Muscle mass maintenance in older people

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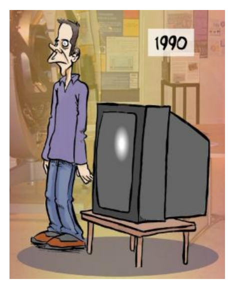
Belfast, May 9, 2014

Muscle reconditioning

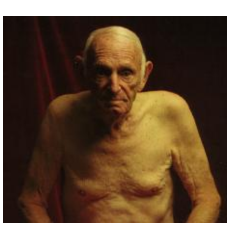
Lance Armstrong

Jay Cutler

Lifestyle changes



Muscle deconditioning



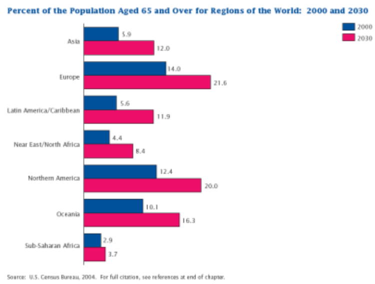
- immobilisation
- sarcopenia
- cancer cachexia
- COPD
- type 2 diabetes
- cardiovascular disease

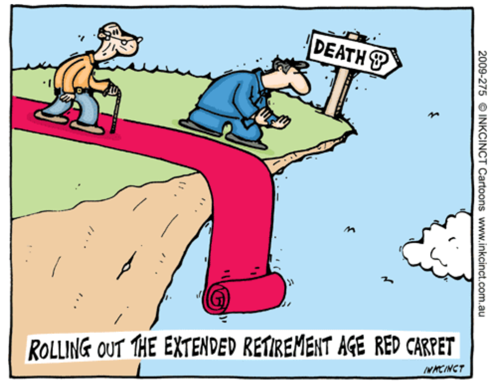
Population demographics

In Europe, the number of people aged 65 years and over are projected to rise by almost 80% over the next 50 years, from 85 million in 2008 to up to 152 million by 2060.

By the year 2060, people with an age of 65 and over will comprise more than 30% of the total EU population.

Global aging

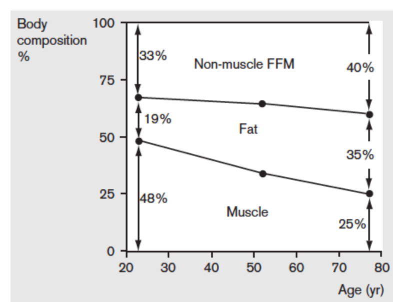




Functional capacity in the elderly

Leenders *et al.*, *Med. Sci. Sports Exerc.*, *2013*.

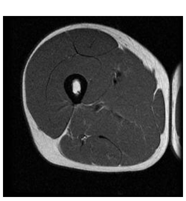
Muscle mass maintenance



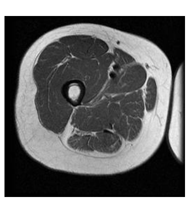
Short and Nair, 2000

Loss of muscle mass with aging

Height and weight matched



Young Male, age 25



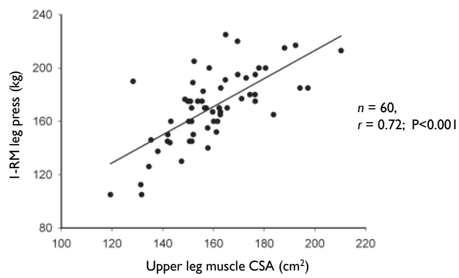
Older Male, age 63

Sarcopenia

- type II muscle fiber atrophy
- muscle fiber type grouping
- muscle fiber loss

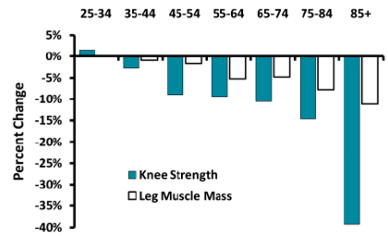
Nilwik *et al.*, 2013

Muscle mass versus muscle strength



Verdijk *et al., unpublished*

Muscle loss versus strength loss



Ferrucci *et al., J. Gerontology*, 2012

Age related decline in muscle strength

- functional capacity
- metabolic disease
- quality of life

What regulates muscle maintenance?

Fractional muscle protein synthesis

1-2 % per day

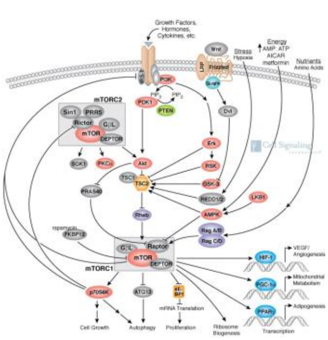
(0.04 – 0.14 $\%\cdot h^{-1}$)

Main anabolic stimuli

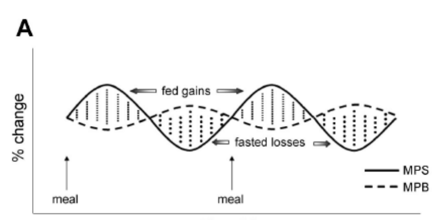
Nutrition is an anabolic stimulus

Amino acids

Amino acids stimulate protein synthesis

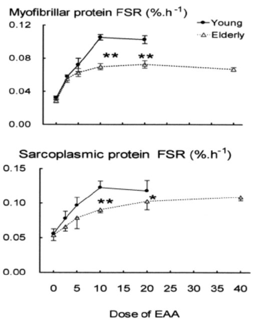


Muscle protein balance



Burd *et al.*, *J Appl Physiol*, 2008

Anabolic resistance



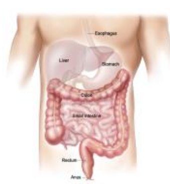
Cuthbertson *et al.*, *FASEB J.*, 2005

Anabolic resistance

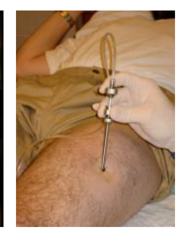
- immobilisation
- sarcopenia
- cancer cachexia
- COPD
- type 2 diabetes
- cardiovascular disease

Anabolic resistance

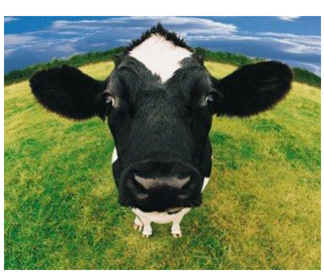
- protein digestion
- amino acid absorption
- plasma amino acid availability
- hormonal response
- postprandial perfusion
- muscle protein signaling proteins
- myofibrillar protein synthesis



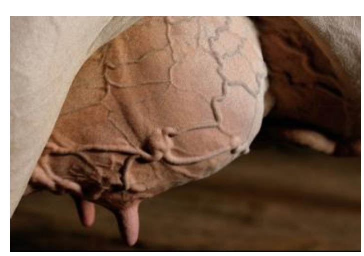
Research methods



Intrinsically labeled protein



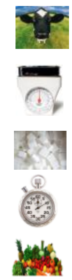
Intrinsically labeled protein



Intrinsically labeled protein

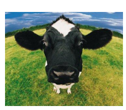
van Loon *et al.*, *J Dairy Sci*, 2009, Pennings *et al.*, *J Dairy Sci*, 2010, Burd *et al.*, *Plos One*, 2013

Post-prandial protein synthesis

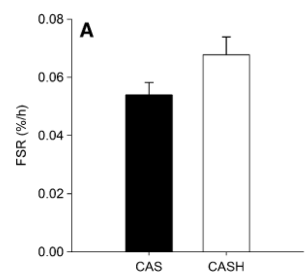


- source of protein
- amount of protein
- macronutrients
- timing
- food compounds

Source of dietary protein

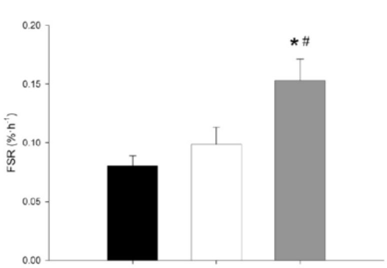


Intact protein versus protein hydrolysate



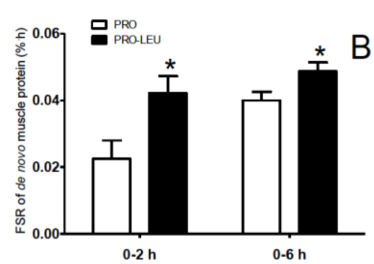
Koopman *et al.*, *Am J Clin Nutr*, 2009

Whey versus casein



Pennings *et al.*, *Am J Clin Nutr*, 2011

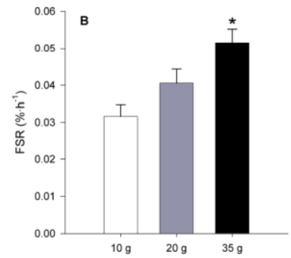
Leucine co-ingestion



Wall *et al.*, *Clin Nutr*, 2012

Amount of dietary protein

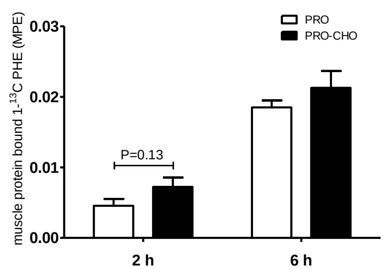
Dose response effect



Pennings *et al.*, *Am J Physiol*, 2012

Carbohydrate co-ingestion

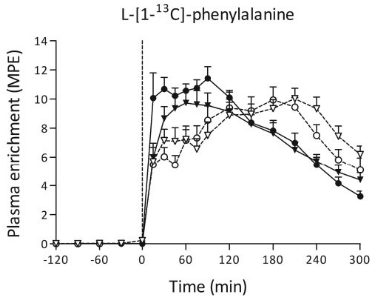
Carbohydrate co-ingestion



Hamer *et al.*, *Nutr Metab*, 2013

Carbohydrate co-ingestion

L-[1-^{13}C]-phenylalanine

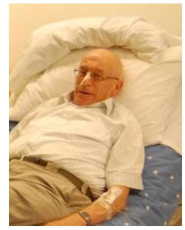


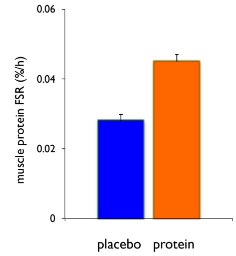
Gorissen *et al.*, *J Clin Endocrinol Metab*, 2014

Timing of protein ingestion

Muscle protein synthesis during sleep

Muscle protein synthesis during sleep





Groen *et al., Am J Physiol*, 2012

Muscle contraction is an anabolic stimulus

Muscle contraction

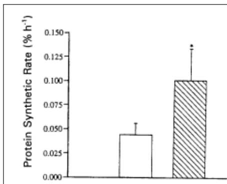
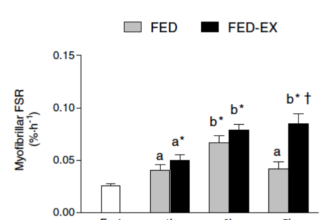


Fig. 1. Muscle protein synthetic rate in biceps brachii from the control and exercised arm, 24 h after a typical weight training session. Values are means (±SD). The open histogram denotes the non-exercised (control) arm and the hatched histogram denotes the exercised arm ($n = 4$).

Chesley *et al.*, 1992

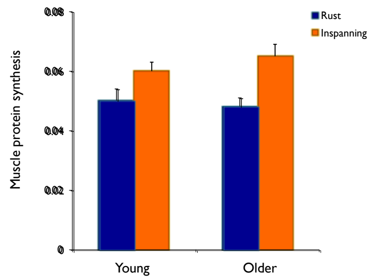
Interaction between physical activity and food intake

Exercise and nutrition



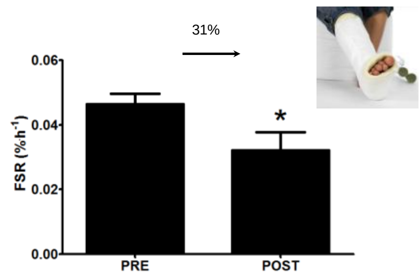
Moore *et al., J. Physiol.*, 2009.

Post-prandial muscle protein synthesis

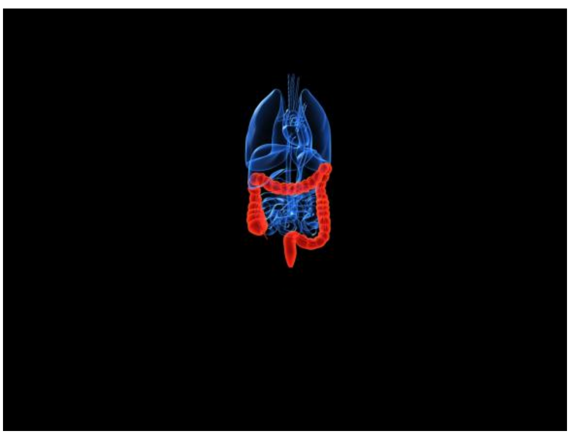


Pennings et al., Am J Clin Nutr, 2010

Anabolic resistance to protein intake

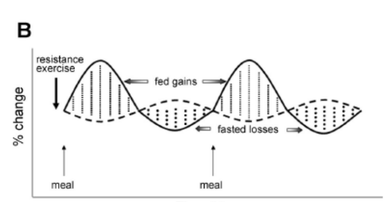


Wall *et al. J Clin Endocrinol Metab*, 2013



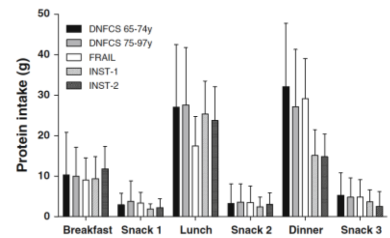
Clinical relevance

Prolonged nutritional intervention



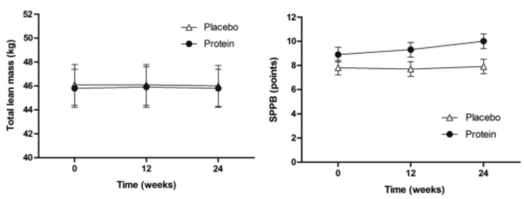
Burd *et al., J Appl Physiol*, 2008

Protein intake in the elderly populations



Tieland et al., Eur J Nutr, 2011

Protein supplementation in frail elderly



Tieland et al., JAMDA, 2012-A

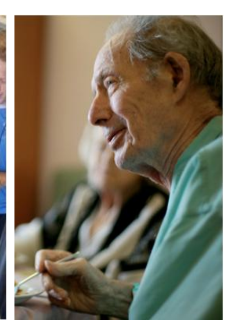
Exercise training in the elderly

Muscle mass and strength

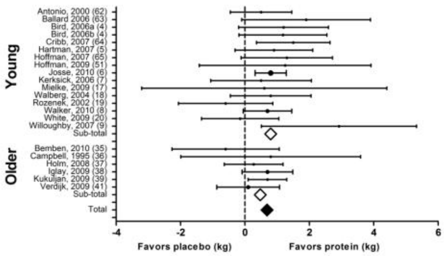
Endurance capacity

Functional capacity

Frontera et al., 1988, 1990, 2003, Fiatarone et al., 1990, 1994, Charette et al., 1991, Lexell et al., 1995,
Ades et al., 1996, Vincent et al., 2002, Bamman et al., 2003, Brose et al., 2003, Ferri et al., 2003, Roth et al., 2003, Short et al., 2003, 2004, Verdijk et al., 2009

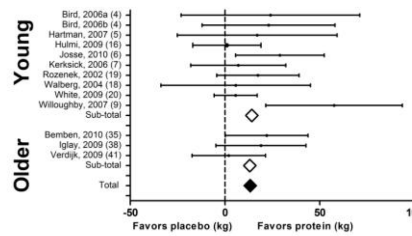


Exercise training and protein supplementation



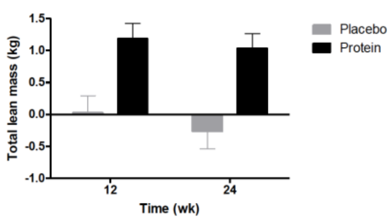
Cermak *et al.*, *Am J Clin Nutr*, 2012.

Exercise training and protein supplementation



Cermak *et al.*, *Am J Clin Nutr*, 2012.

Protein supplementation in frail elderly



Tieland *et al.*, *JAMDA*, 2012

Conclusions

Protein intake and muscle contraction stimulate muscle protein synthesis

Protein ingestion following physical activity increases post-prandial muscle protein accretion

Protein supplementation increases the gains in muscle mass and strength during prolonged resistance type exercise training

Practical recommendations

Provide sufficient dietary protein (20-25 g) with each main meal

Ensure ample protein is ingested with breakfast

Ingest 20-25 g high quality protein immediately after exercise

Ensure some level of physical activity is performed prior to meal ingestion

Whey and casein represent good protein sources

Collaborators and sponsors

M³ research unit

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Naomi Cermak

29-01-1982 - 14-12-2013