

Malaysia Dietitian Association (MDA) Webinar, Sat 15th August, 2020



SARCOPENIA

IN CLINICAL PRACTICE

UPDATES ON DIAGNOSIS AND MANAGEMENT



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Professor | Chair of Exercise and Ageing

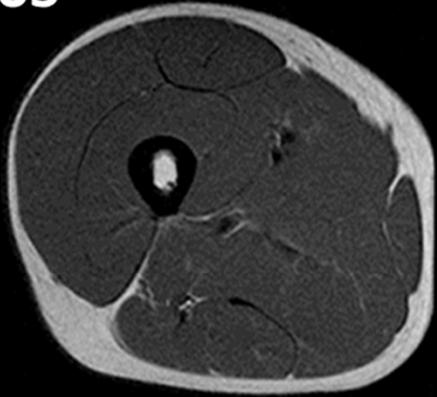
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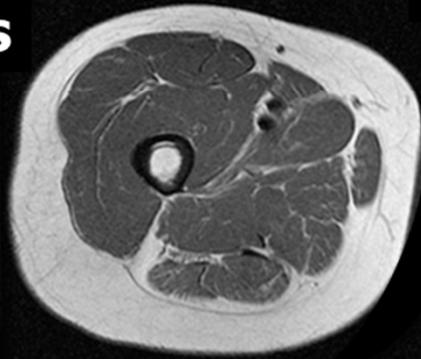
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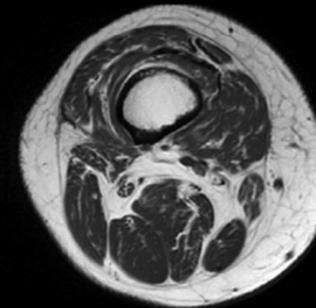
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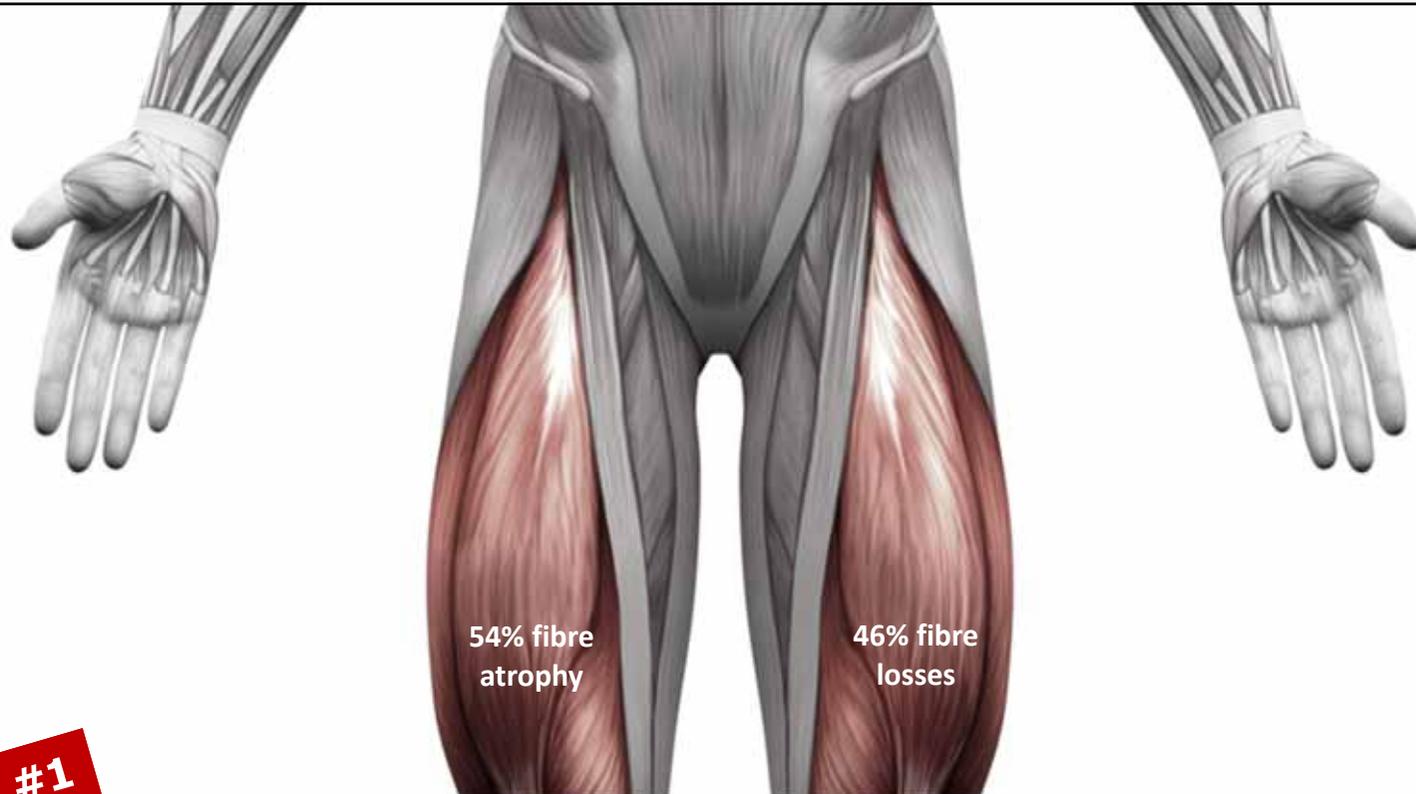


70s



Bedridden / SCI

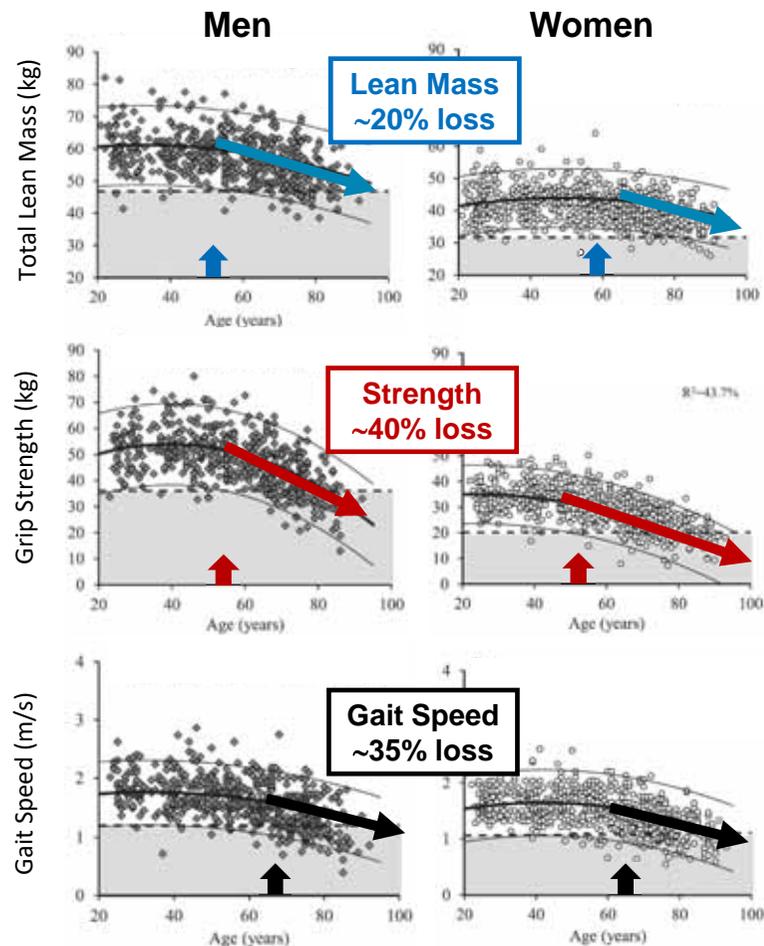




FACT #1

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

Heterogeneity in the Timing and Rate of Muscle Loss



Muscle Mass (DXA)

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

Muscle Strength (Grip)

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

Gait Speed (Usual pace)

Decline starts ~65-70 years of age | rapid 20-25% reduction
(deterioration) in old age.



Key Objectives

- 1 Understand the importance of ***skeletal muscle*** as a key mediator of chronic disease(s).
- 2 Recognising ***sarcopenia*** as a muscle disease. Understand the definition, diagnostic criteria and methods of assessment.
- 3 Understand ***prevention*** and ***treatment options*** for sarcopenia.

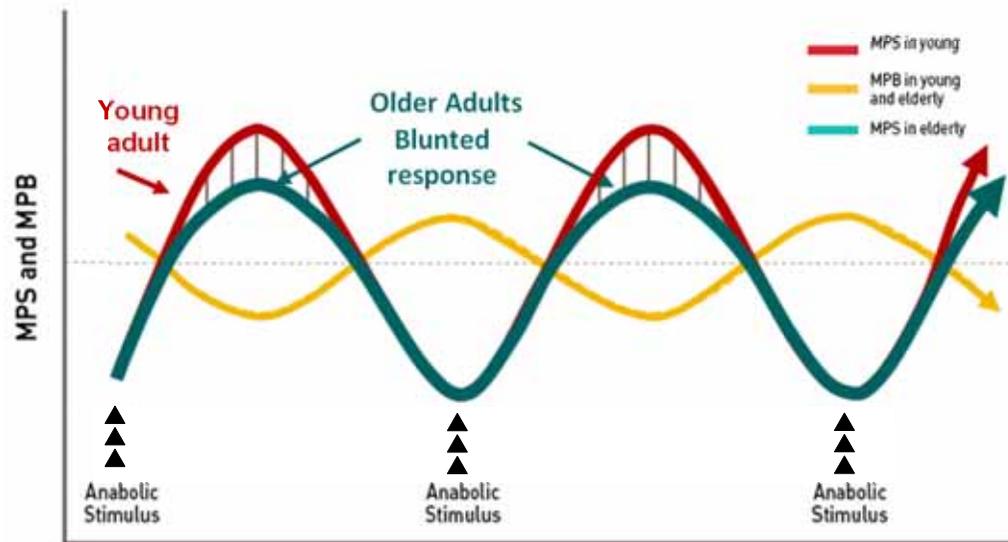
FACT #2

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



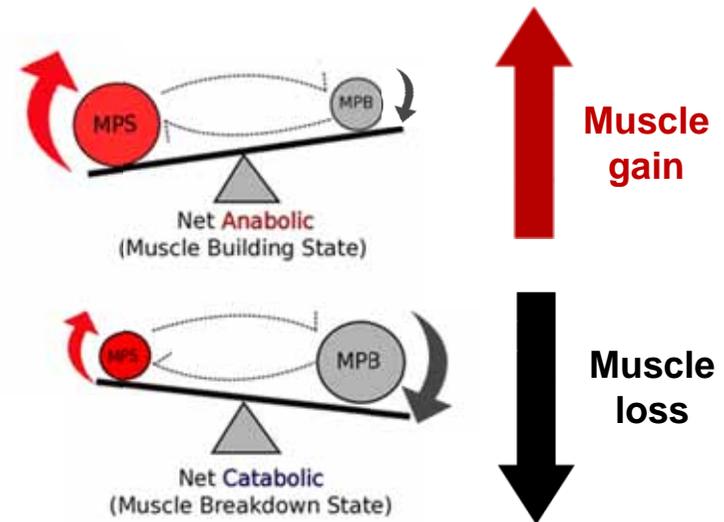
Understanding Muscle Loss

Why We Lose Muscle – ‘Anabolic Resistance’ of Muscle to Ageing



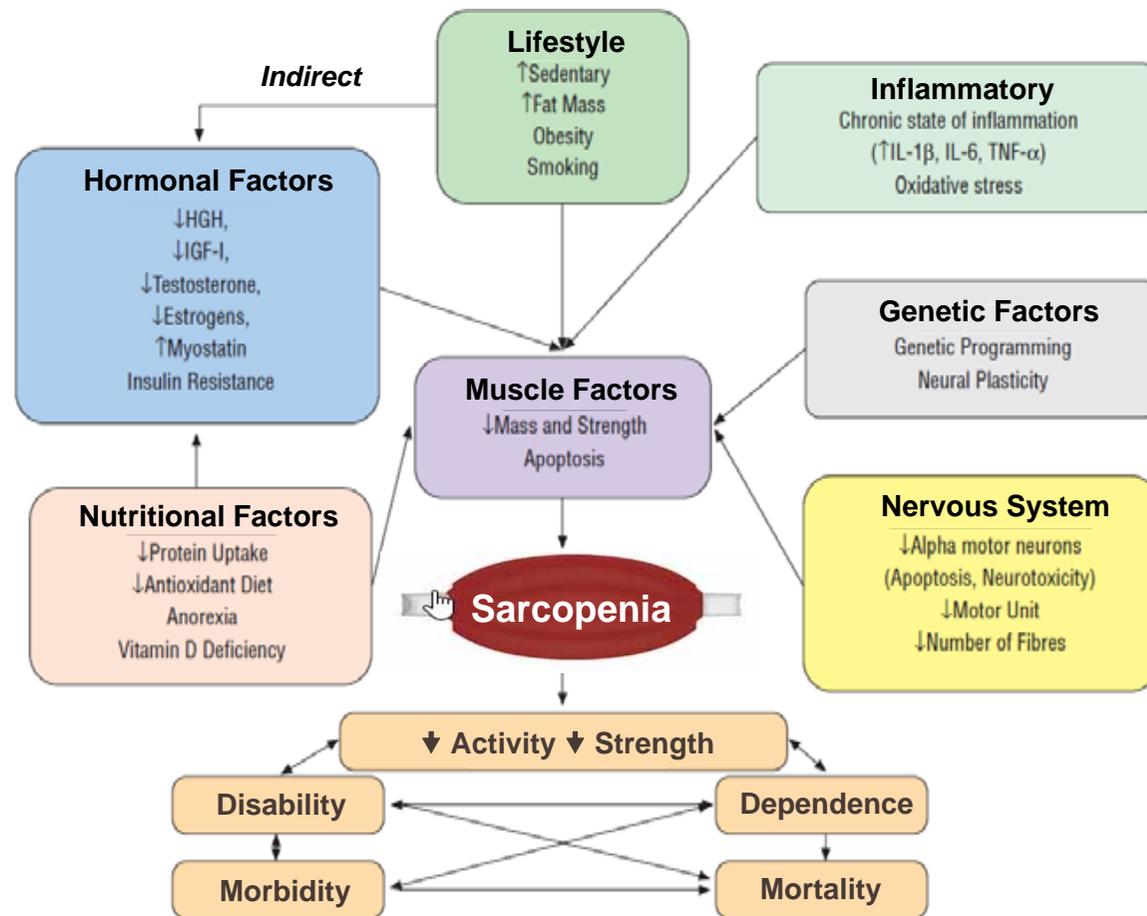
https://upfitness.com/en/article_posts/health-lifestyle/general-health/fighting-ageing-inflammation-hormones-nutrition

MPS, muscle protein synthesis; MPB, muscle protein breakdown

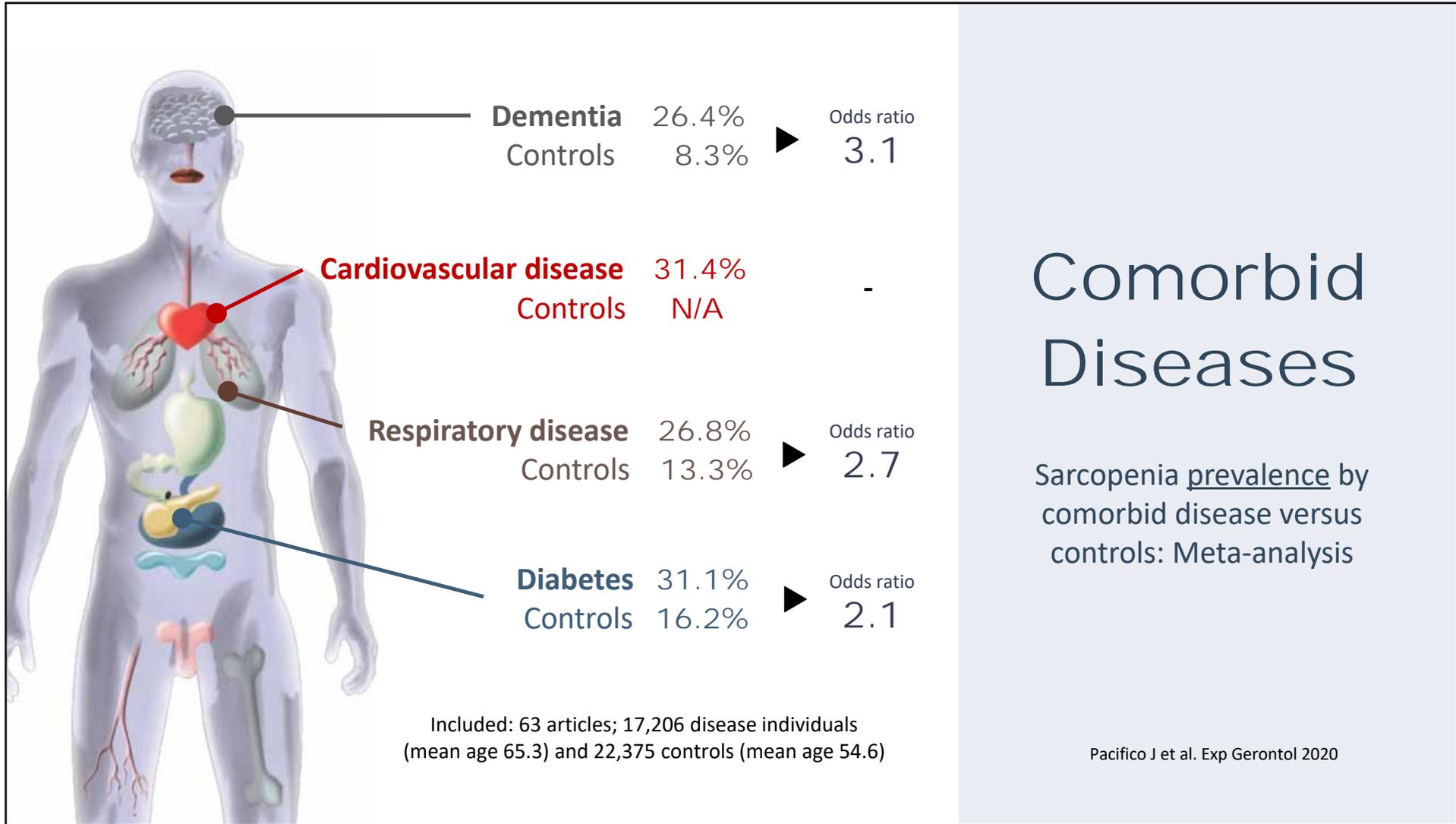


Adapted from Breen and Phillips. Nutrition Metab 2011;8:68

Factors Contributing to Age-related Muscle Loss



Disease-specific mechanisms also contribute to sarcopenia
 (Diabetes, obesity, cancer, HIV/AIDS, osteoporosis, CKD, COPD, CVD, heart failure, hypogonadism, RA +)



Comorbid Diseases

Sarcopenia prevalence by comorbid disease versus controls: Meta-analysis

Pacifico J et al. Exp Gerontol 2020

Consequences of Muscle Loss



Falls

Falls and fractures are the leading cause of injury and death among the elderly



Weight

Muscle mass influences metabolic rate, or how many calories you burn each day



Hospital Complications

Patients with low muscle mass are prone to injury and infection – impact the ability to complete physically demanding treatments



Breathing Problems

For older adults with respiratory health issues, muscle loss can lead to additional complications



Mobility

Loss of muscle strength and power can limit mobility and result in loss of independence and quality of life



Heart Health

Heart is a muscle and muscle loss can impact cardiovascular health



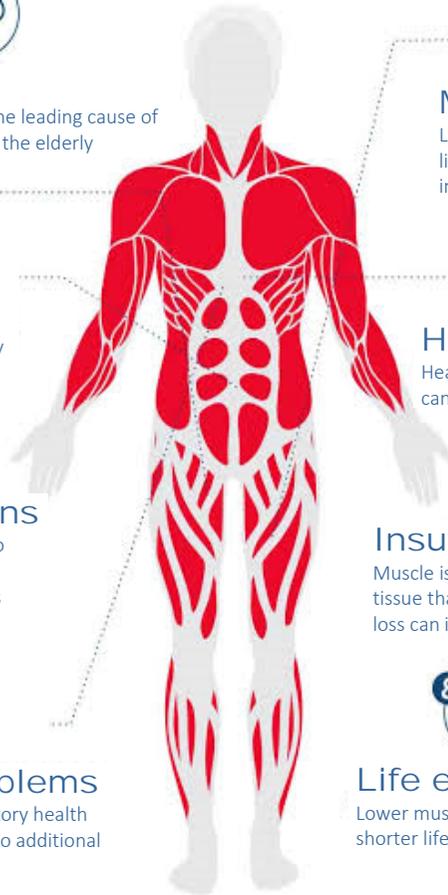
Insulin resistance

Muscle is the largest mass of insulin sensitive tissue that use blood glucose for fuel. Muscle loss can increase risk of IR and type 2 diabetes



Life expectancy

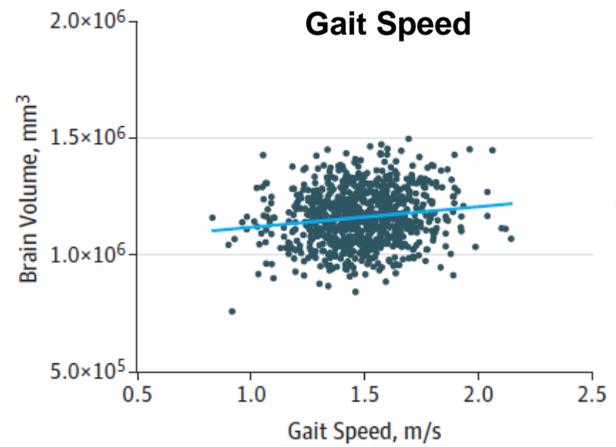
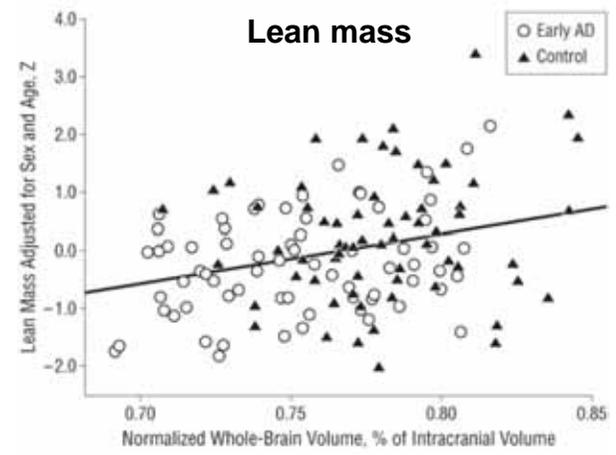
Lower muscle mass is linked to a shorter lifespan in older adults



FACT #3

Muscle and Brain Atrophy

Loss of skeletal lean mass and physical function has been shown to be associated with brain structural abnormalities



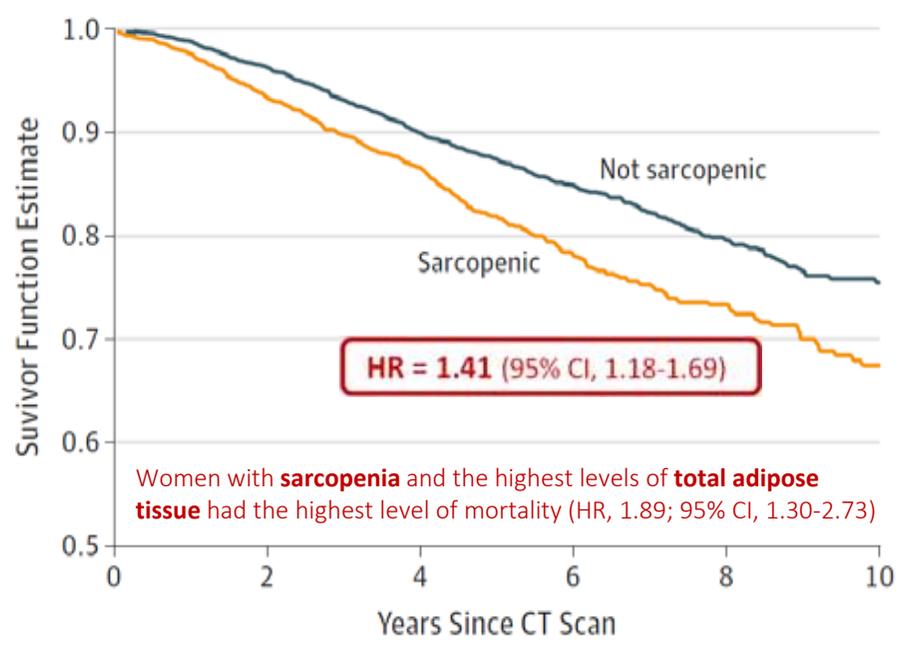
Burns et al. Arch Neurol 67(4): 428-33, 2010

Rasmussen et al. JAMA Network Open 2019;2(10):e1913123

FACT #4

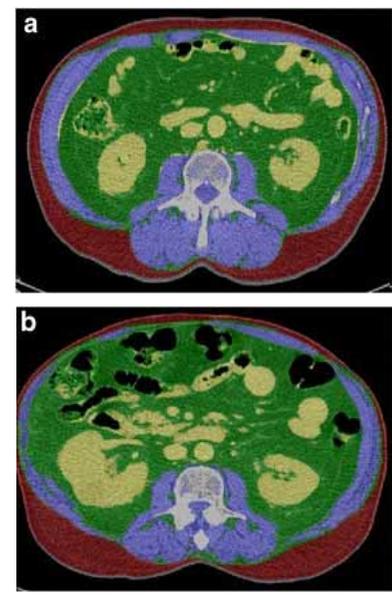
Muscle Loss Influences Survival

Retrospective, observational study of 3241 women with stage II or III breast cancer; median follow up of 6 years



Women with **sarcopenia** and the highest levels of **total adipose tissue** had the highest level of mortality (HR, 1.89; 95% CI, 1.30-2.73)

Caan et al. JAMA Oncol. 2018;4(6):798-804

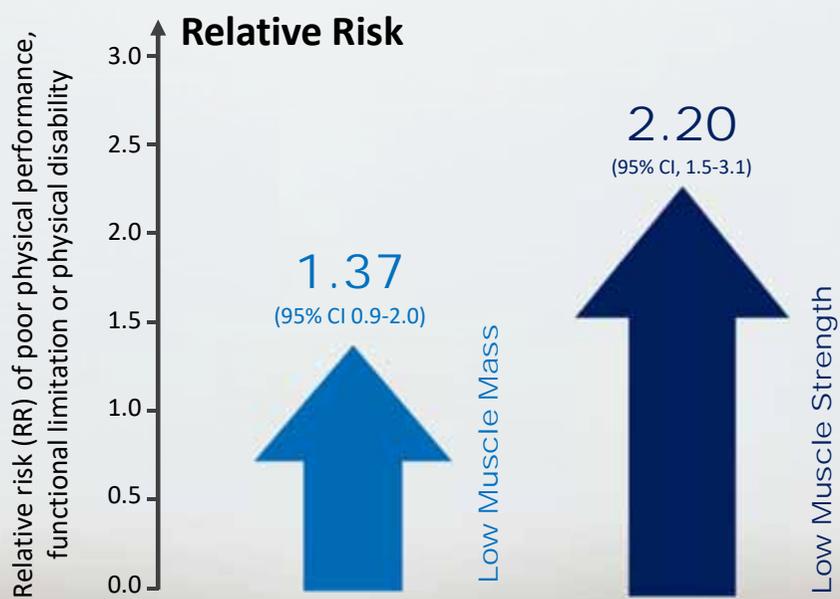


- Muscle
- Visceral fat
- Subcutaneous fat

34% of women presented with sarcopenia (based on muscle area at L3 divided by height)

FACT #5

Low Strength Linked to Disability



“becoming weaker” is important in addition to “being weak.”

Xue et al. JAMA 2011



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

FACT #6

Walking Ability Predicts Dementia

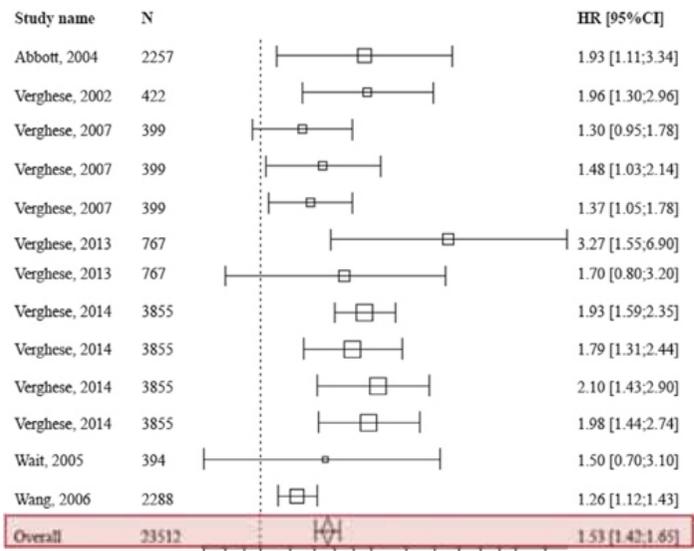
Poor gait performance was present 3 - 9 years before dementia was diagnosed

Beauchet et al JAMDA 2016 Jun 1;17(6):482-90.

Participants who slowed down by 0.1 seconds more per year were 47% more likely to exhibit cognitive decline

Rosso et al. Neurology. 2017 Jul 25;89(4):336-342

Hazard Ratio for Risk of Incident Dementia



Heterogeneity: $\chi^2 = 116.82$, $df = 1$, P -value = .003
 $I^2 = 59.4\%$

OR = 1.53

FACT #7

Muscle Power Critical to Function

Age-related loss in muscle power is linear from around the age of 30-35 y (45-60% loss by 70 y)

Lauretani et al J Appl Physiol 95(5): 1851-60, 2003

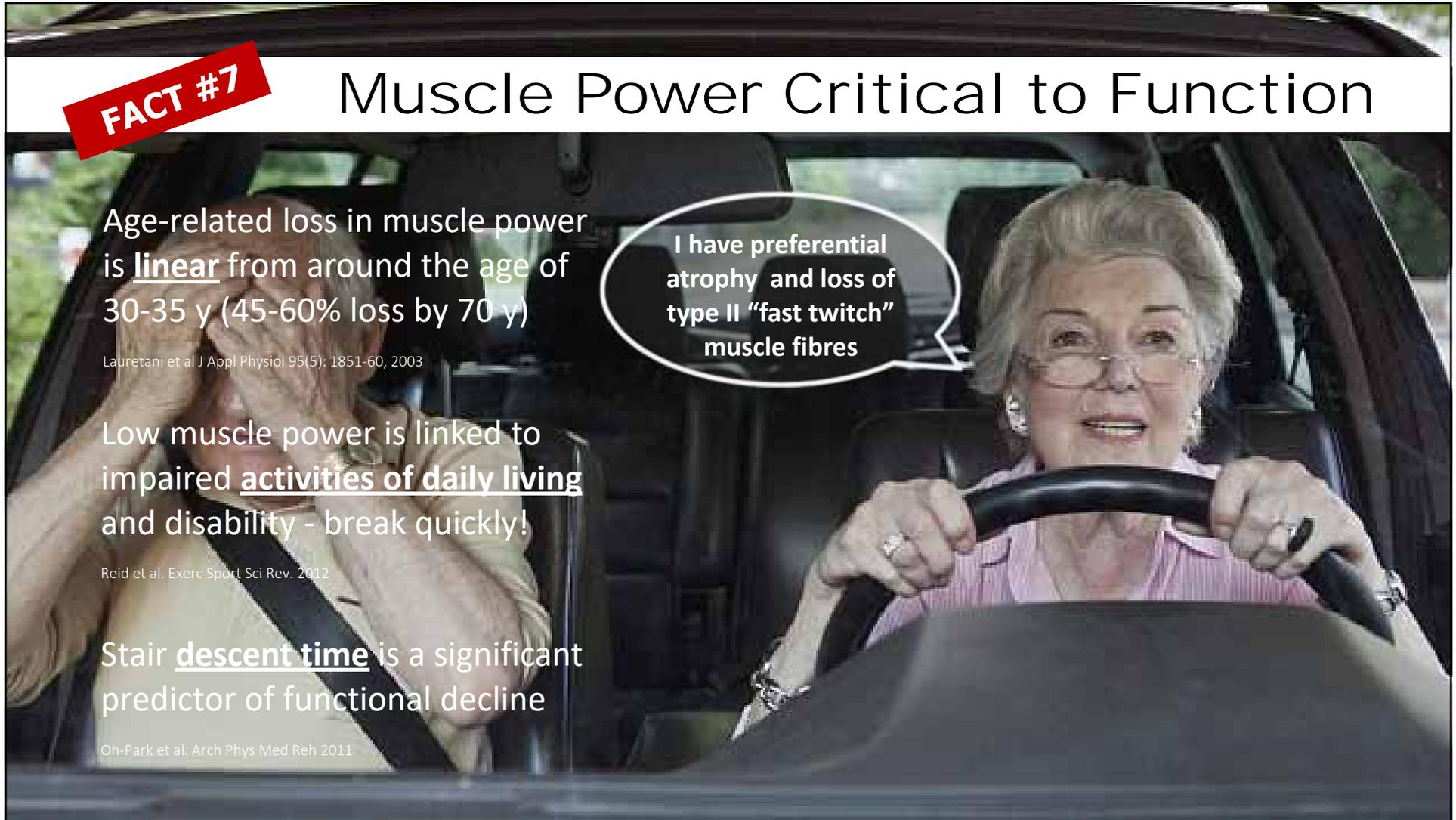
Low muscle power is linked to impaired activities of daily living and disability - break quickly!

Reid et al. Exerc Sport Sci Rev. 2012

Stair descent time is a significant predictor of functional decline

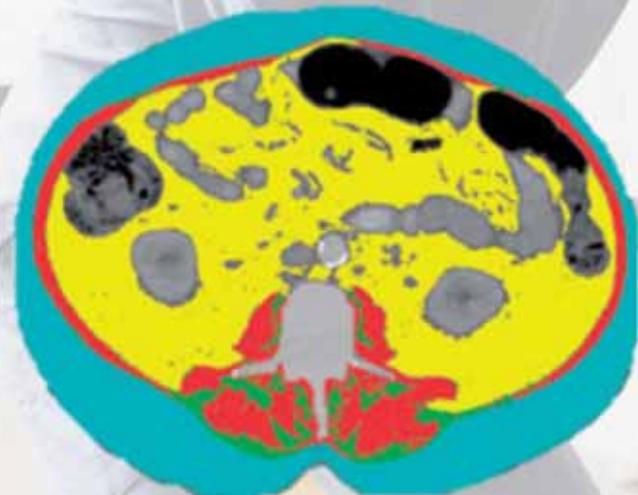
Oh-Park et al. Arch Phys Med Reh 2011

I have preferential atrophy and loss of type II "fast twitch" muscle fibres



FACT #8

Hidden Muscle Wasting is Deadly!



Sarcopenic Obesity
“Fat Frail”

Risk of Death

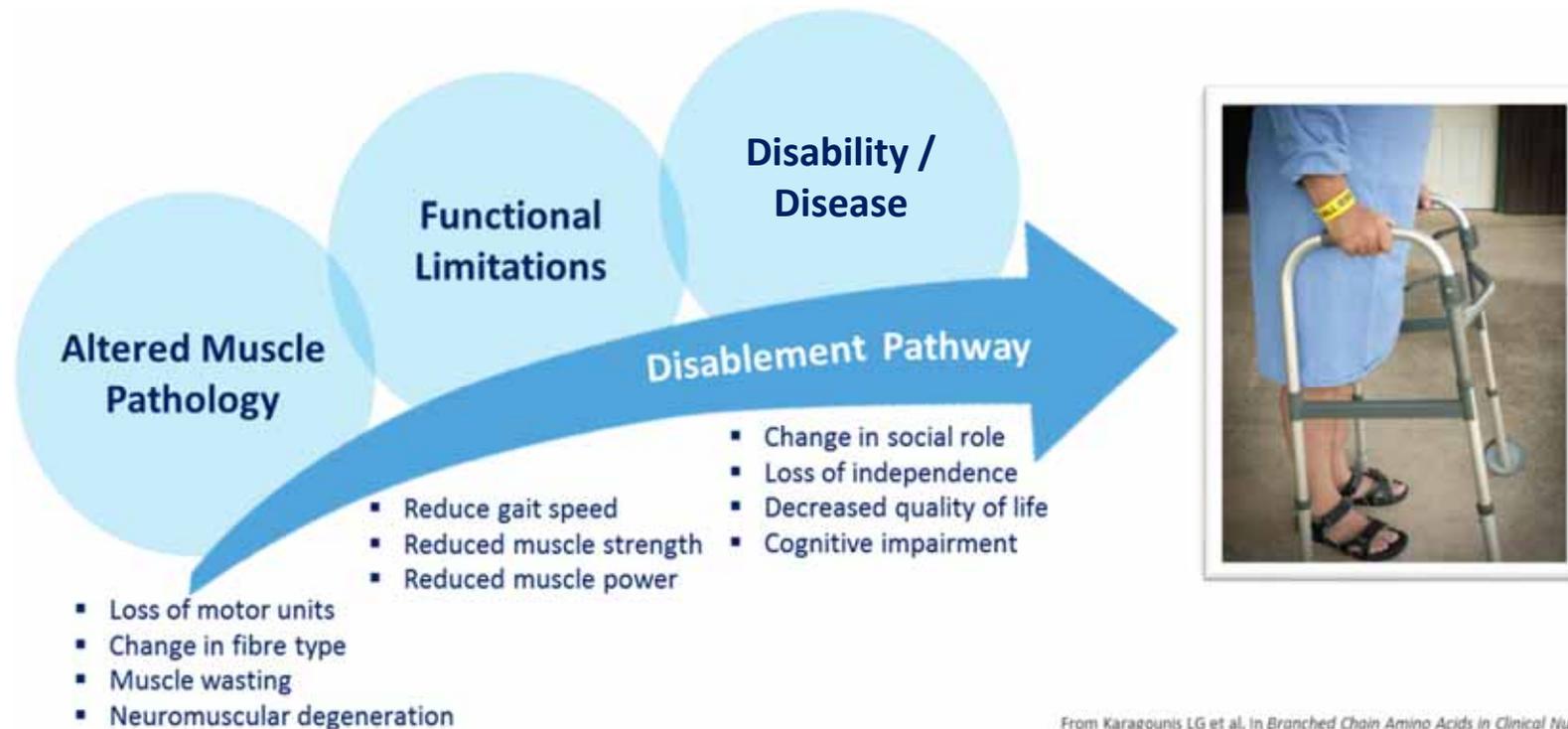
Normal Weight	
+ Preserved muscle mass	1.1-fold
+ Low muscle mass	1.4-fold
Overweight	
+ Preserved muscle mass	Reference
+ Low muscle mass	1.5-fold
Obese	
+ Preserved muscle mass	1.2-fold
+ Low muscle mass	3.2-fold

DXA body composition measured in 11,687 people: NHANES 1999–2004

Abramowitz et al. PlosOne 13(5): e0198318; 2018

Pathway to Disability / Disease

The Disablement / Disease Pathway: **Muscle** as a Mediator



From Karagounis LG et al. In *Branched Chain Amino Acids in Clinical Nutrition* : Volume 2 (Ed Rajendram, Preedy and Patel), Vol 2, Humana Press, 2015.



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Sarcopenia

A New Clinical Condition



Appendicular Lean Mass
Sum of arms and legs

Defining Sarcopenia

'Sarcopenia is a syndrome characterised by progressive and generalised loss of skeletal **muscle mass** and **strength** with a risk of adverse outcomes such as **physical disability, poor quality of life and death.**'

Current Clinical Criteria*

- ▶ Screening for sarcopenia
 - ▶ Diagnosis
 1. *Low muscle strength*
 2. *Low muscle mass (appendicular)*
 3. *Slow gait speed / impaired function*
-

Screening Tool for Sarcopenia

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

Component	Question	Scoring
S trength	How much difficulty do you have in lifting and carrying 10 pounds (~4 kg)	0 = None 1 = Some 2 = A lot or unable
A ssistance in walking	How much difficulty do you have walking across a room?	0 = None 1 = Some 2 = A lot, use of aids, or unable
R ising 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
C limb stairs	How much difficulty do you have climbing a flight of 10 stairs?	0 = None 1 = Some 2 = A lot or unable
F alls	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

Is SARC-F an accurate screening tool for sarcopenia?

 **Low sensitivity**

SARC-F is limited in its ability to detect people who will suffer from sarcopenia.

 **High specificity**

SARC-F is an effective tool for identifying those without sarcopenia.

May be useful as a tool for referral for further testing to confirm a diagnosis of 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



* Can be prone to errors eg. patients with lower extremity oedema

Chen et al. JAMDA 2020 - Asian Working Group of Sarcopenia (AWGS)

Calf Circumference, SARC-F or Both

Sensitivity and Specificity Against the AWGS 2019 Criteria

	Sensitivity, %	Specificity, %
Total	<u>with disease</u>	<u>without disease</u>
Calf circumference	81.4 (76.1–85.9)	77.0 (73.9–79.9)
SARC-F	17.9 (13.4–23.0)	93.7 (91.7–95.2)
SARC-CalF	47.5 (41.4–53.8)	92.0 (89.8–93.8)

SARC-CalF improved the sensitivity of SARC-F, but calf circumference alone was best screening tool for sarcopenia

Calf circumference: Males $\leq 34 = 10$; Females ≤ 33 cm = 10 suggestive of sarcopenia

SARC-F score ≥ 4 suggestive of sarcopenia

SARC-CalF (sum scores): score 11-20 suggestive of sarcopenia

Mo et al. JAMDA 2020 in press

Malnutrition Screening

- Malnutrition (GLIM or EPSEN criteria) associated with a **3-4-fold higher** risk of developing sarcopenia in community-dwelling older adults.
- The Global Leadership Initiative of Malnutrition (GLIM) and the European Society of Clinical Nutrition and Metabolism (ESPEN) criteria might be early indicators to identify individuals that might develop sarcopenia.

Beudart C et al. Nutrients 2019, 11, 2883

EXAMINATION	IDENTIFY MALNUTRITION RISK	IDENTIFY LOSS OF MUSCLE MASS AND FUNCTION																														
<p>Malnutrition screening</p> <p>Use 'MUST' and 'SARC-F' to identify risk of malnutrition and muscle mass loss</p> <p>'Malnutrition Universal Screening Tool' or 'MUST' is a five-step screening tool to identify adults, who are malnourished, at risk of malnutrition, or obese.</p> <p>'SARC-F' is a rapid diagnostic test for sarcopenia based on 5 components.</p>	<p>Check if your patient is at risk of malnutrition by asking the following 3 questions:</p> <table border="1"> <thead> <tr> <th colspan="2">'MUST' Malnutrition screening tool</th> </tr> </thead> <tbody> <tr> <td>What is your current body weight?</td> <td>0 > 20 (> 30 Obese)</td> </tr> <tr> <td>What is your height?</td> <td>1 18.5-20</td> </tr> <tr> <td>Calculate patients BMI kg/m²**</td> <td>2 < 18.5</td> </tr> <tr> <td>What is your usual weight?</td> <td>0 Weight loss < 5%</td> </tr> <tr> <td>Have you experienced unintentional weight loss in the last 3 - 6 months?</td> <td>1 Weight loss 5-10%</td> </tr> <tr> <td></td> <td>2 Weight loss > 10%</td> </tr> <tr> <td>If patient is acutely ill and there has been or is likely to be no nutritional intake for >5 days</td> <td>0 No</td> </tr> <tr> <td></td> <td>2 Yes</td> </tr> </tbody> </table> <p>*Body Mass Index (BMI) is calculated as weight (in kg) divided by the square of height (in m)</p> <p>Add 'MUST' scores together to calculate overall risk of malnutrition:</p> <p>Score 0 Low Risk Score 1 Medium Risk Score 2 or more High Risk</p>	'MUST' Malnutrition screening tool		What is your current body weight?	0 > 20 (> 30 Obese)	What is your height?	1 18.5-20	Calculate patients BMI kg/m ² **	2 < 18.5	What is your usual weight?	0 Weight loss < 5%	Have you experienced unintentional weight loss in the last 3 - 6 months?	1 Weight loss 5-10%		2 Weight loss > 10%	If patient is acutely ill and there has been or is likely to be no nutritional intake for >5 days	0 No		2 Yes	<p>If your patient has one or more of the risk factors above (see in 'Set up' box) or is at risk of malnutrition, check for sarcopenia.</p> <table border="1"> <thead> <tr> <th colspan="2">'SARC-F' Sarcopenia screening Test</th> </tr> </thead> <tbody> <tr> <td>STRENGTH How much difficulty do you have in lifting and carrying 4.5 kg? * *2.5 kg is approximately the weight of a pet cat or pumpkin</td> <td>0 None 1 Some 2 A lot or unable</td> </tr> <tr> <td>ASSISTANCE WITH WALKING How much difficulty do you have walking across a room?</td> <td>0 None 1 Some 2 A lot, use aids, or unable</td> </tr> <tr> <td>RISE FROM A CHAIR How much difficulty do you have transferring from a chair or bed?</td> <td>0 None 1 Some 2 A lot or unable without help</td> </tr> <tr> <td>CLIMB STAIRS How much difficulty do you have climbing a flight of 10 stairs?</td> <td>0 None 1 Some 2 A lot or unable</td> </tr> <tr> <td>FALLS How many times have you fallen in the past year?</td> <td>0 None 1 1-3 falls 2 4 or more falls</td> </tr> </tbody> </table> <p>*SARC-F' score equal to or greater than 4 is predictive of sarcopenia</p>	'SARC-F' Sarcopenia screening Test		STRENGTH How much difficulty do you have in lifting and carrying 4.5 kg? * *2.5 kg is approximately the weight of a pet cat or pumpkin	0 None 1 Some 2 A lot or unable	ASSISTANCE WITH WALKING How much difficulty do you have walking across a room?	0 None 1 Some 2 A lot, use aids, or unable	RISE 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
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HMB - β-hydroxy β-methylbutyrate | EPA - eicosapentaenoic acid
* In obese and sarcopenic obese patients should be calculated with ideal body weight
** The level of protein to be used, eg. in patients with severe kidney disease (a CrCl30 mL/min/1.73m² use 0.6 g of protein/kg BW/day
*** Should be adjusted individually in case of deficiencies

Krznaric et al Clin Nutr 39(7): 1983-87, 2020

Sarcopenia

A New Clinical Condition



Appendicular Lean Mass
Sum of arms and legs

Defining Sarcopenia

'Sarcopenia is a syndrome characterised by progressive and generalised loss of skeletal **muscle mass** and **strength** with a risk of adverse outcomes such as **physical disability, poor quality of life and death.**'

Current Clinical Criteria*

► Screening for sarcopenia

► **Diagnosis**

1. *Low muscle strength*
2. *Low muscle mass (appendicular)*
3. *Slow gait speed / impaired function*

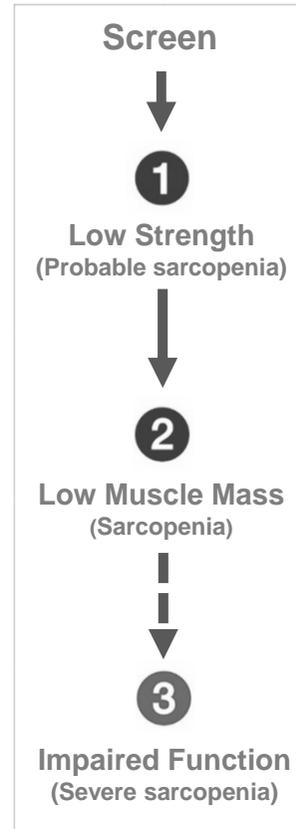
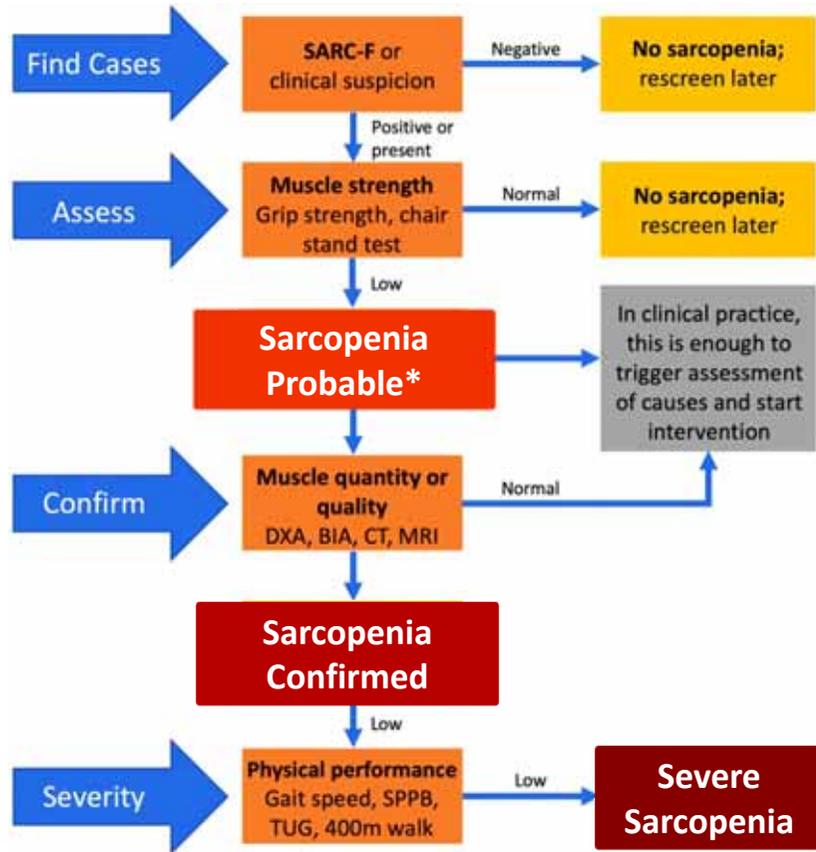
Diagnostic Criteria for Sarcopenia

Recommendation (Reference)	Who to investigate	Muscle strength			Physical Performance				Muscle Mass	
		Hand grip (kg)		Chair stand test	Gait speed (m/s)	SPPB	TUG	400 m walk test	Men	Women
		Men	Women							
IWGS 2009 (11)	Anyone with decline in physical function, strength or overall health	-	-	-	<1.0	-	-	-	ALM/Ht ² ≤ 7.23 kg/m ²	ALM/Ht ² ≤ 5.67 kg/m ²
EWGSOP1 2010 (1)	>65 years	<30	<20	-	≤1.0/6 m course, ≤0.8/4 m course	≤8 point score	-	-	ALM/Ht ² ≤ 7.23 kg/m ² (<2 s.d. young adults – Rosetta study)	ALM/Ht ² ≤ 5.50 kg/m ² (<2 s.d. young adults – Rosetta study)
SSCWD 2011 (12)	>65 years ("Sarcopenia with limited mobility")	-	-	-	<1.0	-	-	<6 min	ALM/Ht ² <2 SD of sex healthy persons, 20 and 30 years of the same ethnic group	-
AWGS 2014 (10)	>60–65 years from community-specific conditions and chronic diseases	<26	<18	-	≤0.8/6 m course	-	-	-	ALM/Ht ² 7.0 kg/m ²	ALM/Ht ² 5.4 kg/m ²
FNIH 2014; 2015 (9)	Functional limitations	<26	<16	-	≤0.8/4 m course	-	-	-	ALM/BMI ≤ 7.89 or ALM ≤ 19.75 kg	ALM/BMI <0.512 or ALM <15.02 kg
EWGSOP2 2018 (7)	Clinical indication or SARC-F ≥ 4	<27	<16	>15 s for five rises	≤0.8/4 m course	≤8 point score	≥20 s	Not finish or ≥6 min for finish	ALM/Ht ² ≤ 7.00 kg/m ² (<2 SD/healthy young adults)	ALM/Ht ² ≤ 6.00 kg/m ² (<2SD/healthy young adults)
ICFSR 2018 (13)	Anyone ≥65 years or after a major health event (use gait speed or SARC-F)	Any of the above	Any of the above	-	Any of the above	-	-	-	Any of the above	Any of the above

Error (5.5 kg/m²)

ALM, appendicular lean mass; AWGS, Asian Working group for Sarcopenia; DXA, dual X-ray densitometry; EWGOP, European Working Group on Sarcopenia in older people; FNIH, Foundation for the National Institute of Health Sarcopenia Project; Ht², squared height; ICFSR, International Clinical Practice Guidelines For Sarcopenia; IWGS, International Working Group on Sarcopenia; SSCWD, Society of Sarcopenia, Cachexia and Wasting Disorders; SPPB, short physical performance battery; TUG, timed get-up-and-go.

Screening and Assessment Algorithm

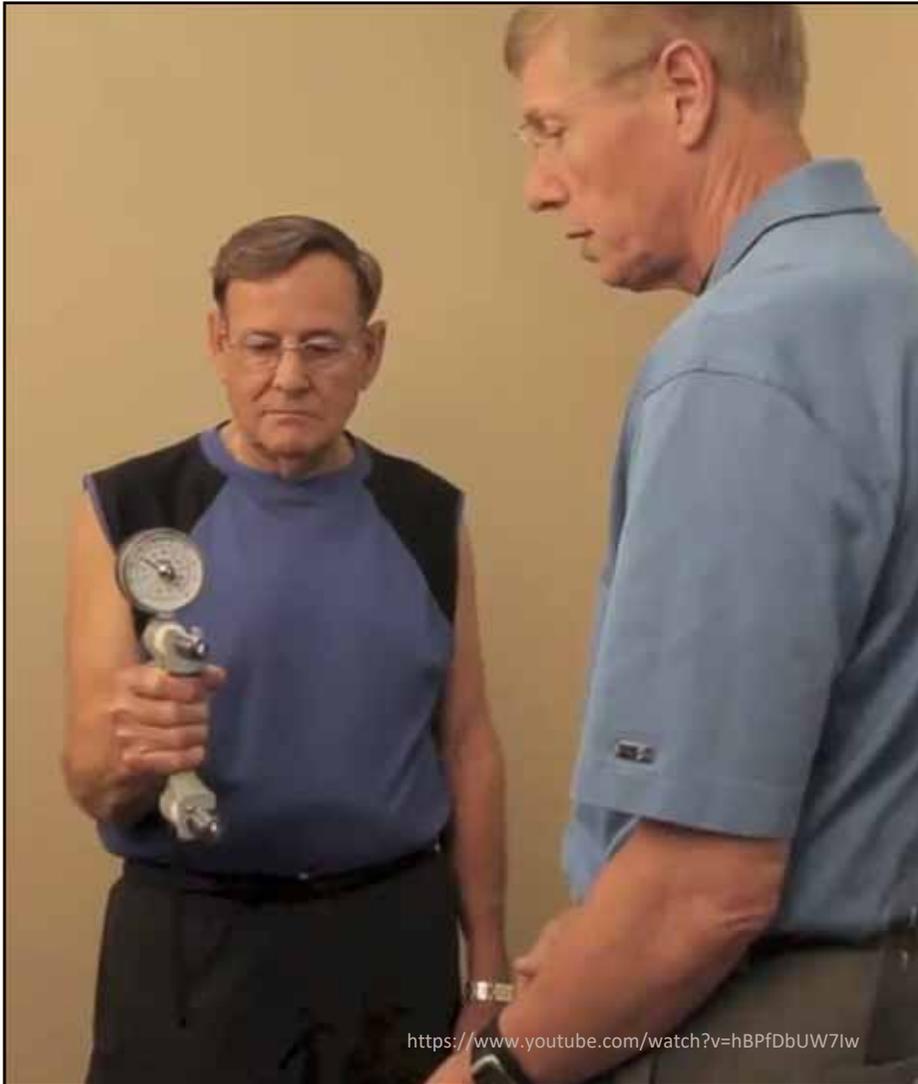


2018 EWGSOP2 Operational Definition of Sarcopenia

Muscle strength is the primary indicator of probable sarcopenia

Physical function is not part of sarcopenia criteria; only used to classify severity of disease.

Cruz-Jentoft A et al. Age and Ageing 2018



<https://www.youtube.com/watch?v=hBPfDbUW7lw>

Muscle Strength Assessment

Grip Strength Clinical Cut-points

European Working Group on Sarcopenia in Older People 2 cut-points



Men < 27 kg *



Women < 16 kg *

Handgrip device: Hydraulic-type (Jamar) or spring-type (Smedley)

* Cut-points should be region and ethnic specific

Low handgrip strength has consistently been linked with long-term disability onset, increased risk of complications and extended hospitalization.

Cruz-Jentoft A et al. Age and Ageing 2018

Muscle Mass Assessment

Appendicular lean mass (ALM): sum of the 4 limbs

- Skeletal muscles make up 40-45% of total body mass, with ~55% of lean mass in the legs.

▪ **Low muscle mass is defined by:**

- $ALM / \text{height (m)}^2$
- ALM / BMI



Body Composition Results

Region	Fat Mass (g)	Lean Mass (g)	Total Mass (g)	% Fat	% Fat Percentile	AM
L Arm	973	3280	4253	22.9		
R Arm	923	2761	3684	25.3		
Trunk	8931	25381	34312	26.0		
L Leg	1993	8134	10127	19.7		
R Leg	2165	8441	10606	20.4		
Subtotal	14999	47997	62996	23.8		
Head	1124	3689	4813	23.4		
Total	16123	51686	67809	23.8	45	6
Android	1536	3806	5342	28.7		
Gynoid	2133	7846	9979	21.4		

Scan Date: 16 November 2010 ID: A1116100Q
Scan Type: a Whole Body

Adipose Indices

Measure	Result	YN	Percentile	AM
Total Body % Fat	23.8	45	6	
Fat Mass/Height ² (kg/m ²)	5.31	53	5	
Android/Gynoid Ratio	1.34			
% Fat Trunk/% Fat Legs	1.30	99	90	
Trunk/Limb Fat Mass Ratio	1.47	90	75	

Lean Mass Indices

Measure	Result	YN	Percentile	AM
Lean Mass/Height ² (kg/m ²)	17.0	15	22	
Append. Lean Mass/Height ² (kg/m ²)	7.44	9	30	

Lunar DXA Body Composition Output



DXA Scan – Total Body Scan
ALM = sum of arms and legs

Assessment of Physical Function

Five times Sit-to-Stand

5-STS Time

Impaired function:

> 12 sec

Recurrent fallers:

> 15 sec



Gait Speed: 4-meter Walk Test

Gait speed

≤ 1.0 m/s associated with shorter survival

≤ 0.8 m/s associated with increased disability risk



Standing Balance

Component of SPPB Test

Side-to-side

Semi-tandem

Tandem

(Hold for 10 sec)



Timed-up-and-go Test (3-meter)

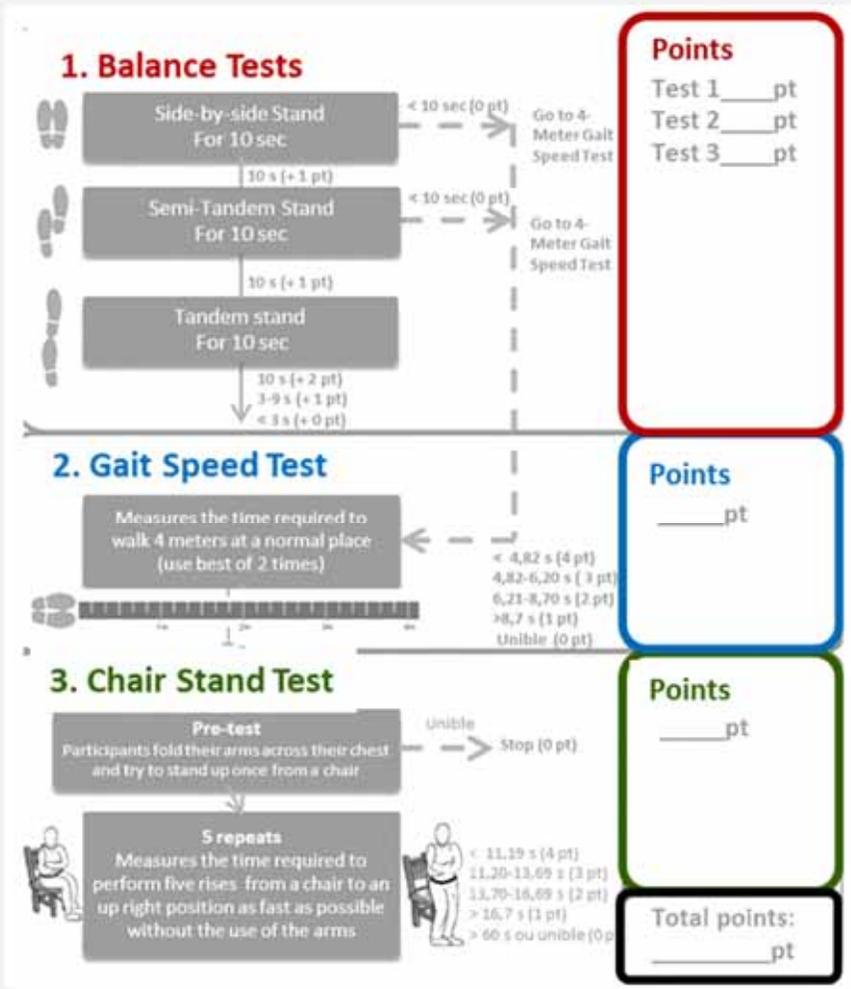
TUG Time

≥ 12 sec is considered to indicate impaired function and linked to an increased falls risk



Observe the patient's postural stability, gait, stride length, and sway

Short Physical Performance Battery (SPPB)



<https://sppbguide.com/>

SPPB Test



Short Physical Performance Battery

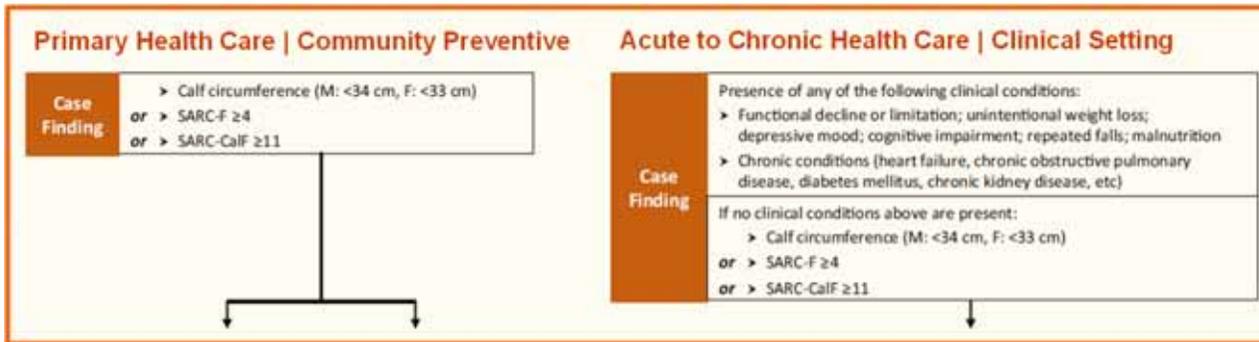
≤8/12

is often used to indicate impaired function

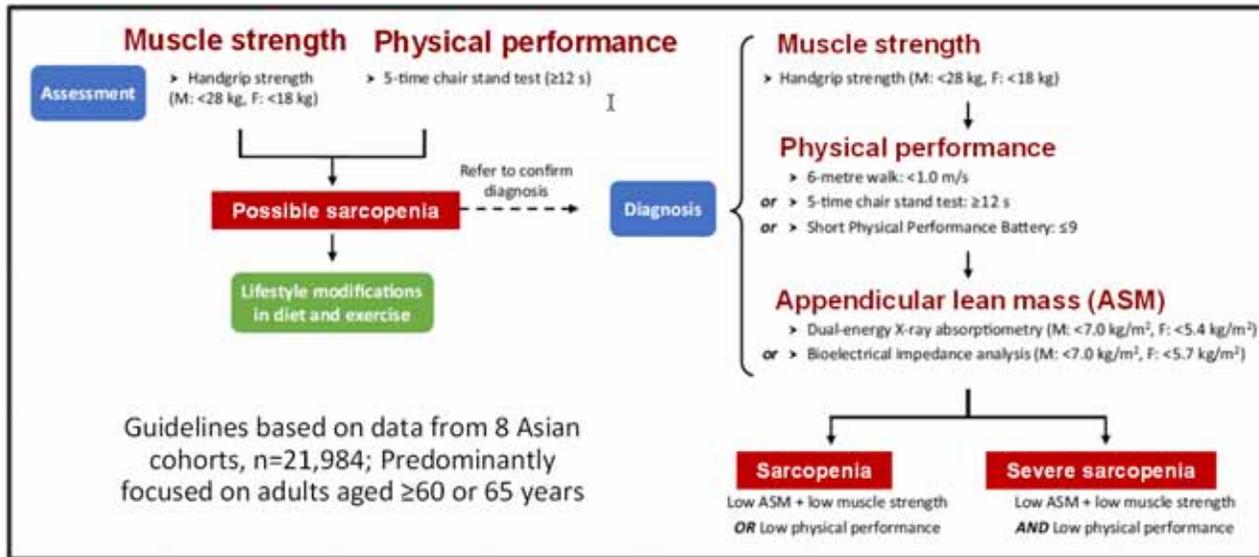


→ Three measures added from 0 (worst) to 12 (best)

Screening



Assessment & Diagnosis



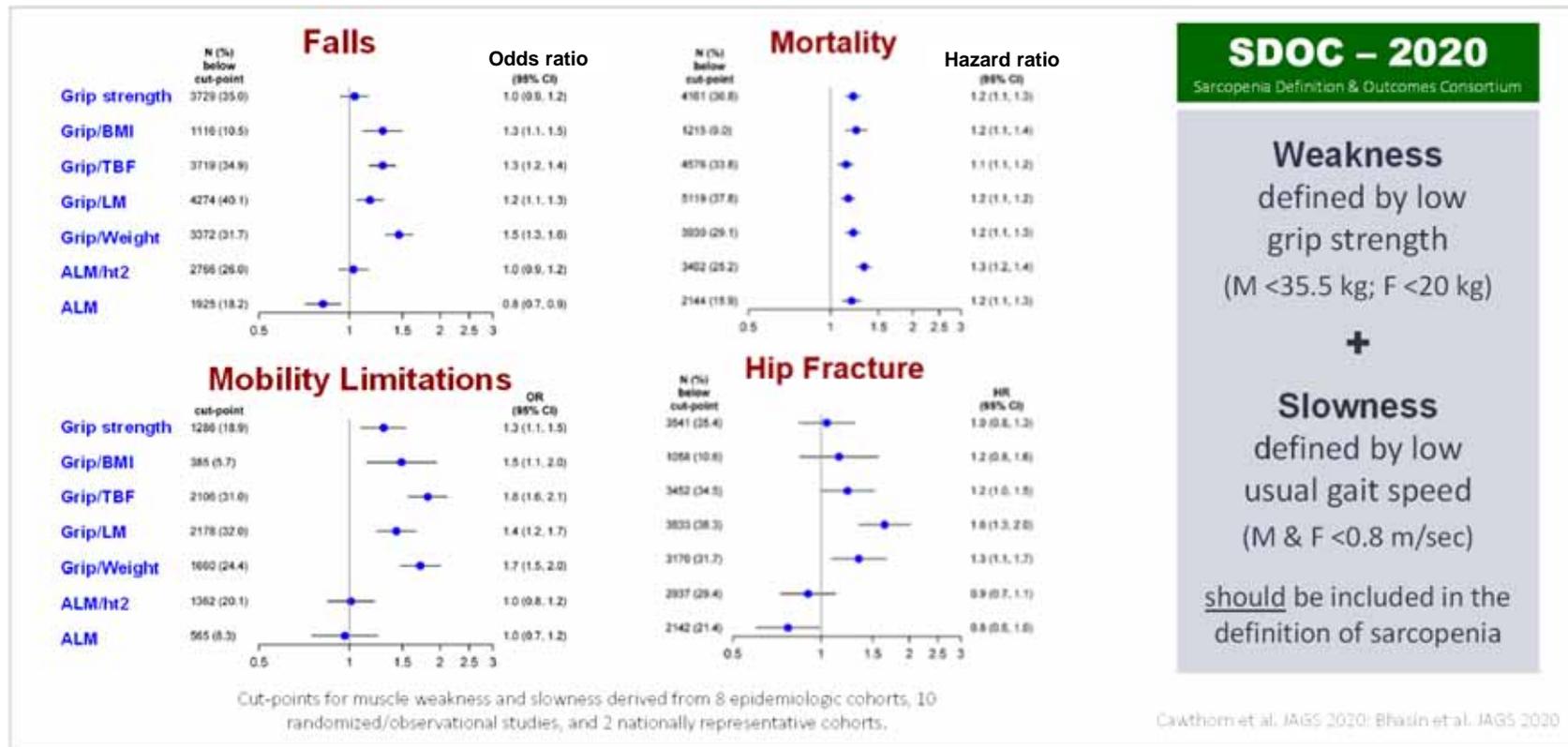
2020 AWSG

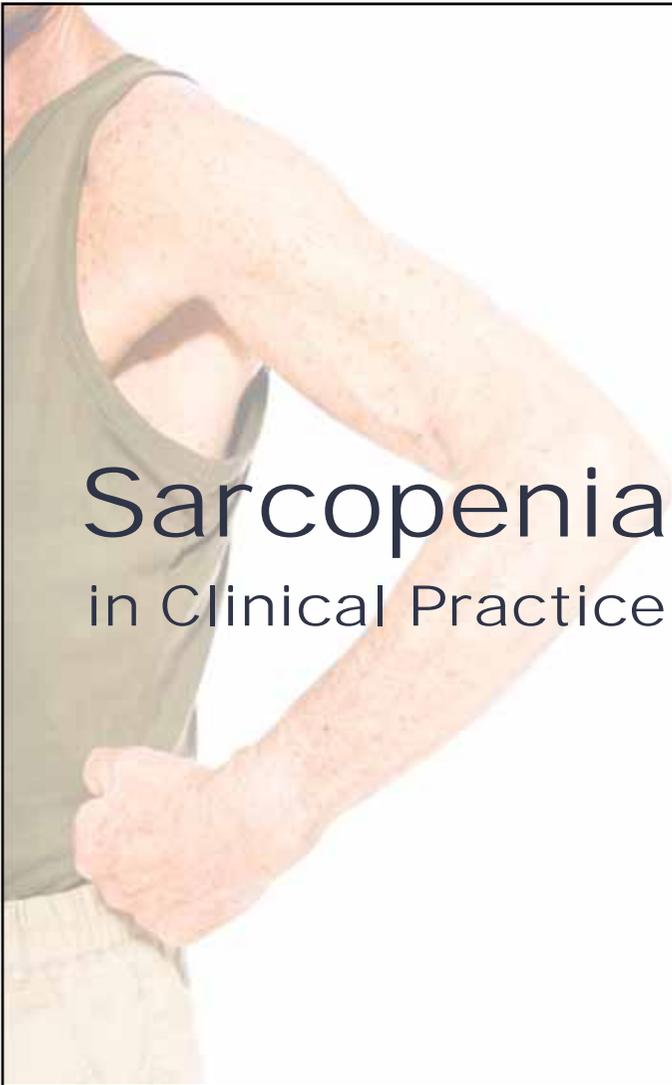
Asian Working Group for Sarcopenia

Definition Sarcopenia
Based on low ALM with low muscle strength and or low physical performance

2020 SDOC Recommendation

Sarcopenia Definitions & Outcomes Consortium (SDOC): Based on Data (Evidence)





Sarcopenia in Clinical Practice

Recommendations

- ▶ Consider muscle loss (sarcopenia) in **ALL** clinical decision making involving older adults / elderly
 - ▶ Screen for **signs/symptoms** of muscle impairment
 - Consider SARC-F + calf circumference
 - Review falls history or falls risk
 - Review physical activity levels
 - Assess malnutrition risk | weight loss | fatigue
 - Secondary or disease-related sarcopenia
 - ▶ Assess **muscle function** (4-m walk or TUG) and/or **muscle strength** (handgrip strength or 5-STS)
 - If weakness and/or slowness identified, treat
 - ▶ If tools available, assess **lean (muscle) mass**
 - Useful to monitor change to a treatment/intervention.
-



Key Objectives

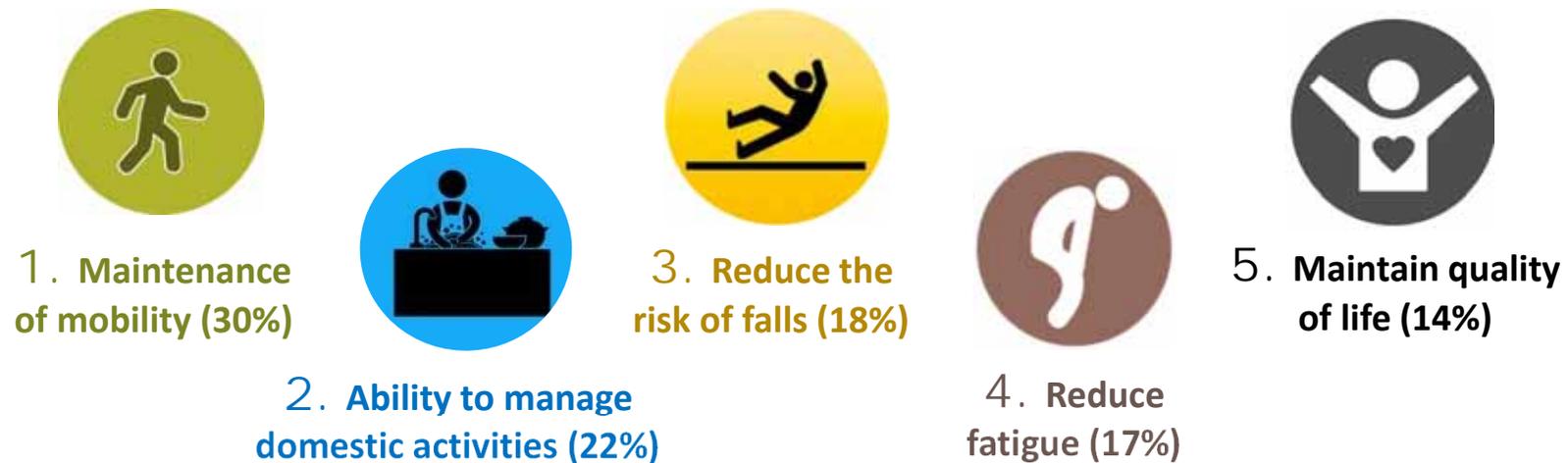
- 1 Understand the importance of ***skeletal muscle*** as a key mediator of chronic disease(s).
- 2 Recognising ***sarcopenia*** as a muscle disease. Understand the definition, diagnostic criteria and methods of assessment.
- 3 Understand ***prevention*** and ***treatment options*** for sarcopenia.

Treatment Options for Sarcopenia



Preferences and Needs

Older Persons (n=216) with Sarcopenia (across 6 countries): Preferences for Outcomes



Highest priority

Progressive Resistance Training



Muscle strength	✓	✓	✓
Muscle mass	✓	✓	✓
Function	✓	✗	

Resistance Training Guidelines

Exercises

- 8-10 exercises (multi-joint) targeting major muscle groups
- Free weight, machines and/or bands can be used

Frequency

- At least 2 day per week; non-consecutive days

Intensity

- Moderate to high intensity (70 – 85% max | RPE: 5 – 8 /10 'Hard-very hard')
(Low load - 30-50% max - resistance training to volitional fatigue also beneficial)
- Program must be progressive; overload is important

Dose

- 2 – 3 sets of 8 – 12 repetitions (commence at 1 – 2 sets of 10 – 15 reps)
- 1 – 2 minutes rest between sets



-
- * Consider including high velocity (rapid) resistance exercises to enhance muscle power and function (1 second fast concentric contraction followed by 2-3 second slower eccentric contraction). Training in technique and supervision is essential

Functional Resistance Exercises

Example of Gym-based and Home-based Functional Strengthening Exercises

<p>Leg Press</p> 	<p>Forward Step-up</p> 	<p>Lat Pulldown</p>  <p>Limit overhead exercises</p>	<p>Squats</p> 	<p>Sit-to-stand</p> 
<p>Fitball Squat</p> 	<p>Lunges</p> 	<p>Seated Row</p> 	<p>Step-ups</p> 	<p>Squats with resistance</p> 
<p>Hip Abduction</p> 	<p>Hip Extension</p> 	<p>DB Side Bends</p> 	<p>Hip abduction/ adduction</p> 	<p>Lunges</p> 
<p>Hip Flexion</p> 	<p>Calf Raises</p> 	<p>Back Extension</p> 		

(Copyright Visualcoaching® Pro software, www.visualcoaching.com; Reproduced with Permission)

Daily exercise snacking (1 min bouts x 3-5; 2-3 day)

Integrating Exercise into Lifestyle Activities

Reduction in Falls Incidence after 12 months



Structured Program

Incidence rate ratio

0.81

(95% CI 0.56, 1.17)
n=210

LiFE Program

Incidence rate ratio

0.69 *

(95% CI 0.48, 0.99)
n=212

Structured Program: balance & lower limb strength exercises using ankle weights (3 times per week) (35% adherence after 6 months).



Turn everyday activities into an opportunity to improve your balance & strength and prevent falls (47% adherence after 6 mo).

<http://www.cec.health.nsw.gov.au/programs/falls-prevention/april-falls-day-2013>

Clemson et al. BMJ 2012;345:e4547

Falls in Aged-Care

Activities associated with the highest proportion of falls:

- Forward walking (24%)
- Standing quietly (13%)
- Sitting down (12%)

The most frequent cause of falling:

- *Incorrect weight shifting (41%)*
- Trip or stumble (21%)
- Hit or bump (11%)
- Loss of support (11%)

Robinovitch et al. Lancet 381, 9860: 47–54, 5 January 2013



Video from Robinovitch et al. Lancet 2013

Train to Improve Movement Speed

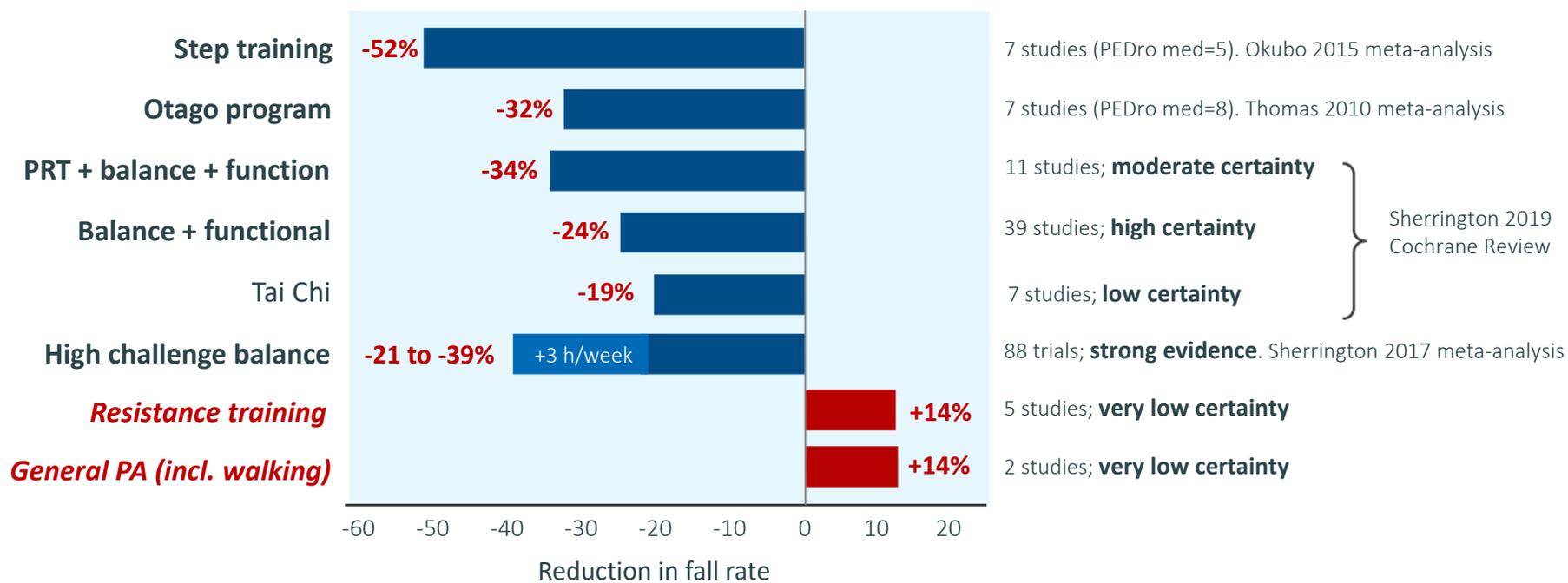
- ✓ **High-velocity (power) training:** perform the lifting phase as rapidly as possible.
- ✓ **Greater benefits** to functional capacity with HV-PRT training compared to traditional PRT.
- ✓ Similar functional benefits with **light vs heavy load** HV-PRT.
- ✓ Meaningful benefits to **'real-life' everyday activities** (e.g, speed of braking in car).

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



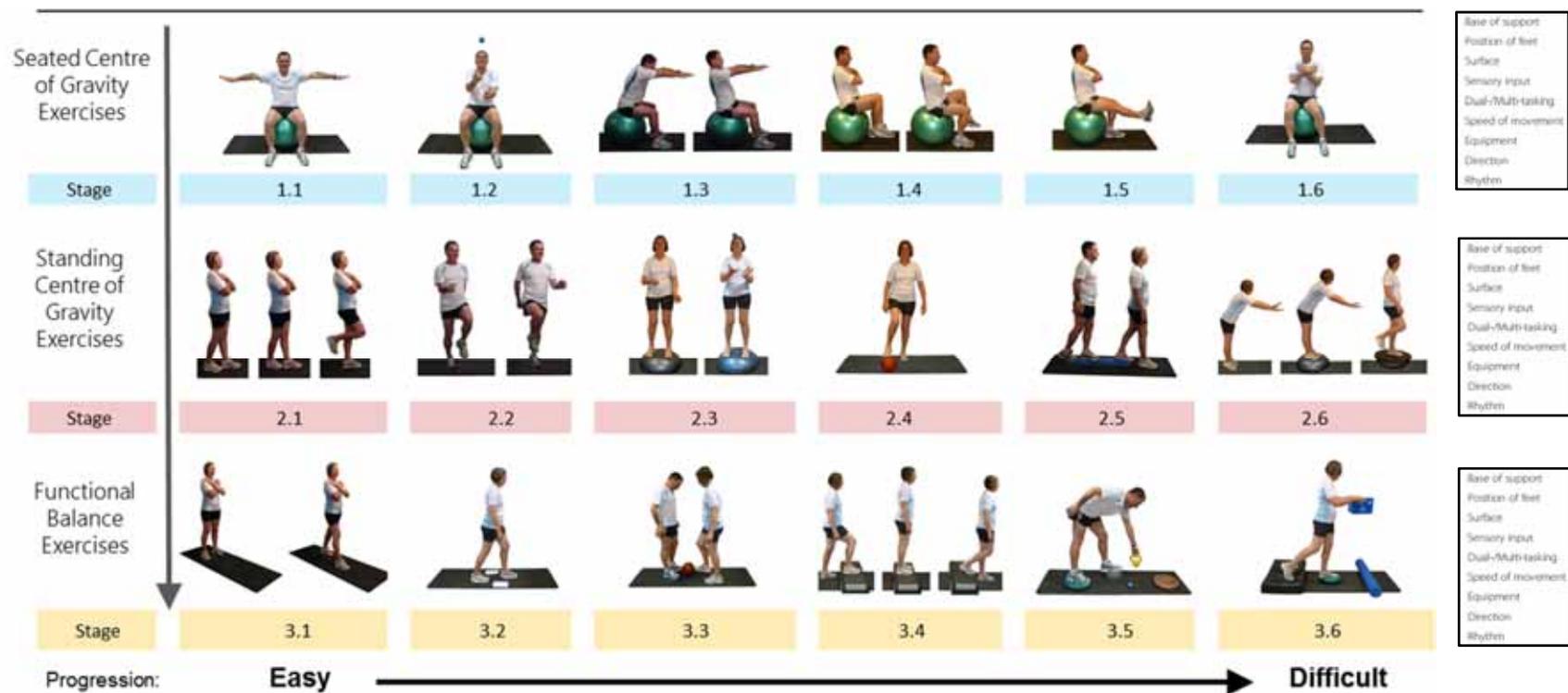
Exercise for Falls Prevention

Fall rate reduction by the type of exercise



Challenging Balance Exercises

Example of progressively challenging balance and stepping exercise training



Dual Task Functional Exercise Training

18-month cluster RCT

(6-month supervised training + 6-month step-down + 6-month follow-up)

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

Daly R et al. unpublished



Functional power and strength training



Challenging balance, stepping and mobility



Dual-task motor and cognitive exercises

Included dual task cognitive and/or motor activities



Included dual task cognitive and/or motor activities



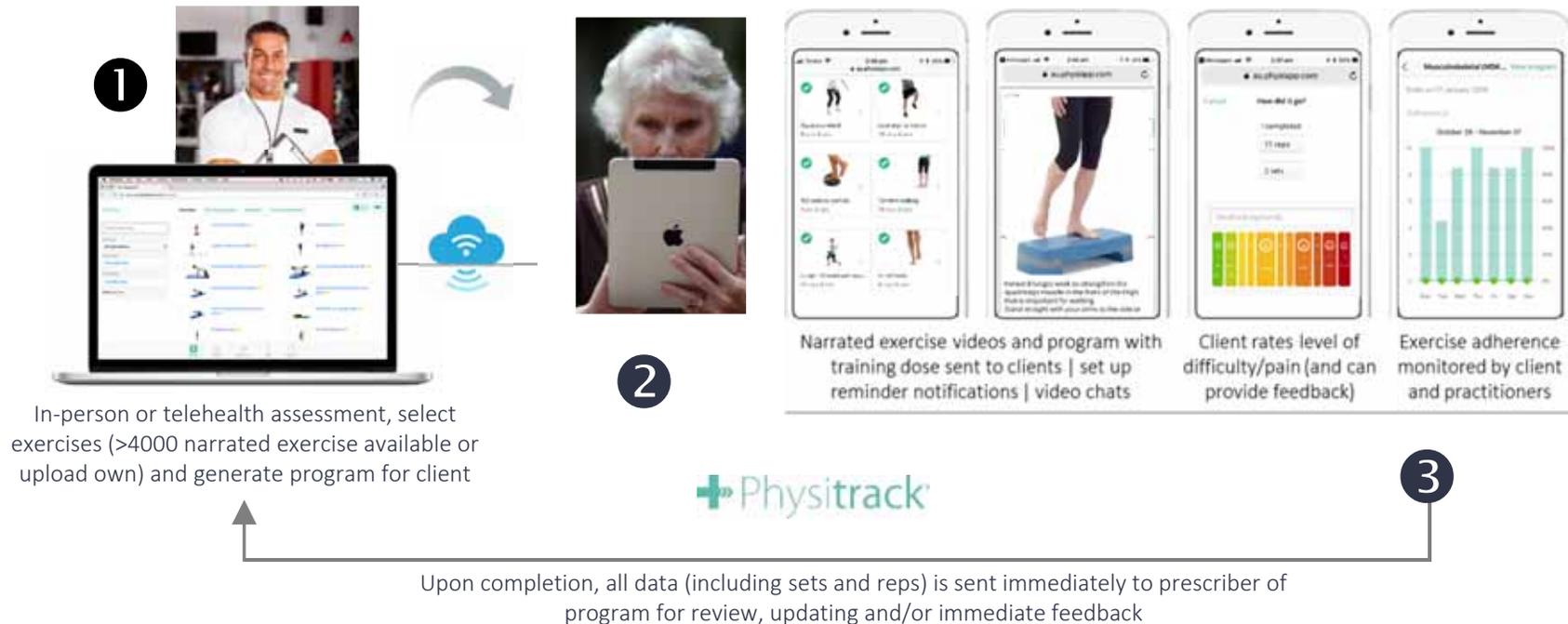
Phase 1: 6 months supervised training (45-60 min, 2/week); Phase 2: step-down maintenance program

What's New

iPrescribe Exercise @ Home

Remote Evidence-based Exercise Prescription and Monitoring for Chronic Disease Management

Combined with in-person visits and 'booster' sessions | video chats / real-time feedback



Bed Rest and Hospitalization

Muscle Loss

Healthy Young
28 days of bedrest



Leg lean mass
▼ ~0.5 kg

Paddon-Jones D et al JCEM
89:4351-58, 2004

Healthy Old
10 days of bedrest



Leg lean mass
▼ ~1.0 kg

Kortebein et al. JAMA
297:1772-4, 2007

Elderly Inpatient
3 days of hospitalization



Leg lean mass
▼ ~1.0 kg

Deutz et al. Clin Nutr
32:704-12, 2013

Healthy Young/Elderly
2-week step reduction

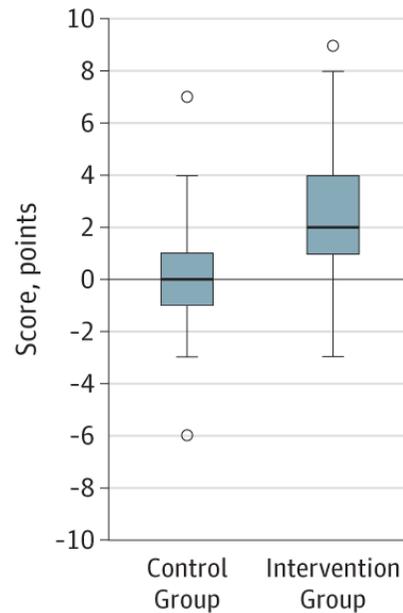


Leg lean mass
▼ ~0.5 kg

Krogh-Madsen R et al J Appl Physiol
108:1034-40, 2009; Breen L et al JCEM
98:2604-12, 2013

Exercise During Acute Hospitalization

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



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

Martinez-Velilla et al. JAMA Int Med 2018



New Approach

Breaking Up Sitting Time

Community-dwelling

(N=123, men and women aged 60+ y (mean 71 y))

- Sitting = 9.7 hrs/d
- Stepping = 1.8 hrs/d
- Sit-to-stands = 48 per/d

Reid et al. Osteoporosis Int 2018 Feb 26



Residential Aged Care

(N=31, mean age 84 years; no cognitive impairment)

- Sitting / lying = 12.4 hrs/d
- Standing = 1.9 hrs/d
- Stepping = 21 min/d

Reid et al. Int J Environ Res Public Health v.10(12); 2013 Dec



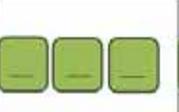
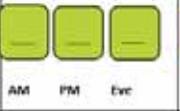
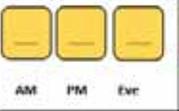
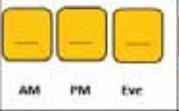
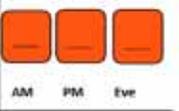
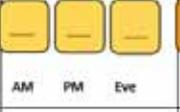
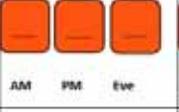
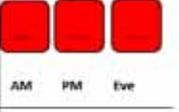
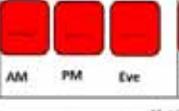
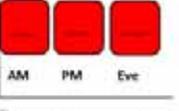
For each 1 hr more sitting time, the risk of falls was increased by 33%, independent of physical activity and other lifestyle factors (OR=1.33, 95% CI=1.04-1.67).

Reid et al. Osteoporosis Int 2018 Feb 26

Movement and Mobility Plan

Patient and Family Mobility Goal: _____

Let's Get Moving Patient Name _____

 <p>Phase 4</p> <ul style="list-style-type: none"> • Walk in Hall 	 Distance: _____	 Distance: _____	 Distance: _____	 Distance: _____
 <p>Phase 3</p> <ul style="list-style-type: none"> • Up in chair with min assist • Stand • Up to sink for self-care • Shower in chair 	 AM PM Eve	 AM PM Eve	 AM PM Eve	 AM PM Eve
 <p>Phase 2</p> <ul style="list-style-type: none"> • Dangle • Up in chair with max assist • In bed strengthening • Participate in self-care 	 AM PM Eve	 AM PM Eve	 AM PM Eve	 AM PM Eve
 <p>Phase 1</p> <ul style="list-style-type: none"> • Range of motion exercises • Chair-position in bed 	 AM PM Eve	 AM PM Eve	 AM PM Eve	 AM PM Eve

Initial in box completed by person assisting with activity

Patient's Mobility Goal for the Following Day: _____

DATE: / Mobility Goal:  DATE: / Mobility Goal:  DATE: / Mobility Goal:  DATE: /

Patients' Bedside

A patient-friendly tool (colourful wall chart) posted at patients' bedside to encourage progressive mobility by showing with simple graphics a standard sequence of increasing activities and engaging patients in tracking their own progress

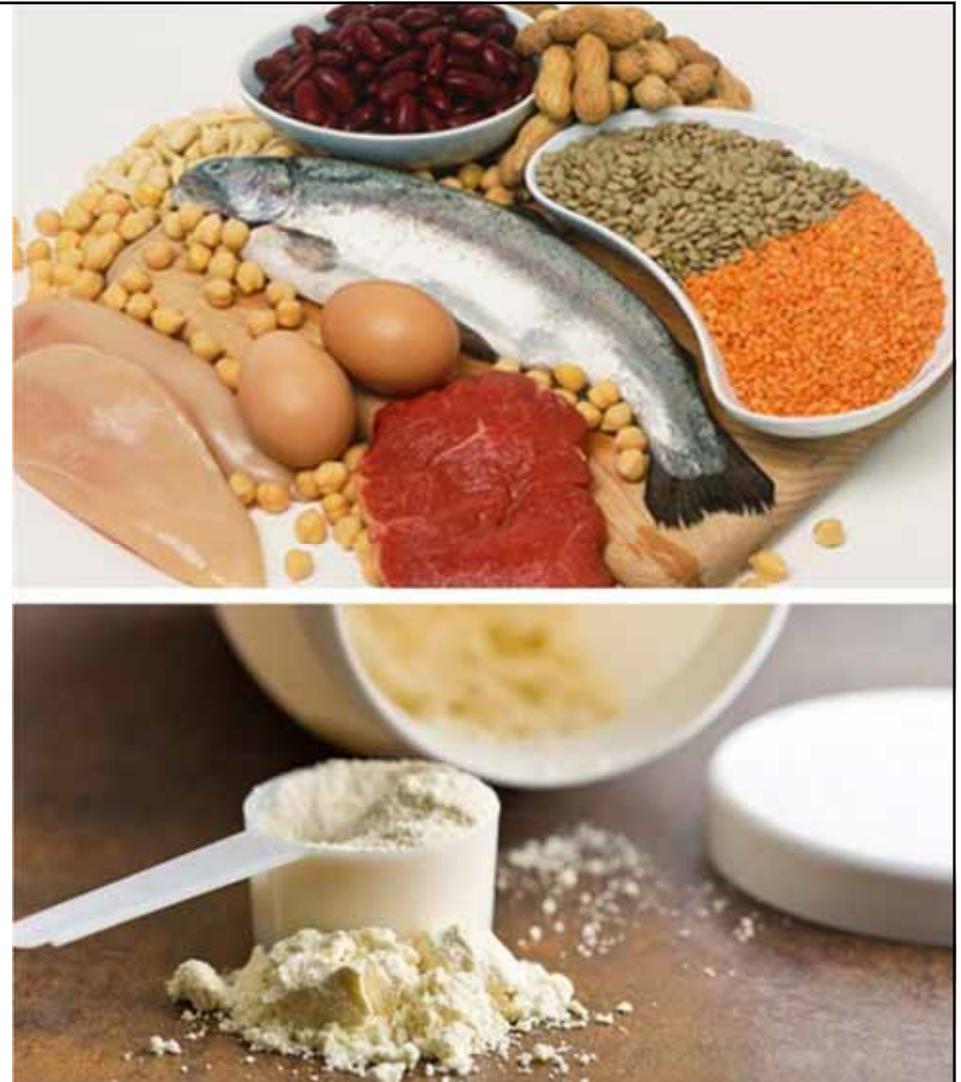
<https://hbr.org/resources/pdfs/leading-health-care-innovation/Mobility%20Chart%20with%20Steps%20and%20Time.pdf>

Nutritional

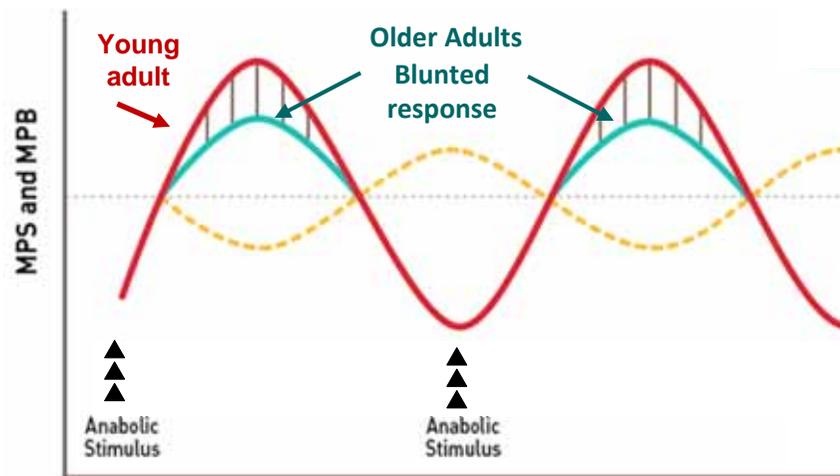
Approaches to Prevent Sarcopenia

- Protein – EAA / Leucine / HMB
- Milk / dairy products
- Vitamin D
- Omega-3 fatty acids
- Creatine
- Antioxidant supplements
- Multi-nutrient blends | ONS
- Whole foods / dietary patterns

HMB, β -hydroxy β -methylbutyrate



Mechanistic Considerations



https://upfitness.com/en/article_posts/health-lifestyle/general-health/fighting-ageing-inflammation-hormones-nutrition

MPS, muscle protein synthesis; MPB, muscle protein breakdown

Evidence linking poor nutrition to muscle wasting and sarcopenia

- **Low food consumption** can lead to insufficient energy intakes (~20% ↓ at age 70) leading to loss of weight/muscle.
- **Protein** provides an anabolic stimulus that has a direct effect on muscle protein synthesis (MPS).
- **Anti-oxidant effects** of some foods and dietary components.
- **Anti-inflammatory effects** of some foods or dietary components.
- Dietary effects on the **gut microbiota?**

Dietary Protein Recommendations

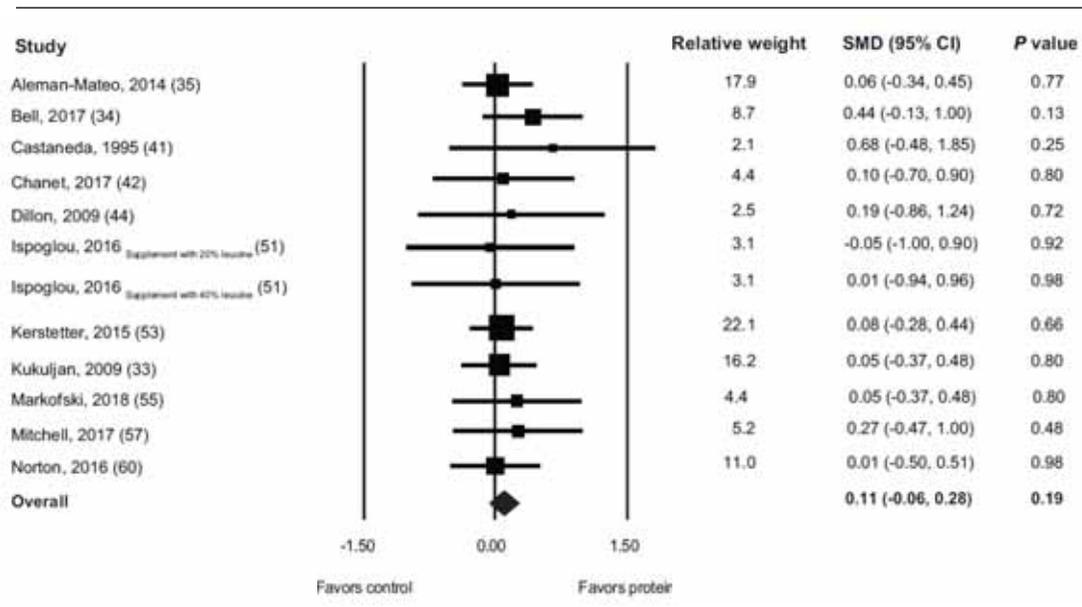
- Healthy older people should consume at least **1.0 to 1.2 g protein kg/d**
- Older people who are malnourished due to acute or chronic illness **1.2 to 1.5 g protein kg/d**
- When undertaking exercise (especially resistance training), higher protein intake (**>1.2g/kg body weight/d**) is advised.
- Per-meal anabolic threshold dietary protein intake is higher in older individuals: **25 -30 g protein per meal.**

Deutz et al. Clin Nutr 2014; Bauer J et al. J Am Med Dir Assoc 2013



Protein Supplementation & Muscle

2018 Systematic review and meta-analysis: non-frail community-dwelling older adults:

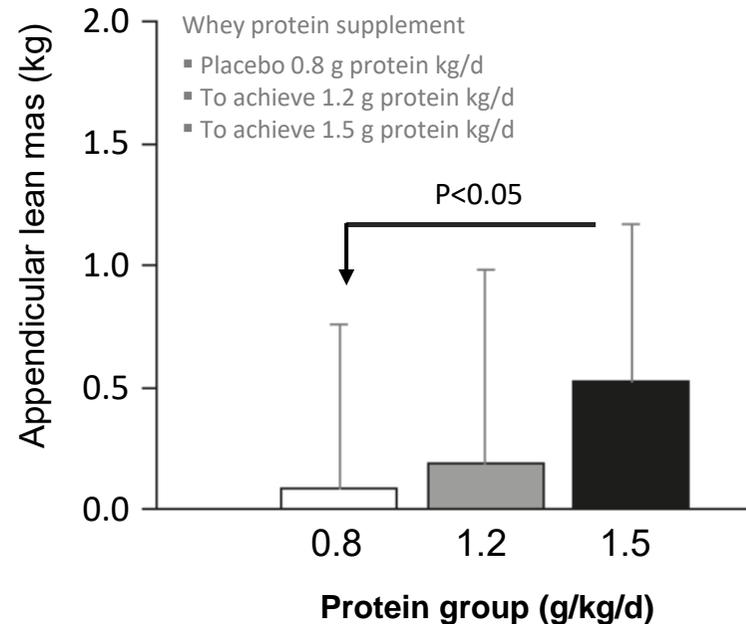


- ✘ Lean mass
- ✘ Handgrip strength
- ✘ Lower leg strength
- ✘ Gait speed
- ✘ Chair rise ability

* Habitual protein intakes of most study participants were already sufficient, and protein interventions differed in terms of type of protein, amount, and timing.

Protein Supplementation & Muscle

12-week, double-blind, RCT in 120 frail/pre-frail elderly at risk of malnutrition



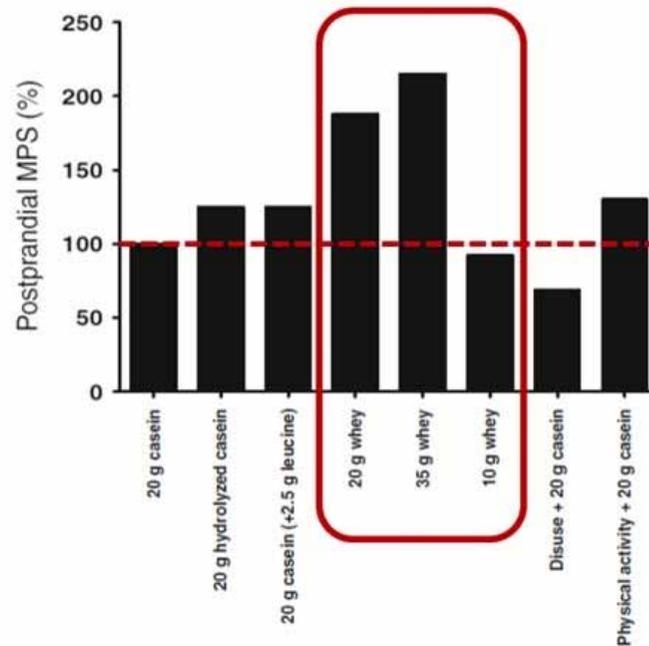
✓ **Gait Speed:** 0.05 m/sec greater in gain in 1.5 g/kg/d after 12 weeks.

✗ **No effect** on any other functional measures.

Mean baseline protein intake ~0.8 g/kg/d

Not All Proteins Sources Are Equal

What is Optimal for Muscle Anabolism in Older Adults?



- **Amount (dose) of protein**

Older adults require 25 to 40 g per meal

- **EAA leucine critical (+ dose)**

Dose ~3-4g needed to trigger MPS (not alone)

- **Timing of intake**

Post-exercise (even prior to sleep/bed)

- **Pattern (distribution) of intake**

Even distribution throughout day

- **Interaction with other nutrients**

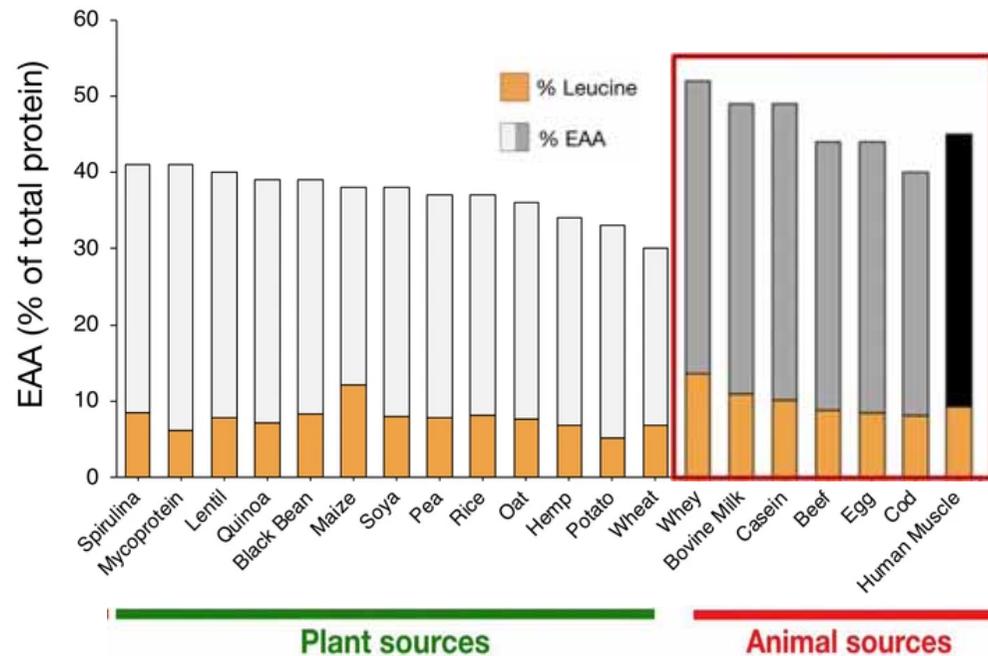
Vitamin D, creatine, omega-3 etc.. (*less clear*)

- **Interaction with exercise**

Synergistic or additive benefits with exercise?

Animal vs Plant-based Protein

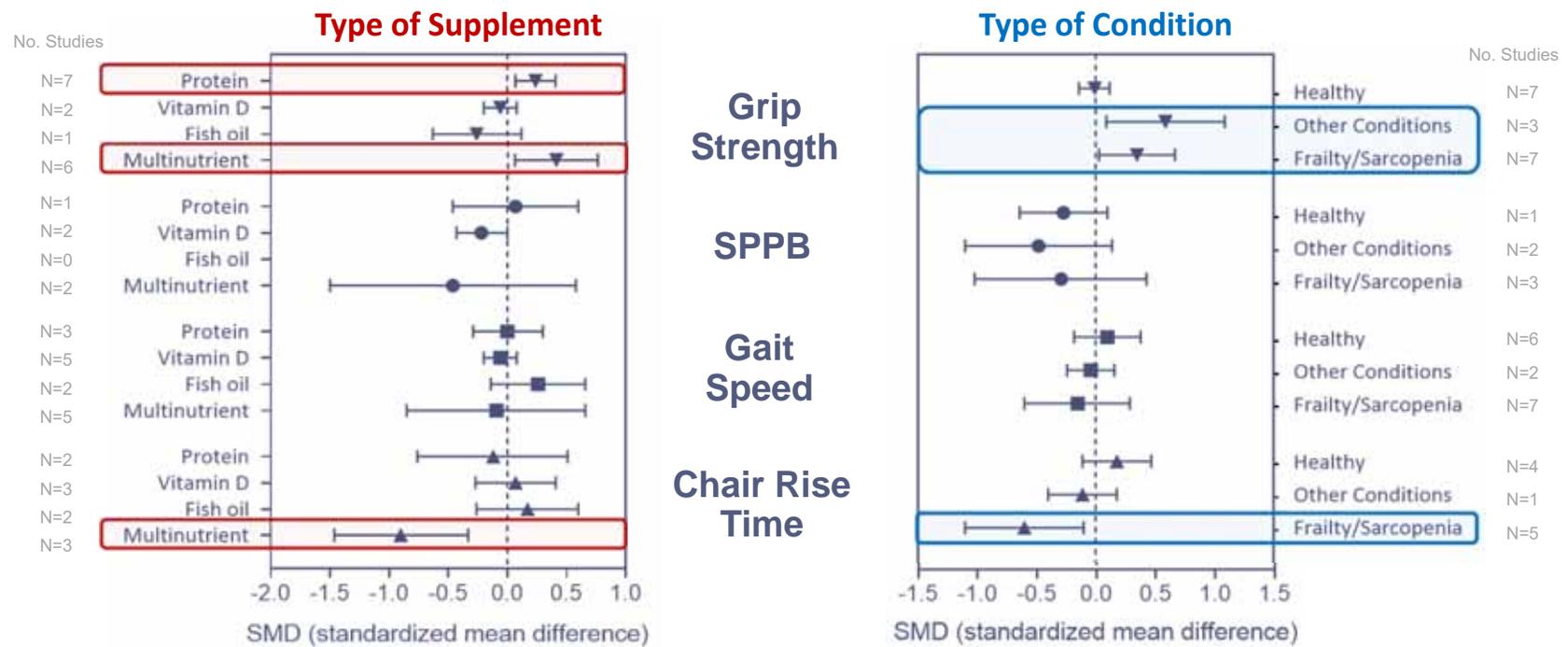
Protein Effectiveness: dependent on digestibility and EAA (leucine) composition



- **Essential amino acid (EAA)** composition of a protein is predictive of its ability to stimulate muscle anabolism.
- **Leucine** content (dose) also an important predictor of MPS response.
- Plant-based **protein blends** – limited and mixed findings.

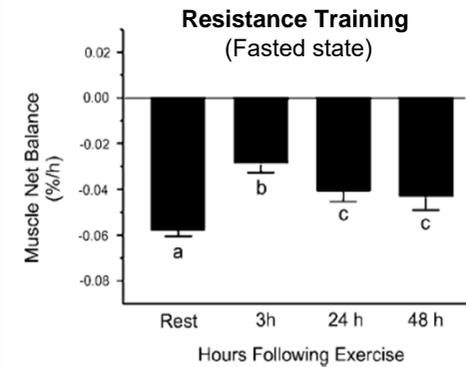
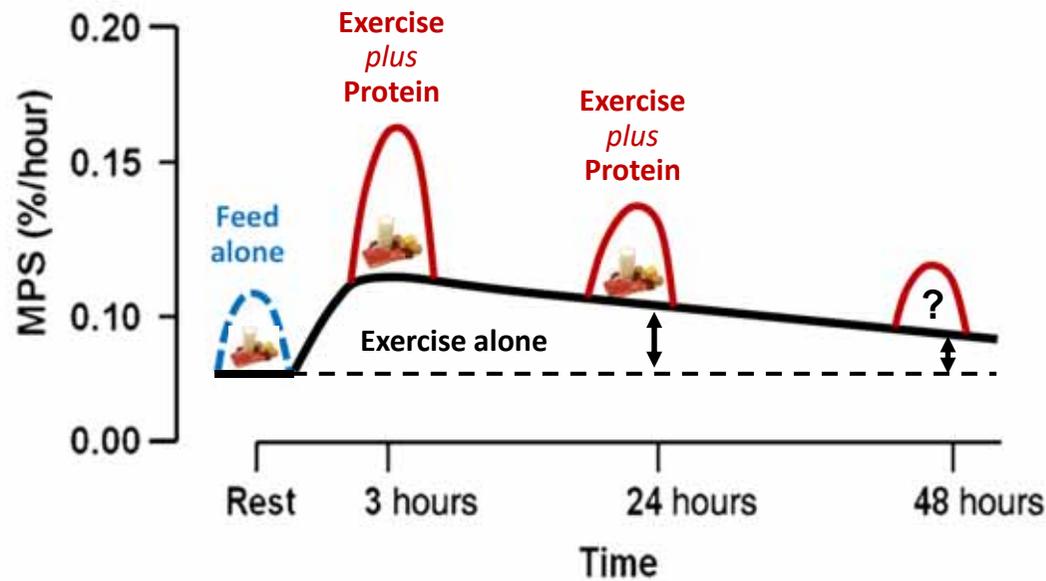
Nutrition and Physical Function

Systematic Review and Meta-analysis in Older People (32 RCTs)



Protein and Exercise Interaction

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



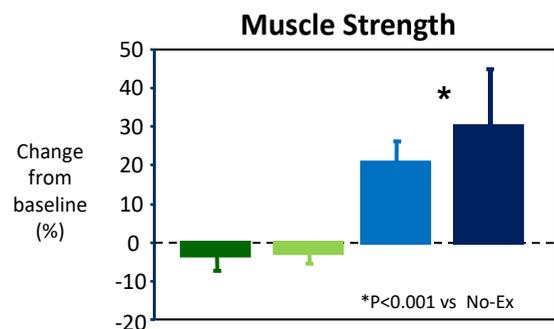
In a fasted state, negative net muscle balance following exercise

Exercise + Nutrition Interactions

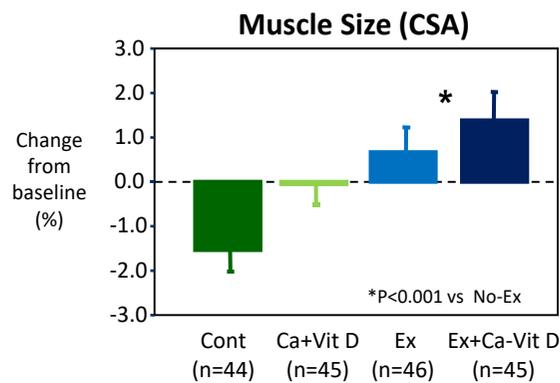
Proportion of RCTs that Reported a Significant **Additive Effect** of Exercise + Nutrition

Exercise	Type Supplement	Muscle Mass	Muscle Strength	Muscle Function
	1. Protein	3/12 (25%)	3/12 (25%)	0/9 (0%)
	2. Essential Amino Acids	0/3 (0%)	0/3 (0%)	0/2 (0%)
	3. HMB (β-Hydroxy β-Methylbutyrate)	1/3 (33%)	0/3 (0%)	0/2 (0%)
	4. Multi-nutrient	0/4 (0%)	1/5 (20%)	0/4 (0%)
	5. Creatine	4/5 (80%)	4/5 (80%)	1/4 (25%)
	6. Vitamin D	0/1 (0%)	0/2 (0%)	1/2 (50%)
	7. Other	0/6 (0%)	0/5 (0%)	2/5 (50%)
Summary	8 / 34 (23%)	8 / 35 (23%)	4 / 28 (14%)	

Multi-modal Exercise Program



Positive effect of exercise on muscle strength



Positive effect of exercise mid femur muscle CSA

Data represents mean changes (SE)

GENTS Osteoporosis Prevention Study 18-month RCT men aged 50+ years



Exercise Intervention

High intensity PRT + weight-bearing impact exercise (1.5-9.7 BW), 3/week (compliance 63%)



Calcium-vitamin D₃ Milk

2 x 200 ml tetra packs per day; 1000 mg/d of calcium and 800 IU/d vitamin D

Kukuljan et al. J Appl Physiol 107:1864-73, 2009

Exercise ± Multi-Nutrient Dairy Drink

Sedentary women 45-65 years

4-month, double-blind, placebo-controlled randomized trials in 244 women

Multi-modal training: resistance, mobility, balance and postural training, 3 d/wk (community-based)

Multi-nutrient fortified dairy drink

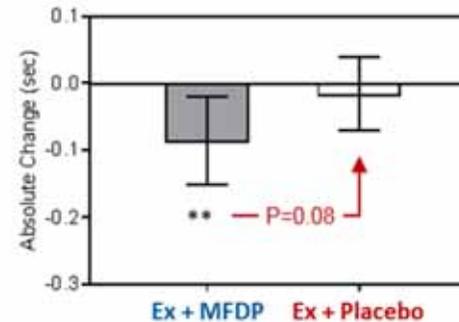
18 g protein, 1200 mg calcium, 600 IU vitamin D, 400 mg phospholipids plus vitamins & minerals (per day)



Energy-matched placebo control

Daly R et al. Am J Clin Nutr 2020

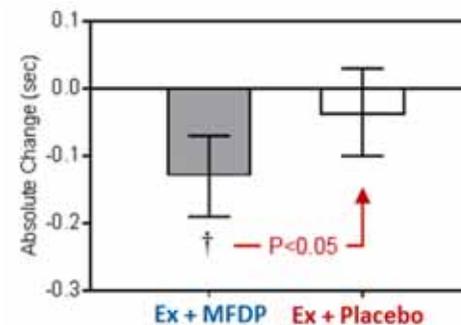
Regular Pace Ascent Time



5-step stair ascent and descent



Regular Pace Descent Time



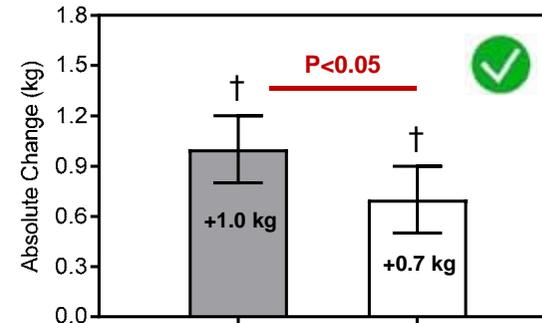
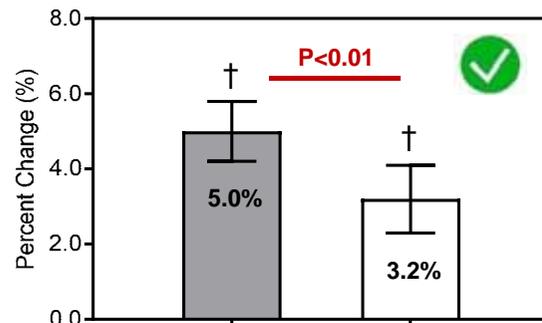
10-step stair ascent and descent



No group differences for fast pace stair ascent and descent

DXA and pQCT Body Composition

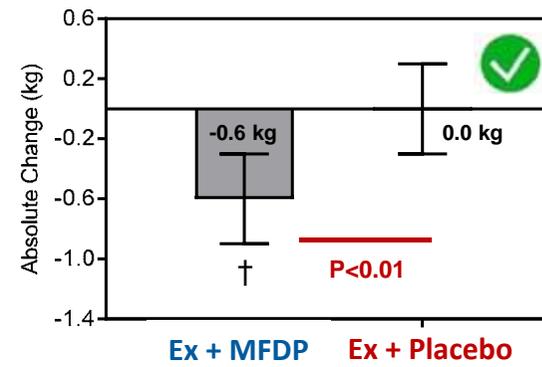
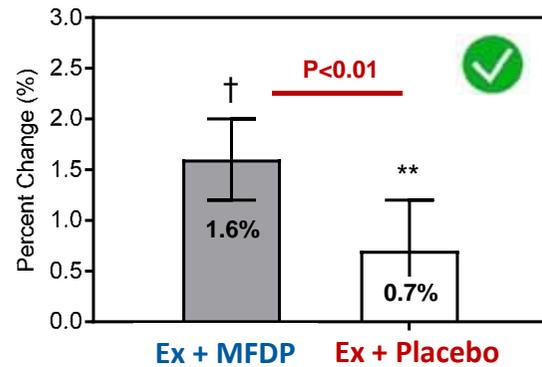
**50% Femur
Muscle CSA**



**Total Body
Lean Mass**

pQCT

**66% Tibia
Muscle CSA**

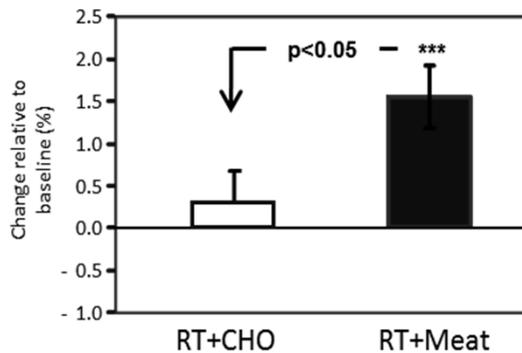


DXA

**Total Body
Fat Mass**

** P<0.01; † P<0.01 within group change relative to baseline; Values are means with 95% CI

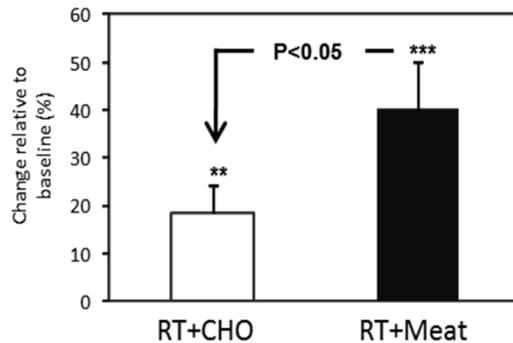
Study 1: Exercise + Lean Red Meat



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

Take Home Message



Muscles create movement – use them!

- Recognize sarcopenia (“muscle failure”) as a disease
- Encourage regular everyday movement and avoid periods of prolonged sitting



Targeted – personalized – multimodal

- No single approach is suitable for all people; regularly re-evaluate
- Progressive and specific; targeted to everyday activities of daily living



Nutritional factors alone will not maintain mobility

- No single nutrient is best; greater emphasis of quality whole foods / meal experience
- There is a role for functional foods / supplements in high risk groups



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