NUTRITIONAL INTERVENTIONS TO IMPROVE MUSCLE STRENGTH AND FUNCTION IN THE ELDERLY

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THE UNIVERSITY OF NEWCASTLE AUSTRALIA

NSW GOVERNMENT Health Hunter New England Local Health District

DECLARATIONS

Speaker Honoraria/ Travel Grants:

Australian Nutrition Trust

National Asthma Council

Thoracic Society of Australia & New Zealand

NSA LLC

DSM Nutritional Products

CGi LLC

Boehringer-Ingelheim

Research grants:

National Health and Medical Research Council

Asthma Australia

NSA LLC

Australian Health & Nutrition Association Ltd

DSM Nutritional Products

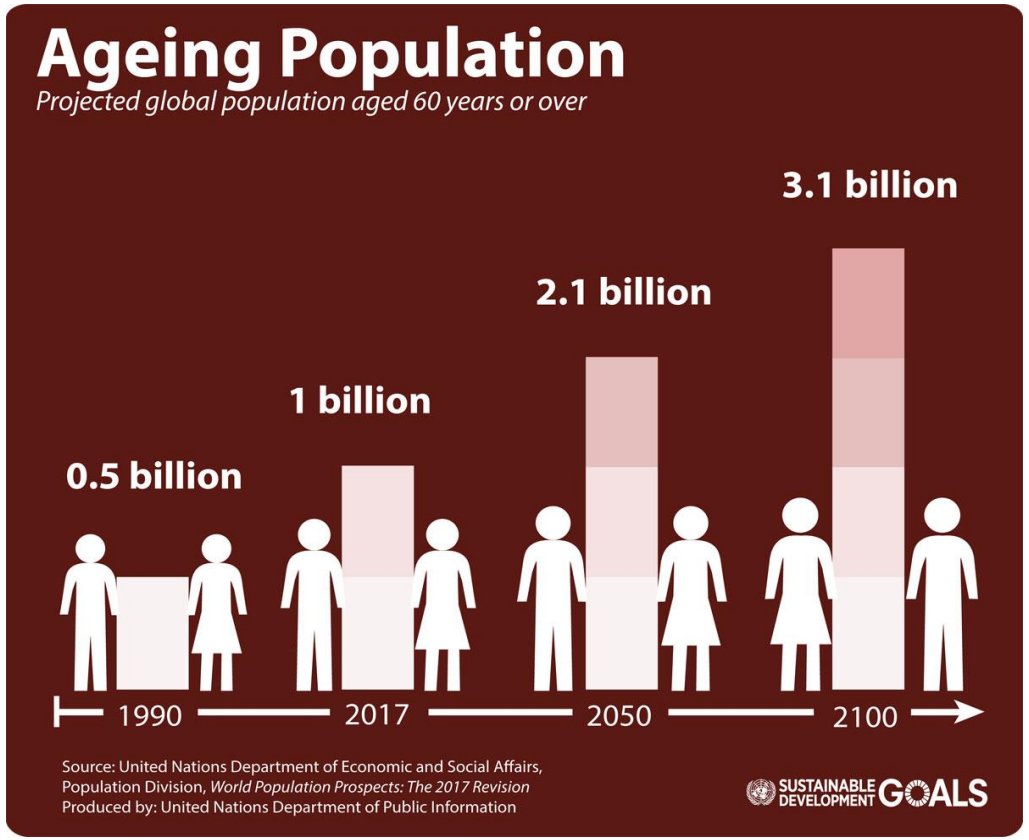
Healthworld

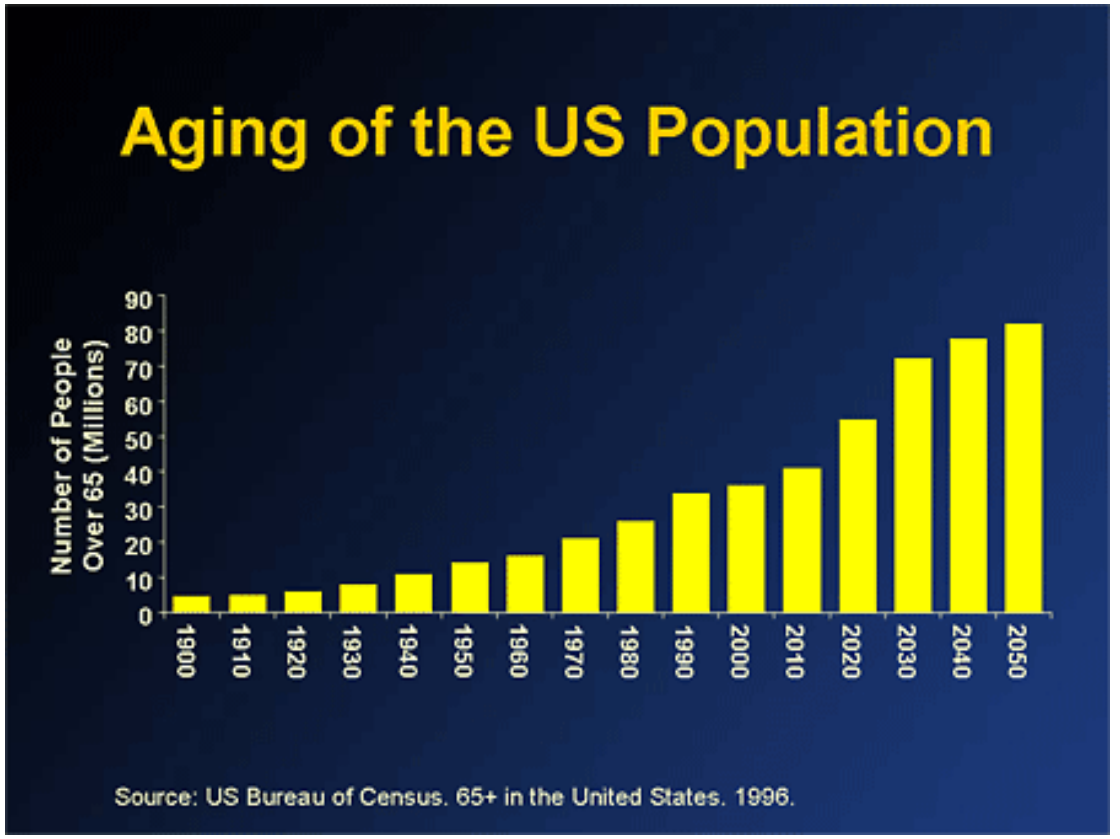
Novartis

OUTLINE

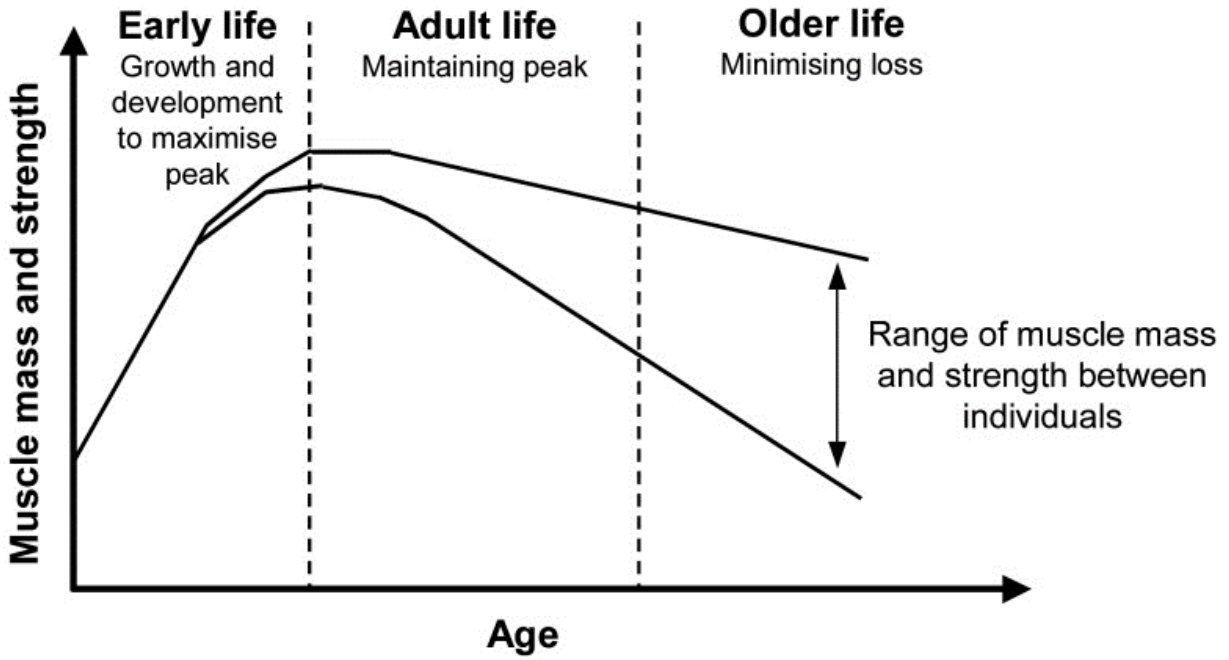
- Aging and body composition
- Sarcopenia: definition, diagnosis, prevalence, consequences, mechanisms
- Nutritional approaches to improving muscle strength and function
  - Protein
  - Protein combined with exercise
  - Other nutritional strategies (vitamin D, antioxidants, omega-3 fatty acids, creatine)
- Recommendations for clinicians

THE AGING POPULATION



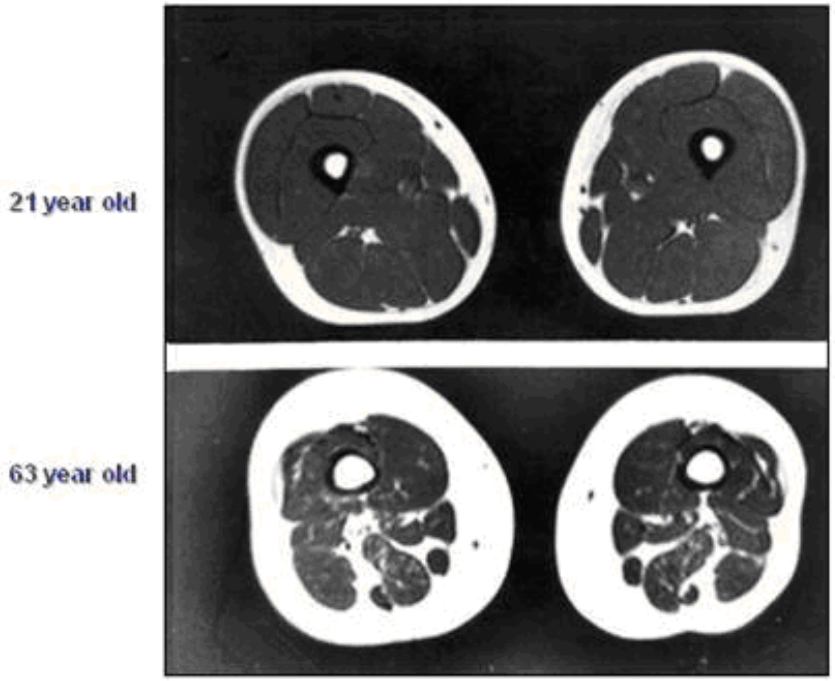


AGING AND BODY COMPOSITION

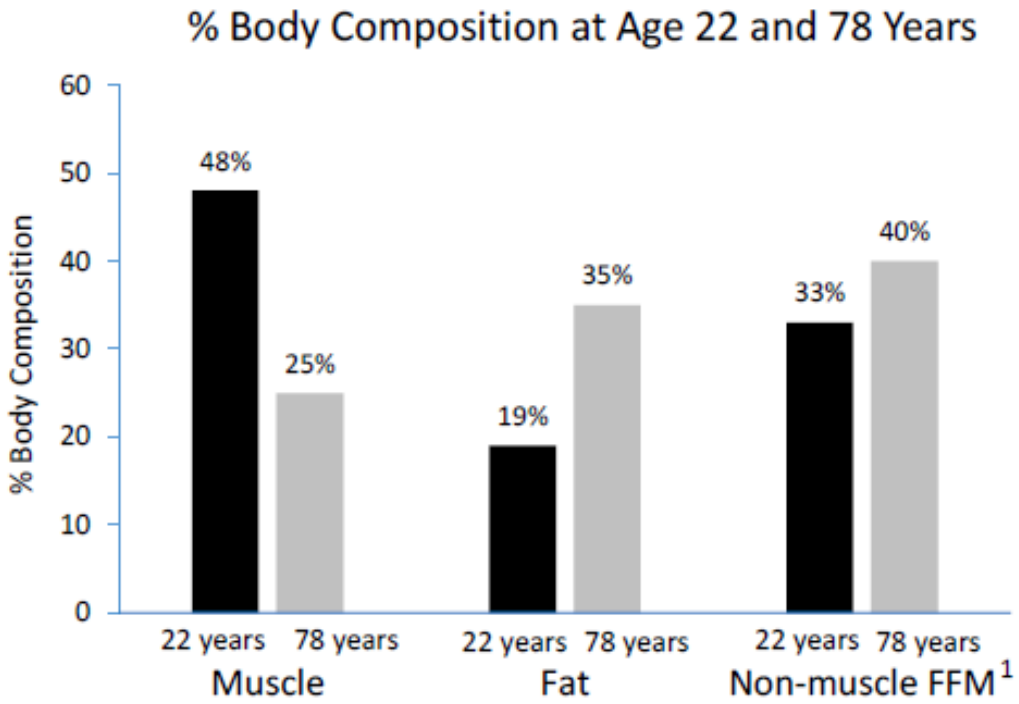


(Sayer, J Nutr Health Aging, 2008)

AGING AND BODY COMPOSITION



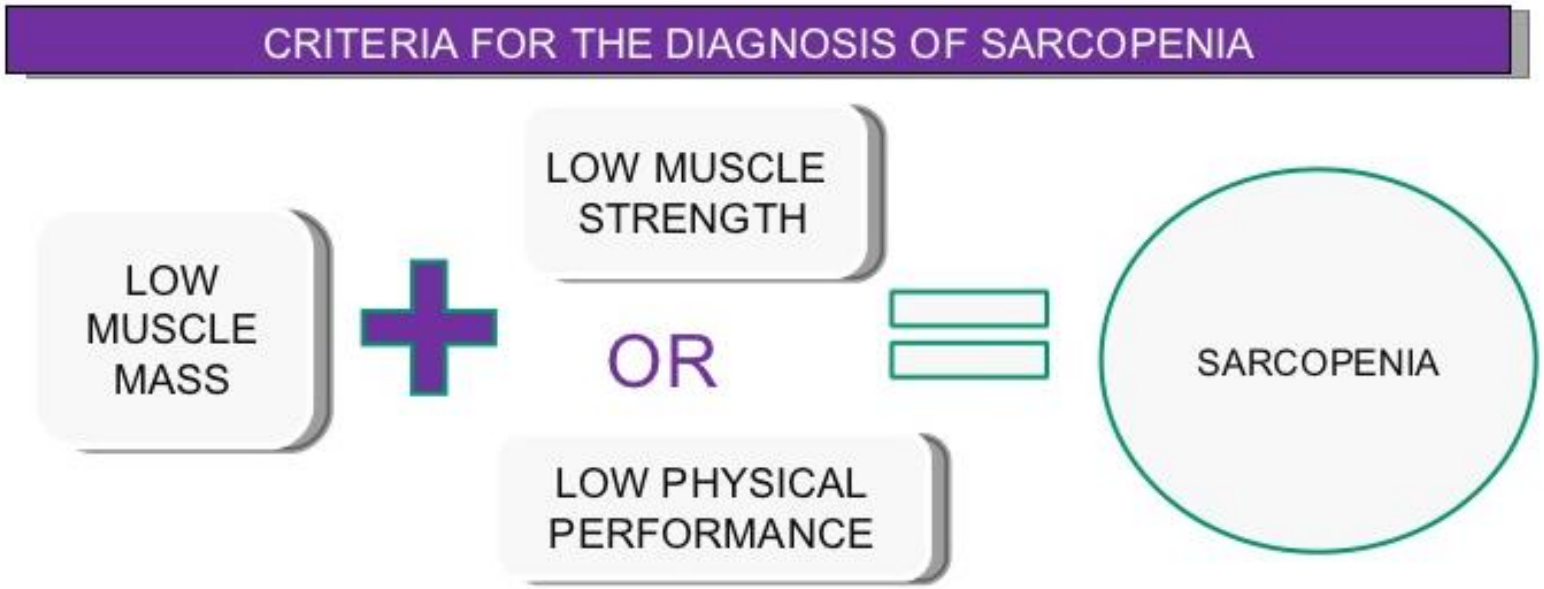
Age-related changes in muscle mass in thigh cross-sectional area of two people with similar BMI



(Roubenoff R, et al. J Gerontol A Biol Sci Med Sci 55: M716-24, 2000; Nowson et al, Nutrients, 2015)

SARCOPENIA: DEFINITION & DIAGNOSIS

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



(Cruz-Jentoft, et al. Report of the EWGSOP: European Working Group on Sarcopenia in Older People, Age & Aging, 2010)

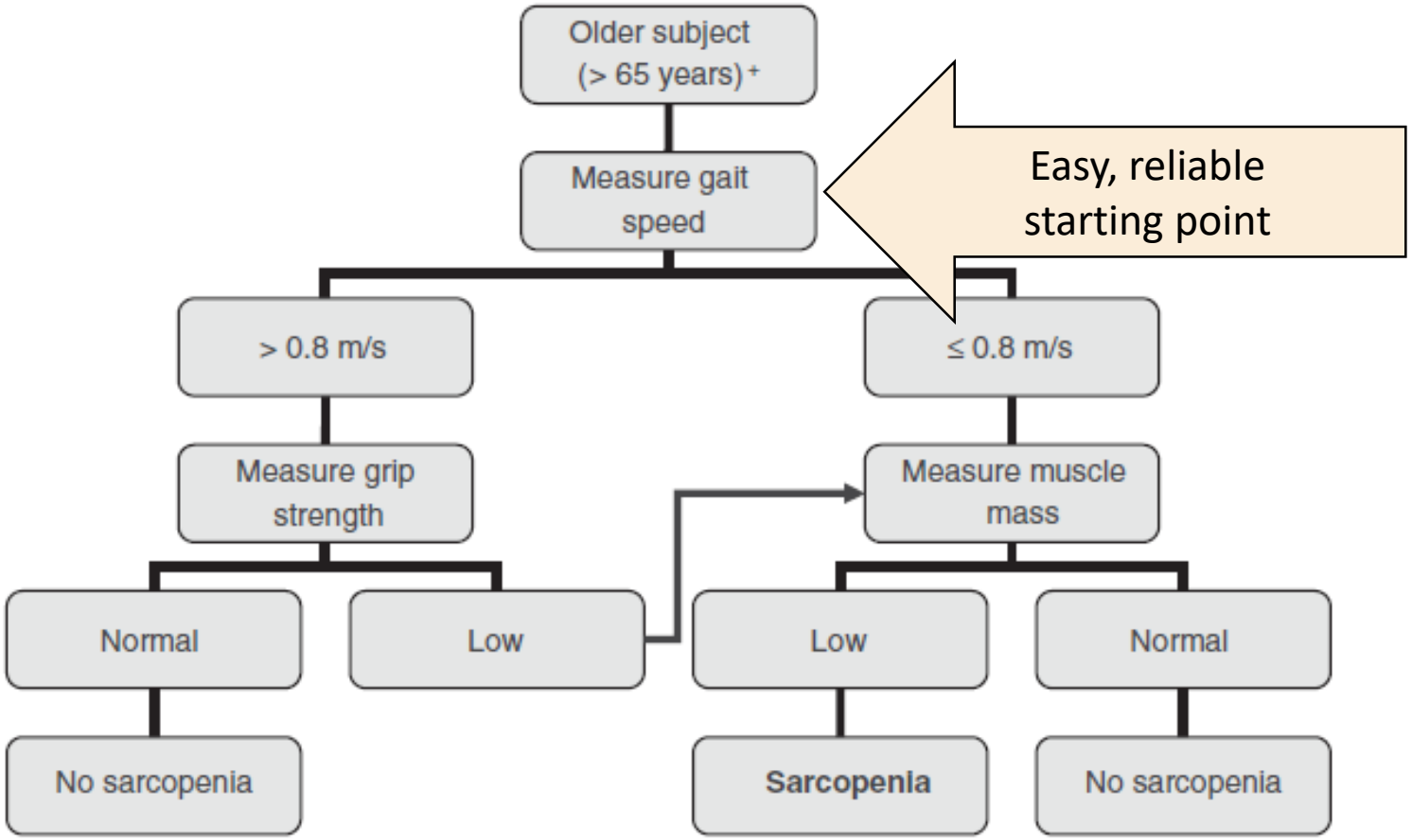
SARCOPENIA: DIAGNOSIS

Sarcopenia staging, which reflects the severity of the condition, is a concept that can help guide clinical management of the condition.

Stage	Muscle mass	Muscle strength	Performance
Presarcopenia	↓		
Sarcopenia	↓	↓	Or ↓
Severe sarcopenia	↓	↓	↓

(Cruz-Jentoft et al, Age & Aging, 2010)

SARCOPENIA: DIAGNOSIS



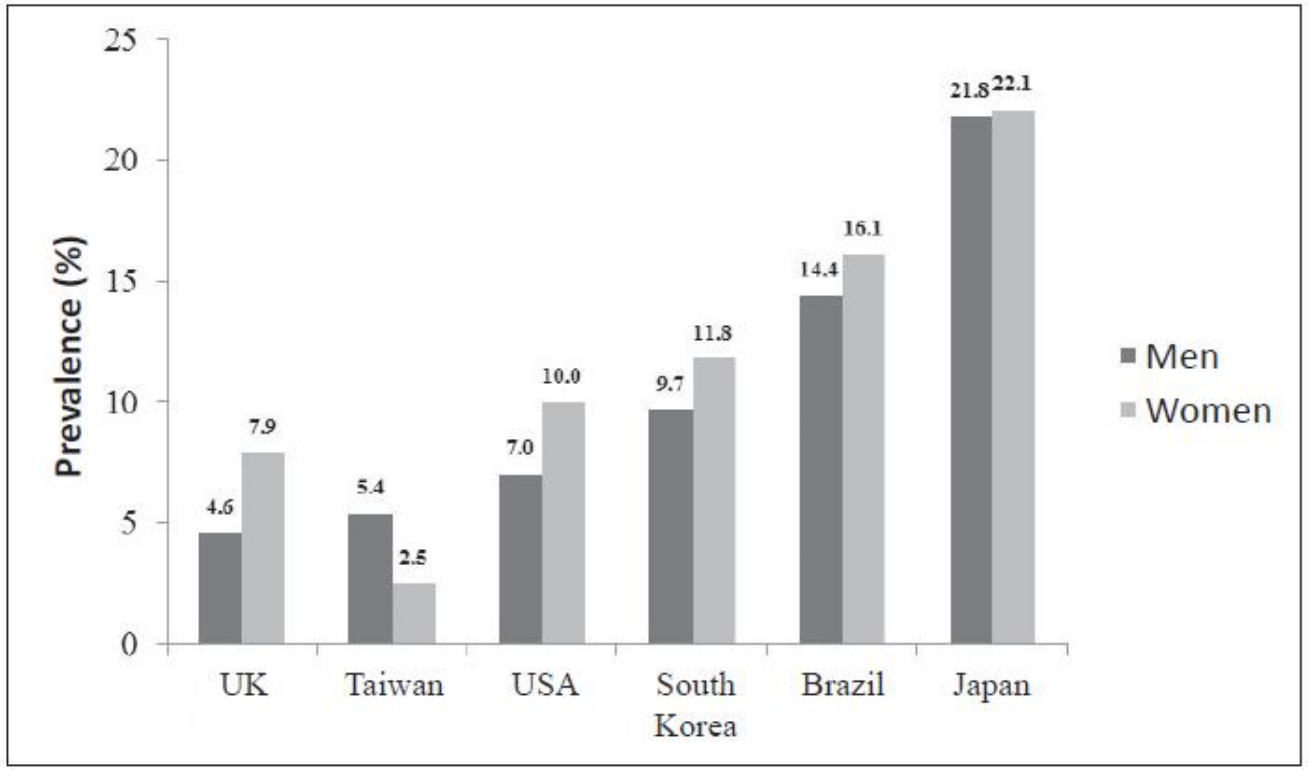
(Cruz-Jentoft, et al. Age & Aging, 2010)

SARCOPENIA: DIAGNOSIS

(Cruz-Jentoft, et al. Age & Aging, 2010)

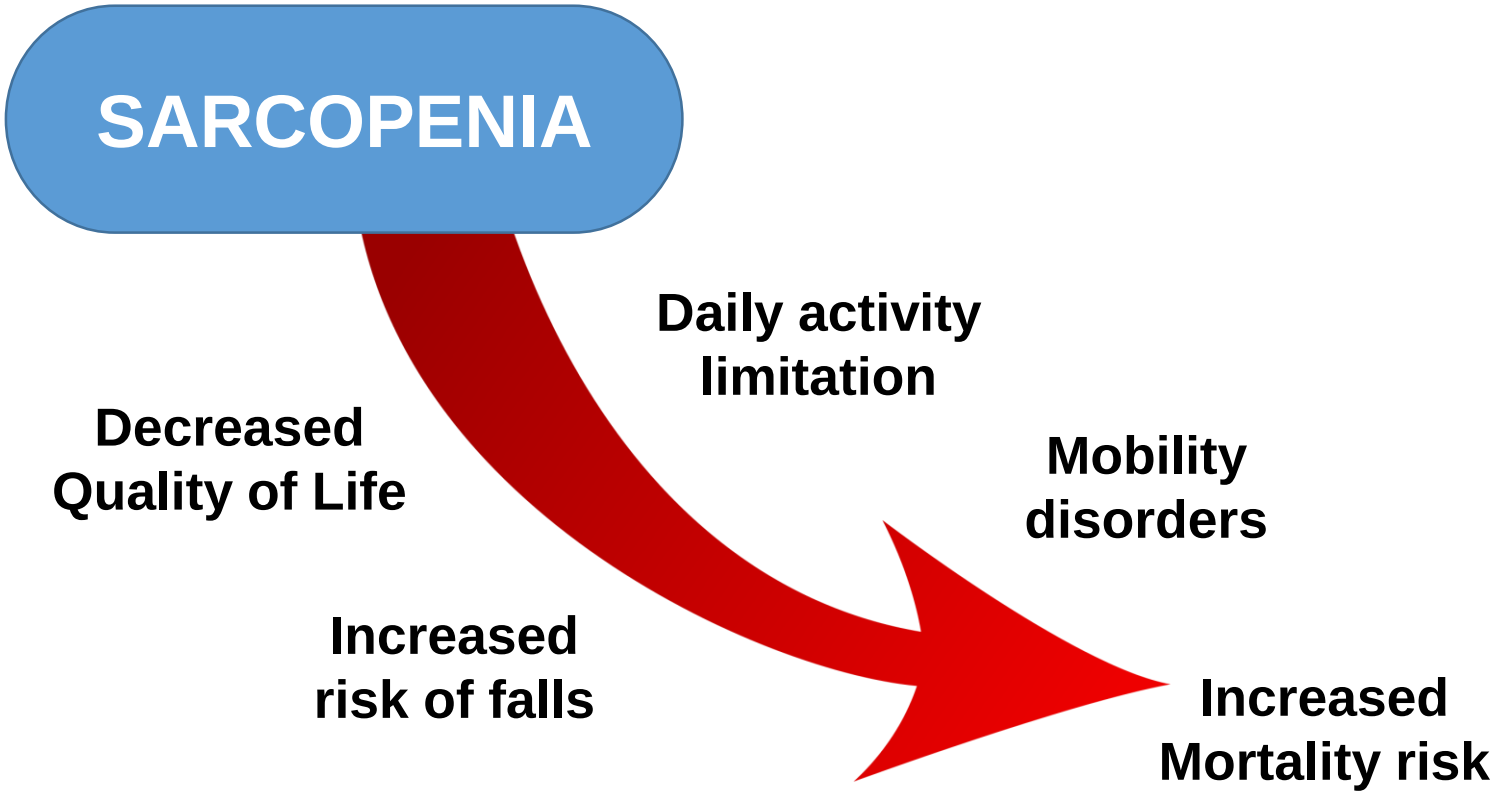
SARCOPENIA: PREVALENCE

(individuals >60 years)



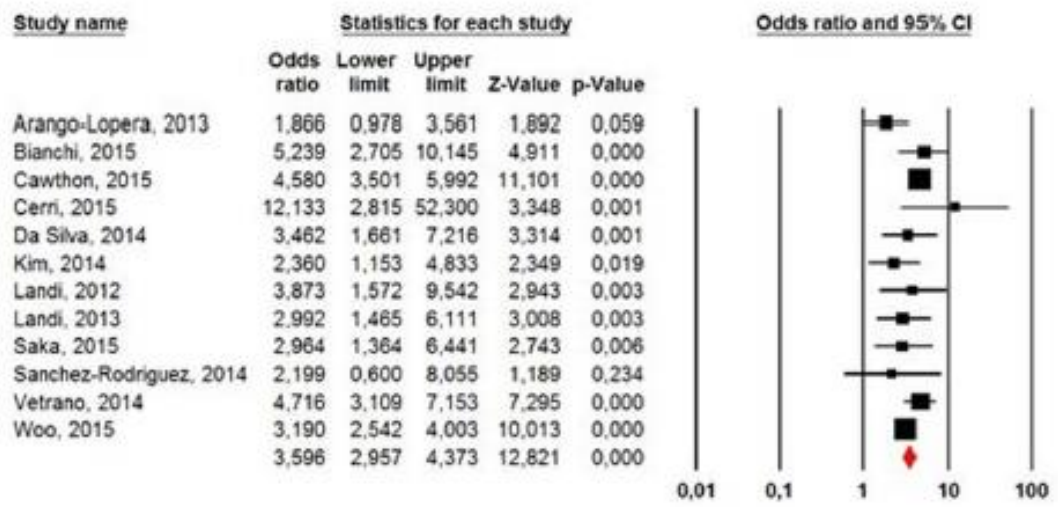
(Diz, Rev Bras Geriatr Gerontol, 2015)

SARCOPENIA: HEALTH CONSEQUENCES

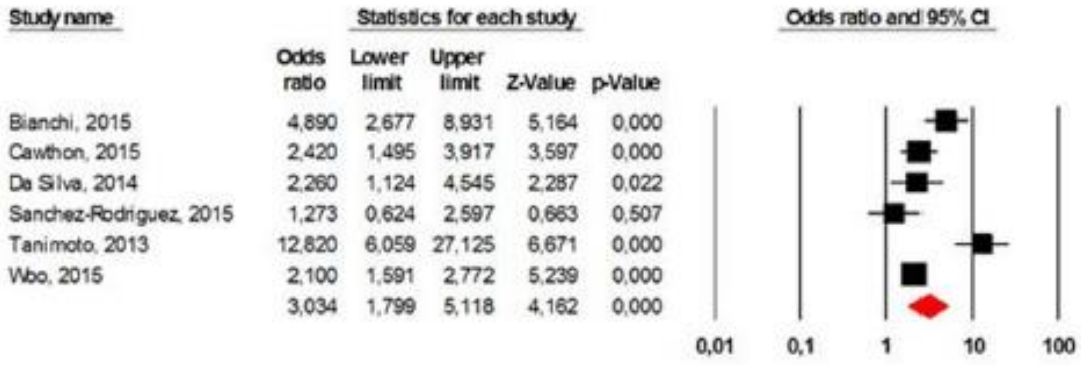


SARCOPENIA: HEALTH CONSEQUENCES

- **Higher Mortality: OR 3.6 (95% CI 2.9-4.4)**



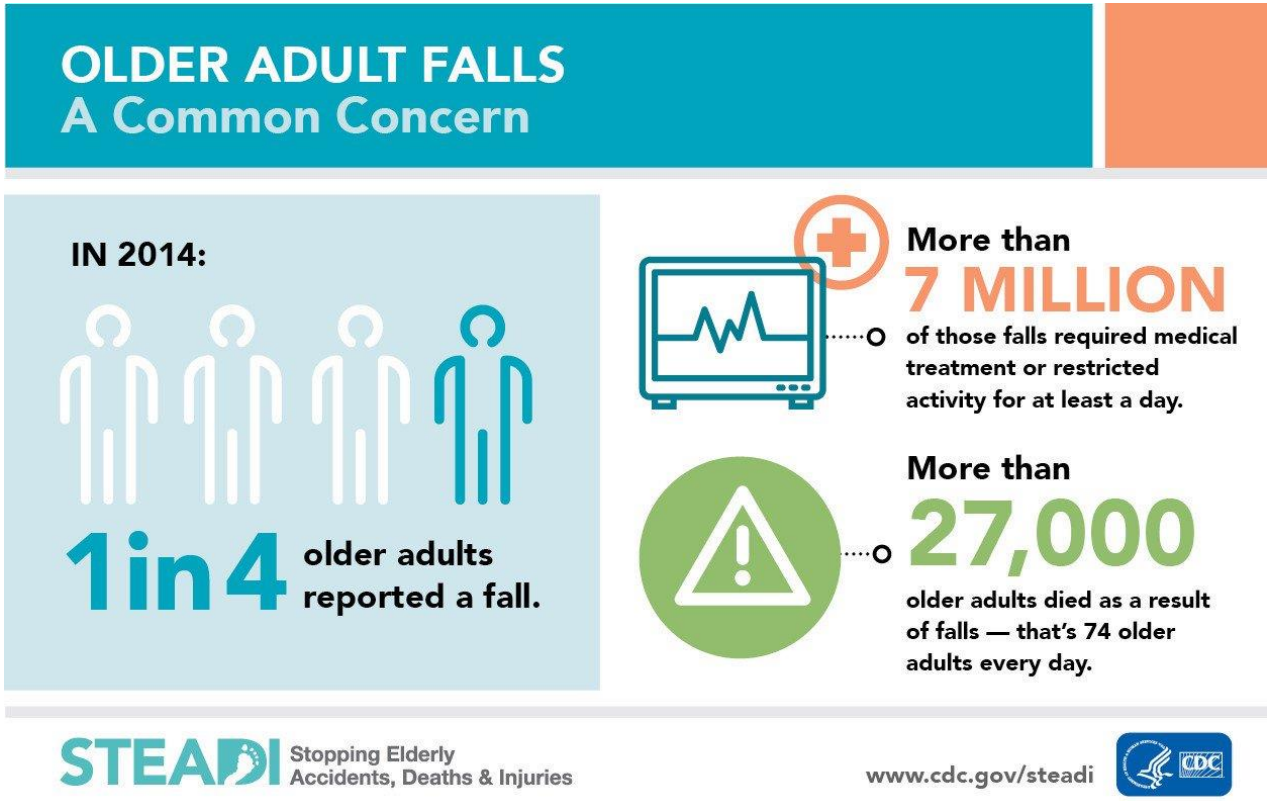
- **Functional decline: OR 3.0 (1.8-5.1)**

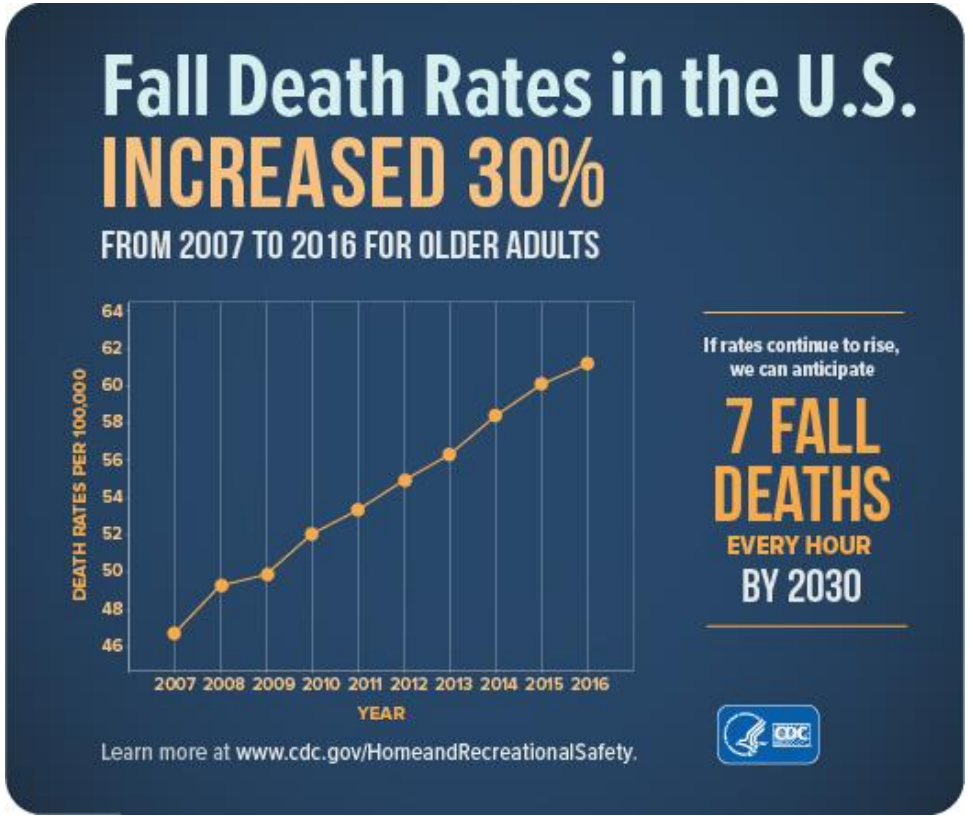


- **Increased Hospitalisations**
- **Increased Falls**

(Beaudart C et al, PLoS ONE, 2017)

SARCOPENIA: HEALTH CONSEQUENCES





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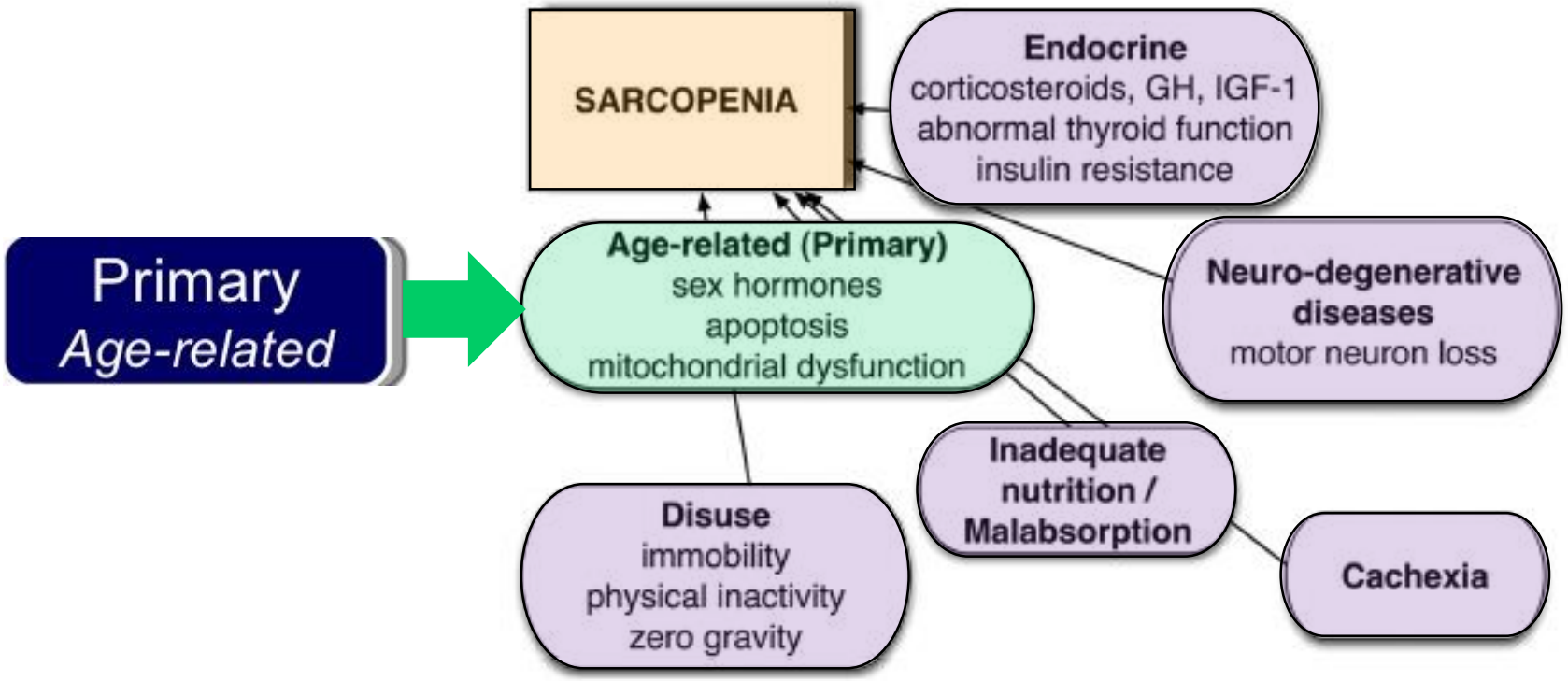
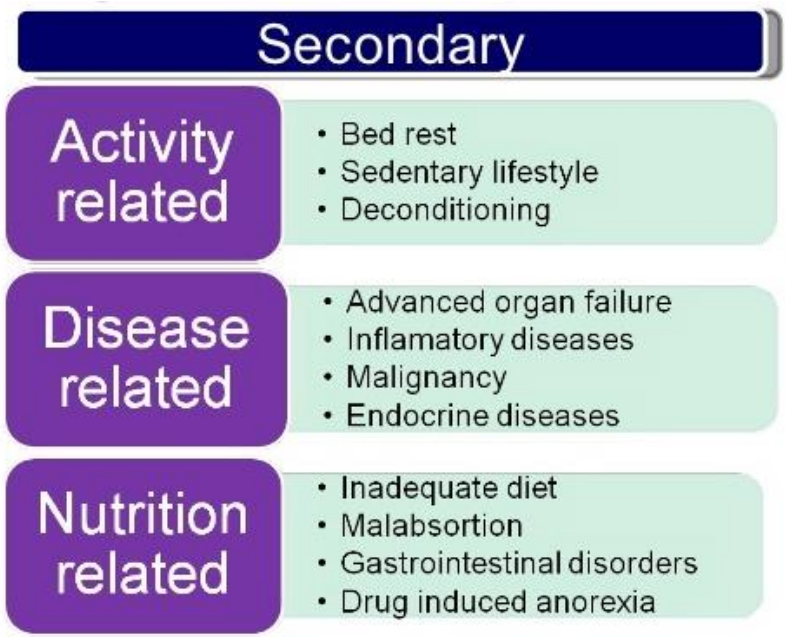
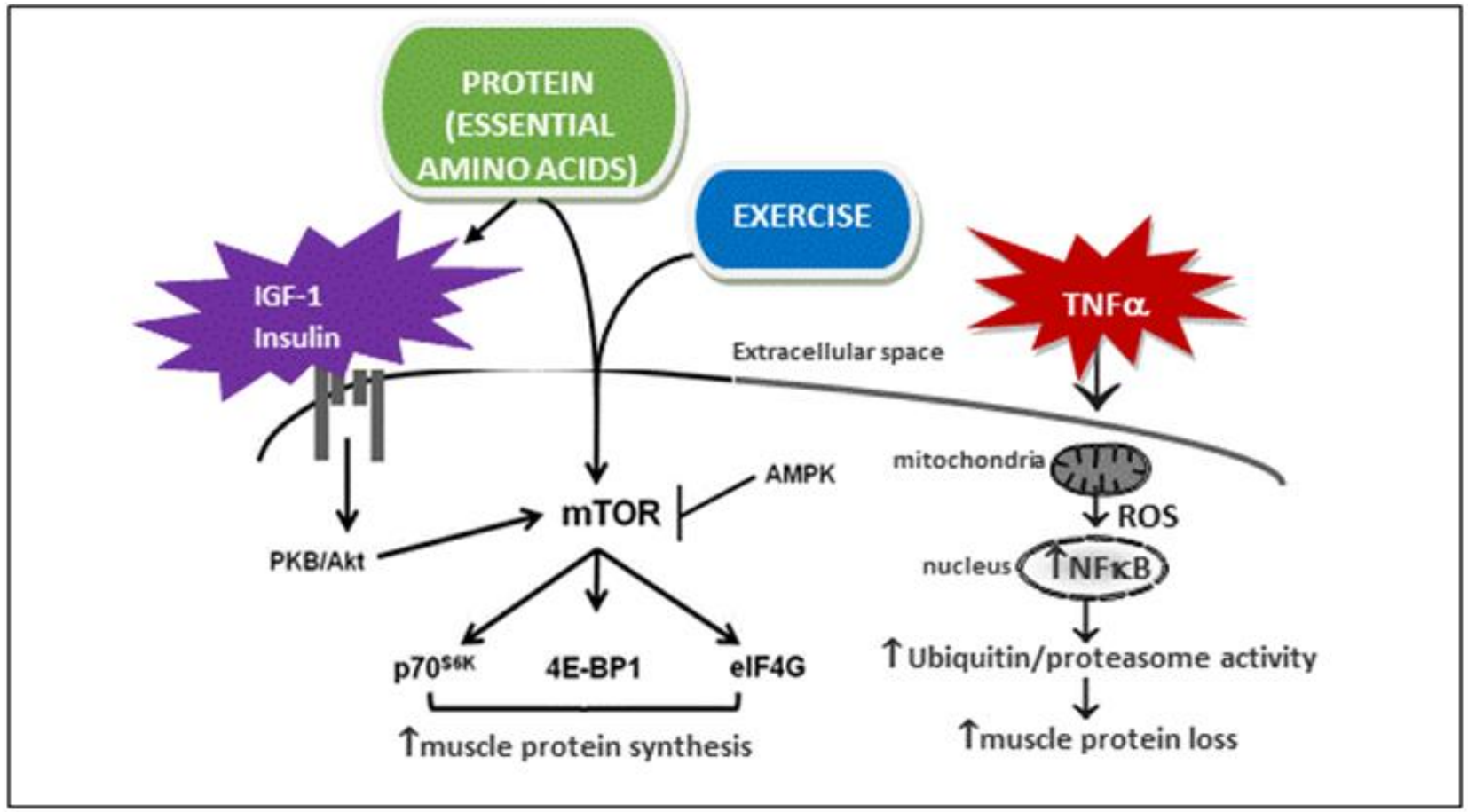
SARCOPENIA: MECHANISMS





(Cruz-Jentoft, et al. Age & Aging, 2010)

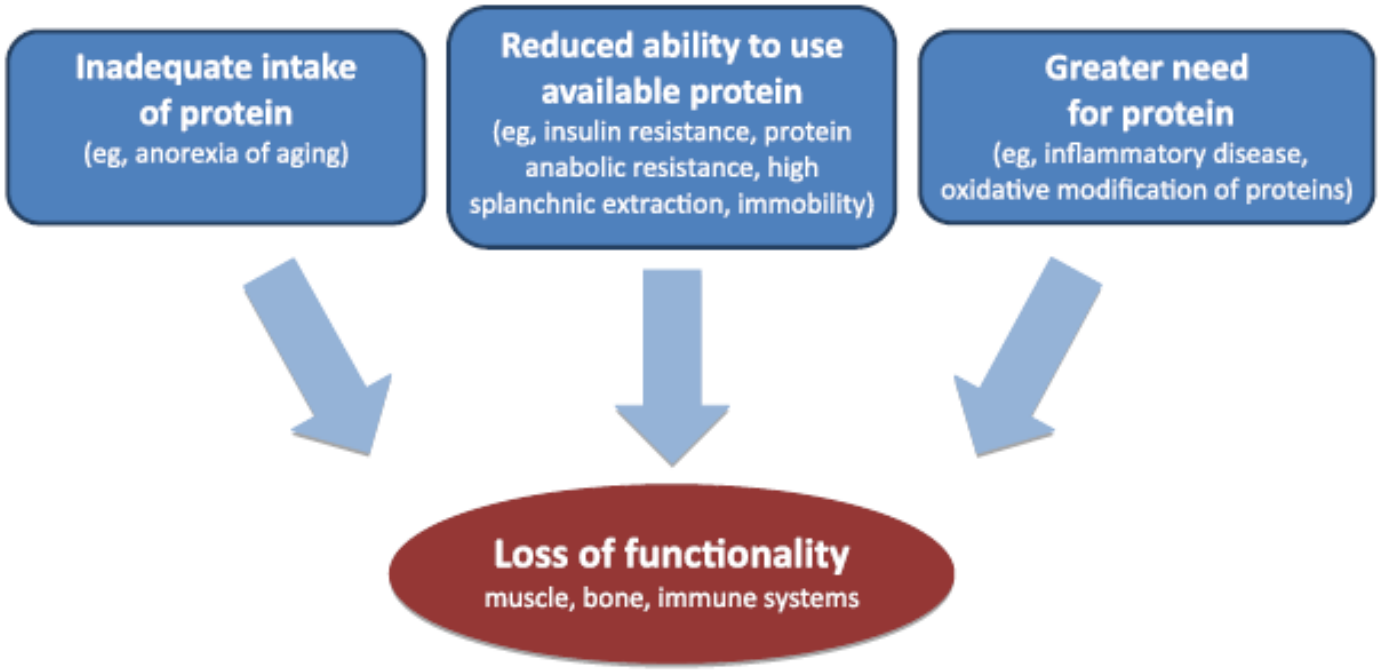
SARCOPENIA: MECHANISMS



NUTRITIONAL APPROACHES

NUTRITIONAL INTERVENTIONS: PROTEIN

Aging-related causes of protein shortfall

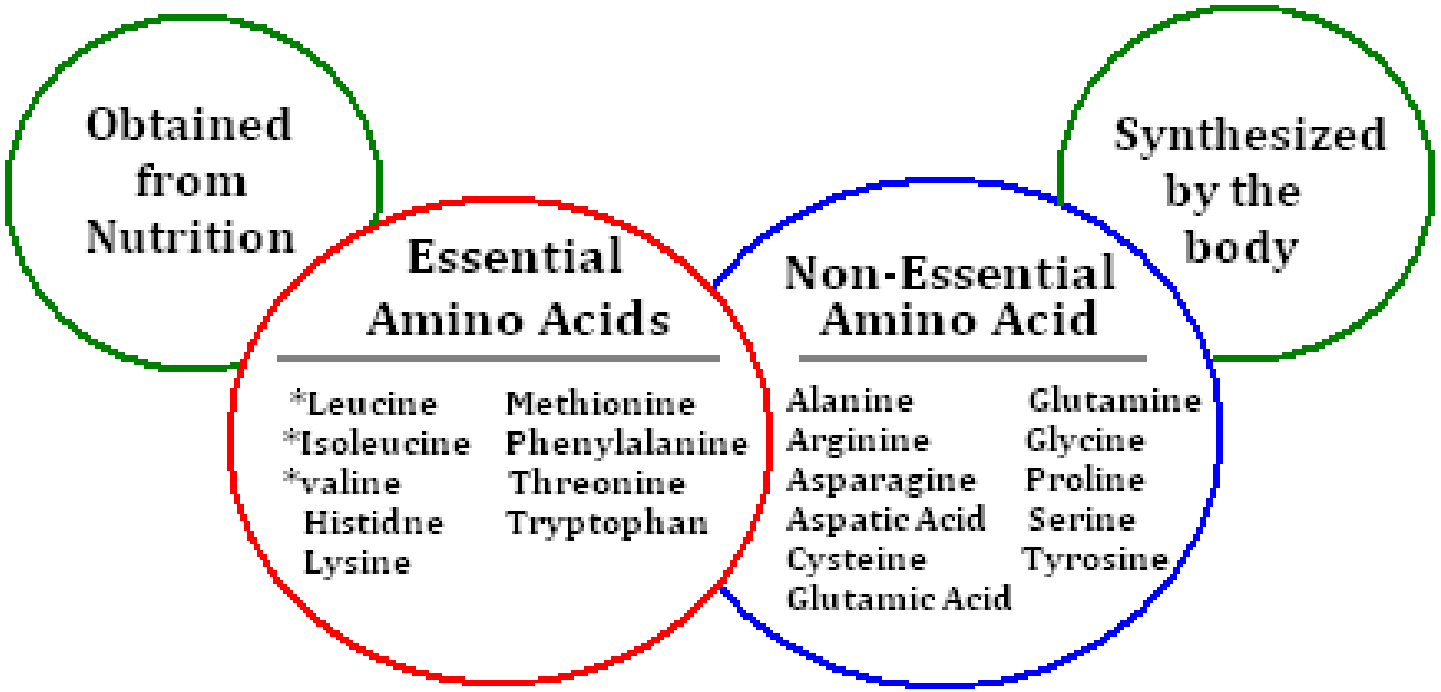


(Bauer et al. Position Paper from the PROT-AGE Study Group, JAMDA, 2013)

NUTRITIONAL INTERVENTIONS: PROTEIN

PROTEIN QUALITY:
is the digestibility and quantity of essential amino acids

*branched chain amino acids



NUTRITIONAL INTERVENTIONS: PROTEIN

PROTEIN QUALITY:

Protein quality scores highest for animal-based proteins and soy.

DIAAS, digestible indispensable amino acid score
PDCAAS, protein digestibility–corrected amino acid score

(Rutherford et al. J Nutr, 2015)

	DIAAS	PDCAAS
Milk Protein Concentrate	1.18	1.00
Whey Protein Isolate	1.09	1.00
Whey Protein Concentrate	0.973	1.00
Soy Protein Isolate	0.898-0.906	0.979-1.00
Cooked peas	0.579	0.597
Cooked beans	0.588	0.648
Cooked rice	0.595	0.616
Cooked rolled oats	0.542	0.670
Wheat bran	0.411	0.525

NUTRITIONAL INTERVENTIONS: PROTEIN

PROTEIN QUALITY:

(Gorissen et al. Proc Nutr Soc, 2017)

Total EAA content higher for animal vs plant proteins; leucine comparable depending on source

%of total protein	Plant sources					Animal sources							
	Wheat	Maize	Rice	Oats	Soyabean	Whey	Milk	Casein	Beef	Pork	Chicken	Egg	Cod
Essential amino acids													
Histidine	2·1	2·8	2·5	2·3	2·6	1·9	2·7	2·7	3·6	2·6	2·9	2·4	2·8
Isoleucine	4·1	3·8	3·8	4·1	4·7	6·4	5·1	5·0	5·0	5·4	5·9	6·2	4·5
Leucine	6·8	12·9	8·2	7·9	8·0	9·9	9·5	8·9	8·5	8·5	8·2	8·7	8·2
Lysine	1·4	2·8	3·8	4·0	6·6	9·2	6·9	7·6	9·3	9·4	8·8	6·9	9·7
Methionine	1·6	2·0	2·3	1·8	1·3	2·0	2·5	2·6	2·8	2·8	2·8	3·3	3·3
Phenylalanine	5·1	5·0	5·2	5·4	5·1	3·8	4·6	4·9	4·6	4·4	4·4	5·6	4·9
Threonine	2·5	3·7	3·9	3·6	4·0	6·7	4·0	4·3	4·8	4·8	4·4	5·0	5·0
Valine	4·2	5·0	5·5	5·5	4·9	6·3	6·2	6·3	5·2	5·9	5·7	6·7	5·1
Total EAA	27·8	38·1	35·2	34·7	37·1	46·2	41·6	42·4	43·7	43·8	43·2	44·8	43·5

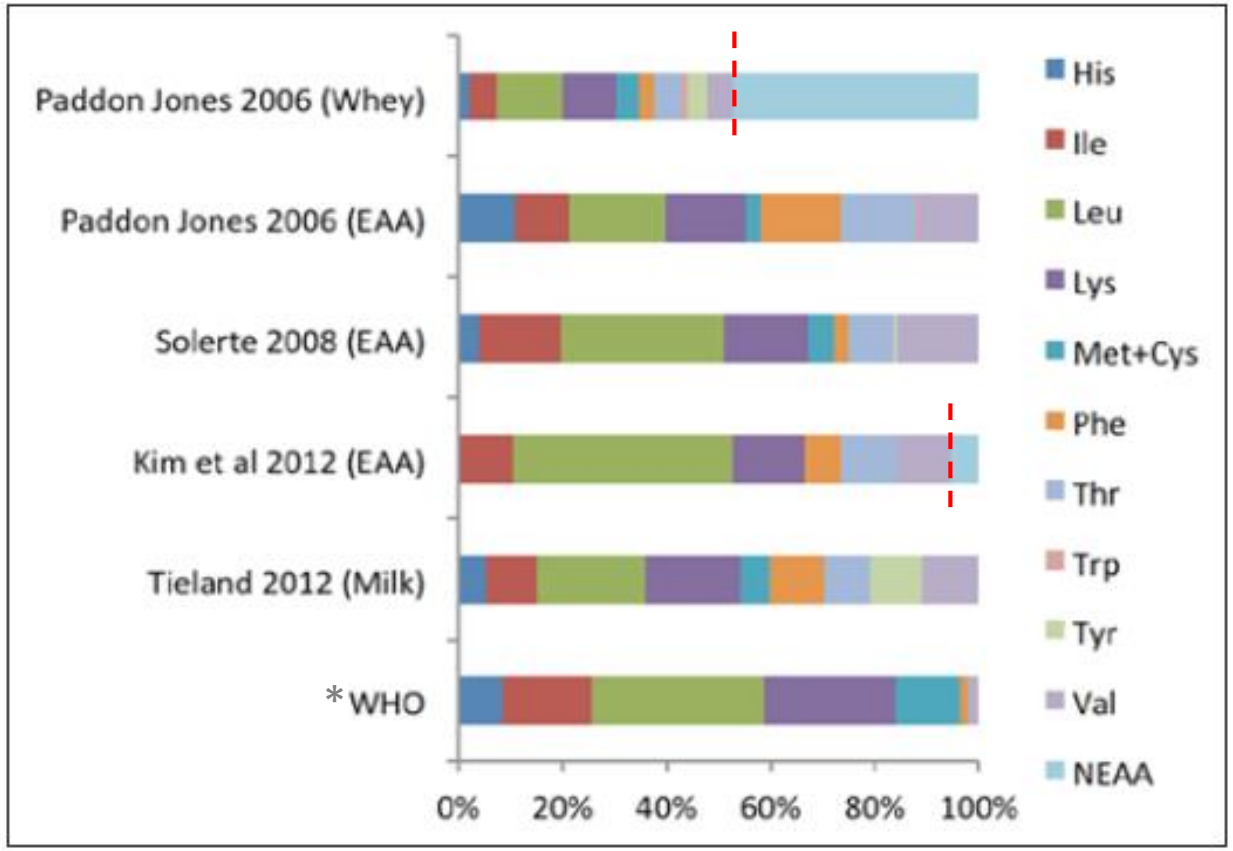
NUTRITIONAL INTERVENTIONS: PROTEIN

PROTEIN QUALITY:
Amino acid composition of supplements demonstrating a positive effect on muscle protein synthesis/ performance;

High degree of variability

*WHO amino acid requirements of adults (2007)

(Beasley et al. Nutr Clin Pract, 2013)

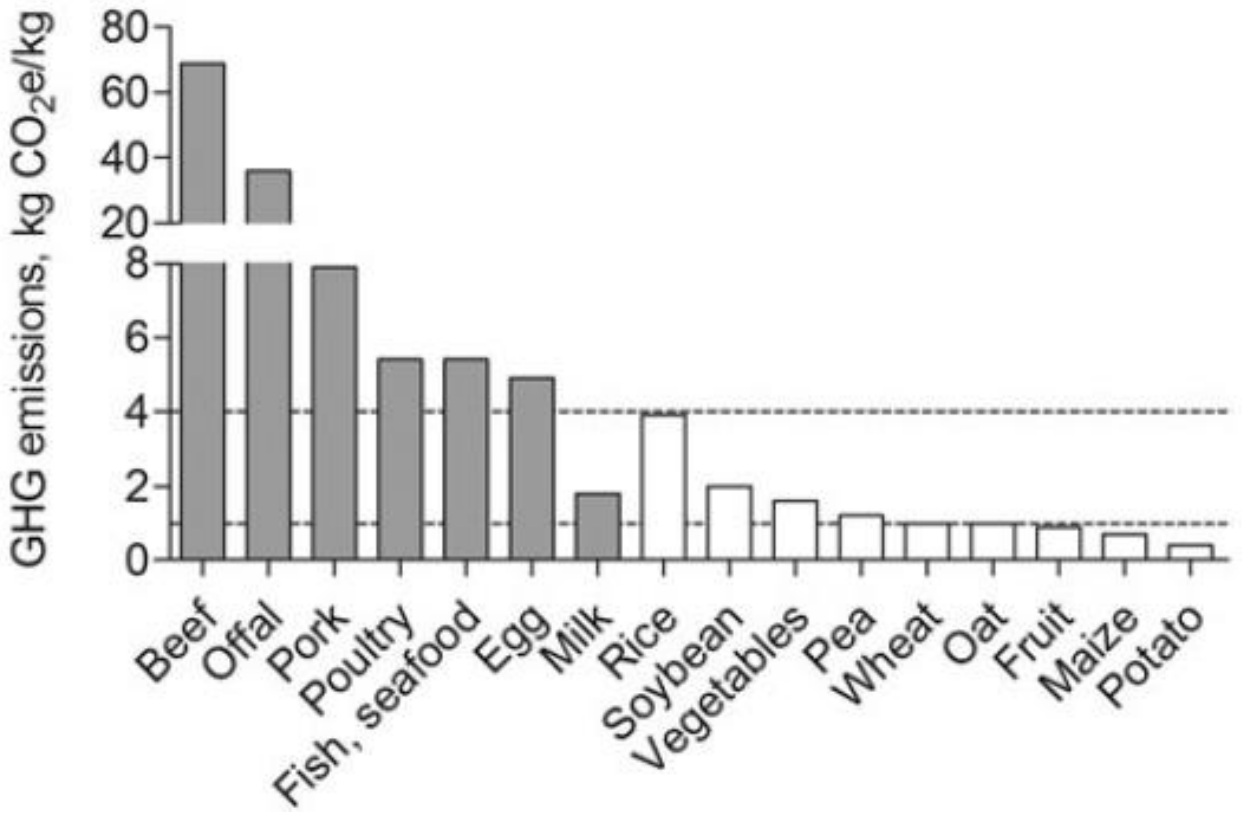


NUTRITIONAL INTERVENTIONS: PROTEIN

PROTEIN QUALITY:
Estimated greenhouse gas (GHG) emissions for common animal (grey) and plant-based (white) proteins;

Environmental impact greater for animal proteins

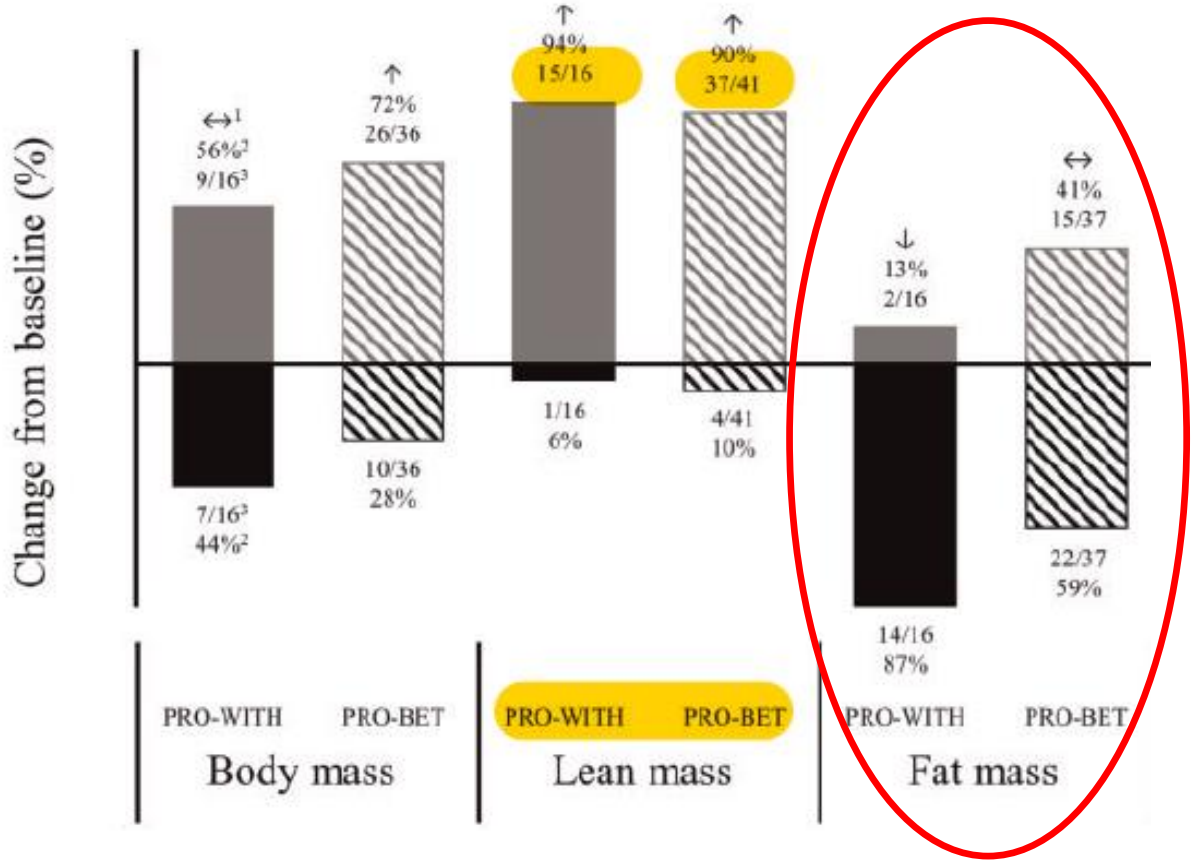
(Gorissen et al. Proc Nutr Soc, 2017)



NUTRITIONAL INTERVENTIONS: PROTEIN

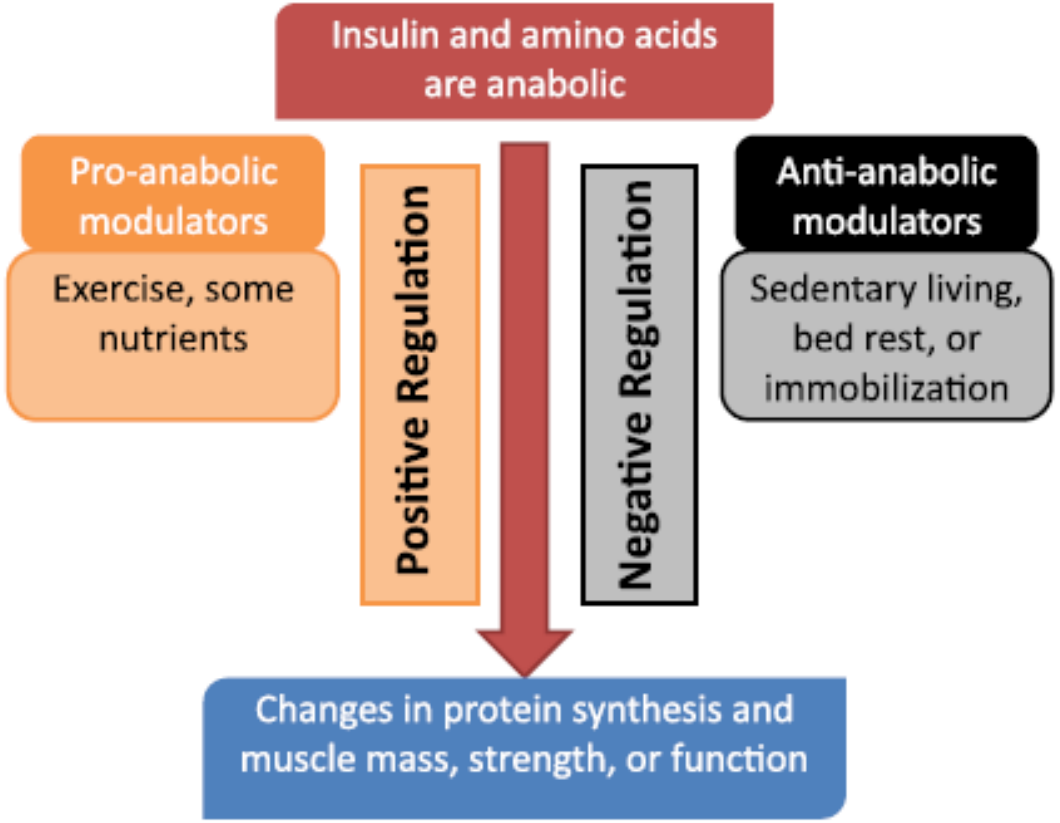
TIMING WRT MEALS:

- Both ‘between meal’ and ‘with meal’ supplements improve lean mass;
- ‘Between meal’ supplements also increase fat mass



(Hudson et al, Nutr Rev, 2018)

NUTRITIONAL INTERVENTIONS: PROTEIN & RESISTANCE EXERCISE



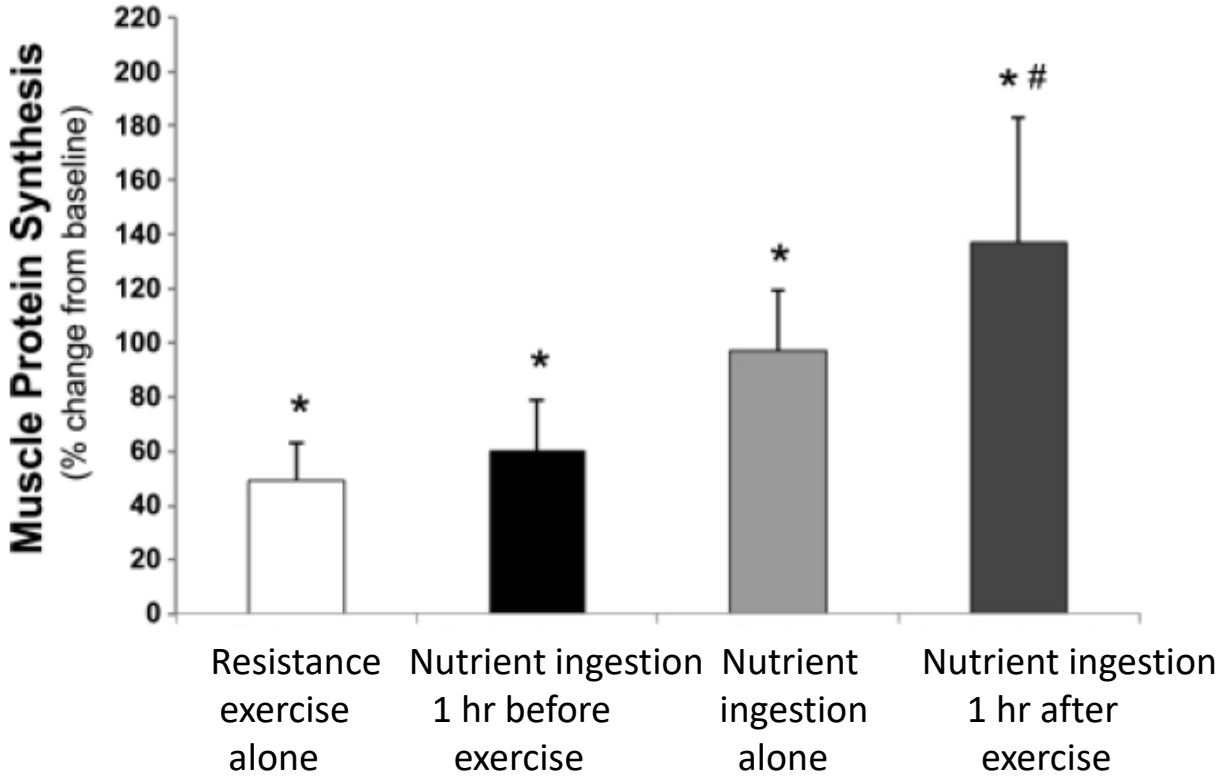
(Bauer et al, JAMDA, 2013)

NUTRITIONAL INTERVENTIONS: PROTEIN & RESISTANCE EXERCISE

TIMING WRT EXERCISE:

- Muscle protein synthesis during 2 hr post recovery period.
- Nutrient ingestion post exercise maximises protein synthesis

(Drummond et al, J Appl Phys 2009)

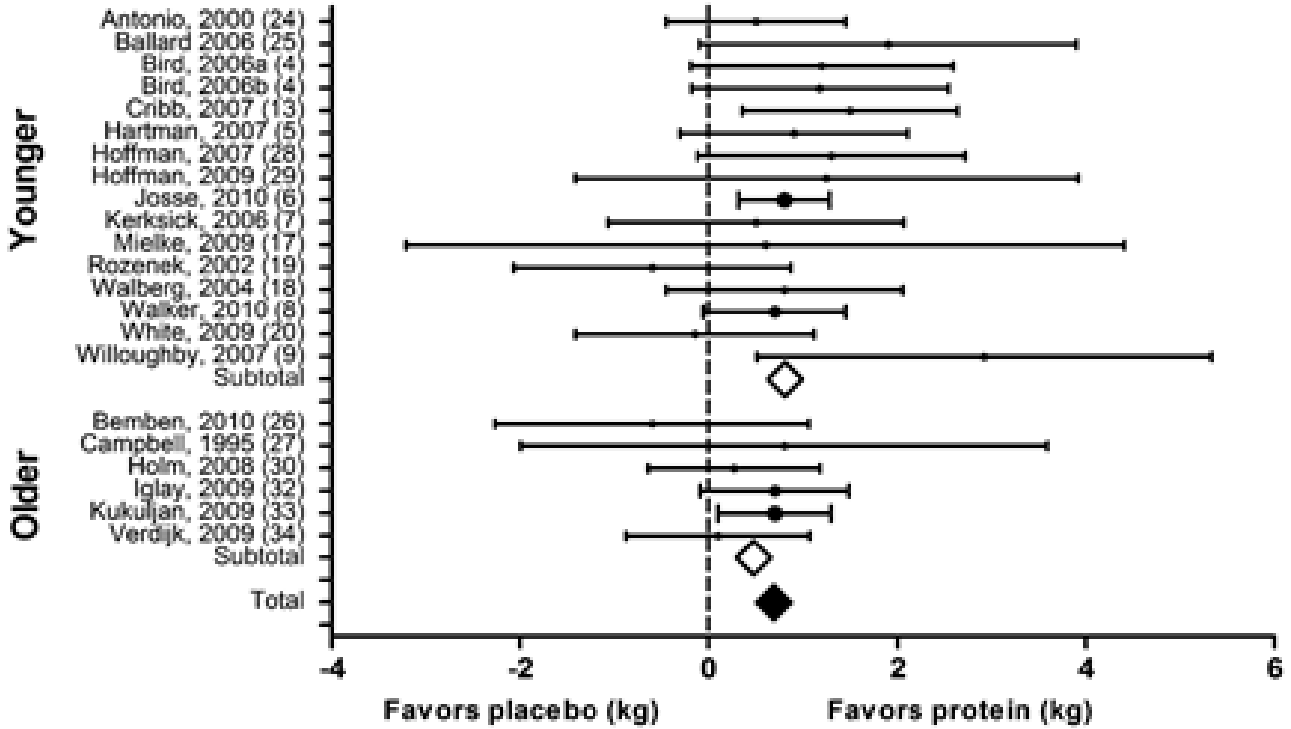


NUTRITIONAL INTERVENTIONS: PROTEIN & RESISTANCE EXERCISE

- N=680
- 22 RCTs
- Protein dose:
  - mean: 42 g/day
  - range: 6-106 g/day
- Resistance exercise frequency:
  - 3 days/week
- Duration of intervention:
  - mean: 12 weeks
  - range: 6-24 weeks

(Cermak et al, Am J Clin Nutr 2012

Fat Free Mass



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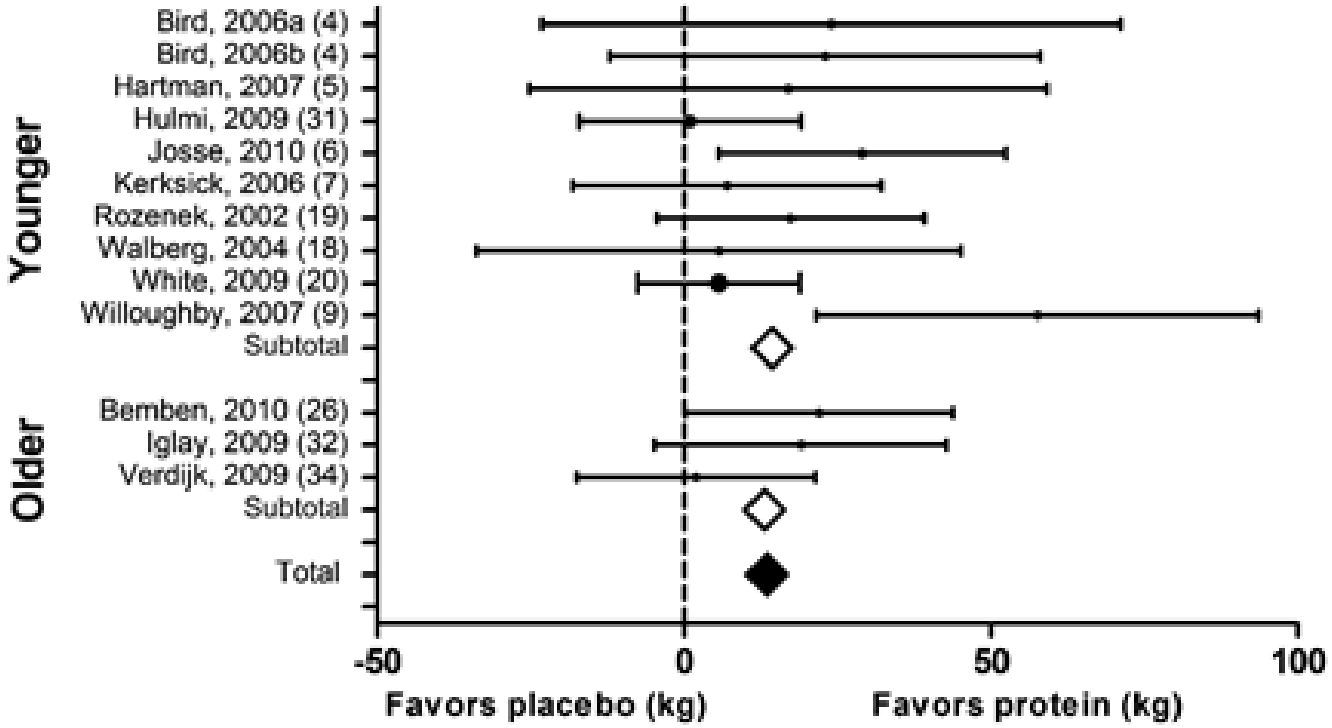
Leg Press Strength (1-RM)



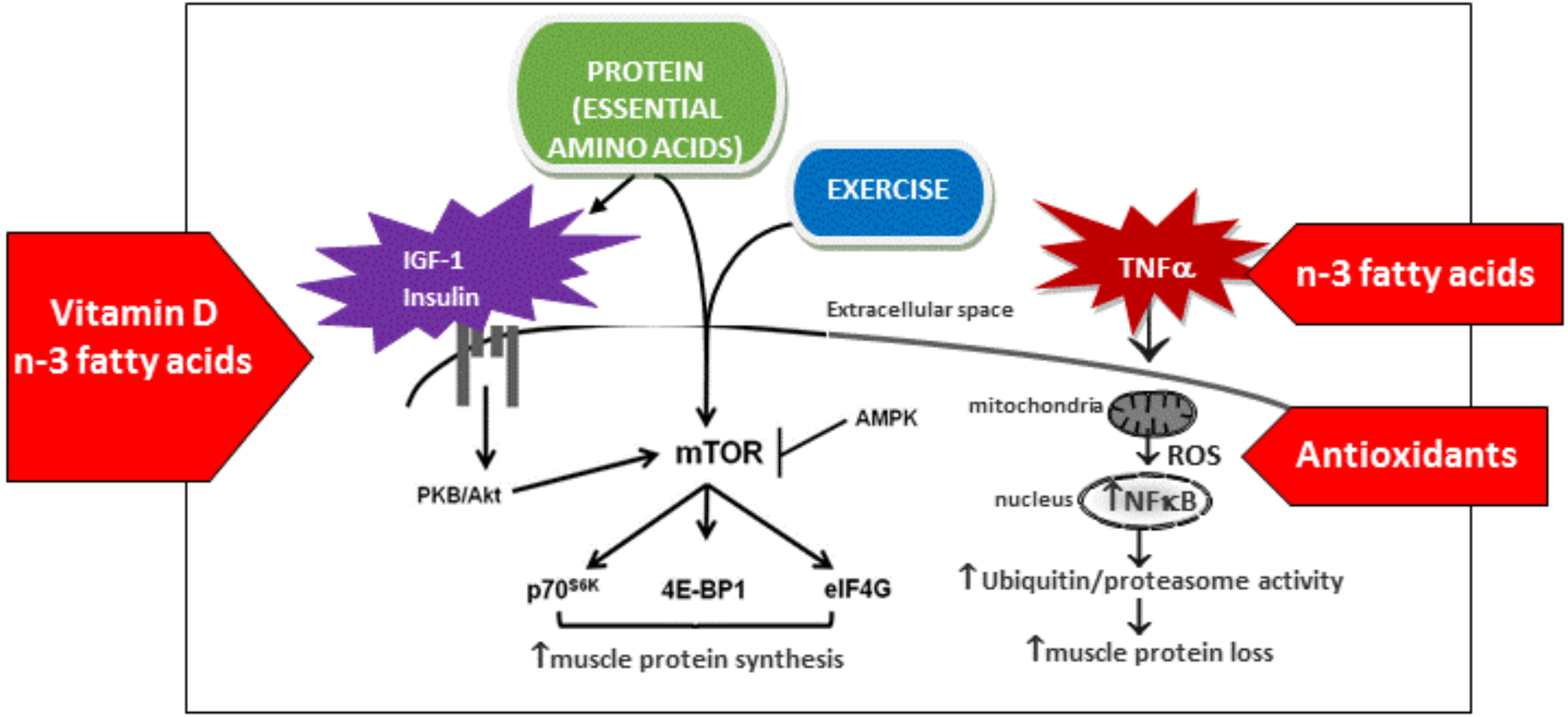
NUTRITIONAL INTERVENTIONS: PROTEIN & RESISTANCE EXERCISE

RECOMMENDATIONS:

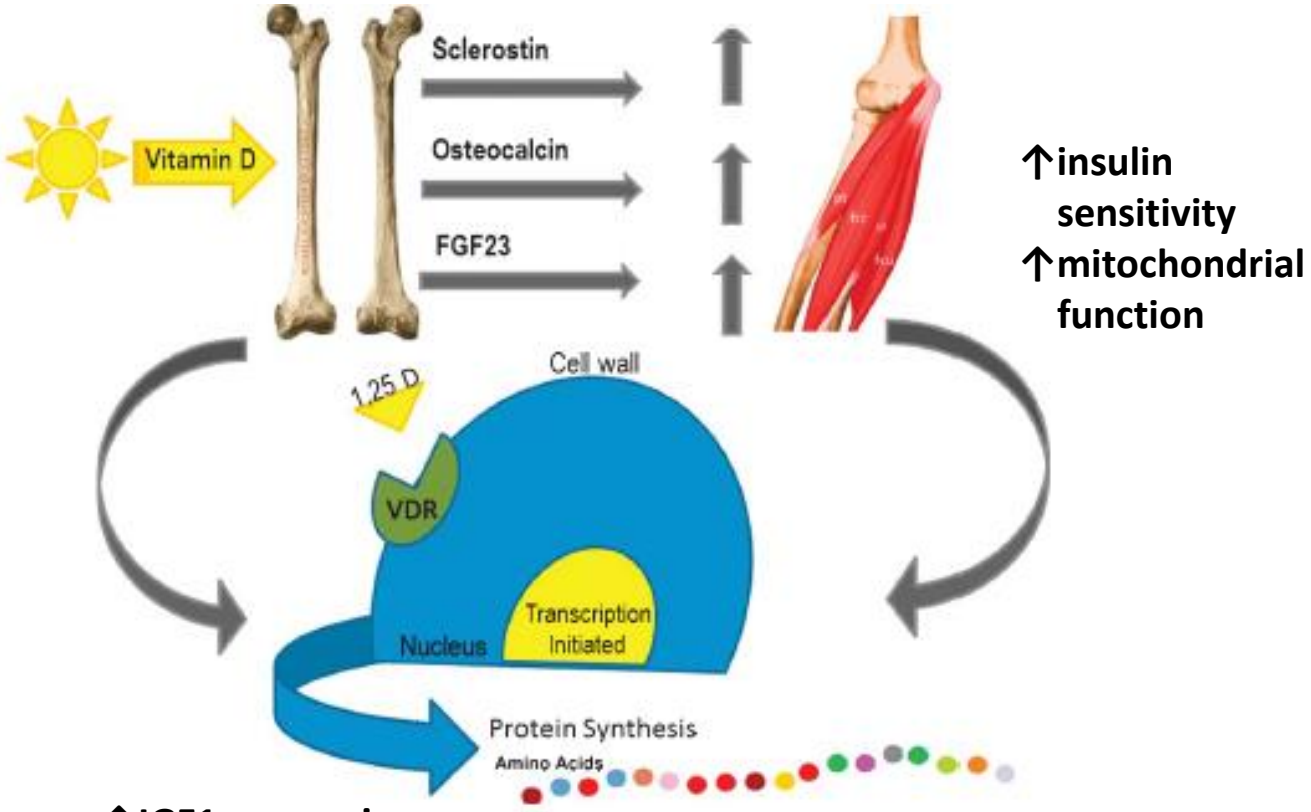
- Older people need more dietary protein; 1.0-1.2 g/kg BW/d^ When exercising, achieve intake of at least 1.2g protein/kg BW/d; consider a 20g protein supplement after exercise sessions.*
- Per-meal anabolic threshold of amino acid intake is higher in older individuals (ie 25-30g protein per meal, containing 2.5-2.8g leucine). Dietary enrichment with leucine or branched chain amino acids may help; further studies needed.*
- Endurance exercise recommended for 30 minutes per day where safe and tolerated. Include progressive resistance training; consider 2-3 times per week for 10-15 minutes.*
- Timing of protein supplementation; some evidence supports protein consumption after exercise*; some evidence supports consumption with meals;
- More research studies with better methodologies needed on protein needs in older adults.*

*(^1.2-1.5 g in acute/chronic disease, excludes severe kidney disease (eGFR<30mm/min/1.73m^2); *Bauer, PROT-AGE, JAMDA, 2013)*

NUTRITIONAL INTERVENTIONS: WHAT ELSE??



NUTRITIONAL INTERVENTIONS: VITAMIN D



↑insulin sensitivity
↑mitochondrial function

↑IGF1 expression

NUTRITIONAL INTERVENTIONS: VITAMIN D

- 13 RCTs
- Age: mean: 78 yr
  range: (63-99 yr)
- Dose: 800-1000 IU/day*
- Duration: 2-36 months

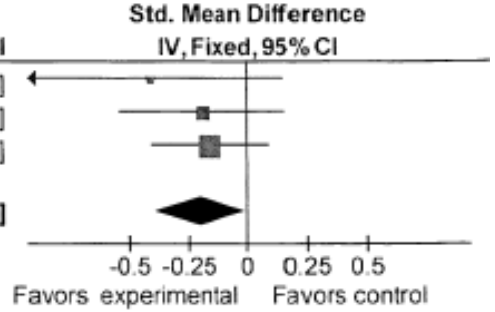
**All studies using >800 IU/day showed benefit.*

Also the dose recommended by the International Osteoporosis Foundation for older people.

Balance Sway

	Vitamin D supplementation			Control				Std. Mean Difference	Std. Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Fixed, 95% CI	IV, Fixed, 95% CI
Bunout 2006	119.8	38.3	24	134.7	31.9	24	11.4%	-0.42 [-0.99, 0.16]	
Dhesi 2004	0.0899	0.046	62	0.0999	0.057	61	29.8%	-0.19 [-0.55, 0.16]	
Pfeifer 2009	81	32	121	86	30	121	58.8%	-0.16 [-0.41, 0.09]	
Total (95% CI)			**207**			**206**	**100.0%**	**-0.20 [-0.39, -0.01]**	

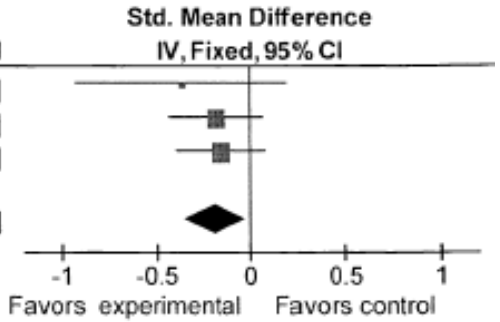
Heterogeneity: Chi² = 0.64, df = 2 (P = 0.73); I² = 0%
Test for overall effect: Z = 2.02 (P = 0.04)



Timed Up and Go

	Vitamin D supplementation			Control				Std. Mean Difference	Std. Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Fixed, 95% CI	IV, Fixed, 95% CI
Bunout 2006	13.8	2.5	24	15.2	4.7	24	8.6%	-0.37 [-0.94, 0.21]	
Pfeifer 2009	7.5	3.4	121	8.3	5.1	121	44.0%	-0.18 [-0.44, 0.07]	
Zhu 2010	8.1	3.9	129	9	7	132	47.4%	-0.16 [-0.40, 0.09]	
Total (95% CI)			**274**			**277**	**100.0%**	**-0.19 [-0.35, -0.02]**	

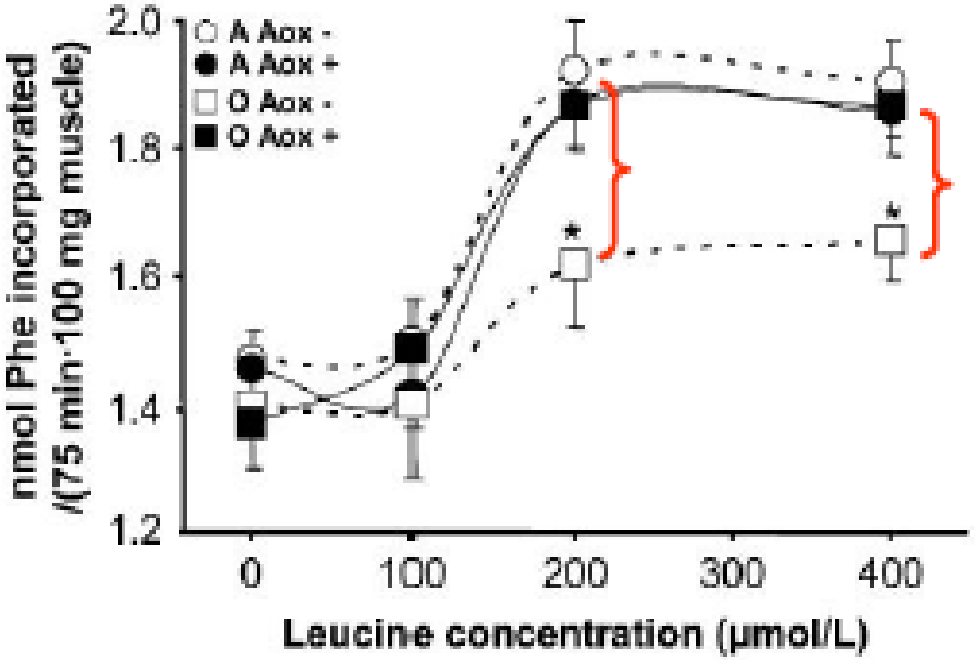
Heterogeneity: Chi² = 0.43, df = 2 (P = 0.81); I² = 0%
Test for overall effect: Z = 2.19 (P = 0.03)



NUTRITIONAL INTERVENTIONS: ANTIOXIDANTS

- Human RCTs needed

Mouse model (7 wk): Vit E, Vit C, rutin, Zn, Se

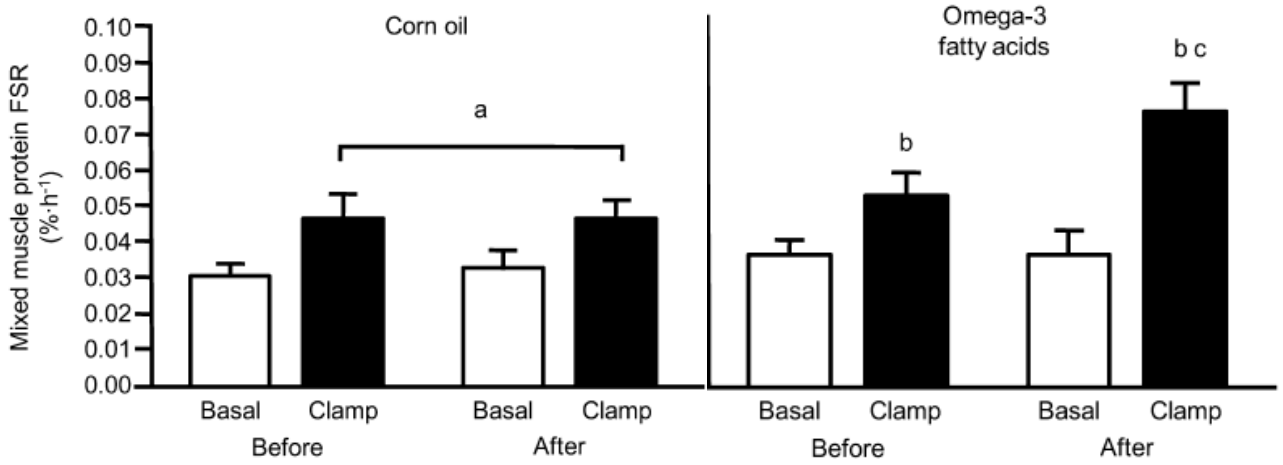


(Marzani, J Nutr, 2008)

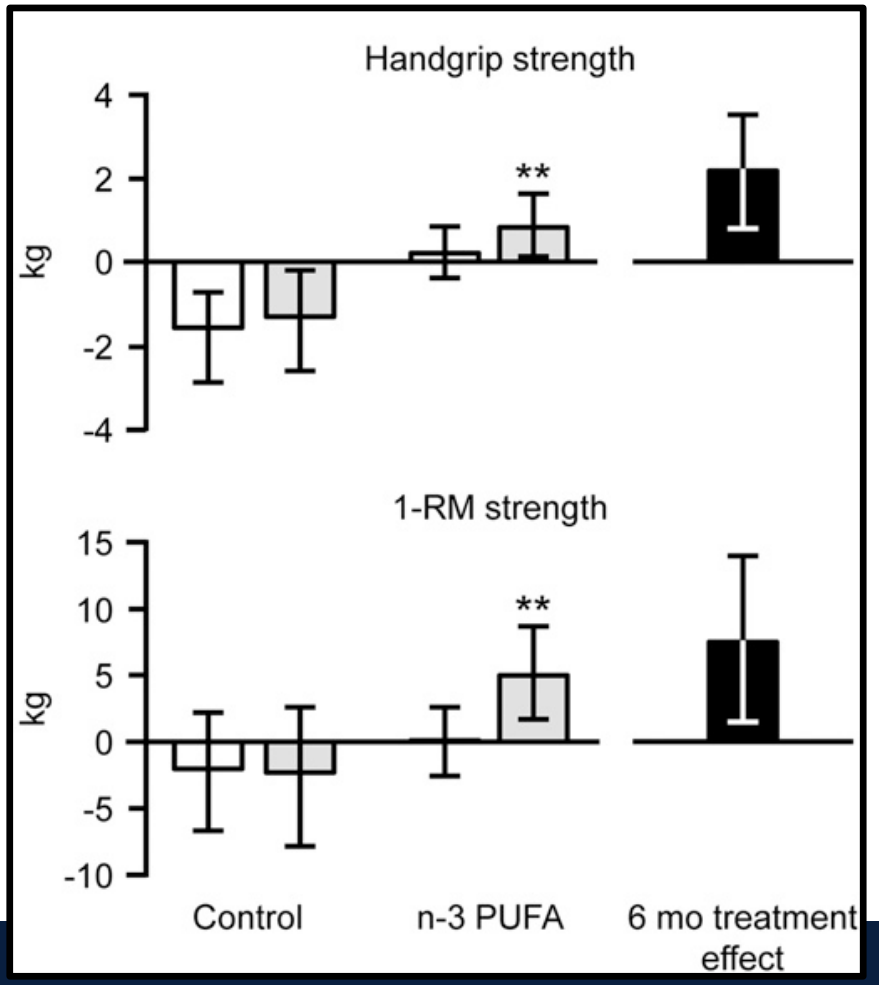
NUTRITIONAL INTERVENTIONS: OMEGA-3 FATTY ACIDS

RCT, n=16 older adults (65+ yr)
Omega-3 fatty acids doubled anabolic response to amino acids and insulin. *(Smith, AJCN, 2011)*

Muscle protein synthesis rate



RCT, n=60 adults (60-85 yr)
Omega-3 fatty acids increased thigh muscle volume, handgrip and muscle strength *(Smith, AJCN, 2015)*



RECOMMENDATIONS FOR CLINICIANS

Avoid sarcopenia and its many negative health outcomes:

Dietary Protein

- Protein intake: 1.0-1.2g/kg BW/day, increase to >1.2g if exercising
- Per meal: 25-30g protein including 2.5-2.8g leucine
- Consume protein supplements *with* meals

Exercise Training

- Endurance exercise for 30 min per day
- Include resistance exercise 2-3 times per week, for 10-15min
- Supplement with 20g protein *after* exercise

Other Nutrients

- Supplement with 800-1000 IU/day Vitamin D
- Antioxidants and omega-3 fatty acids beneficial, supplemental doses undefined; consume diet high in fruit and vegetables and oily fish

THANKYOU!