HUR Australia Webinar April 2021

MUSCLES AND MOBILITY MATTER

LESSONS FROM RESEARCH TO INFORM PRACTICE

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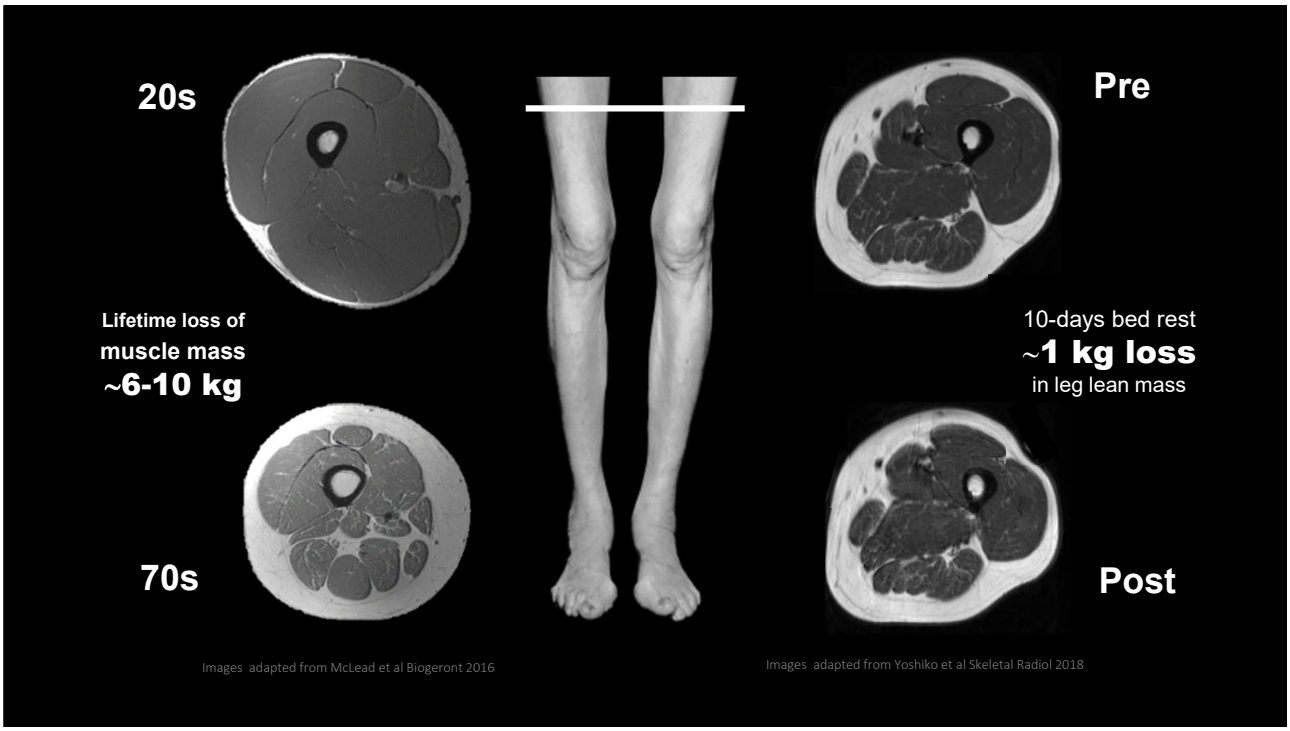

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FACT #1

Skeletal muscle tissue has a turnover rate of 1–2% per day implying full renewal of muscle tissue every **2–3 months**

Smeets et al Brain 141(4), 112-29, 2018

Photo by engin akyurt on Unsplash

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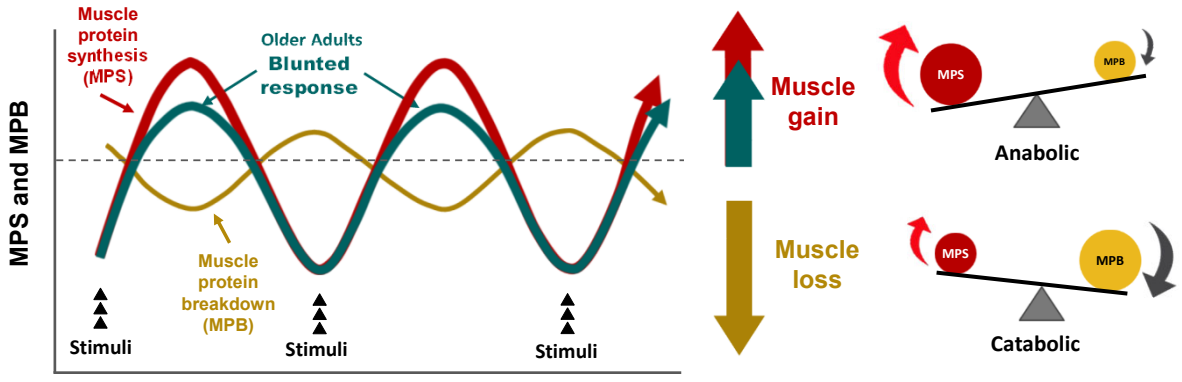
Understanding Muscle Loss

Why We Lose Muscle –'Anabolic Resistance' of Muscle to Ageing



Adapted from Breen and Phillips. Nutrition Metab 2011:8:68

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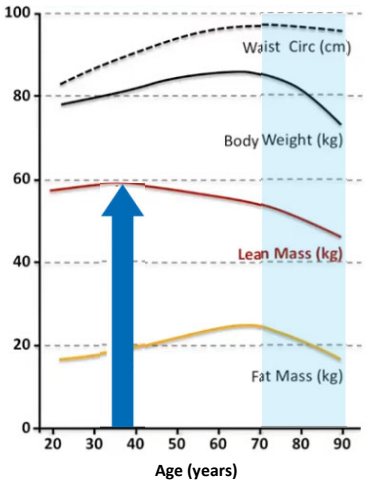
Age-related Skeletal Muscle Loss

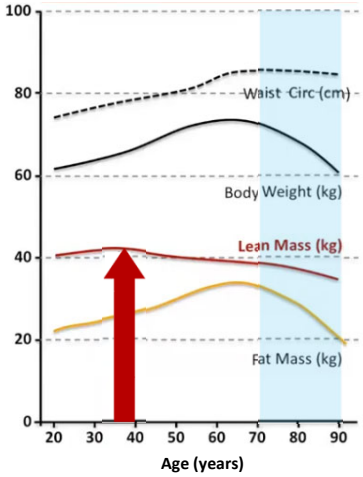
Is skeletal muscle loss an <u>early marker of ageing</u>?

Men



Muscle loss starts around 40-45 years

… <u>but</u> muscle mass, muscle strength or function is not routinely assessed in mid-life?



Women

Ferrucci L and Studenski S. Clinical Problems of Aging. In Harrison's Principles of Internal Medicine, 18th Ed. Longo, Fauci, Hauser, Jameson and Loscalzo, McGraw Hill 2011

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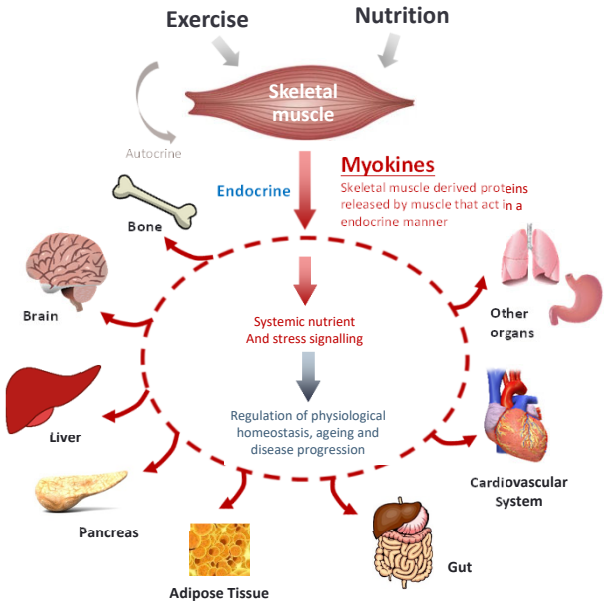
Underappreciated Role of Muscle

- Skeletal muscle is a **<u>secretory</u>** organ with endocrine functions.
- Skeletal muscle responds to dietary and exercise challenges (and metabolic dysfunction) by secreting myokines (and other factors) that regulate systemic nutrient and stress signalling.
- **<u>Myokines</u>** mediate the communication of the muscle with other target tissues in an autocrine, paracrine and endocrine manner.

Rai M and Demontis F Ann Rev Phyisol 78:85-107, 2016



Adapted from Rai M and Demontis F Ann Rev Phyisol 78:85-107, 2016

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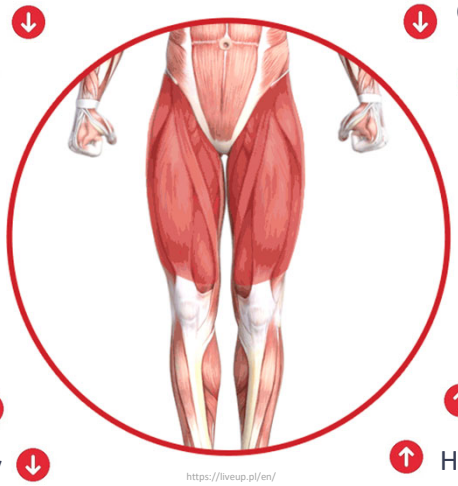
Consequences of **Muscle Loss**



- Brain volume ↓
- Immunity ↓
- COPD ↑
- Falls ↑
- Strength ↓
- Mobility ↓
- Osteoporosis / Fx ↑
- Life expectancy ↓
- Cognition ↓
- CVD Risk ↑
- Metabolic rate ↓
- Weight ↑
- IR and T2D ↑
- Cancer Outcomes ↓
- Pressure ulcers ↑
- Hospital Complications ↑

https://liveup.pl/en/

Age 40 50 60 70 80 90

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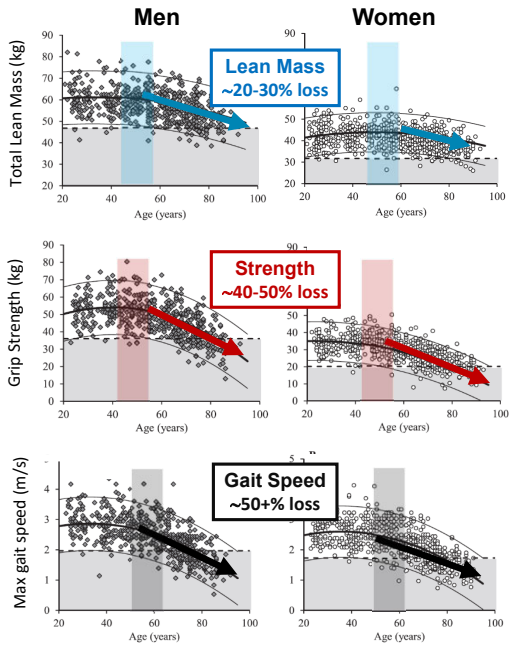

Heterogeneity in the *Timing and Rate of Muscle Loss*

Muscle Mass

Starts ~50-60 years of age| loss of ~20-30% throughout life (~10 kg in men and ~6 kg in women)

Muscle Strength

Starts ~50 years of age| loss of ~40-50% throughout life. Accelerated loss after the age of 70-75.

Physical Performance

Starts ~55-60 years for men and ~50 years for women; accelerates after 70-75; 45% decrease with age.

Suetta C et al. J Cachexia, Sarcopenia and Muscle 2019

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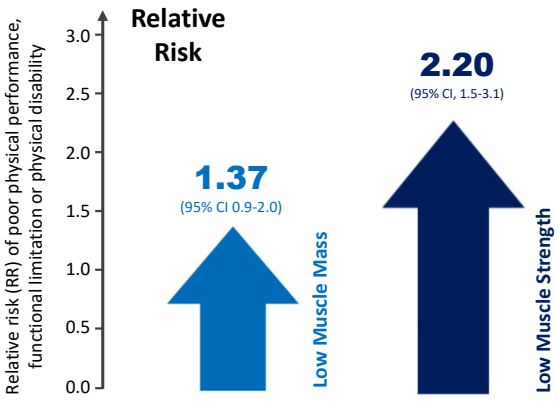
FACT #2

Low Strength Linked to Disability



Risk of Poor Physical Performance or Disability in Adults with Low Muscle Strength or Muscle Mass

Manini TM and Clark DC. J Gerontol A Biol Sci Med Sci 2011

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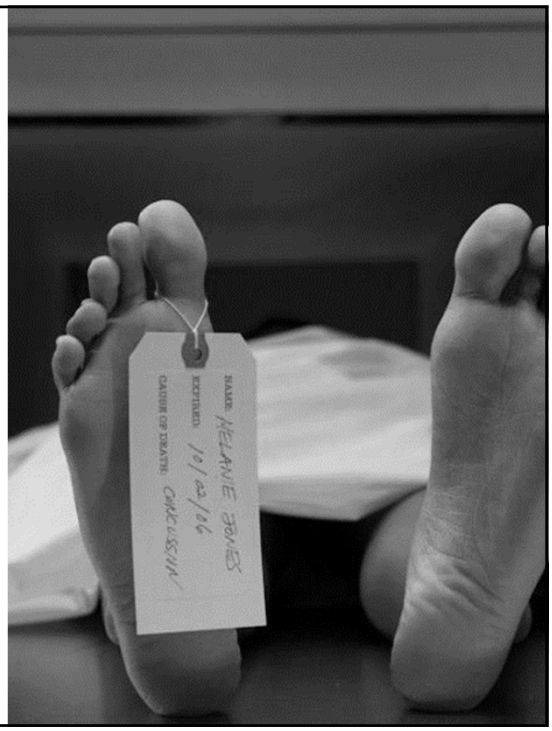
Strength | Function

Linked to Falls and Mortality

Hazard ratios (95% CI) per SD for components of sarcopenia and their association with all-cause mortality and falls-related hospitalization over 9.5 years in 903 older women (80 y)

	HR All-cause mortality [1]	HR Falls-related hospitalization [2]
ALM/height² (per SD)	1.00 (0.89-1.14)	0.94 (0.83-1.06)
ALM/BMI (per SD)	0.95 (0.83-1.07)	1.14 (0.96-1.35)
Grip strength (per SD)	**0.83** (0.73-0.93)	**0.79** (0.70-0.88)
TUG (per SD)	**1.40** (1.29-1.51)	**1.31** (1.20-1.42)

ALM = appendicular lean mass; HR = Hazard ratio; [1] Sim M et al. J Am Med Dir Assoc. 2019 Jan;20(1):76-82; [2] Sim M et al. Osteoporosis Int 2019; 30(1): 167-76



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ICD-10-AM Code (2019)

Sarcopenia: *A Clinical Condition*

Sarcopenia is a syndrome characterized by progressive and generalized loss of skeletal ***muscle mass, strength*** and/or ***function.***

Low Muscle Strength

- Grip Strength: *Men < 27 kg; Women < 16 kg* *or*
- Sit to stand > 15 sec for five rises

Low Muscle Mass

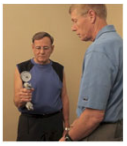
- Men: ALM < 20 kg; ALM/height^2 < 7.0 kg/m^2
- Women: ALM < 15 kg; ALM/height^2 < 5.5 kg/m^2

** ALM = Appendicular Lean Mass*

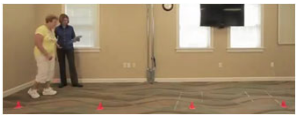
Impaired Physical Function

- Gait speed < 0.8 m/s (or <1.0 m/s) *or*
- SPPB (Short Physical Performance Battery) * ≤ 8 points

DXA Appendicular lean (muscle) mass


Grip strength


Sit to stand


Gait Speed (4-6 m walking

No universal consensus on the definition/criteria for sarcopenia

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Screening Tool for Sarcopenia

SARC-F: Self-administered simplified screening questionnaire for assessing sarcopenia risk

Component	Question	Scoring
Strength	How much difficulty do you have in lifting and carrying 10 pounds (~4 kg)	0 = None 1 = Some 2 = A lot or unable
Assistance in walking	How much difficulty do you have walking across a room?	0 = None 1 = Some 2 = A lot, use of aids, or unable
Rising from a chair	How much difficulty do you have transferring from a chair or bed?	0 = None 1 = Some 2 = A lot or unable without help
Climb stairs	How much difficulty do you have climbing a flight of 10 stairs?	0 = None 1 = Some 2 = A lot or unable
Falls	How many times have you fallen in the past year?	0 = None 1 = 1-3 falls 2 = 4 or more falls

SARC-F score of ≥ 4 is predictive of sarcopenia

Malmstrom TK and Morley JE JAMDA 14:531-32, 2013

- ***SARC-F*** has a high specificity: effective tool for identifying those without sarcopenia.

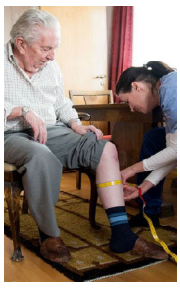
Bahat G et al. JNHA 22(9):1034-38, 2018; Ida S et al. JAMDA 19:685-89, 2018; Hajaoui et al. JAMDA 20L1178-89, 2019

- ***SARC-F + calf girth*** improved the sensitivity of SARC-F, but calf girth alone was best screening tool for sarcopenia.

Cut points (moderate/severe):

Males <34 cm; <32 cm

Females <33 cm; <31 cm



Gonzalez et al. AJCN 2021; Mo et al. JAMDA 21(2):288-89, 2020

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Muscle Fibre Loss

Around
40,000
individual muscle fibres
are lost from the quadriceps per year beyond the age of 30 years.

McPhee JS et al. J Gerontol A Biol Sci Med Sci, 2018, 73(10), 1287–1294

Neural Changes

Around
40-50% of motor units
(thus motor neurons) supplying the muscles to the thigh are lost by the age of 70 year

A motor unit consists of the alpha motor neuron and the muscle fibers it innervates.

Piasecki et al. J Physiol 594(16): 4525-36, 2016

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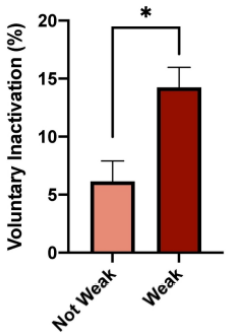
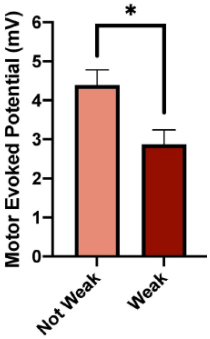
Is There a Failure to Communicate?

Relative contribution of neural excitability and thigh lean mass to clinically meaningful weakness in older adults

Weak older adults had 84% lower strength compared to not weak *(*Thigh lean mass was similar).*



Weak = decreased ability to fully activate leg extensor muscles.



Weak = decreased corticospinal excitability (↓ neural drive to muscles).

Neural excitability explained ~33% and thigh lean mass ~29% of the variability in strength

Clark et al. J Gerontol A Biol Sci Med Sci 2020; Clark and Carson J Gerontol A Biol Sci Med Sci 2021

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Loss in **Muscle Power**

Greater than Strength or Mass

Muscle Power (Maximal)

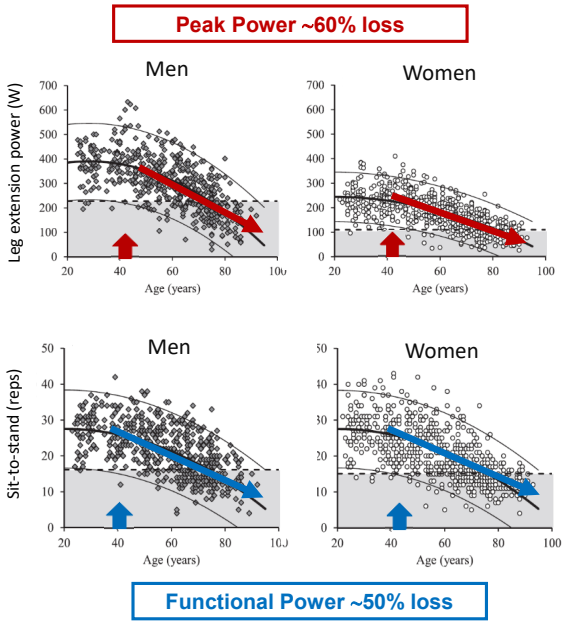
Starts ~40-50 years of age and is greater than rate of loss in muscle mass or strength; ~60% decrease with age.

Preferential loss in type II (fast-twitch) muscle fibres
Movement speed is a key determinant of power loss

Muscle Power (Functional)

Starts from ~45-50 years; no difference between men and women; ~50% decrease with age.

Suetta C et al. J Cachexia, Sarcopenia and Muscle 2019



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FACT #3

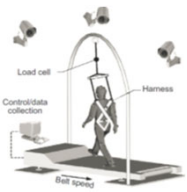
Power More Critical Than Strength

Muscle power more important than strength to prevent slip-related falls

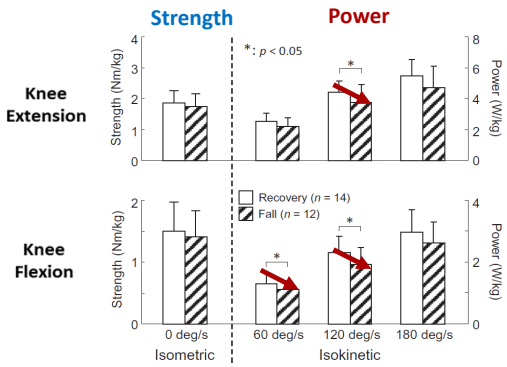
Set-up
26 young adults

Perturbation while walking on treadmill

Slip-related Fall



Video from https://blog.neura.edu.au/2019/05/exercise-right-week-qa-dr-kim-van-schooten-dr-yoshi-okubo/



Odds Ratio for slip-related falls				
Ext	1.37	1.94	2.11	1.96
Flex	1.25	2.28	2.25	1.77

Han and Yang. Hum Movement Sci 44:192-200, 2015

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Resistance Training is Effective

Meta-analyses of RCTs in Older Adults and the Very Elderly (aged ≥75 years)

Typically **<10% of older adults participate** in muscle strengthening activities.

- Progressive resistance training (PRT) is the most effective modality for improving muscle strength and muscle mass.
- At least 2 sessions/week, progressive and periodized programs with 2-3 sets of 7-9 reps at moderate/high intensity (70-79% of max).
- Heterogeneity with regard to the effects of PRT on *physical function.*

Borde et al. Sports Med 2015; Peterson et al. Med Sci Sports Exer 2011; Peterson et al Ageing Res Rev 2010; Grgic et al. Sports Med 2020; Kneffel Z et al. J Sports Sci 2021

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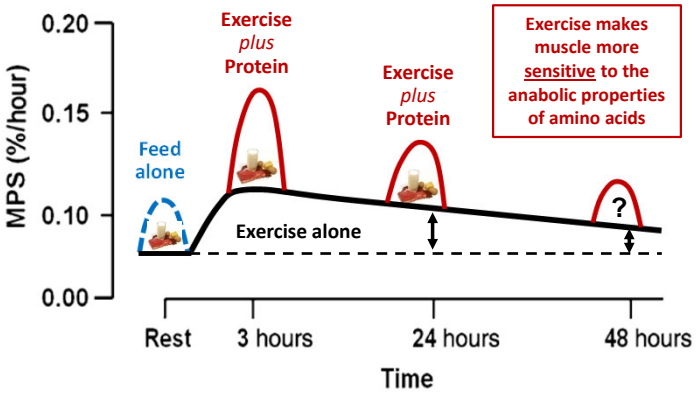
Protein and Exercise Interaction

Exercise (PRT) stimulates an increase in MPS that can remain elevated for at least 48 hrs



- When undertaking exercise (resistance training), older adults should consume **≥1.2g/kg body weight/d** of high quality protein.
- At least **20-30g of high quality protein** (e.g. whey or milk protein or lean red meat) post exercise has been shown to effectively stimulate an increase in muscle protein synthesis.

Churchward-Venne TA, et al. Nutr Metab. 2012;9:40; Phillips et al Am J Physiol 1997 273:E99-107.

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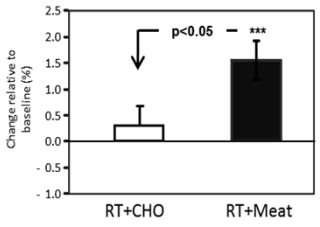
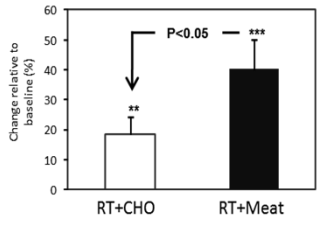
Exercise + Lean Red Meat



Total body lean mass

- RT+ Meat +0.6 kg
- RT+ CHO +0.1 kg

*** p<0.001 vs baseline



Leg muscle strength

- RT+ Meat 40%
- RT+ CHO 19%

** p<0.01, *** p<0.001 vs baseline

High quality Lean Red Meat

160 g cooked (~45 g protein) of lean red meat for 6 days per week

Protein intake increased from ~1.1 to 1.3 g/kg

Carbohydrate (pasta, rice, bread)

Protein intake stable at ~1.1 g/kg

Daly R et al. Am J Clin Nutr 2014;99(4):899-910

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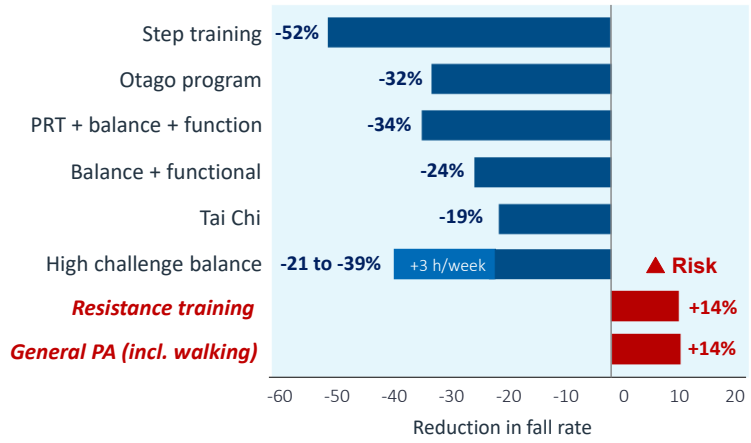
Exercise for Falls Prevention

Fall rate reduction varies by the type of exercise: Cochrane Review



7 studies (PEDro med=5). Okubo 2015 meta-analysis

7 studies (PEDro med=8). Thomas 2010 meta-analysis

11 studies; **moderate certainty**

39 studies; **high certainty**

7 studies; **low certainty**

Sherrington 2019 Cochrane Review

88 trials; **strong evidence**. Sherrington 2017 meta-analysis

5 studies; **very low certainty**

2 studies; **very low certainty**

Sherrington C, et al. Cochrane Database of Systematic Reviews 2019; Okubo et a; Br J Sports Med 2017; Thomas et al. Age Ageing 2010; Sherrington et al. Br J Sports Med 2017

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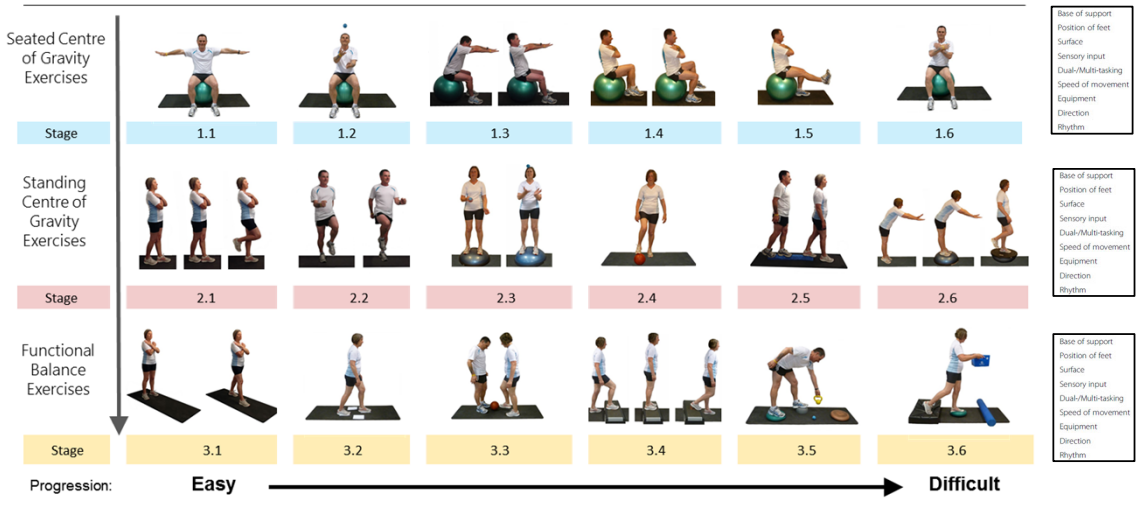
Challenging Balance and Stepping

PACE-IT Trial: Progressively challenging balance / stepping / dual task exercises



Daly et al. Trials 2015 Mar 27;16:120

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Frequent Cause(s) of Falls in Older Adults

1 *in* 3

community dwelling older adults fall each year
(1 in 5 suffer multiple falls)

Community-dwelling Elderly

Activities associated with the highest proportion of falls:

- **Walking** (61%) at home (61%) during day (88%)
- Displacement from quiet position (13%)
- Gardening (9%) & getting out of bed/chair (5%)

The most frequent cause of falling:

- ***Lost balance (32%)***
- ***Slipped on an uneven/slippery surface (29%)***
- ***Tripped over obstacle (27%)***
- High risk activity (9%)

Sanders et al. Osteoporosis Int 2017 Published Online 19 July

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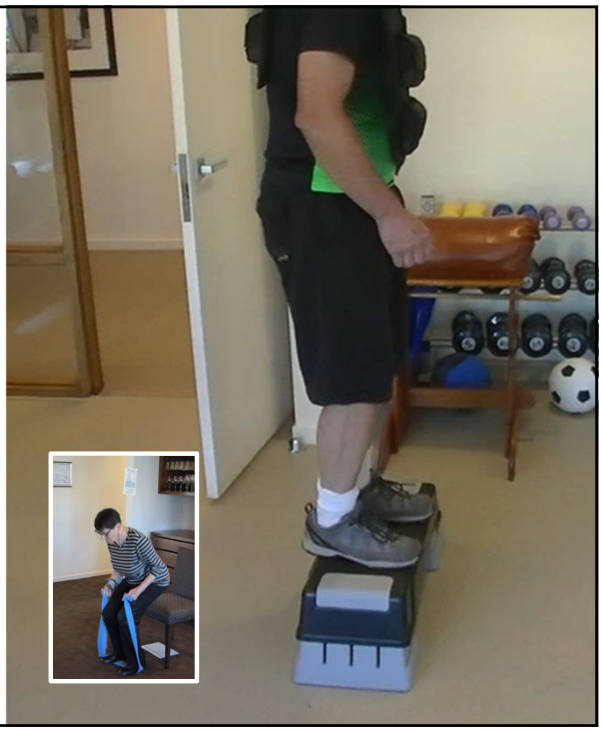
Train to Improve Movement Speed

- **High-velocity (power) training**: perform the lifting phase as rapidly as possible.
- **Greater benefits** to functional capacity or mobility with HV-PRT training compared to traditional PRT.
- Meaningful benefits to **'real-life' everyday activities** (e.g. stair climbing ability, car braking speed).

Steib et al. Med Sci Sports Exerc. 2010; 42:902-14; Glenn JM et al Age Ageing 1-6, 2015; Reid et al. J Geront A Biol Sci Med Sci 2015



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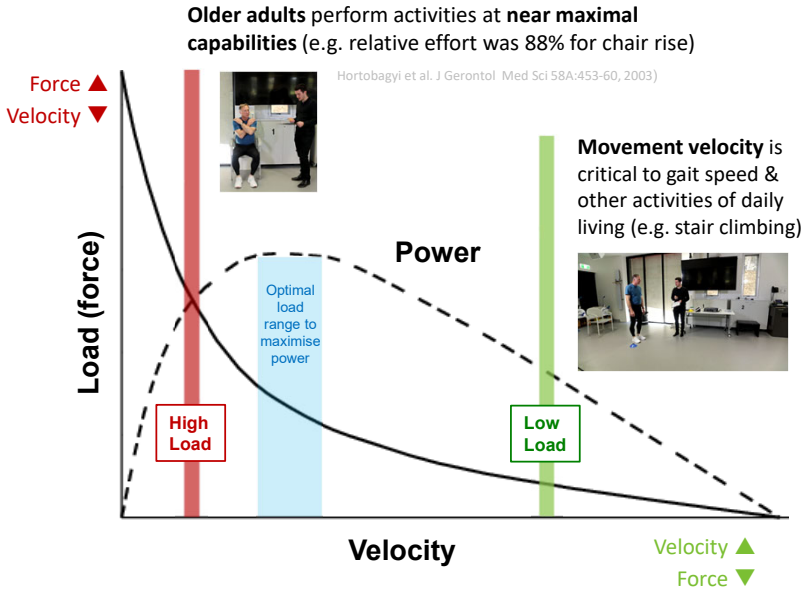

Targeting Muscle Power

Muscle power
is the product of force times velocity (F x V)

Specificity of Training:
Select an appropriate load when targeting a given functional task

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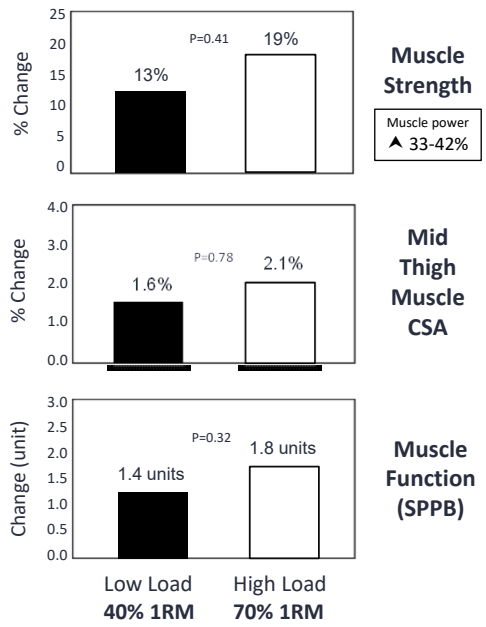
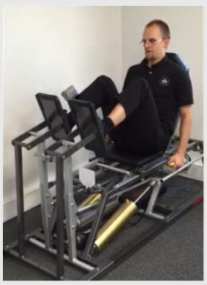
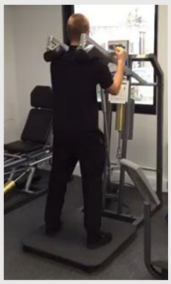


Light *vs* Heavy Load Power Training

16 week RCT in 52 older adults (mean age 78 years)





16-week training at either 40% of 1-RM or 70% 1-RM
(3 sets of 10 reps knee extension and leg press); 2/week

Reid et al. J Geront A Biol Sci Med Sci 2015

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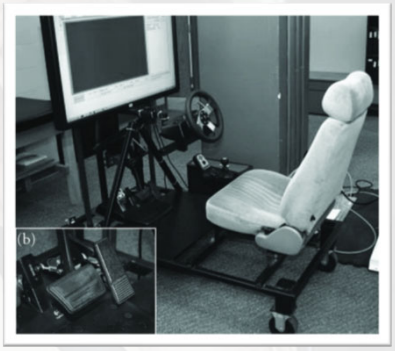
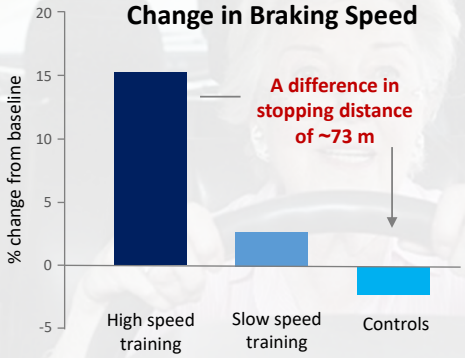
Improved Braking Speed

12 week RCT in 72 older adults: High speed vs slow speed training





High speed (40% 1-RM); Slow speed (80% 1-RM); 3x/week
Leg press and leg extension

Sayers and Gibson J Aging Res 2012

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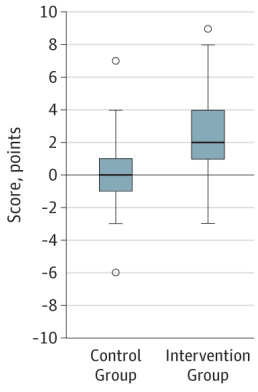
Multi-modal Exercise Acute Hospitalization

370 very elderly patients (mean age 87 years); median 5 days



Martinez-Velilla et al. JAMA Int Med 2018

Mean **2.4 point** increase in SPPB score
[1.0 point increase is clinically significant]

Exercise Intervention

- 2 daily sessions (morning & evening); 20 min duration (morning session only supervised)
- Resistance training (2-3 sets, 8-10 reps); 3 exercises performed at high speed.
- Challenging balance and gait retraining

No effect on length of hospital stay, falls during hospitalization or 3-month readmission

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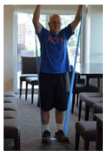
Dual Task Functional Power Training

PACE-IT Trial

12-month cluster RCT

Residents (n=300) at fall risk in 22 independent living retirement villages randomised to DT-FPT or usual care control group

Study protocol available at
Daly R et al. Trials. 2015 Mar 27;16:120.




Included dual task cognitive and/or motor activities

Functional power and strength training

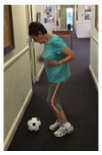
+

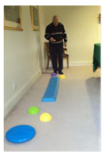


Included dual task cognitive and/or motor activities

Challenging balance, stepping and mobility

+



Dual-task motor and cognitive exercises

Phase 1: 6 months supervised training (45-60 min, 2/week); Phase 2: step-down maintenance program

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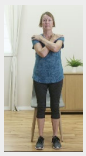
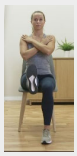
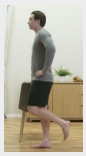
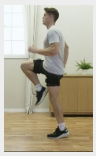
Strength | Power
Exercise Snacking

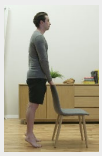
Twice-daily, 10-minute resistance 'exercise snacks' for 28 days


Chair Sit to stand


Seated leg extension


Standing leg curls

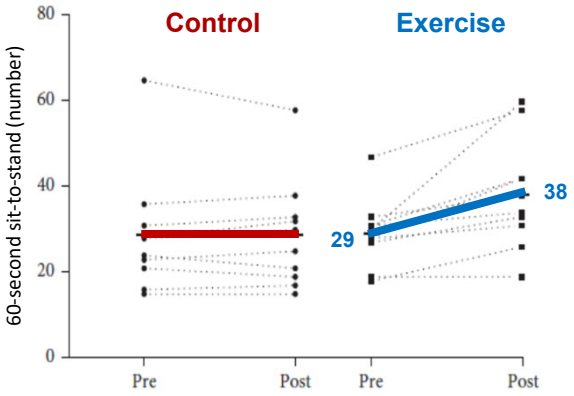

Marching on the spot


Standing Calf raises

All 5 exercises performed continuously for 60-seconds (60 sec recovery between exercises)

Mean adherence 98%; no adverse events

Healthy older adults aged 65-80 years
28-day unsupervised, home-based exercise program



Perkin et al. J Ageing Res 2019

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Take Home Message

Recognize sarcopenia ('muscle failure') as a disease

- Assessment of muscle mass, strength and function provides a wealth of information about health and disease risk. Include them in your assessment battery

Targeted and personalized programs

- Muscle loss is heterogenous; speed and power are critical for older people
- Program must be targeted, progressive and functionally relevant to everyday activities

Multifactorial interventions with exercise are needed

- Falls and fracture (and most chronic diseases) are multifactorial in nature and so a multifaceted approach is needed targeting specific areas of concern/weakness.

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