PROTEIN PACKING PRODUCTS: THE NUTRITIONAL RATIONALE

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Protein Trends & Technologies Seminar

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Disclosures

Abbott Laboratories 

This program is not intended for continuing education credits for any healthcare professional

The talk does not include any Abbott funded research or reference any Abbott products

The talk does not include any reimbursement information

Topics

1. Overview of Protein in Health
2. Protein Type & Quality
3. Nutritional role of protein in supporting LBM/muscle mass in the lifecycle including:
   - Athletic performance
   - Weight management
   - Sarcopenia & aging

Why is protein so important for the body?

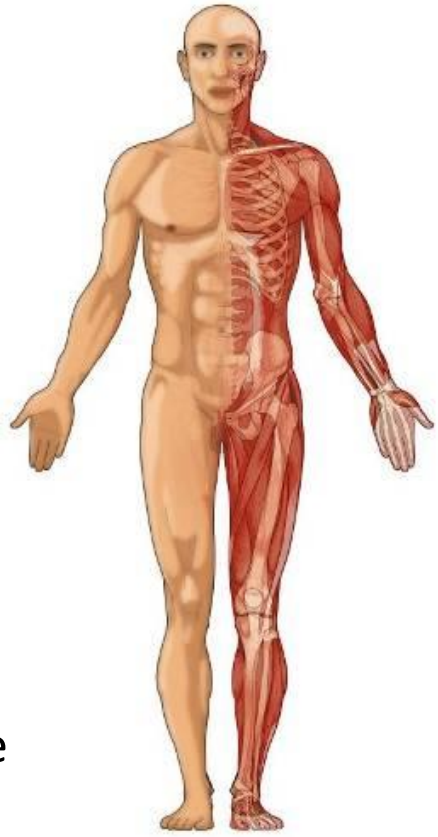
- Protein is vital for:
  - Immune system function
  - Proper digestion and absorption of nutrients
  - Hormone function
  - Nutrient transport and regulation of blood volume
- Protein helps to promote the growth of muscle tissue and repair muscles after strenuous exercise.

Churchward-Venne TA, Burd NA, & Phillips SM, *Nutr. Metab.* 2012, v 9, p 40, d**oi:** 10.1186/1743-7075-9-40

What Is Lean Body Mass (LBM)?

- Muscles
- Organs
- Bone

→ Everything BUT fat



- LBM accounts for 75% of normal body weight
  - Muscle = largest component of LBM

Functions of skeletal muscle:

- Mobility, balance and physical strength
- Generates heat (energy)
- Protein / amino acid pool for skin, immune & digestive systems
- Survival during periods of metabolic stress

Wardlaw GM, Kessel M. Perspectives in Nutrition. 5th ed. New York, NY: McGraw-Hill; 2002.

Protein Type

- Complete Protein = contains all essential AAs in amounts that meet what is required by humans to prevent deficiency
- Incomplete Protein = Too low in one or more of the essential AAs
- Complementary Proteins = Combination of proteins that, when added together, result in a complete protein (e.g. beans and rice)
  - Legumes: ↓ methionine, ↑ lysine
  - Grains: ↑ methionine, ↓ lysine

Protein Quality

- **BV** = Biological Value;
  - proportion of absorbed protein that is retained in the body for maintenance and/or growth
  - Most common; scale of 0-100
  - Measurement of nitrogen retention or indicator of utilization
  - Does not take into account digestibility directly
- **PD** = Protein Digestibility;
  - proportion of food protein absorbed
- **NPU** = Net Protein Utilization;
  - proportion of food protein absorbed & utilized
  - Calculated as BV X PD
- **PER** = Protein Efficiency Ratio;
  - Mass gain in body weight divided by weight of protein consumed
- **PDCAAS** = Protein Digestibility Corrected Amino Acid Score;
  - The essential amino acid score multiplied by a digestibility factor

Protein Quality: Protein Digestibility Corrected Amino Acid Score

- Standard by FAO/WHO assess protein quality
- Complete proteins have PDCAAS of ≥1.00

Protein Source	PDCAAS
Egg	1.0
Milk	1.0
Whey Protein	1.0
Casein	1.0
Soy Protein	1.0
Black Beans	0.75
Peanuts	0.52
Wheat	0.42

Institute of Medicine. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Fiber, Protein, and Amino Acids. Washington, DC: National Academies Press, 2005, p 686-689.
Hoffman JR and Falvo MJ. J Sports Sci Med. 2004; 3:118-130.
Schaafsma G. J Nutr. 2000; 130(7):1865S1867S.

Recommended Daily Requirements for Protein

Population	IOM RDA (g/kg body weight/day)	Range to Optimize Body Composition and Health (g/kg bw/day)
Infants to 1 yr	1.5	
Children 1-3 yr	1.1	
Children 4-13 yr	0.95	
Children 14-18 yr	0.85	
Adults 19-59 yr	0.8	
Adult Endurance Athlete	0.8	1.2-1.4
Adult Strength Athlete	0.8	1.2-1.7
Adults ≥60 yr	0.8	1.0-1.3
Dieting Adults	0.8	1.2-1.6

Protein requirements increase during pregnancy and lactation as well during trauma and high metabolic stress; increases also in premature infants, not included above.

De Souza 2010; FAO/WHO/UNU 2007; IOM 2005; Layman 2009; Lejeune 2005; MSSE 2009; Mojtahedi 2011

Recommended Daily Requirement: Adults

- RDA 0.8 g/kg bw/day adults
  - ~65 g/d for 180 lb (82 kg) individual
  - ~47 g/d for 130 lb (59 kg) individual
- Many Americans consume adequate protein by this standard.
  - Median protein intake for all adult age and gender groups ranged 55-101 g/d
  - Adequate intake does not necessarily = optimal for health or performance

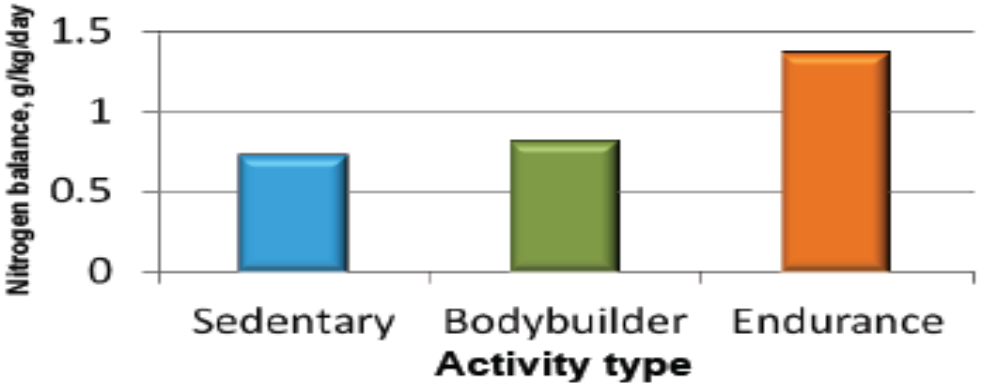
Institute of Medicine. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Fiber, USDA National Agricultural Library Food and Nutrition Information Center. US Dept Ag, Ag Res Ser, Continuing Survey of Food Intakes by Individuals 1994-96, 1998 and Diet and Health Knowledge Survey 1994-6.

Sports Nutrition

Protein needs in athletes may increase with increased physical activity and vary with type of activity (e.g. endurance, strength)

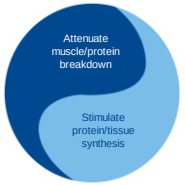
Recommended Daily Requirement: Athletes

- RDA 0.8 g/kg bw/day adults
- Endurance athletes, 1.2 - 1.4 g/kg/ day
- Strength athletes, 1.2 - 1.7 g/kg/day
- Despite increased recommendations, ACSM does not state that protein supplementation has positive impact on performance



Tarnopolsky MA et al J Appl Physiol 1988; 64(1): 187-193
Tipton KD and Wolfe RR, J Sports Sci 2004; 22: 65-79
ACSM, AND Med Sci Sports Exerc. 2009; 41(3):709-731.

Governance of Skeletal Muscle Mass



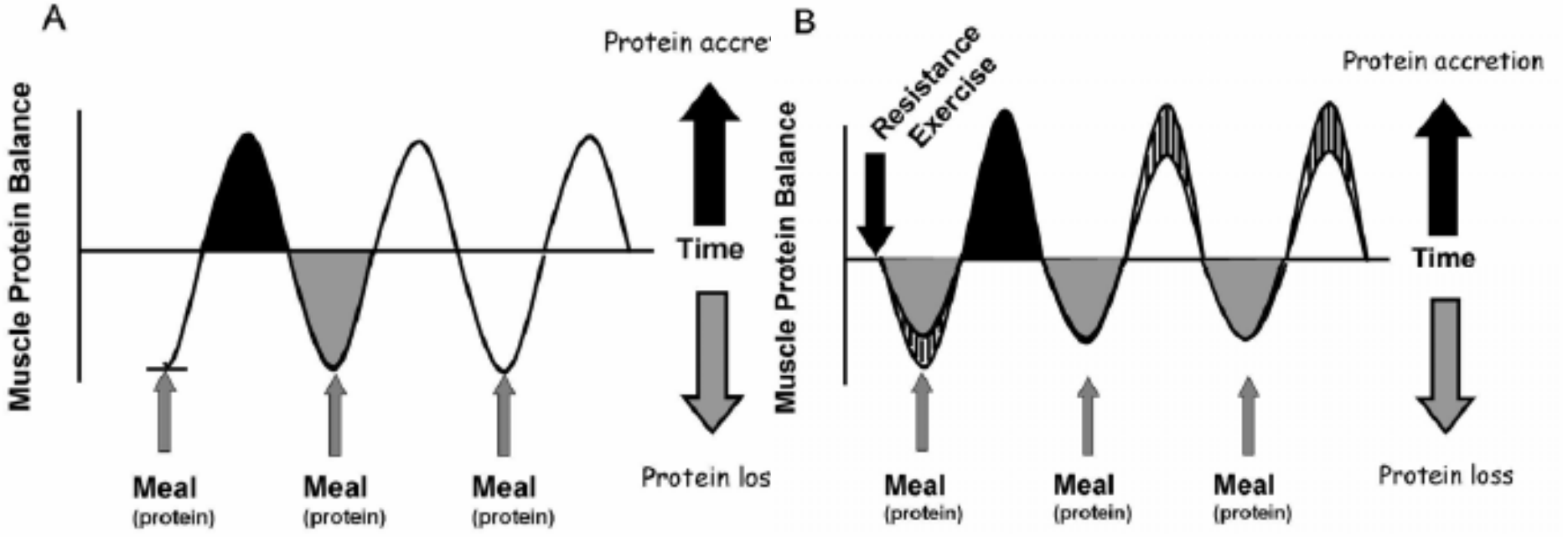


Fig 1. (A) Normal fed-state gains and fasted-state losses in skeletal muscle protein balance (synthesis minus breakdown). The area under the curve in the fed state (black area) would be equivalent to the fasted loss area under the curve (grey area); hence, skeletal muscle mass is maintained by feeding. **(B) Fed-state gains and fasted-state losses in skeletal muscle protein balance with performance of resistance exercise.** In this scenario, fasted-state gains are enhanced by an amount equivalent to the stimulation (striped area) of protein synthesis brought about by exercise (black area). In addition, fasted-state losses (striped area) appear to be less (grey area) due to persistent stimulation of protein synthesis in the fasted state.[17] Adapted from reference 38.

Phillips SM, Role of Protein Absorption and Nutrient Timing on Muscle Mass Accretion. 110th Abbott Nutrition Research Conference, 2009

Nutritional regulation of muscle protein synthesis with resistance exercise

- Muscle protein synthesis > basal levels for up to 48 hours after resistance training
- Protein from milk (whey and casein), egg, soy, and beef have been shown to stimulate muscle protein synthesis.

Churchward-Venne TA, Burd NA, & Phillips SM, *Nutr. Metab.* 2012, v 9, p 40, d**oi:** 10.1186/1743-7075-9-40

Weight Management

Sustained periods of negative energy balance can decrease body mass as well as skeletal muscle mass and consuming dietary protein at levels above RDA may attenuate loss of muscle mass

Negative Energy Balance can lead to loss of muscle

- Typical weight loss reported ~5-10% initial body weight
  - As total body mass decreases in response to sustained periods of negative energy balance:
    - ~75% adipose, ~25% fat-free mass
- Loss of muscle may negatively impact metabolic process

Carbone JW Adv Nutr, 2012; 3: 119-126
Weinheimer EM et al Nutr Rev 2010; 68: 375-88.
Farnsworth E et al Am J Clin Nutr 2003. 2003; 78:31-9
Layman DK et al J Nutr 2003; 133: 411-7
Skov AR et al Int J Obes Relat Metb Disord 1999; 23: 528-36
Rodriguez NR, Garlick PJ. Am J Clin Nutr 2008; 87:1551S-3S
Westerterp-Plantenga MS et al Brit J Nutr 2012; 108: S105-S112.

Dietary Protein impacts satiety

- Acute high protein meals induce satiety
- CHO+Pro gastrointestinal anorexigenic peptides
  - Cholecystokinin, glucagon-like peptide 1, and peptide YY
  - Acting on brain regions involved in energy homeostasis (brain stem, hypothalamus)
  - Vagal signaling by proteins and amino acids induces neuronal activation in the nucleus tractus solitarius (NTS)
- Pro+FAT ketogenesis & increased ketone body concentrations
  - Ketogenic AA (leucine, lysine)
  - Keto & gluco AA (isoleucine, phenylalanine, tryptophan, tyrosine)

Westerterp-Plantenga MN et al. Annu Rev Nutr 2009; 29: 21-41
Westerterp-Plantenga MS et al Brit J Nutr 2012; 108: S105-S112.
Journel M et al Adv. Nutr. 3: 322–329, 2012.

Dietary Protein impacts body composition during weight loss

- Higher protein ad libitum diets may help muscle-sparing effects
  - 10-15% Cal vs 20-35% Cal
  - 0.8 g/kg/d vs 1-2 g/kg/d
- AA sparing
- Thermogenesis
- IGF-1

Westerterp-Plantenga MN et al. Annu Rev Nutr 2009; 29: 21-41
Westerterp-Plantenga MS et al Brit J Nutr 2012; 108: S105-S112.
Journel M et al Adv. Nutr. 3: 322–329, 2012.

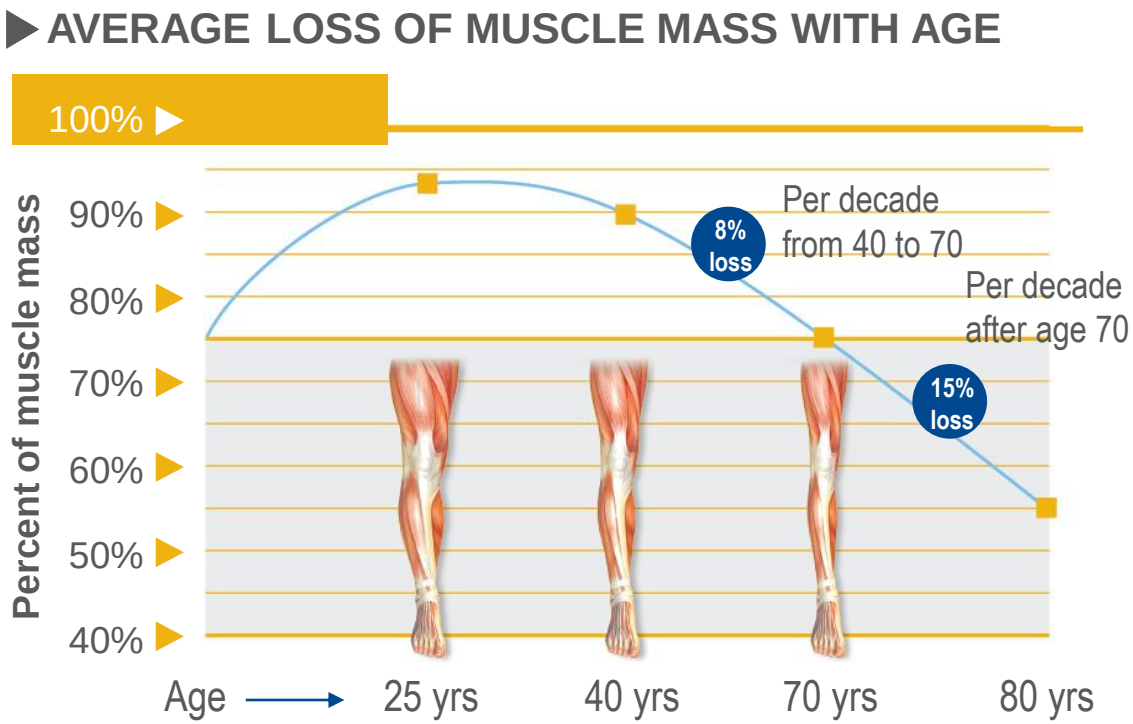
Sarcopenia & Aging

Lean body mass loss declines with age

Sarcopenia is prevalent in aging population

Protein needs in patient populations and in aging may increase depending on condition

Progressive LBM / muscle mass loss occurs with aging

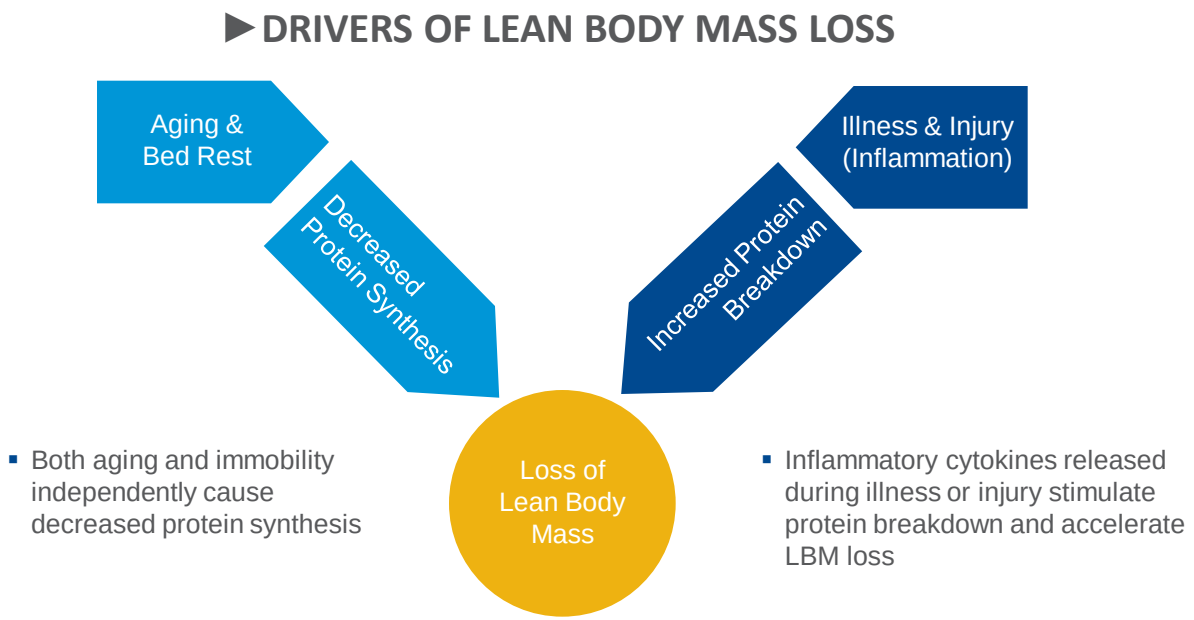


Age-related loss of muscle mass, strength and/or functionality: ***sarcopenia***

Demling RH. *Eplasty*. 2009;9:65-94
Grimby G et al. *Acta Physiol Scand*. 1982;115:125-34
Grimby, et al. *Clin Physiol.* 1983;3:209-18.
Larsson L, et al. *J Appl Physiol.* 1979;46:451-6.
Janssen I, et al. *J Appl Physiol*. 2000;89:81-8.

What drives age-related loss of LBM / muscle mass?

- Physical inactivity and poor nutrient intake
- ↓ protein synthesis and ↑ protein breakdown
- Infiltration of fat into muscle



Evans WJ et al. *Clin Nutr*. 2008;27:793-9.
Vetta F et al. *Clin Nutr*. 1999;18:259-67
Engelen MP et al. *Eur Respir U*. 1994;7:1793-7.
Nixon DW et al. *Am J Med*. 1980;58:683-90.
Baumgartner RN et al. *Am J Epidemiol*. 1998;147:755-63.

EWGSOP suggested definition and diagnosis

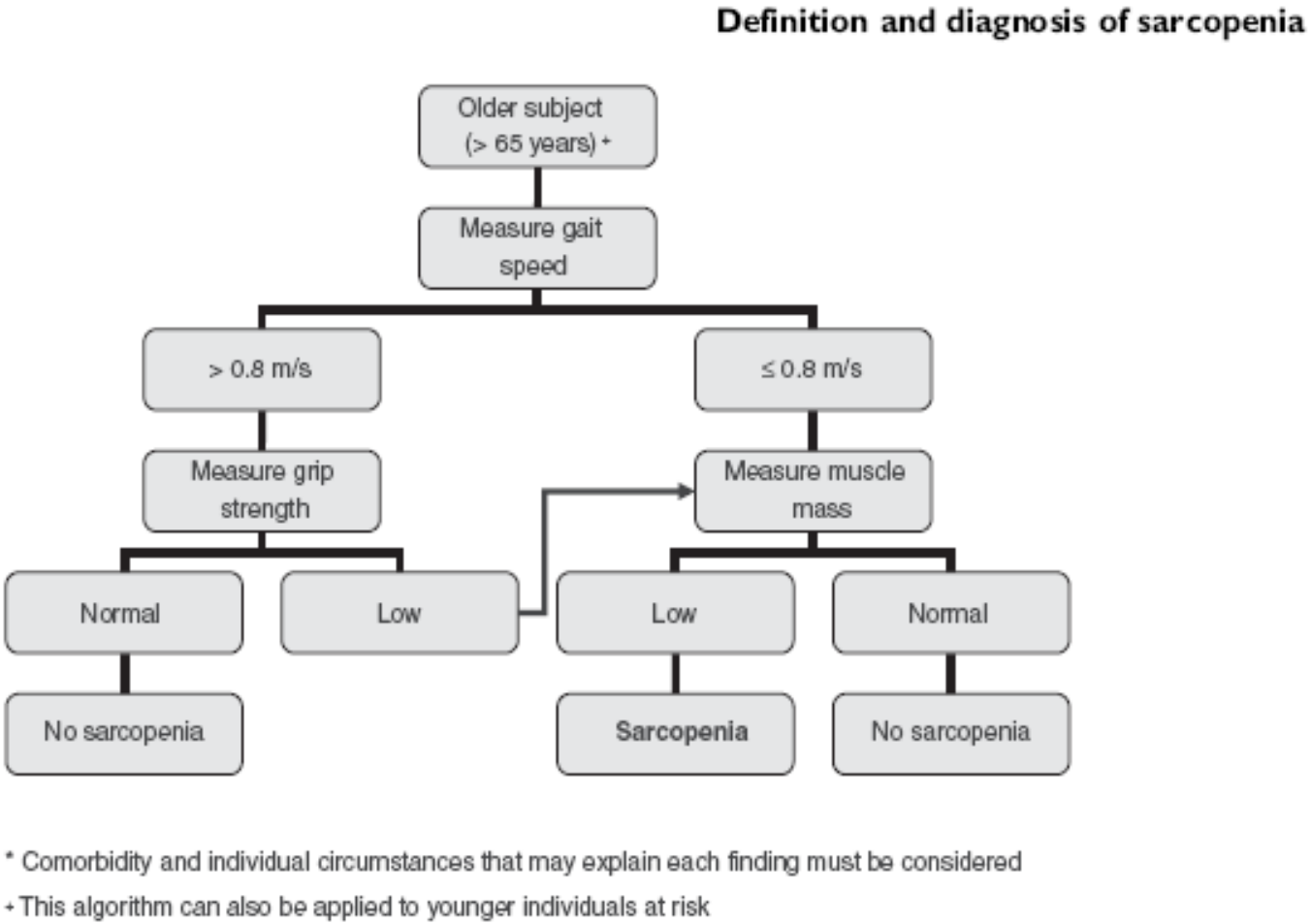
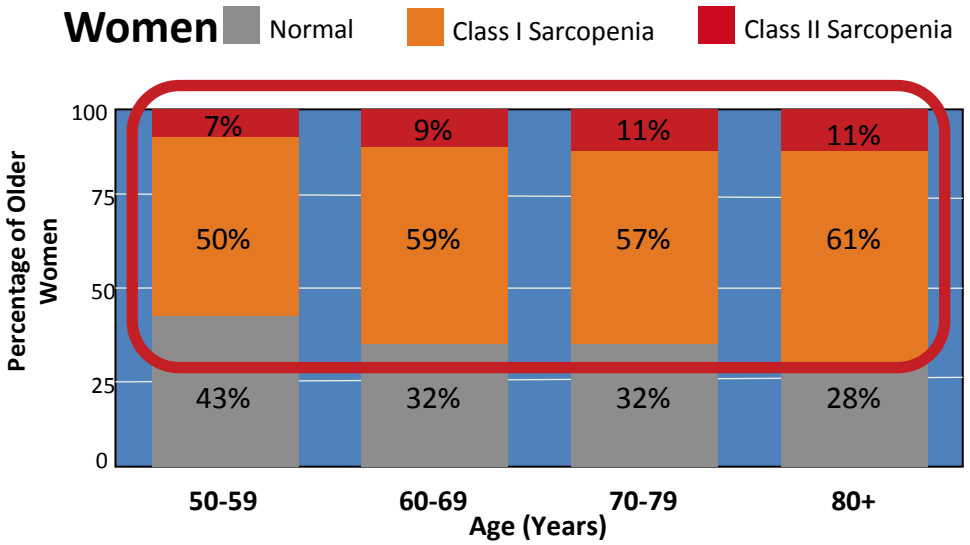
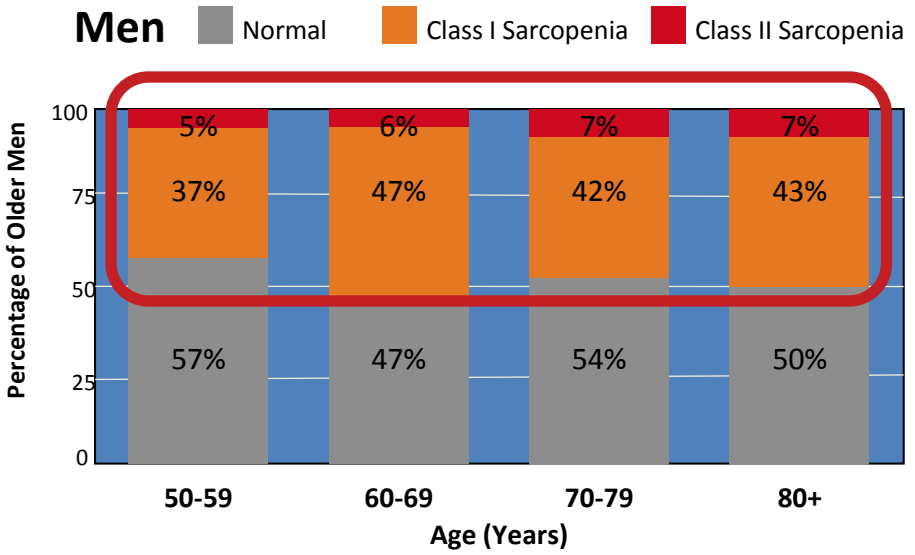


Figure 2. EWGSOP-suggested algorithm for sarcopenia case finding in older individuals.

What is the prevalence sarcopenia among older men and women?





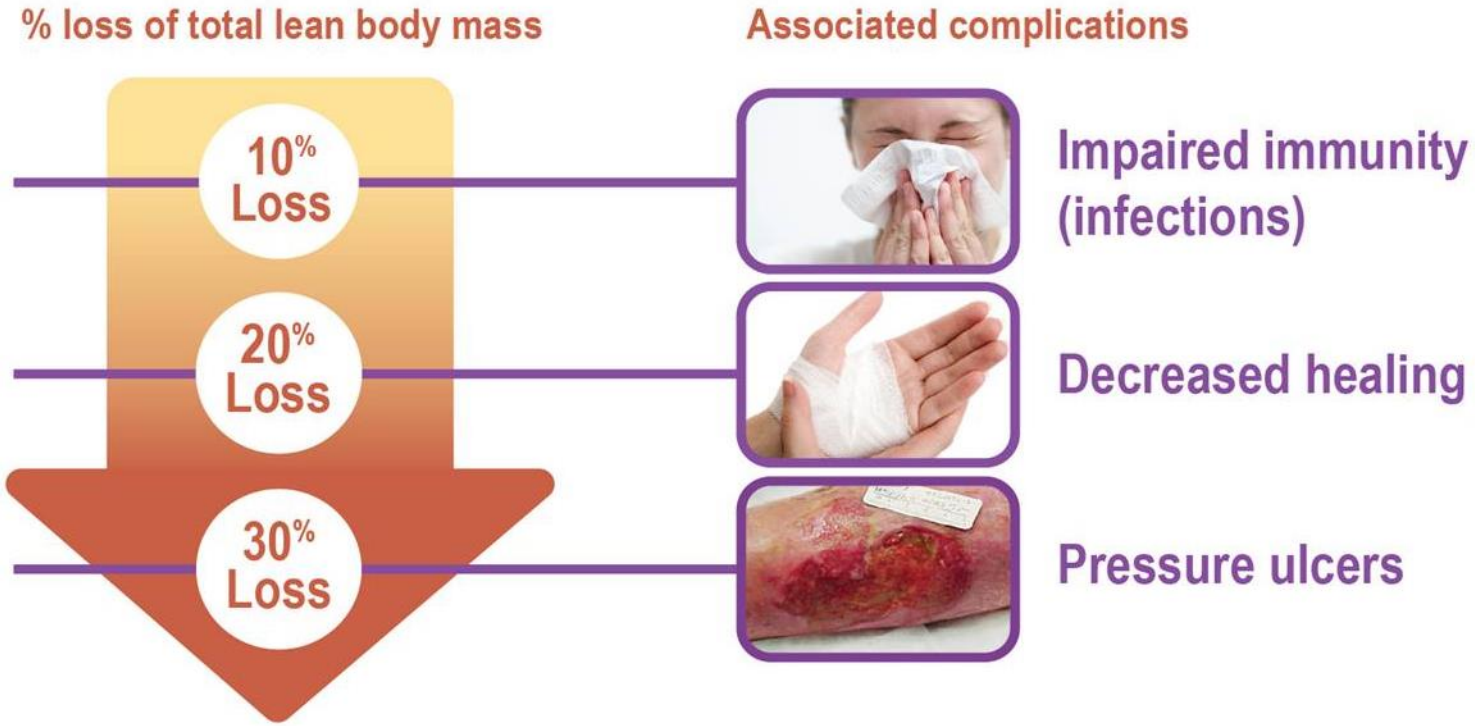
Janssen I, Heymsfield SB, Ross R. *J Am Geriatr Soc.* 2002; 50(5):889–896.

Loss of LBM can be debilitating[1-5]

- Loss of physical strength and energy, independence and reduced ADLs
- Increased susceptibility to illness and infection
- Impaired wound healing
- Increased risk of falls and fractures
- Increased risk of disability
  - 3 to 4 times more likely

1. Baumgartner RN et al. *Am J Epidemiol*. 1998;147:755-763.
2. Pichard C et al. *Am J Clin Nutr*. 2002;79:613-618.
3. Baumgartner RN et al. *Am J Epidemiol*. 1998;147:755-763.
4. Pichard C et al. *Am J Clin Nutr*. 2002;79:613-618.
5. Wolfe RR. *Am J Clin Nutr.* 2006;84:475-482.

How does loss of lean body mass affect patients?

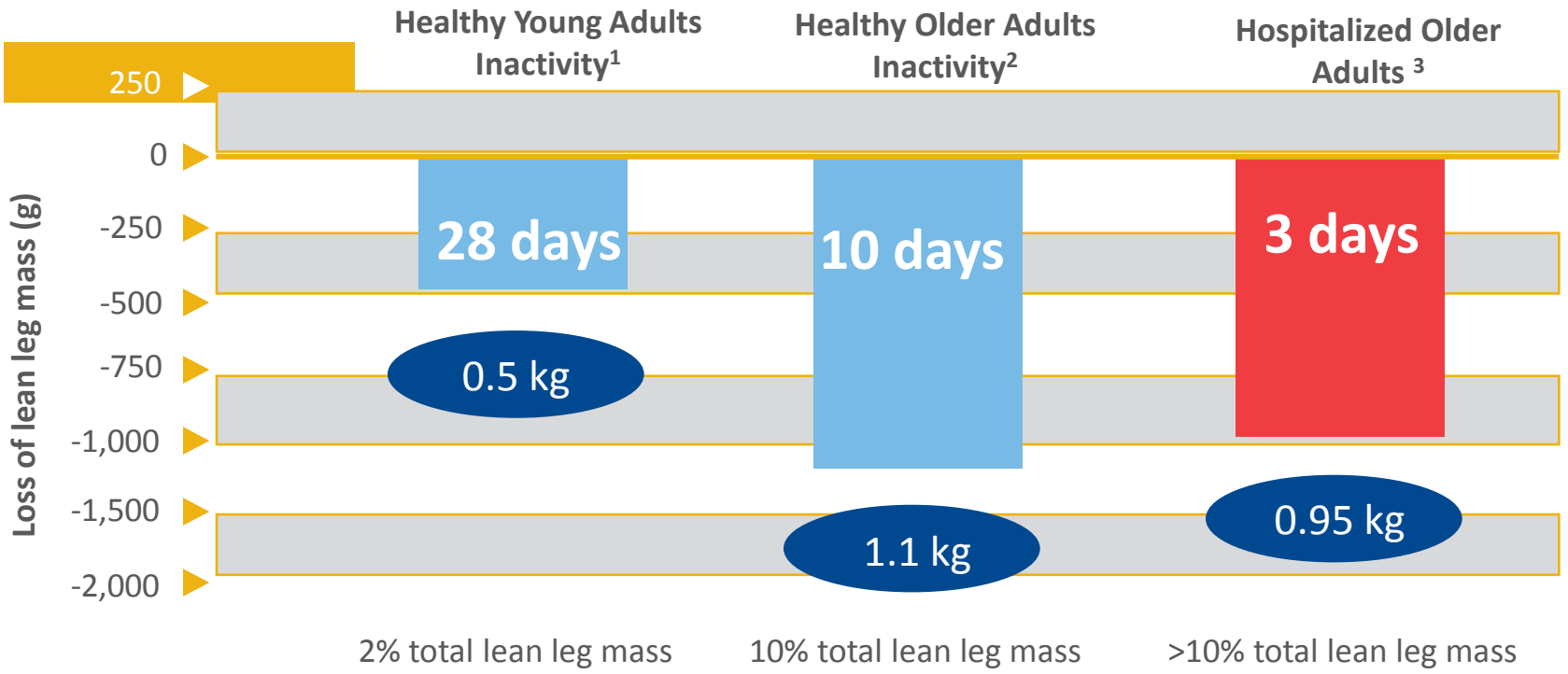


Loss of LBM approaching 40% increases the risk of death – usually from pneumonia.

Demling RH. *Eplasty*. 2009;9:65-94

Bed rest or hospitalization is associated with loss of muscle mass

LBM LOSS ASSOCIATED WITH BED REST OR HOSPITALIZATION IN HEALTHY YOUNG ADULTS, HEALTHY AGING ADULTS, AND HOSPITALIZED OLDER PATIENTS



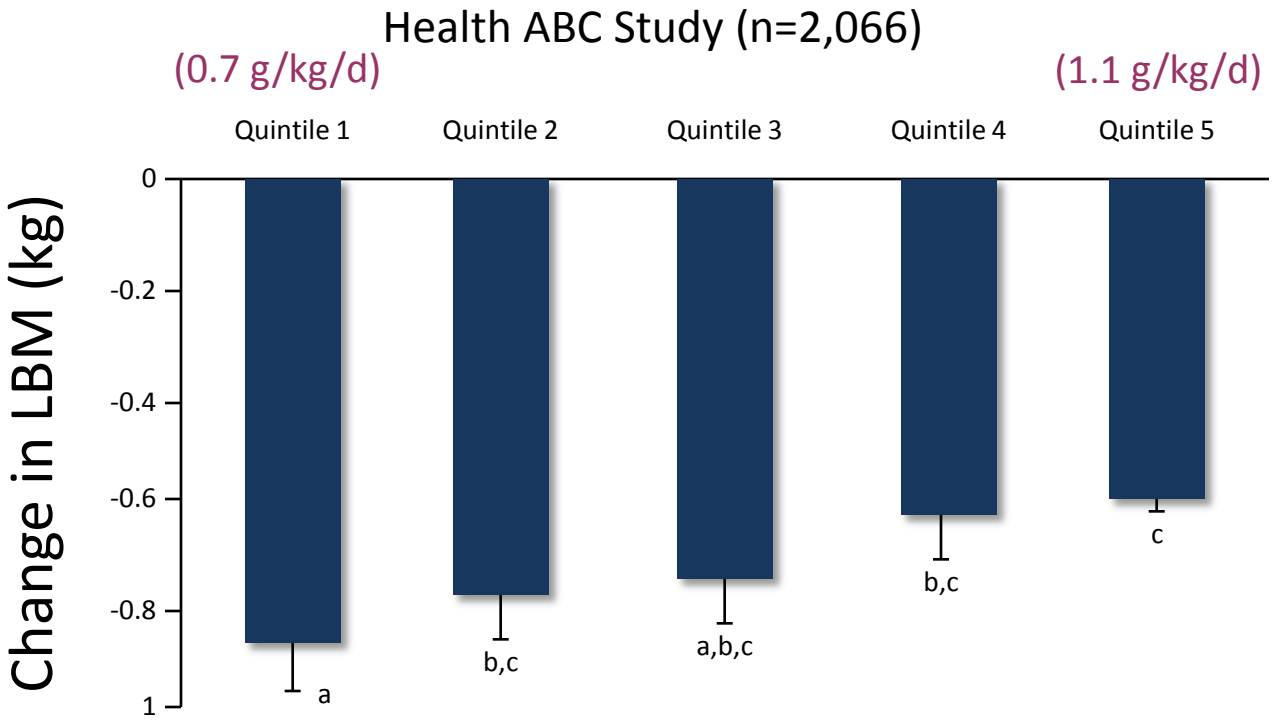
1. Paddon-Jones D, et al. *J Clin Endocrinol Metab*. 2004;89:4351-4358.
2. Kortebein P, et al. *JAMA*. 2007;297:1772-1774.
3. Paddon-Jones D. 110th Abbott Nutrition Research Conference; June 23-25, 2009; Columbus, Ohio.

Are protein needs are greater for older adults?

- RDA for protein (0.8 g/kg/day) insufficient to maintain muscle mass and nitrogen balance
- 40% of people ≥70 years do not meet RDA for protein
- >50% do not consume full meal
  - 6-8% of patients are offered nutritional supplementation

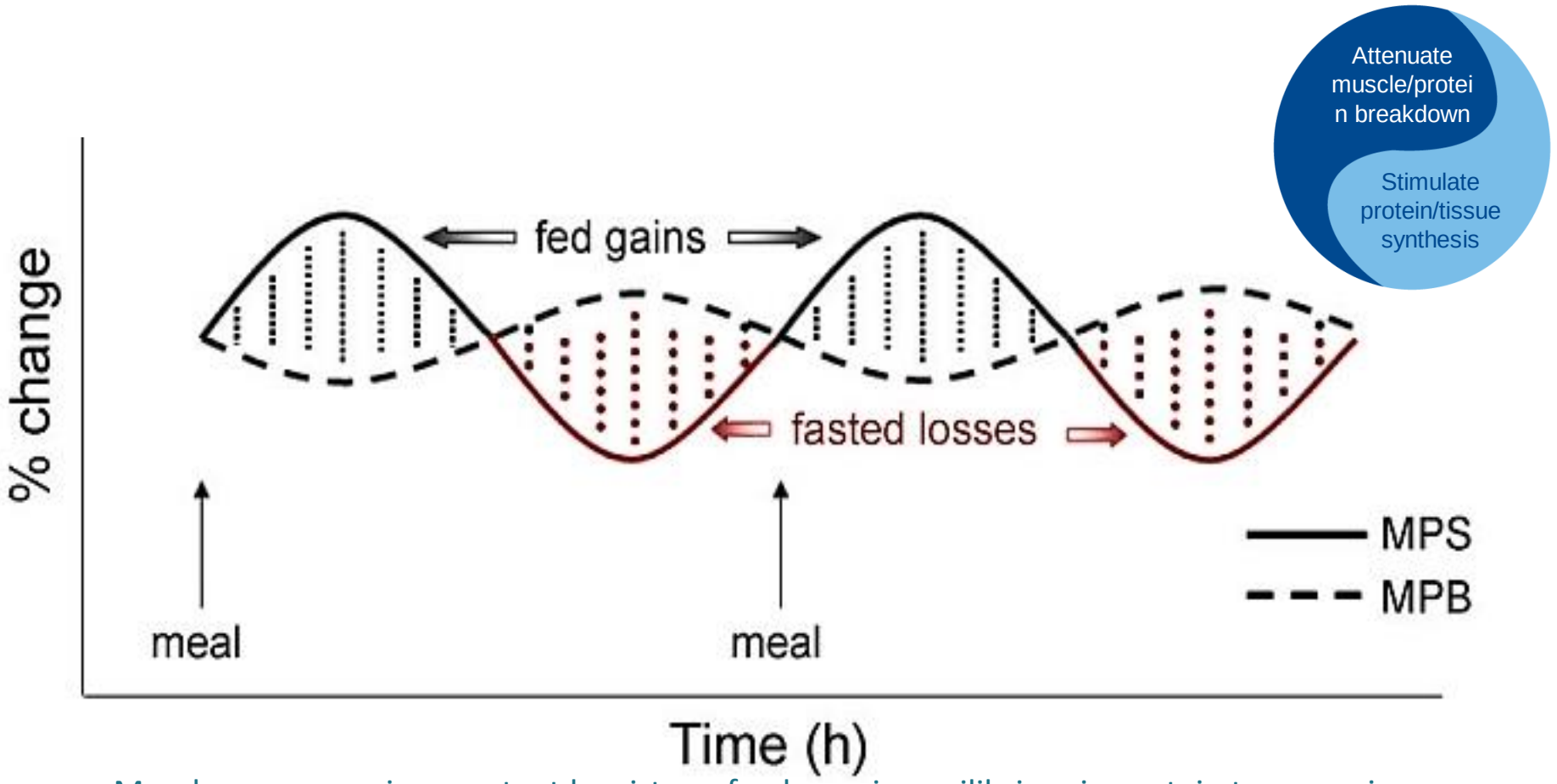
Kortebein P, et al. *JAMA*. 2007;297:1772-1774.
Paddon-Jones D. *Am J Clin Nutr*. 2008;87:1562S-6S.
Paddon-Jones D. *Curr Opin Clin Nutr Metab Care*. 2009;12:86-90
Houston DK, et al *AJCN* 2008;87:150-5.
Hiesmayr M, et al *Clin Nutr* 2009;28:484-491

Dietary Protein Intake and Change in LBM in Elderly



Houston DK et al. *Am J Clin Nutr* 2008;87(1):150-155.

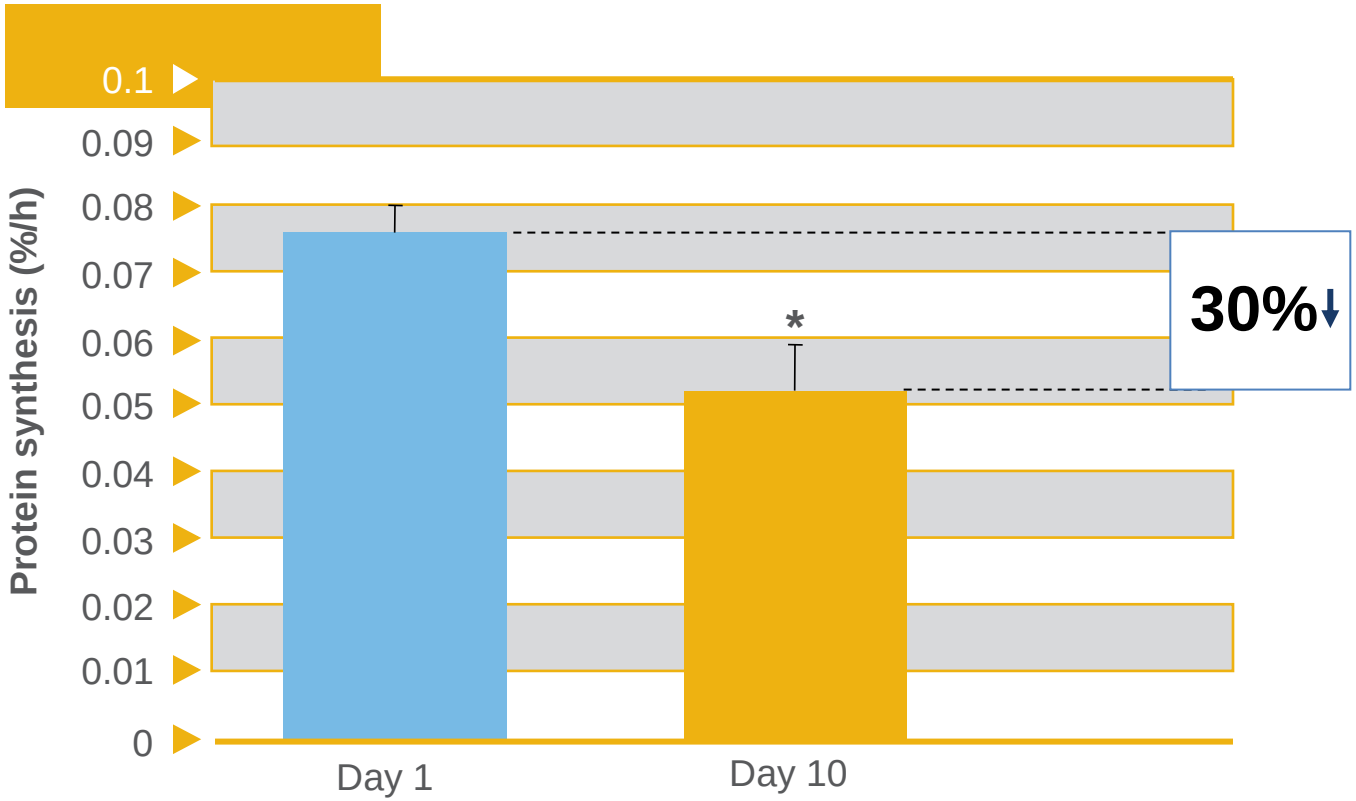
Governance of Skeletal Muscle Mass



Muscle mass remains constant by virtue of a dynamic equilibrium in protein turnover i.e. MPB>MPS [fasted], MPS>MPB [fed]

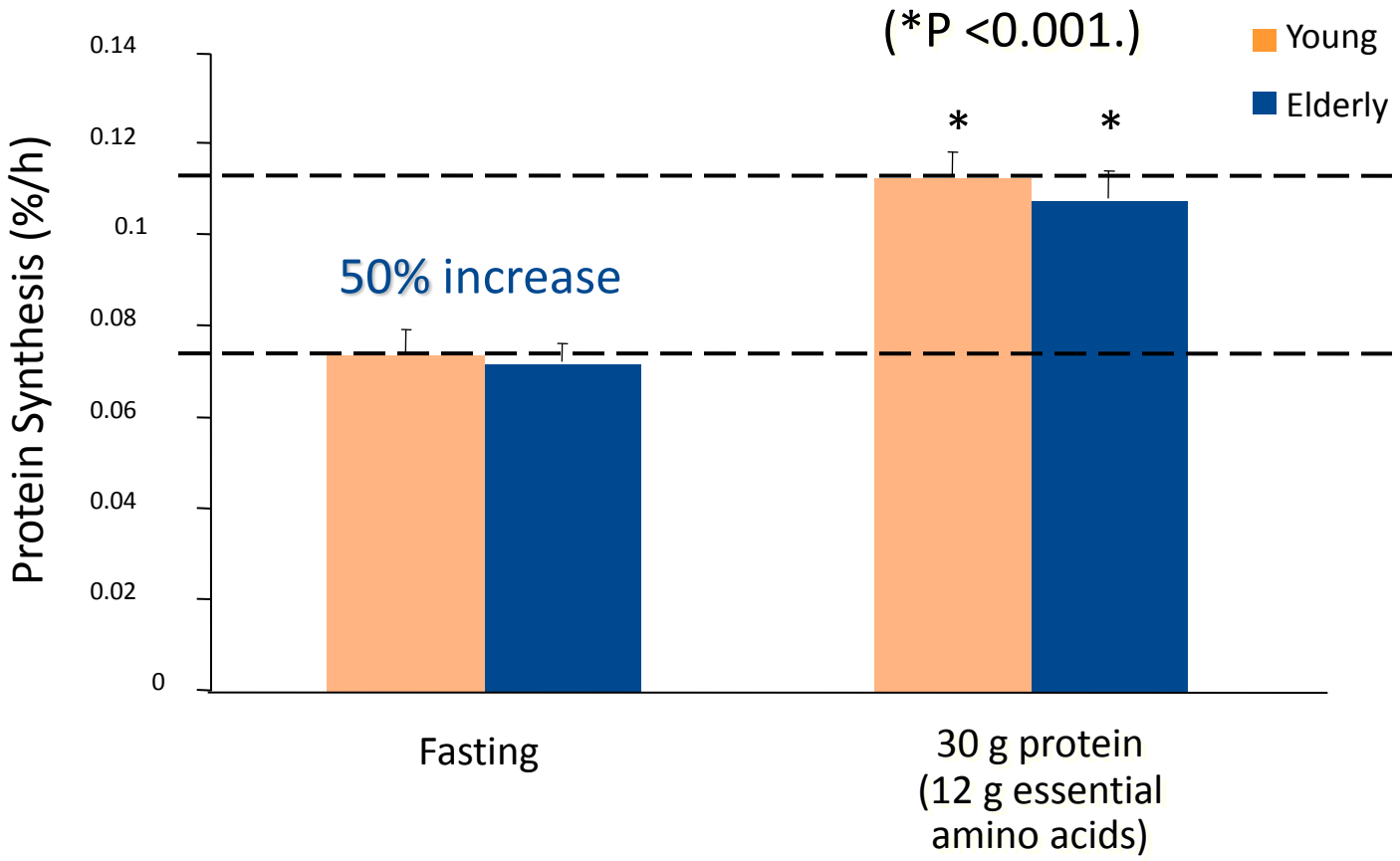
Inactivity reduces muscle protein synthesis in older adults

▶ 24-HOUR MUSCLE PROTEIN SYNTHESIS DURING 10 DAYS OF INACTIVITY IN ELDERS (STABLE ISOTOPE METHODOLOGY)



Kortebein P, et al. *JAMA*. 2007;297:1772-1774.

Intact Protein Increases Muscle Protein Synthesis

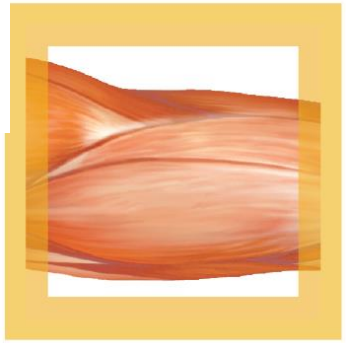


N=20 healthy volunteers Young: 41±8 years,
n=10 Elderly: 70±5 years, n=10

Symons TB et al. *Am J Clin Nutr.* 2007;86:451-456.

Key takeaways

1. Protein sources vary in amino acid composition and therefore quality
2. Protein needs change through the lifespan and with exercise, catabolic stress, recovery, etc.
3. Muscle mass is key to strength, physical activity and immunity
4. Protein is important for helping to maintain LBM and muscle health



Questions?

Thank you for your attention.