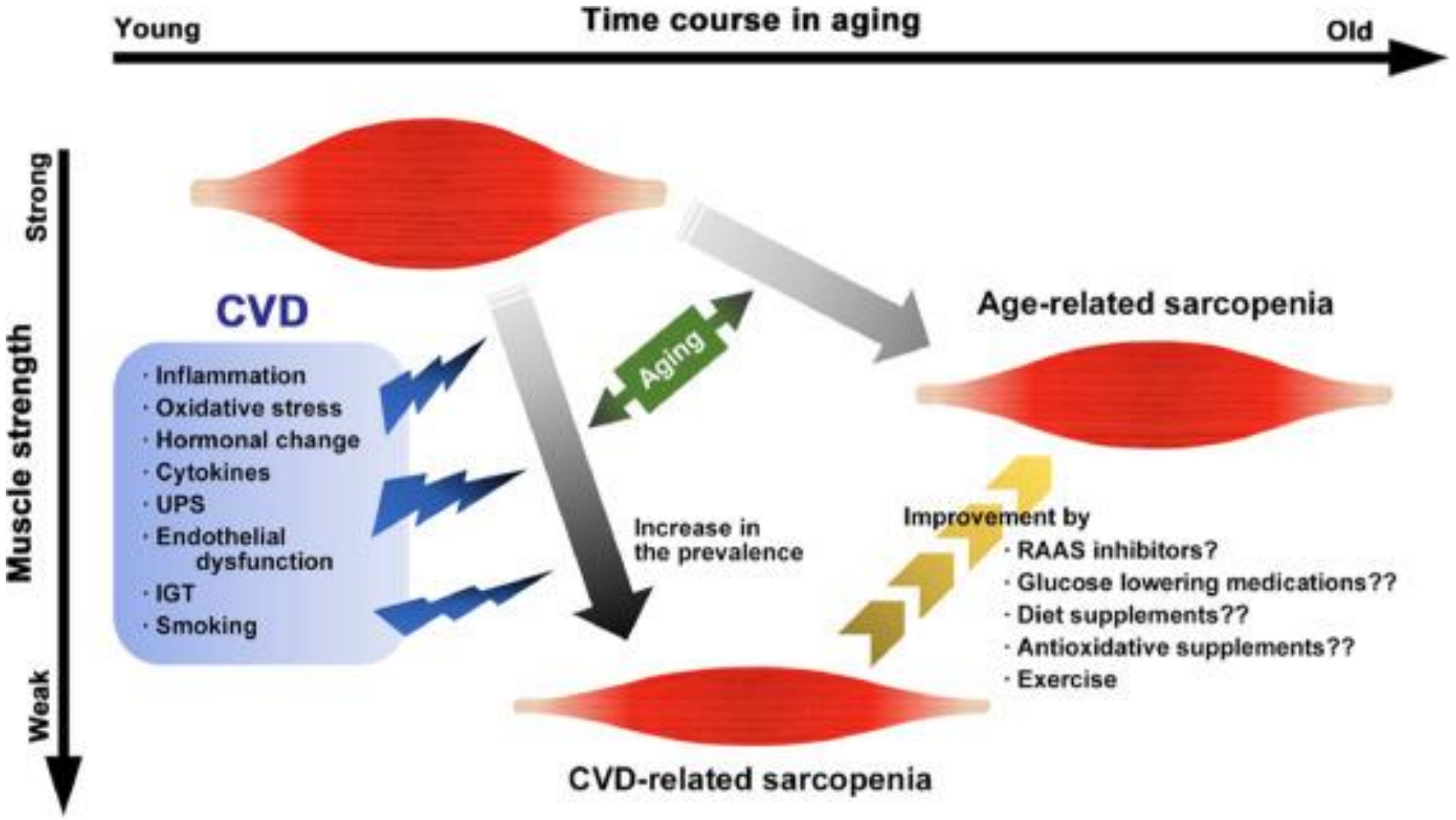
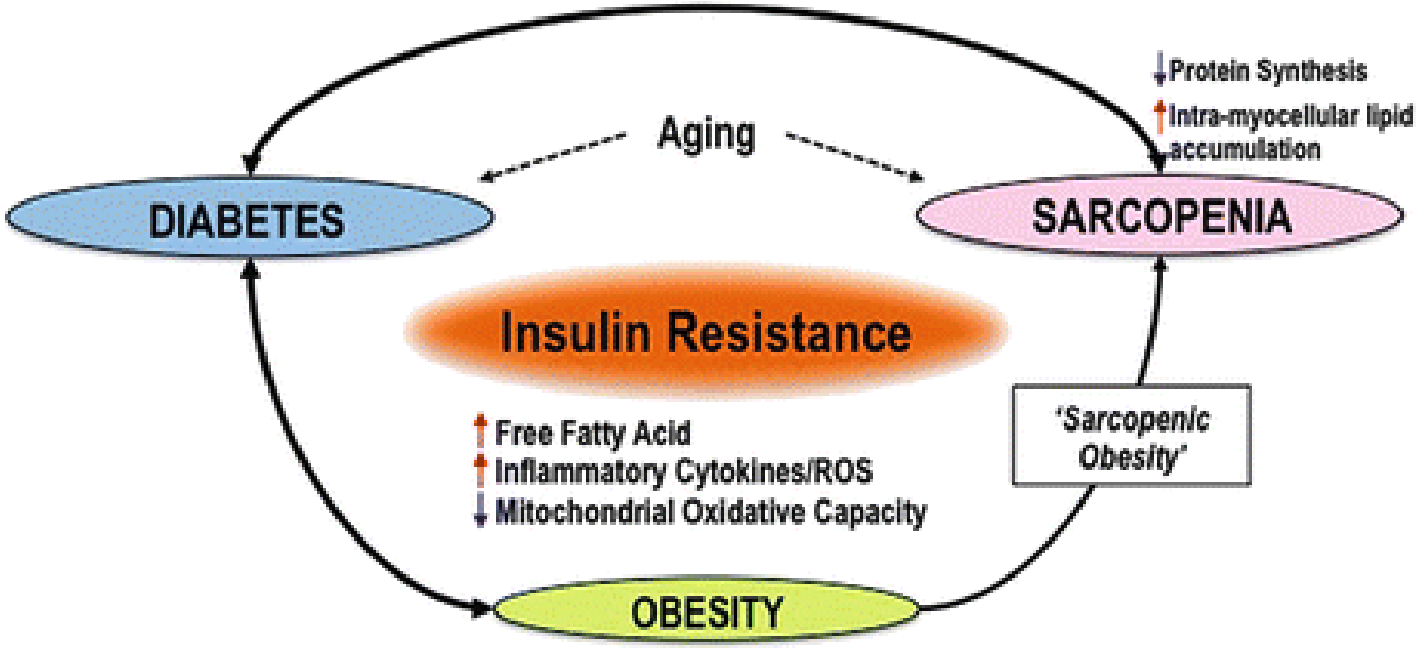
The Aged Skeletal Muscle: Sarcopenia as a Comorbidity



Ken-ichiro Sasaki,, Journal of Cardiology, Volume 79, Issue 5,2022,Pages 596-604,ISSN 0914-5087,https://doi.org/10.1016/j.jjcc.2021.10.013.

The Aged Skeletal Muscle: Sarcopenia as a Comorbidity

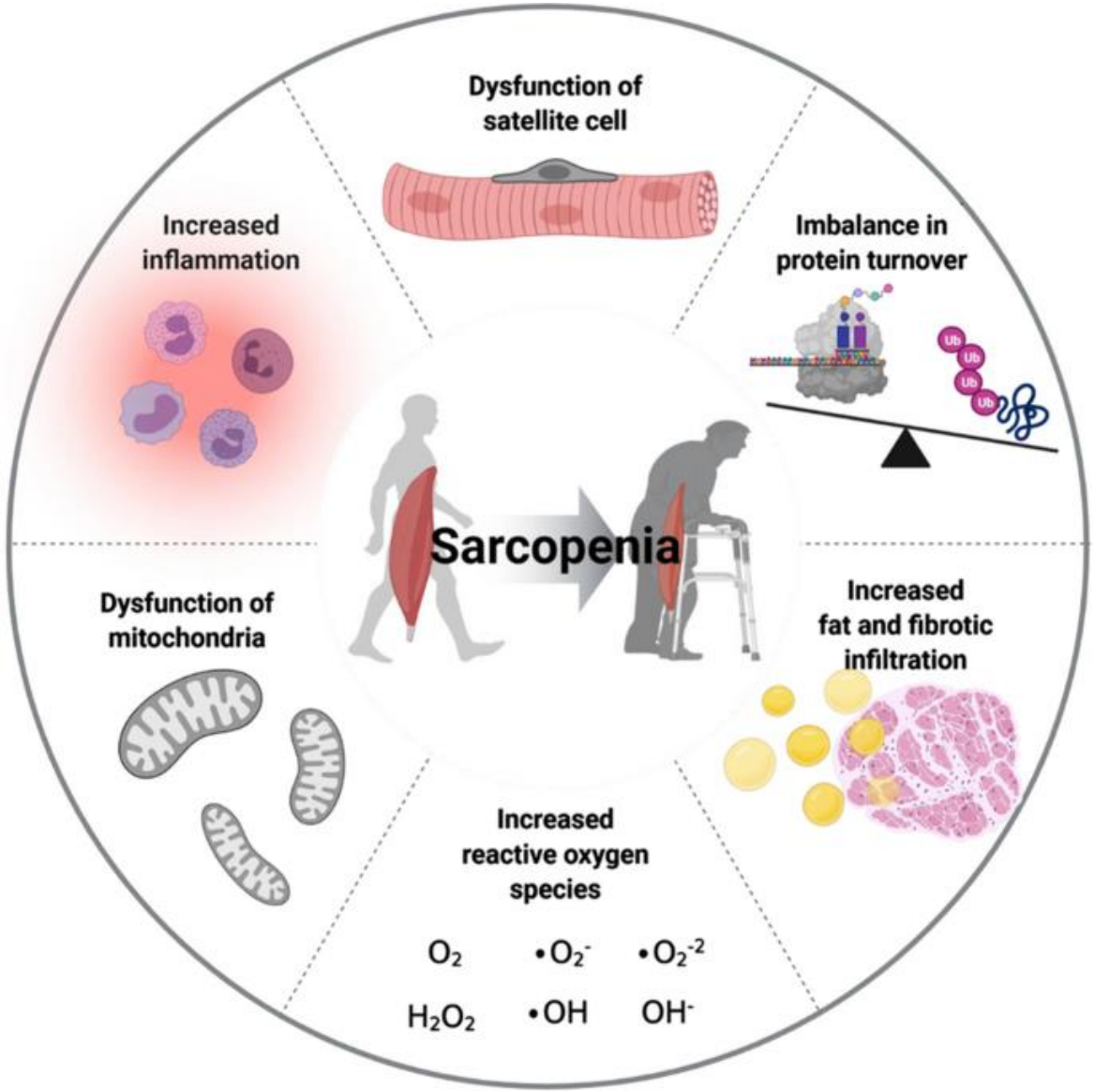


Coexistence of sarcopenia with diabetes or/and obesity increases Risk for:

- Fall/Disability
- Cardiovascular/Cerebrovascular Diseases

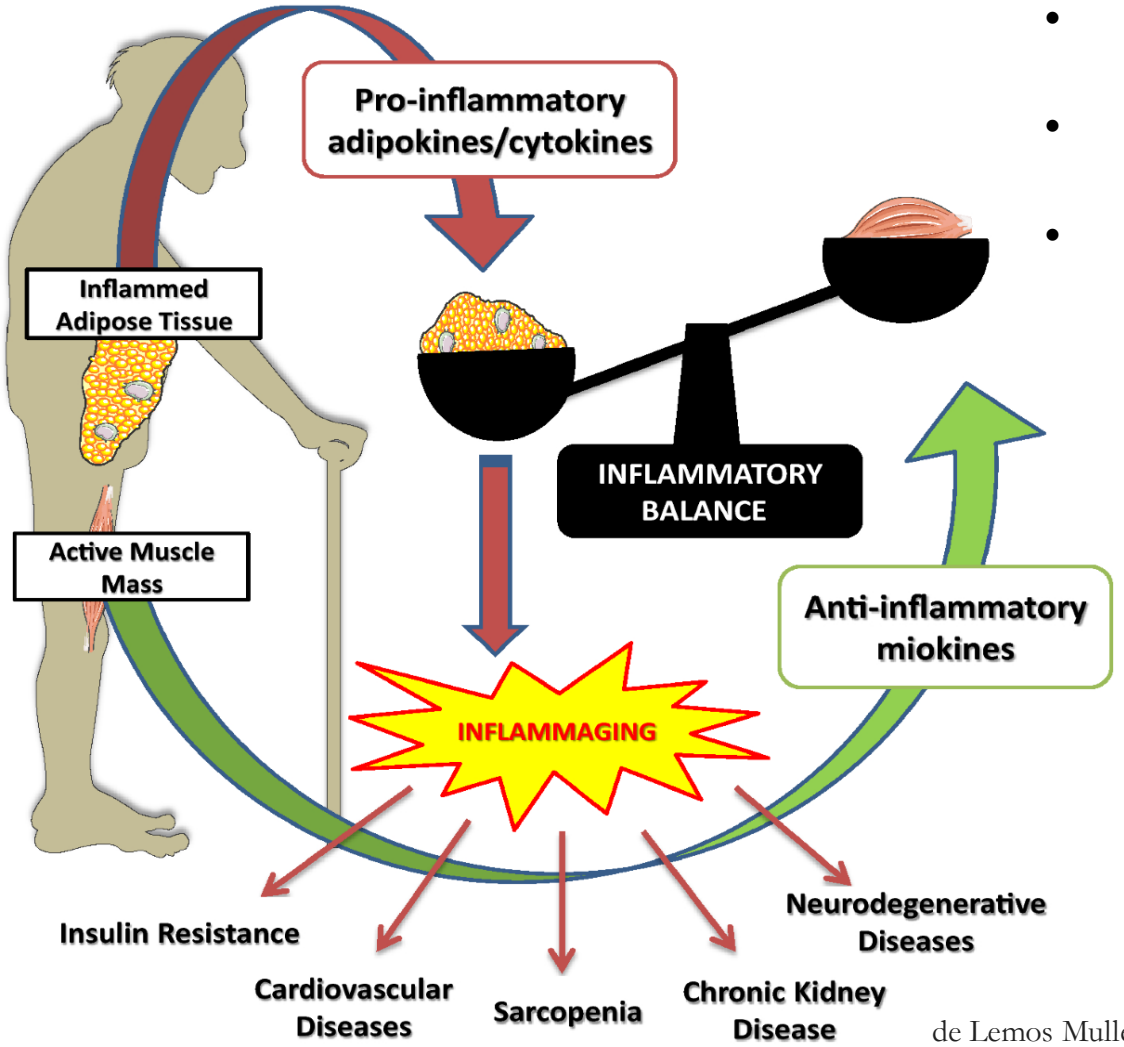
Sugimoto, K.(2016). Sarcopenia in Diabetes Mellitus. In: Inaba, M. (eds) Musculoskeletal Disease Associated with Diabetes Mellitus. https://doi.org/10.1007/978-4-431-55720-3_16

The Aged Skeletal Muscle: The Mechanisms of Sarcopenia



Köller, M. *Wien Med Wochenschr* **173**, 97–103 (2023). https://doi.org/10.1007/s10354-022-00927-0

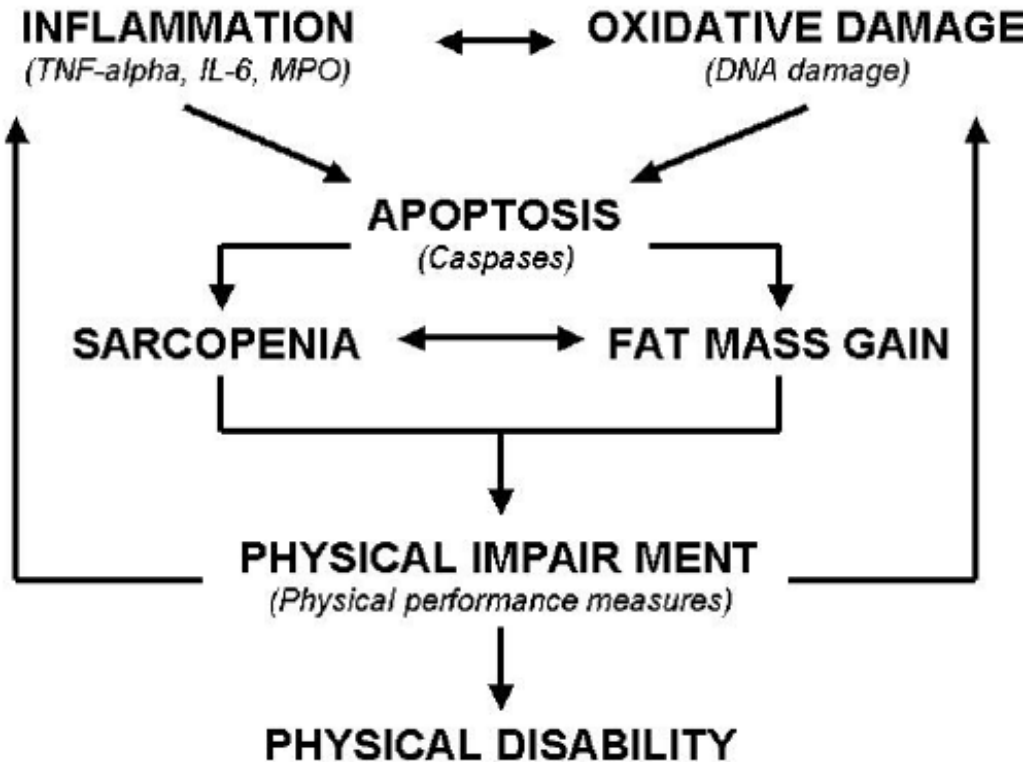
The Aged Skeletal Muscle: Inflammaging



- Low, chronic inflammatory response coupled with immunosenescence.
- ↑ insulin resistance, impaired glucose tolerance and T2DM.
- Impaired myokines

de Lemos Muller, C.H., . *J. of SCI. IN SPORT AND EXERCISE* **1**, 97–115 (2019). https://doi.org/10.1007/s42978-019-0015-6

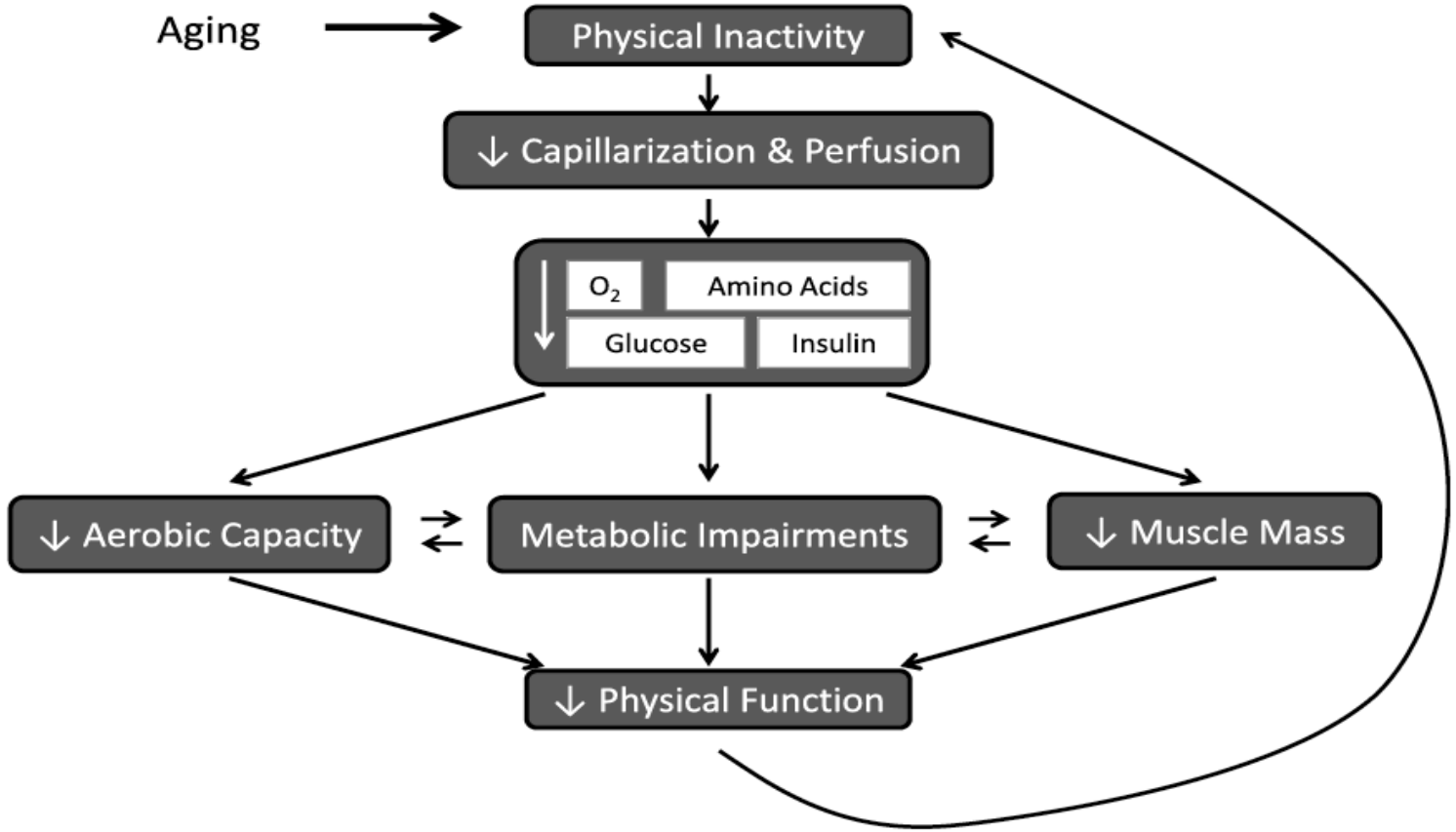
The Aged Skeletal Muscle: Oxidative Stress and Dysfunctional Protein Turnover



- Damages lipids, proteins and DNA.
- Weak antioxidant system.
- Accumulation of protein aggregates, apoptosis & ↓ protein synthesis.

Tieland, 2018
Baumann JAP 2016

The Aged Skeletal Muscle: Blood Flow and Mitochondria



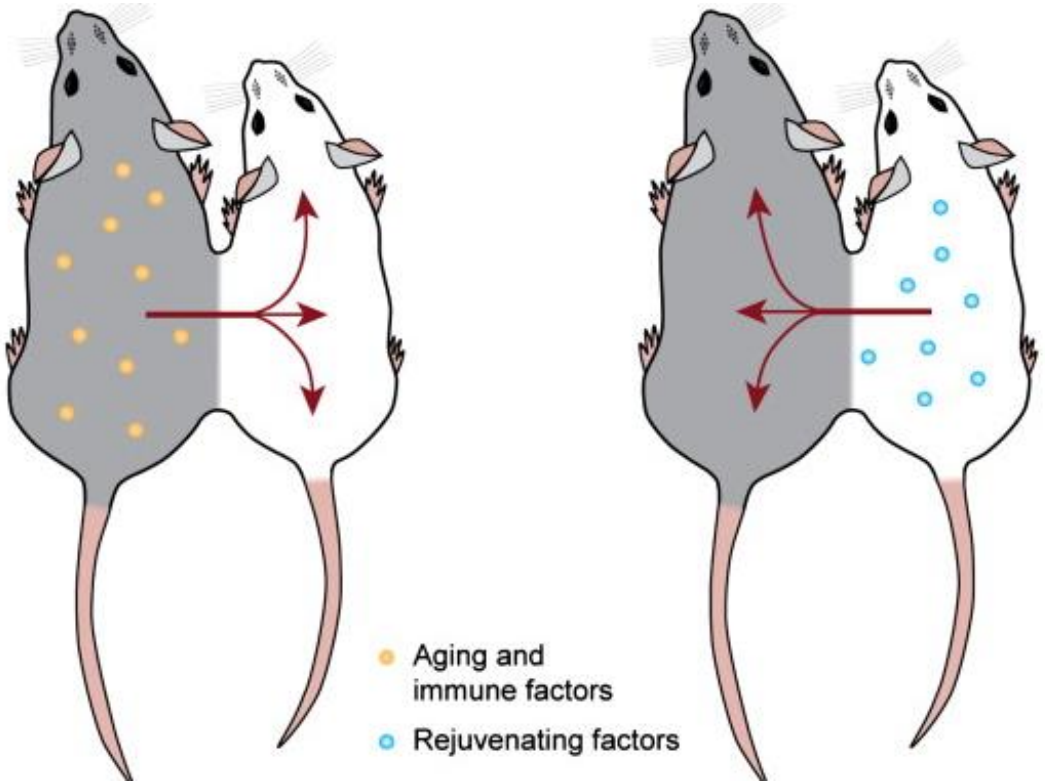
- 12-25% ↓ capillarization (refraction) than young.
- ↑ insulin resistance, impaired glucose tolerance and T2DM; abnormal mitochondria shape.

Ramos, 2018

The Aged Skeletal Muscle: Impaired Muscle Repair

Dysfunctional adult skeletal muscle stem cells → fibrosis, ↓ Sat cell #s, poor muscle repair.

Improved muscle repair



Aged into young

Young into age

Fountain of Youth?

Conboy,2005

The Effect of Exercise Training on the Aged Skeletal Muscle

- ↑ Capillarization.
- ↓ # of abnormal NMJs
- Enhance muscle repair (to an extent)
- Enhanced mitochondria
- Less falls
- Increased bone mineral density
- Manage blood glucose levels
- Comorbidity Disease Tx

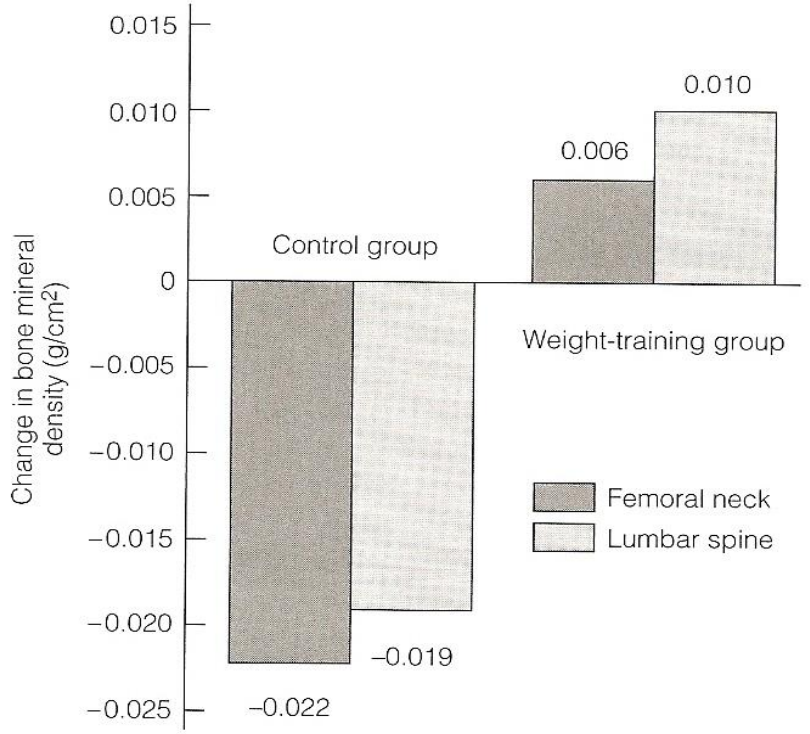
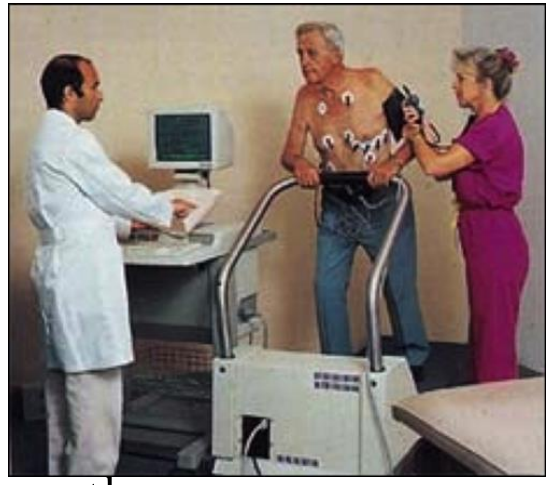
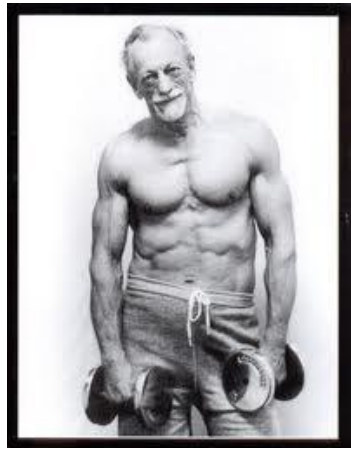


Figure 13.33 Changes in bone mineral density with intensive strength trainir 45 minutes, high intensity. High-intensity weight training improved bone dens Fiatarone MA, Morganti CM, Trice I, Greenberg RA, Evans WJ. Effects of high-intensity str fractures: A randomized controlled trial. *JAMA* 272:1909–1914, 1994.

Exercise Testing & Prescription for the Aged Skeletal Muscle



- Most do not require a test prior to starting a program
- Pre-testing Considerations
  - Ex Test (CV)- Choosing the mode (TM vs. bike)
  - Ex Test (Muscle fitness)
  - Ex Test (Gait + Balance): assessments to determine lower-extremity strength and function

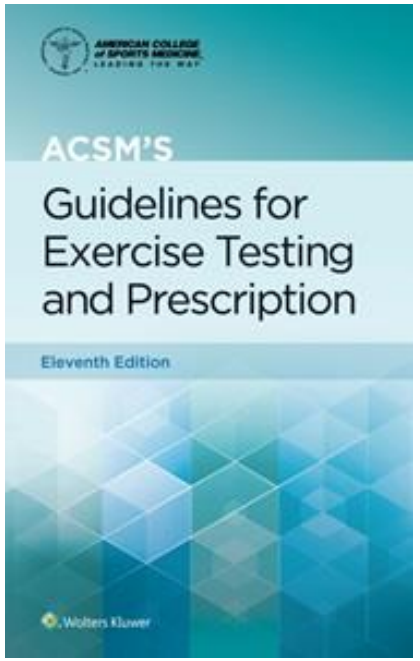


FITT	FITT RECOMMENDATIONS FOR OLDER ADULTS (112,114,116)		
	Aerobic	**Resistance**	**Flexibility**
Frequency	≥5 d · wk^{-1} for moderate intensity; ≥3 d · wk^{-1} for vigorous intensity; 3–5 d · wk^{-1} for a combination of moderate and vigorous intensity	≥2 d · wk^{-1}	≥2 d · wk^{-1}
Intensity	On a scale of 0–10 for level of physical exertion, 5–6 for moderate intensity and 7–8 for vigorous intensity	*Progressive weight training:* Light intensity (*i.e.*, 40%–50% 1-RM) for beginners; progress to moderate-to-vigorous intensity (60%–80% 1-RM); alternatively, moderate (5–6) to vigorous (7–8) intensity on a 0–10 scale *Power training*: light-to-moderate loading (30%–60% of 1-RM)	Stretch to the point of feeling tightness or slight discomfort.
Time	30–60 min · d^{-1} of moderate intensity exercise; 20–30 min · d^{-1} of vigorous intensity exercise; or an equivalent combination of moderate and vigorous intensity exercise; may be accumulated over the course of the day	*Progressive weight training*: 8–10 exercises involving the major muscle groups; ≥1 set of 10–15 repetitions for beginners; progress to 1–3 sets of 8–12 repetitions for each exercise *Power training*: 6–10 repetitions with high velocity	Hold stretch for 30–60 s.
Type	Any modality that does not impose excessive orthopedic stress such as walking. Aquatic exercise and stationary cycle exercise may be advantageous for those with limited tolerance for weight-bearing activity.	Progressive or power weight-training programs or weight-bearing calisthenics, stair climbing, and other strengthening activities that use the major muscle groups	Any physical activities that maintain or increase flexibility using slow movements that terminate in static stretches for each muscle group rather than rapid ballistic movements

1-RM, one repetition maximum.

American College of Sport Medicine's Guidelines

Intensity and duration of PA should be light at the beginning in particular for older adults who are highly deconditioned, functionally limited, or have chronic conditions that affect their ability to perform physical tasks.



Exercise Testing & Prescription for the Aged Skeletal Muscle- Prioritize Physical Activity Needs

- Start w/ 1 component of exercise at a time
- Significant strength or balance deficits should be addressed prior to starting an aerobic training program.
  - Why?
- Individuals with sarcopenia, a marker of frailty, need to increase muscular strength before they are physiologically capable of engaging in aerobic training.

Table 5–4 Types of Resistance Training Including Advantages and Limitations

Option	Advantages	Limitations	Examples
Body weight	Always available for use in a variety of ways. Low cost. Exercises resemble activities of daily life with resistance relative to the individual.	Difficult to increase or decrease the resistance. Excess body weight or an injury can make the body's weight difficult. It may be challenging to find body weight exercises for all major muscle groups.	Chair raisers under control with limited arm use. Curl ups or push-ups. Side leg raises (standing or lying).
Weight machines	Motion is controlled. Weights cannot be dropped. A wide range of easily modified resistance. Exercises are easy to follow. Social interaction may be enhanced as machines are usually in a shared facility.	Instruction is recommended to start and modify a program. Expense may be an issue depending on access to a facility. Setting and machines can be intimidating initially. Not all machines are easily accessible or accommodate small changes in resistance. Most machines are designed for symmetrical exercise, and injuries may prohibit this.	Pneumatic resistance (*e.g.*, air or water pressure). Machines commonly available in fitness centers.

Chodzko-Zajo ACSM
S Ex for Older Adults,2014

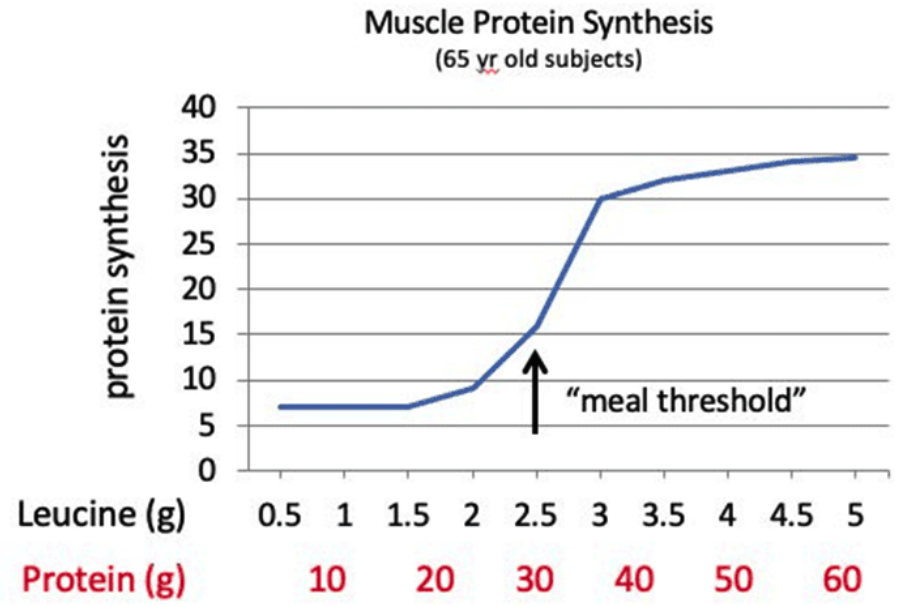
Table 5–4 Types of Resistance Training Including Advantages and Limitations

Option	Advantages	Limitations	Examples
Free weights	Many exercises mimic functional activities. Can be performed in many settings. Both seated and standing exercises are possible. Asymmetry of movement can be accommodated.	Instruction is needed to lift and return weights safely. Needing a range of resistance makes free weights a fairly expensive option. Gripping free weights may be a problem for those with low grip strength or injuries. Difficult to find exercises for all muscle groups that need training.	Dumbbells and barbells. Ankle and wrist weights. Household containers filled with water or sand.
Bands and tubes	Can be performed in many settings. Both seated and standing exercises are possible. Relatively low cost, but must be checked regularly for tears and material fatigue.	Monitoring resistance and improvement is difficult to measure. Tubing handles determine the resistance in several exercises because of the length of the tubing so a range of tubes is required. Wrist form and strain can be a concern.	Exercise bands with optional grip assists. Rubber tubing with handles. Tubing or bands attached to a solid structure.
Water	Recommended for those with certain painful conditions (arthritis or fibromyalgia). Social interaction is common in group. Stress on joints can be controlled by depth of water.	Intensity can depend on perceived exertion. Difficult to assess gains in strength. Difficulty in pool accessibility. Participant's discomfort in a bathing suit. Fear of water.	Foam floatation devices (weights, noodles). Leg and arm resistance.

Chodzko-Zajo ACSM
S Ex for Older Adults,2014

Other Treatments for Sarcopenia

- Protein intake – leucine- 30g protein
- Vitamin D- 880 IU/D
- Omega-3 fatty acids
- Caloric Restriction 20%-40%



https://optimisingnutrition.com/leucine-foods/#h-how-much-leucine-do-you-need
McCormick 2018,
Breen *Nutr Metab (Lond)* **8**, 68 (2011). https://doi.org/10.1186/1743-7075-8-68
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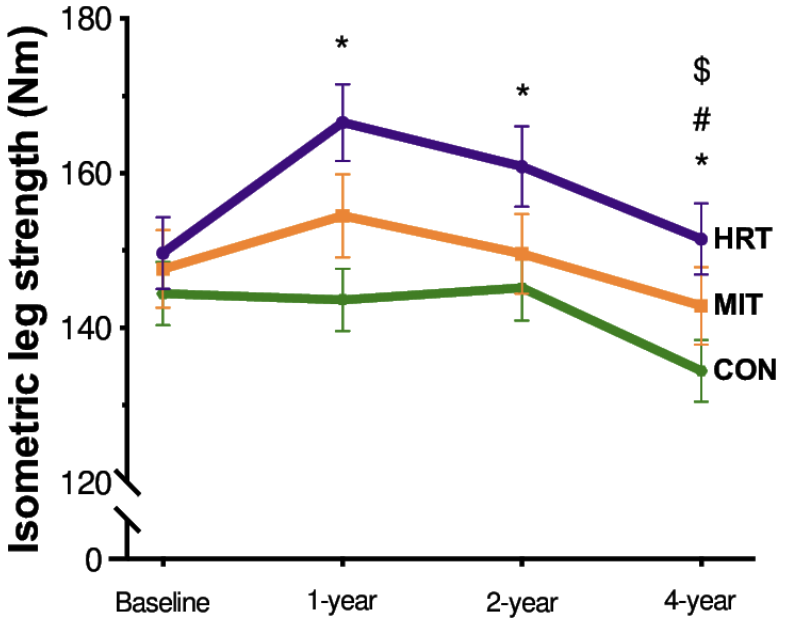
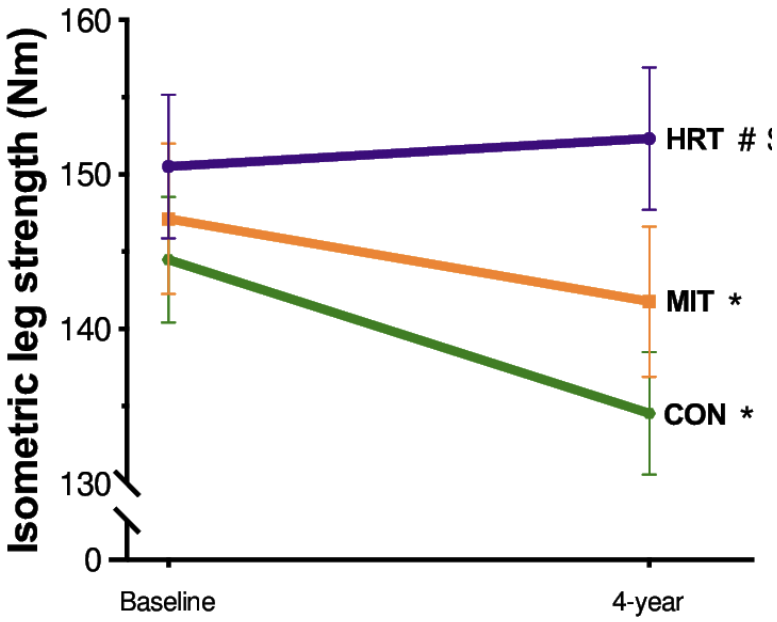
Cereda E,. *Nutrients*. 2022; 14(7):1524. https://doi.org/10.3390/nu14071524

Exercise Testing & Prescription for the Aged Skeletal Muscle: NEW INSIGHTS- Heavy Resistance Training

- HRT= 3 sets of 6-12 reps at 70-85% 1 RM
- MIT= 3 sets 10-18 reps at 50-60% 1 RM.





Bloch-Ibenfeldt. BMJ Open Sport & Exercise Medicine 2024;**10**:e001899. doi:10.1136/bmjsem-2024-001899.

Exercise Testing & Prescription for the Aged Skeletal Muscle: NEW INSIGHTS

Intervention		Quality of life	Muscle strength	Physical performance		
		Quality of life (scale, SMD, 95% CI)	Handgrip strength (MD, 95% CI)	Usual gait speed (MD, 95% CI)	Timed up and go (MD, 95% CI)	Chair stand test (MD, 95% CI)
Resistance	Resistance	**1.11 (0.54 to 1.68)**	**2.69 (1.78 to 3.61)**	**0.11 (0.04 to 0.18)**	-0.83 (-1.68 to 0.02)	-0.4 (-2.21 to 1.41)
	Resistance plus Nutrition	**1.07 (0.23 to 1.91)**	**3.93 (2.22 to 5.65)**	**0.13 (0.01 to 0.25)**	-0.77 (-2.16 to 0.63)	-0.75 (-2.58 to 1.07)
Resistance and Balance	Resistance and Balance	0.02 (-0.55 to 0.58)	1.23 (-0.16 to 2.62)	**0.16 (0.08 to 0.24)**	**-1.85 (-3.22 to -0.49)**	**-1.79 (-2.97 to -0.6)**
	Resistance and Balance plus Nutrition	0.36 (-0.26 to 0.98)	**4.19 (2.55 to 5.83)**	**0.16 (0.06 to 0.26)**	-1.54 (-3.33 to 0.25)	
Resistance and Aerobic	Resistance and Aerobic	-0.07 (-0.52 to 0.38)	**1.94 (0.79 to 3.08)**	0.1 (-0.01 to 0.22)		**-1.72 (-3.17 to -0.27)**
	Resistance and Aerobic plus Nutrition	0.12 (-0.34 to 0.58)	**3.02 (1.64 to 4.4)**	0.06 (-0.06 to 0.18)		**-2.28 (-3.73 to -0.83)**
Resistance and Aerobic and Balance	Resistance and Aerobic and Balance	**0.68 (0.32 to 1.04)**	0.2 (-3.5 to 3.9)	0.04 (-0.14 to 0.22)	-1.7 (-3.99 to 0.59)	
	Resistance and Aerobic and Balance plus Nutrition		1.3 (-0.14 to 2.73)			
Aerobic	Aerobic	0.58 (-0.06 to 1.23)	0.46 (-1.13 to 2.04)			
Balance	Balance		0.38 (-2.32 to 3.09)			

Shen Y., *Journal of Cachexia, Sarcopenia and Muscle*, 14, 1199 1211, https://doi.org/10.1002/jcsm.13225

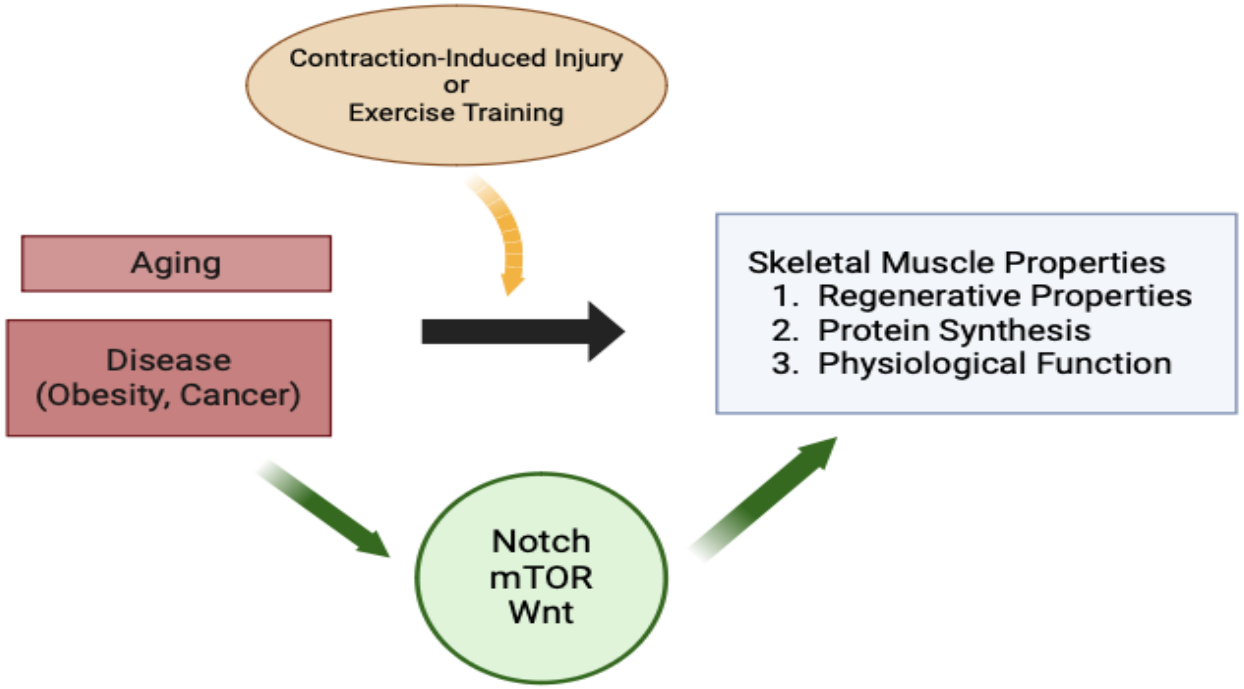
Exercise Testing & Prescription for the Aged Skeletal Muscle-Neuromotor (Balance) Exercises for frequent fallers

- How can we prevent the increase of falls in the aged?
- Neuromuscular training –2-3D/wk
- Progressively difficult postures that ↓ base of support
  - 2-legged stand, semi-tandem stand, tandem stand, 1-legged stand
- Dynamic movements that perturb the COG
  - tandem walk, circle turns
- Stressing postural muscles
  - heel, toe stands
- ↓ Sensory input
  - Stand w/ eyes closed
- Tai chi

Table 5-5 Balance Exercises and How Each May Relate to Environmental Challenges

Focus of Challenge	Balance Exercise Challenges and Progressions	Relationship to Balance and Function	Examples of Environmental Challenges
Progressively difficult postures that gradually reduce the base of support.	Two-legged stand with feet shoulder width apart, stand with feet together, stand on one leg. Semi-tandem stand (big toe touching inside of contralateral back heel), full-tandem stand (feet directly in line with each other), walk on a line on the floor or a balance beam.	Inactive older adults find it difficult to keep the center of gravity over a small base of support.	Walk with big steps that include a heel strike, step up and down a curb or over a crack in the sidewalk (requires time with weight supported on one foot).
Dynamic movements that perturb the center of gravity (COG).	Walk, stop, continue walking. Walk, stop, back step, walk. Diagonal step, swing arms out and up, return to start. Catch and throw a medicine or other ball.	Moving about freely requires automatic corrections without concentration.	Maneuver around and between people and avoid others. Bend over to retrieve a dropped object.
Stressing postural muscle groups.	Heel stands, toe stands. Lean forward, back, to each side without moving feet. Rotate a ball in a big *figure 8* across the front of the body.	All muscle groups need to coordinate automatically to maintain balance.	Lean forward to pick up a heavy object. Stretch up on toes to reach something from a high shelf.
Reducing input from the senses that contribute to balance.	Decrease touch while challenging balance. Progression: Start with a good grip on something stable, loosen the grip, move to one hand touching, decrease touch to fingertips, hover hands over the surface.	Touch gives very strong input.	Walk without use of handrails or assistive device.
	Decrease vision while challenging balance. Keep head steady and shift focus from side to side of room, focus on something that is moving. Progress to closing eyes.	Focusing on a stable object is often the most used sense to keep balanced.	Scan as you walk or make eye contact with others.
	Decrease vestibular input by maintaining focus on something stable while moving the head. Look up at the ceiling.	Moving the head or being dizzy decreases vestibular input.	Look up, down, left, and right.
	Decrease sensory input from ankles and feet. Stand on a foam cushion, half round roller, rocker board, or inflated disc. Walk on an exercise mat.	Foot position is detected by the sensory input from the lower leg.	Walk on grass or a rocky surface or walk-up a ramp.

Chodzko-Zajo ACSM
S Ex for Older Adults,2014



THANK YOU

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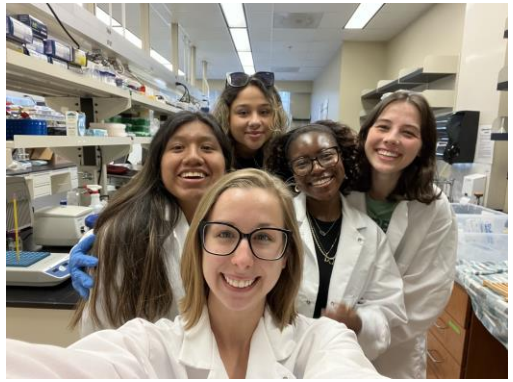
Molecular Exercise Myology Lab Members



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