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Protein Requirements for Optimal Health in Older Adults: Current Recommendations and New Evidence

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Outline

- Current recommendations for protein intake
- Protein intake and physical function in older adults
- Anabolic resistance
- Importance of protein quantity and intake distribution pattern
- Special considerations for hospitalized older adults
- Conclusions

Current Recommendations

Dietary Reference Intakes (DRI) for protein for healthy adults of any age:

- Estimated Average Requirement: 0.66 g/kg/day
  - Minimum protein amount to avoid deficiency in 50% of the population
- Recommended Dietary Allowance: 0.8 g/kg/day
  - Minimum amount to avoid deficiency in 97 - 98% of the population

Acceptable Macronutrient Distribution Range (AMDR) for protein:

- 10 - 35 % of total energy (35 kcal/kg/day)
- 0.85 - 3 g/kg/day

Problems with Current Recommendations

- Applicable only to healthy people
- Based on nitrogen balance studies, mostly done in younger people
  - Highly controlled with small number of subjects
  - Difficult estimation of intake and losses
  - Meaning of N balance
  - Protein sparing effect of low protein diet
  - 0 balance inadequate in people who already lost lean mass
- Lower end of AMDR range is higher than RDA
- Minimalistic approach
  - Avoiding deficiency vs. optimal intake for health

Why is Dietary Protein So Important?

- Provides amino acids for general cell function, and is particularly important for:
  - Muscle growth and homeostasis
  - Immune function
  - Skin integrity
  - Gut function
  - Neurotransmitters
- Unlike fat and glucose, there is no inactive storage for protein
  - Skeletal muscle serves as storage for protein

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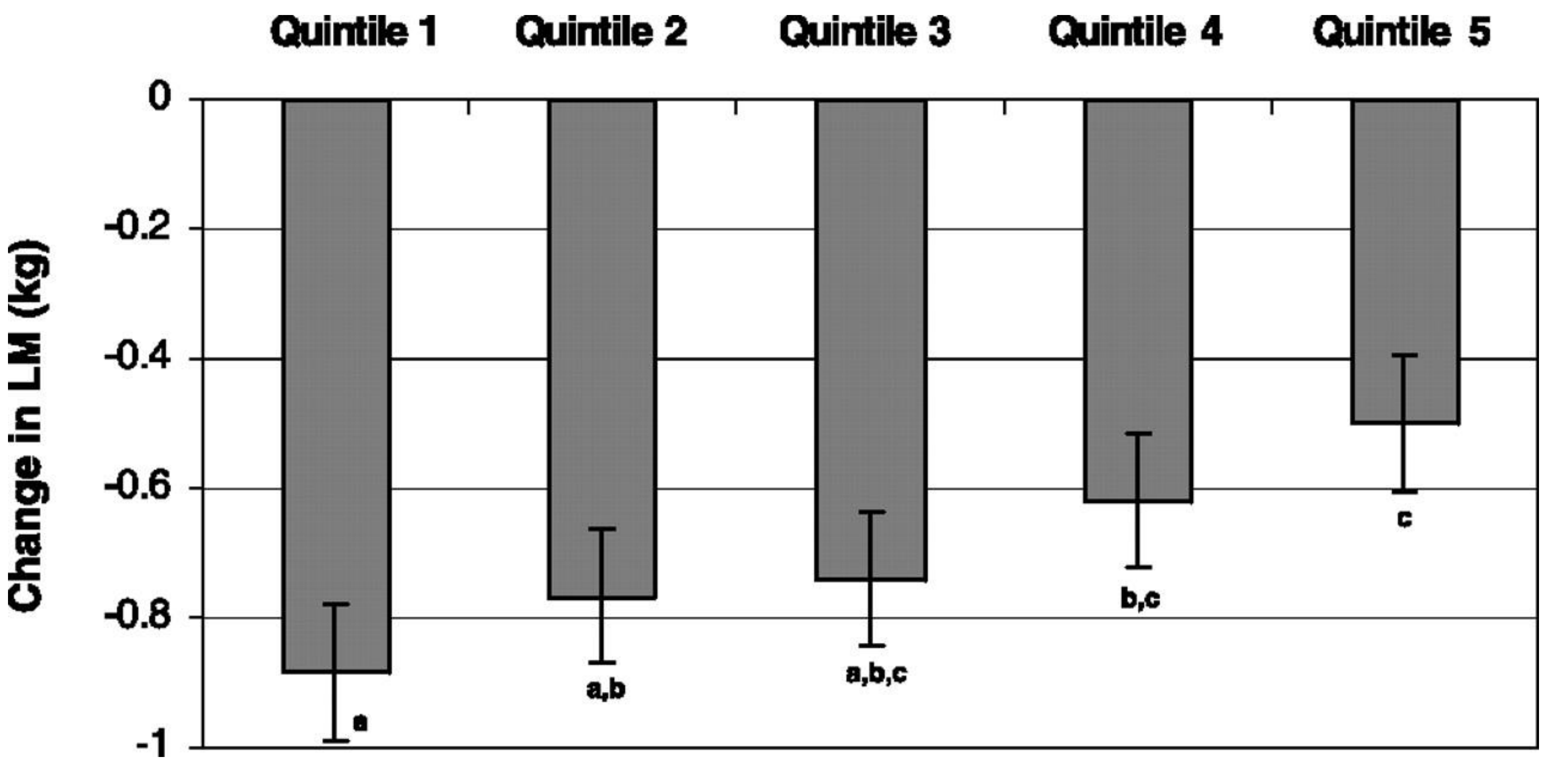
Protein Intake and Muscle Loss with Aging

Health ABC Cohort

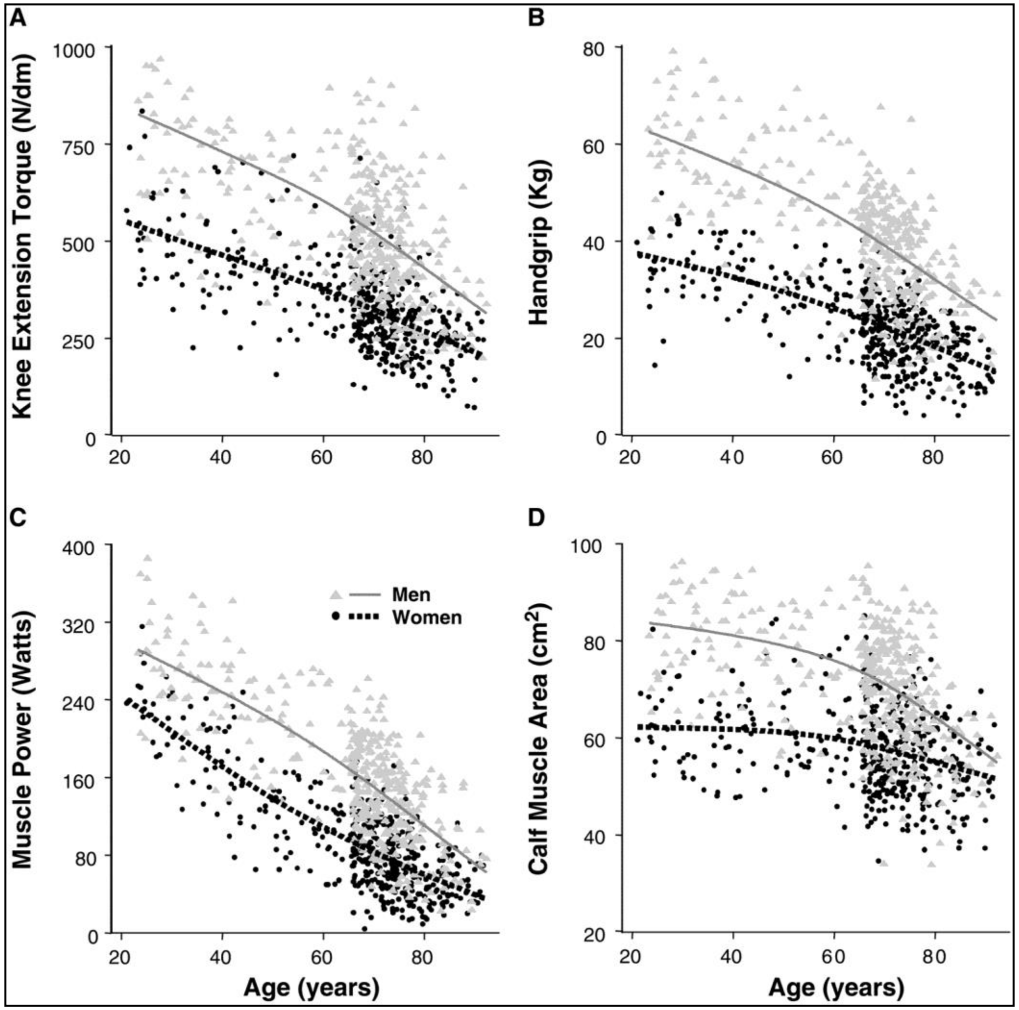
Energy-adjusted total protein intake



Unadjusted protein intake	0.8±0.3	0.7±0.3	0.8±0.3	0.9±0.3	1.2±0.4

Houston DK et al. Am J Clin Nutr 2008

Sarcopenia



Diagnostic Criteria of the European Working Group

1. Low muscle mass

+

2. Low muscle strength

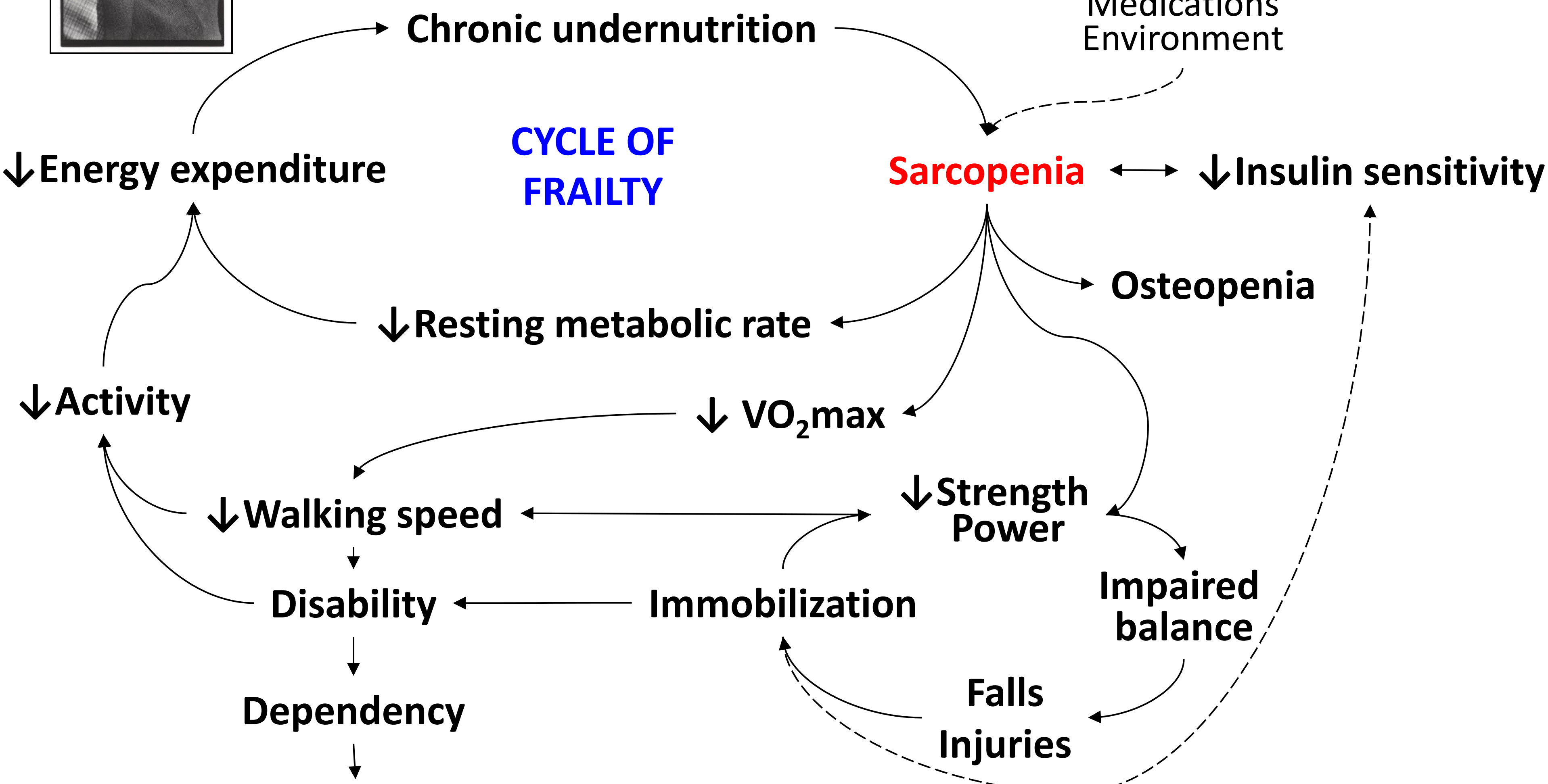
or

3. Low physical performance

Cruz-Jentoft AJ et al. Age & Ageing 2010

InChianti Cohort - Lauretani et al. J Appl Physiol 2003

Frailty and Sarcopenia

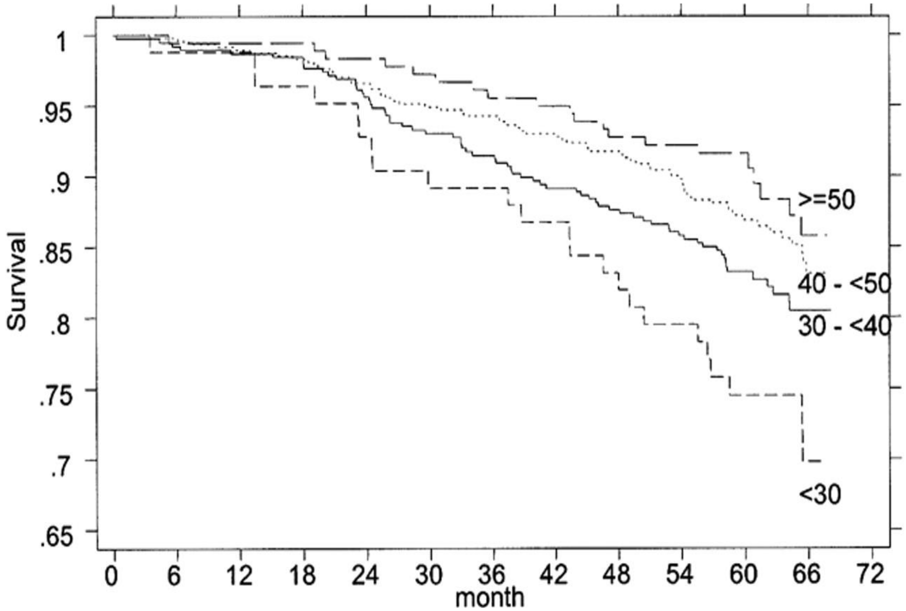


Modified from Fried et al. Sci. Aging Knowl. Environ. 2005

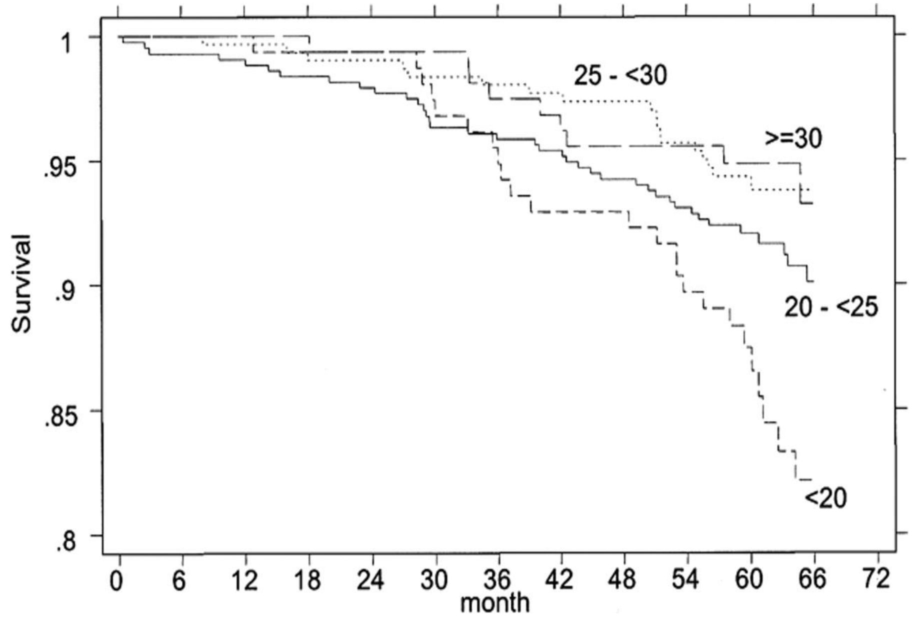
Strength and Mortality in Older Adults

Health ABC Study

2,292 healthy older adults, 70-79 yr at enrollment



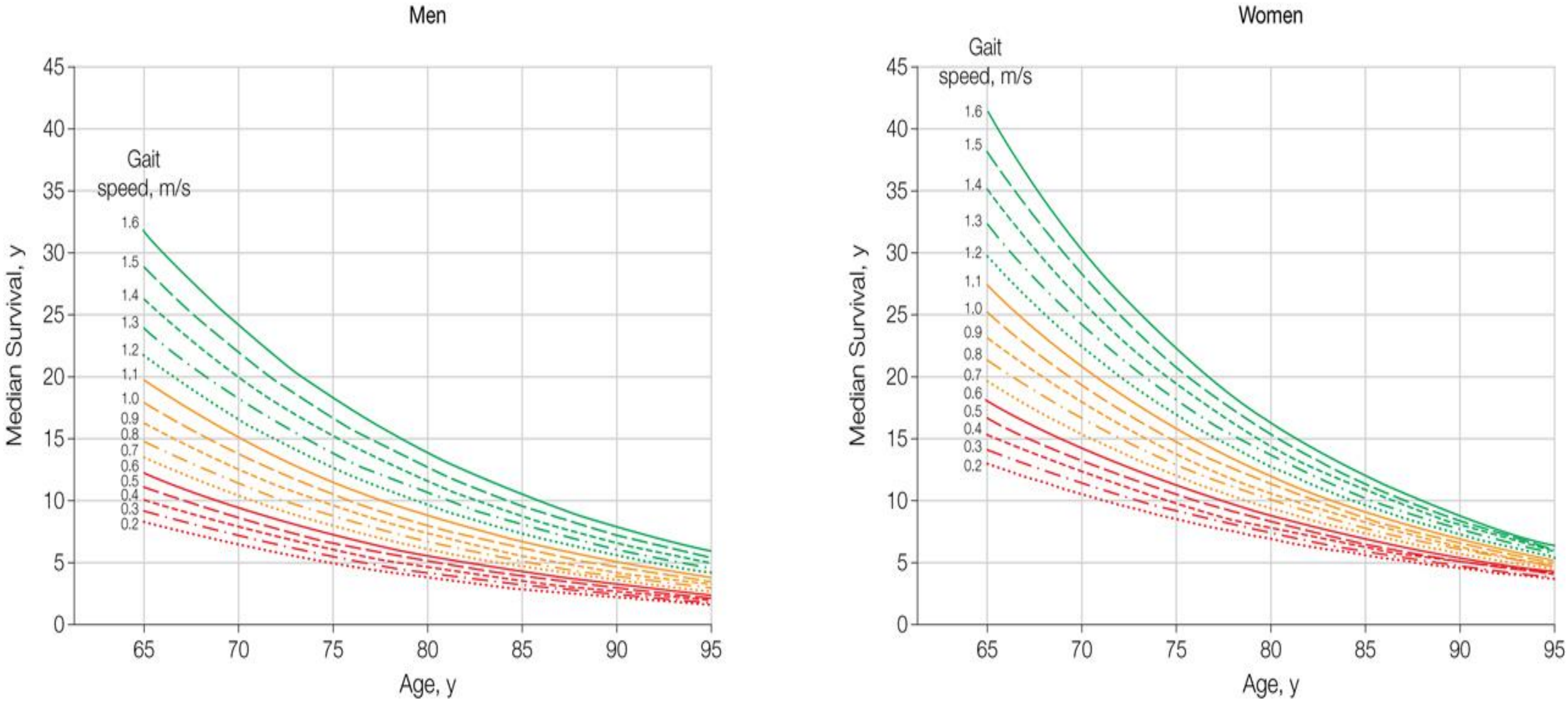
Men



Women

Newman et al. J Gerontol A Biol Sci Med Sci, 2006

Gait Speed Predicts Median Life Expectancy in Older Adults



Pooled analysis of 9 cohort studies
N = 34,485

Studenski S et al. JAMA 2011 JAMA

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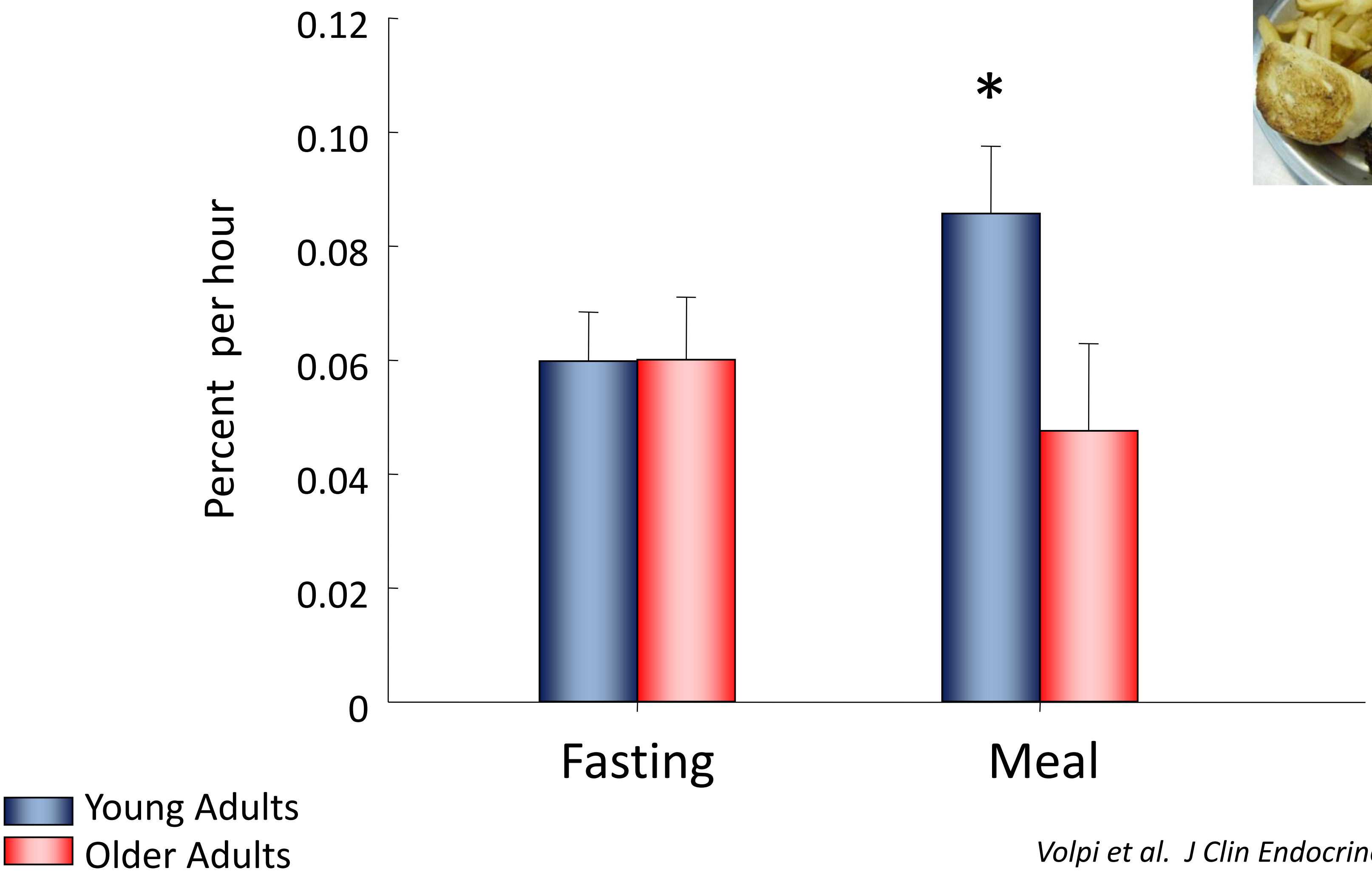
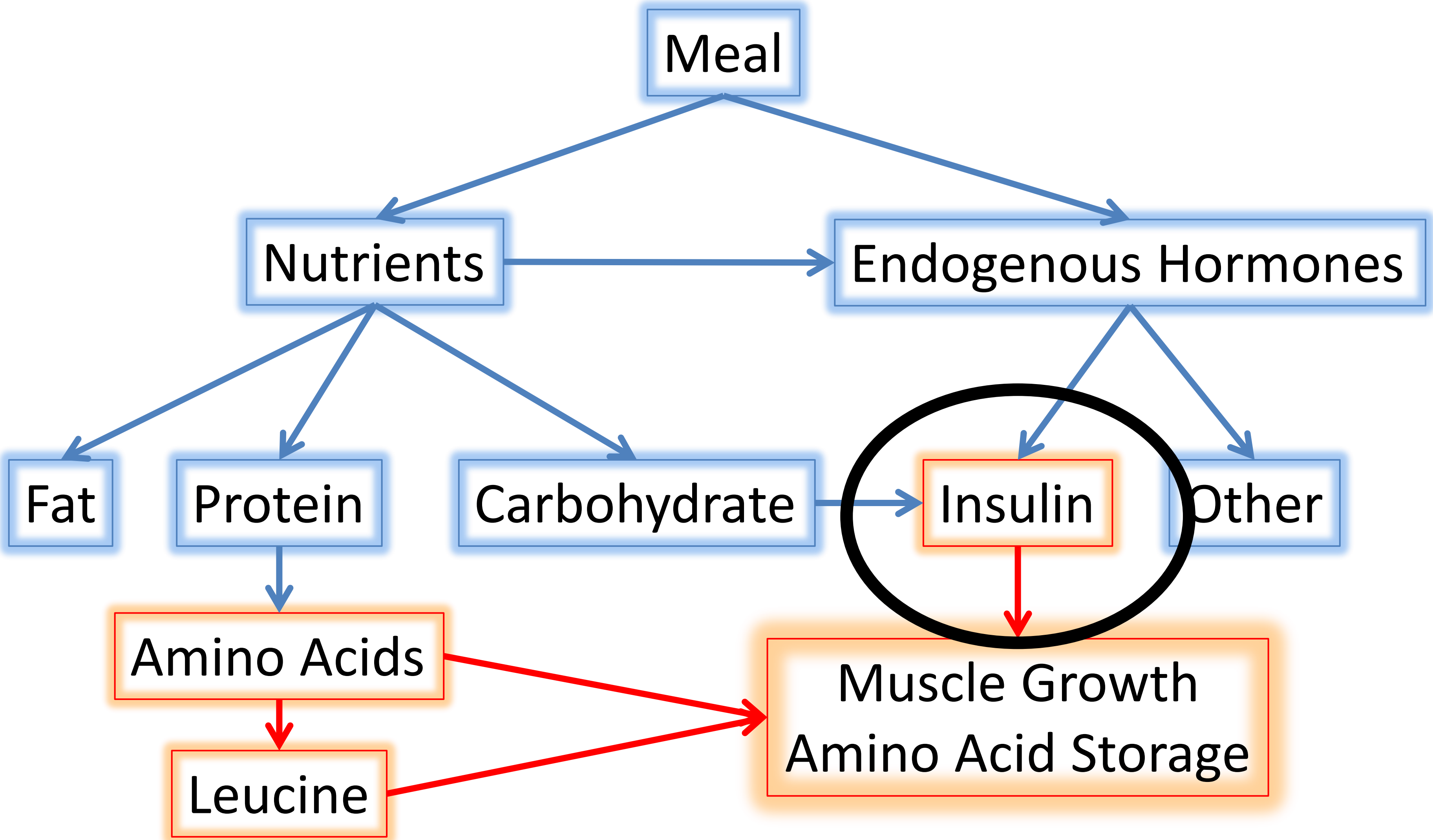
Aging Attenuates the Meal Stimulated Increase in Muscle Protein Synthesis

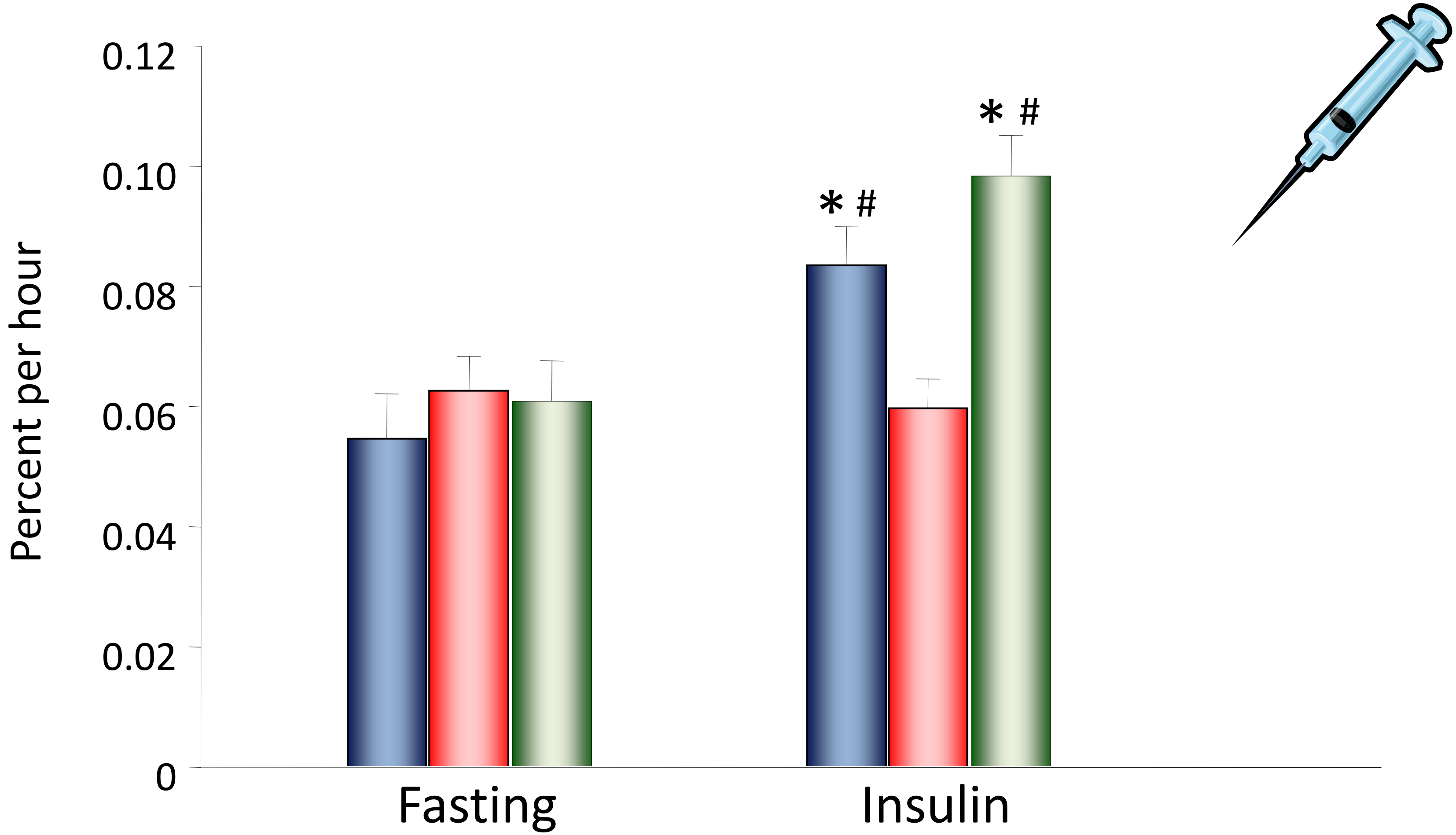


Volpi et al. J Clin Endocrinol Metab, 2000

What Are the Mechanisms of Anabolic Resistance to a Meal with Aging?



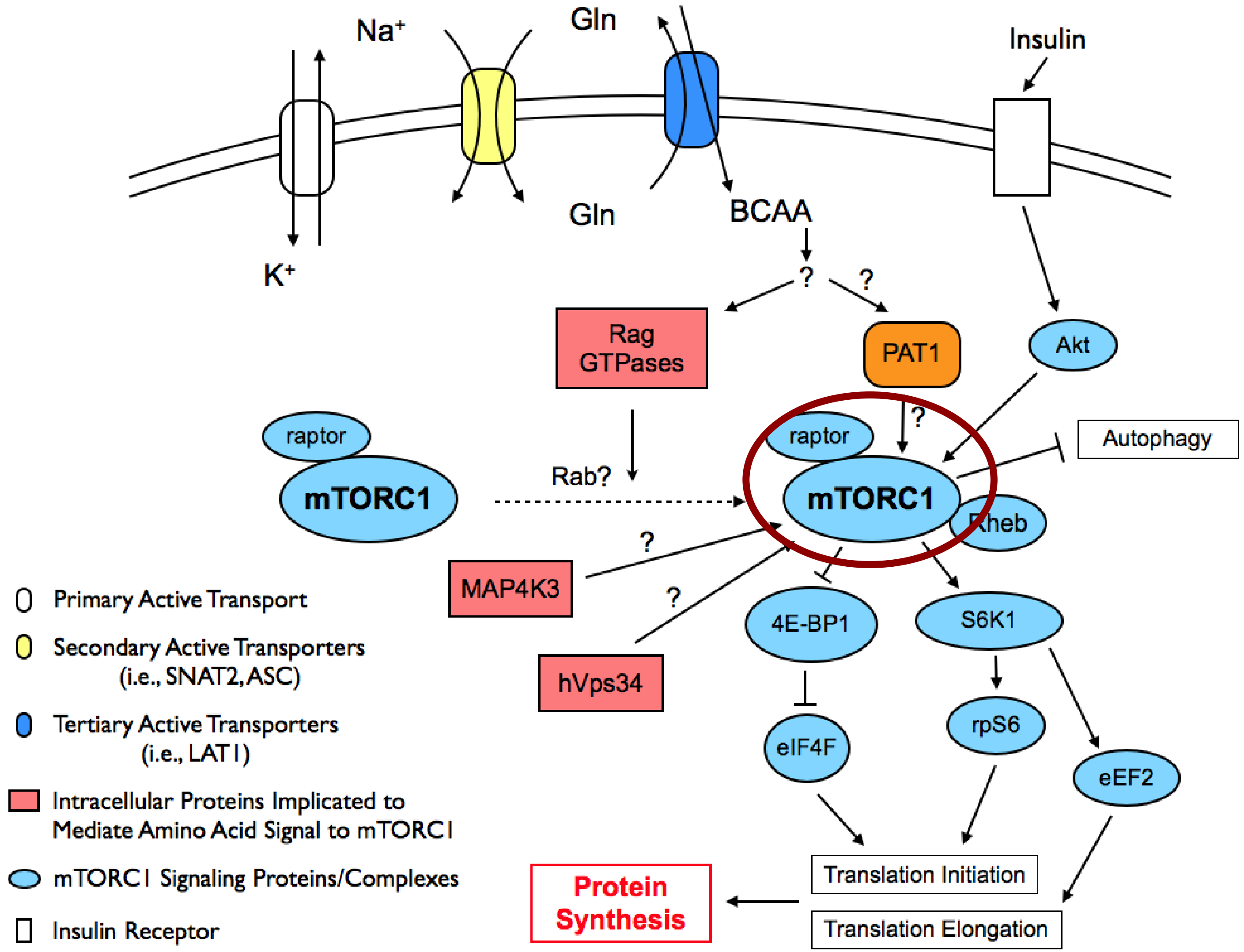
Muscle Protein Synthesis is Resistant to the Anabolic Effect of Insulin in Older Adults



Young Adults Prandial Dose
Older Adults Prandial Dose
Older Adults High Dose

Rasmussen et al., FASEB J, 2006
Fujita et al. Diabetologia, 2009

Cellular Mechanisms of Resistance to Anabolic Stimulation in Older Adults

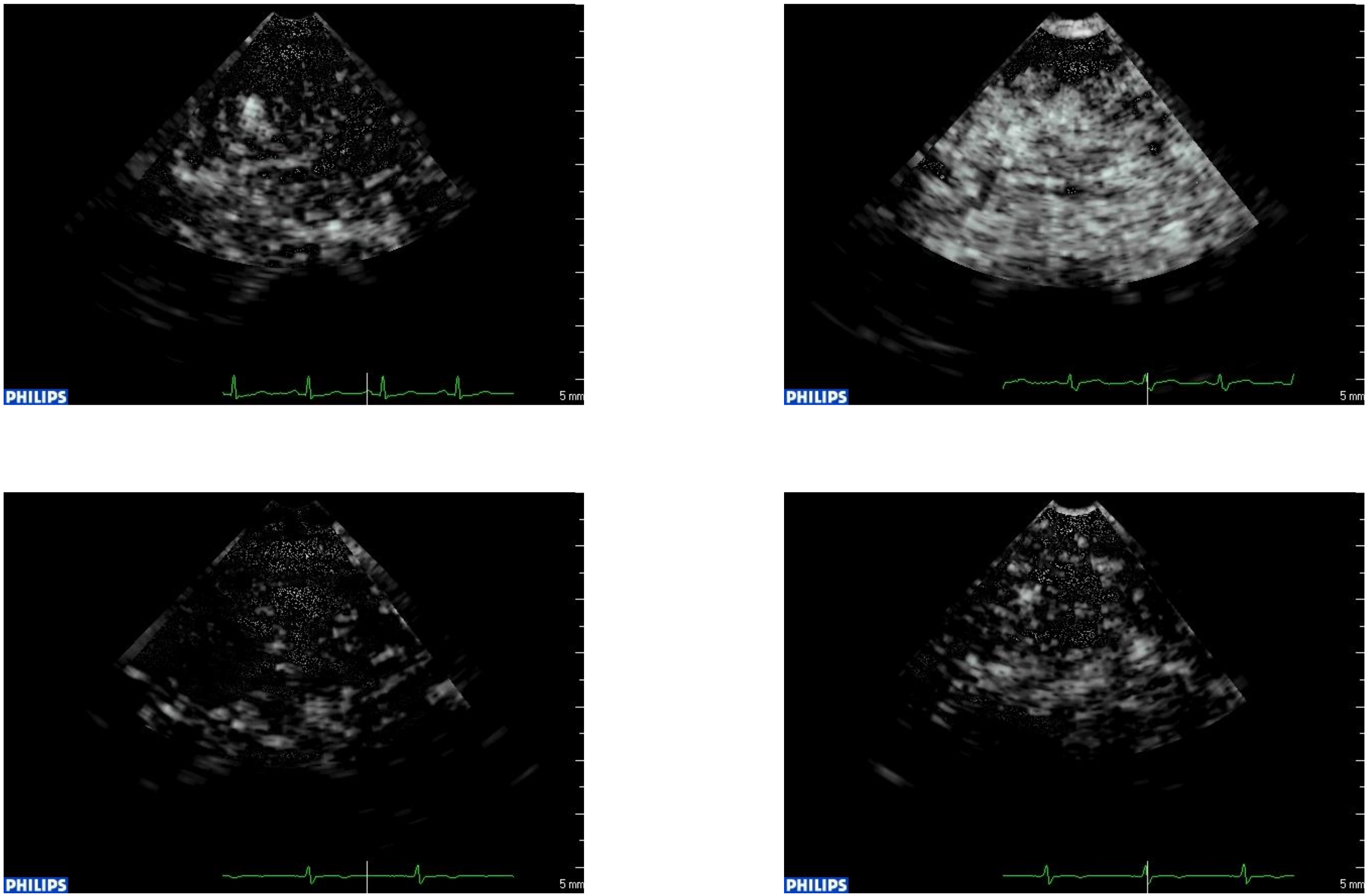


Endothelial Dysfunction Contributes to Anabolic Resistance in Older adults

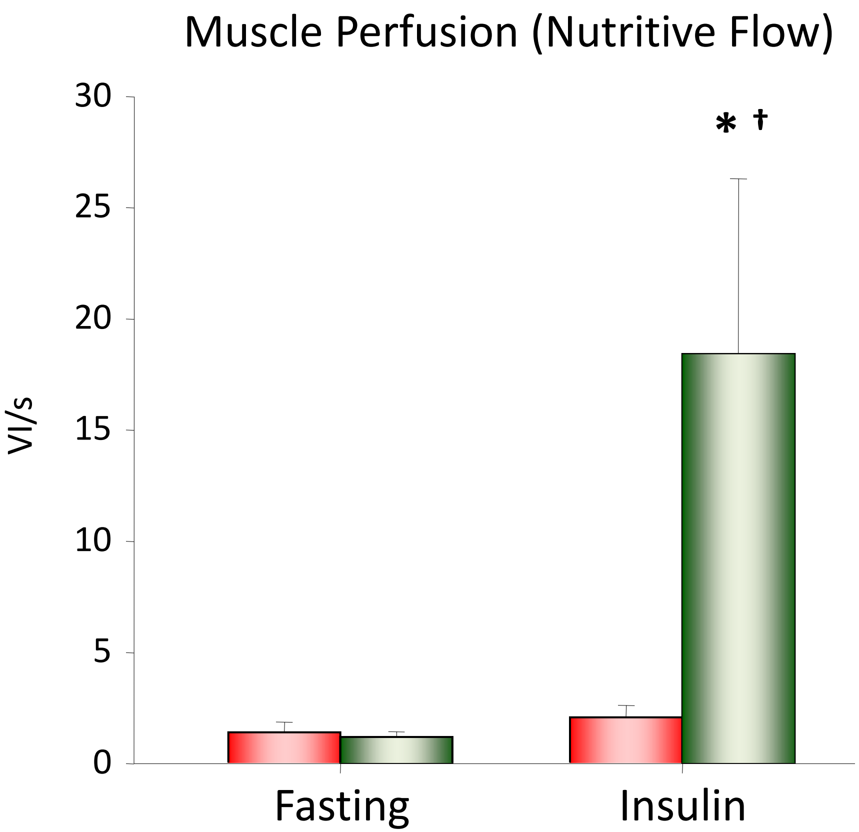
Basal | Insulin

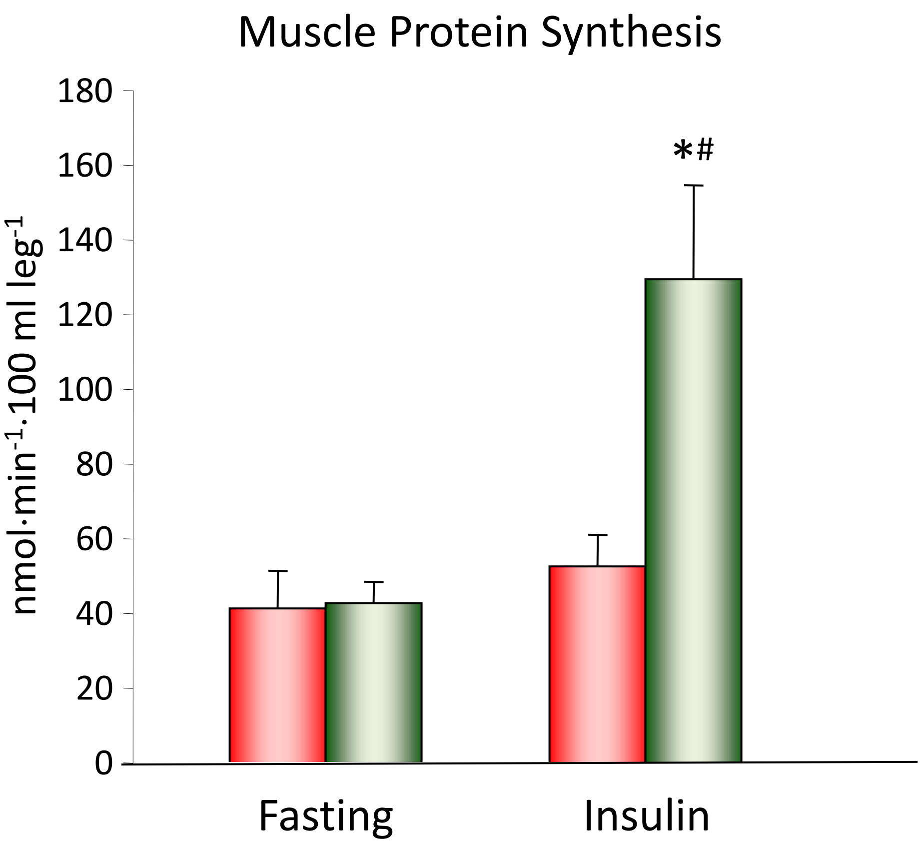
Young Subject

Older Subject



Pharmacological Vasodilation Restores the Anabolic Response of Muscle to Insulin in Older Adults

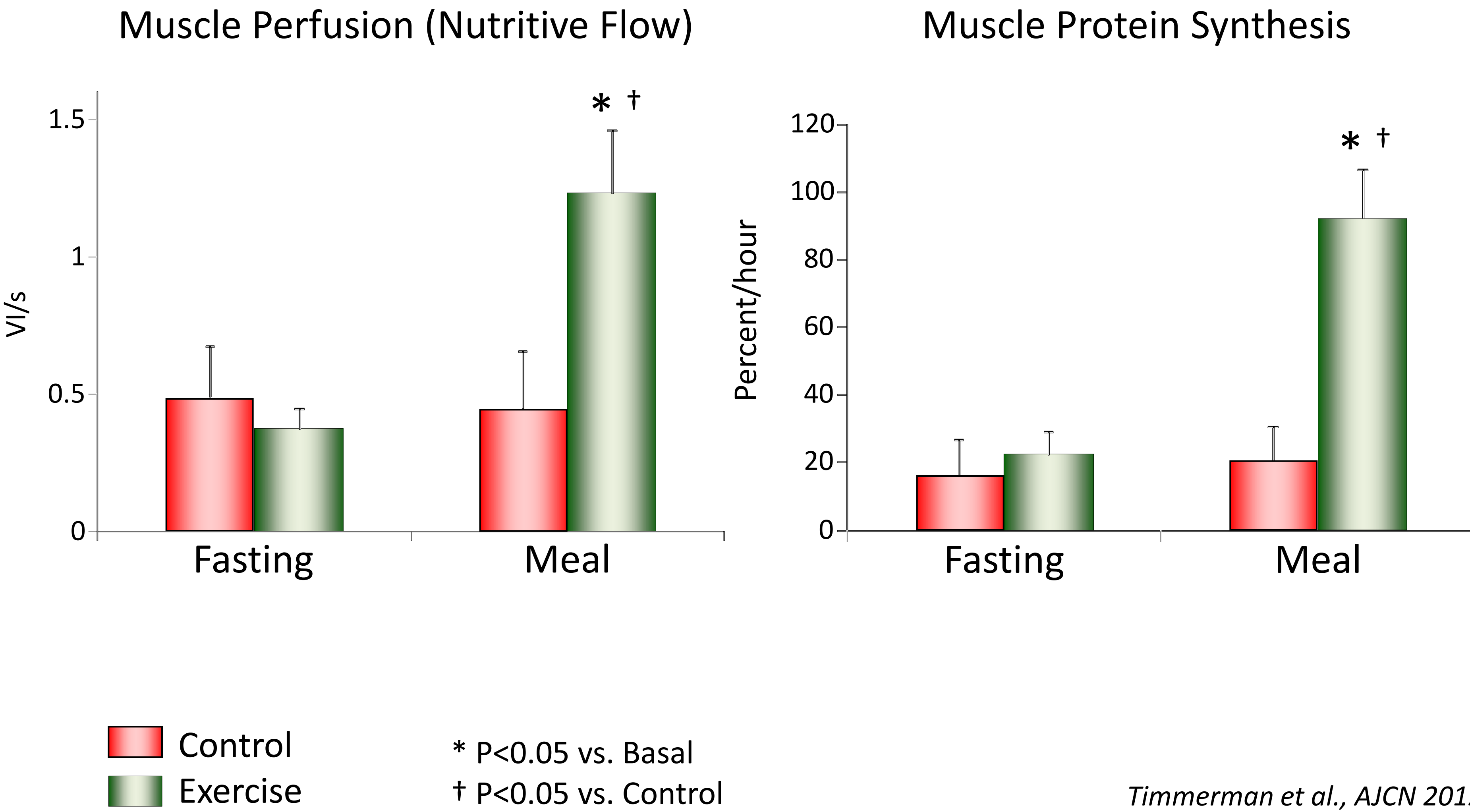




Older Control
Older Sodium Nitroprusside

Timmerman, Lee et al., Diabetes, 2010

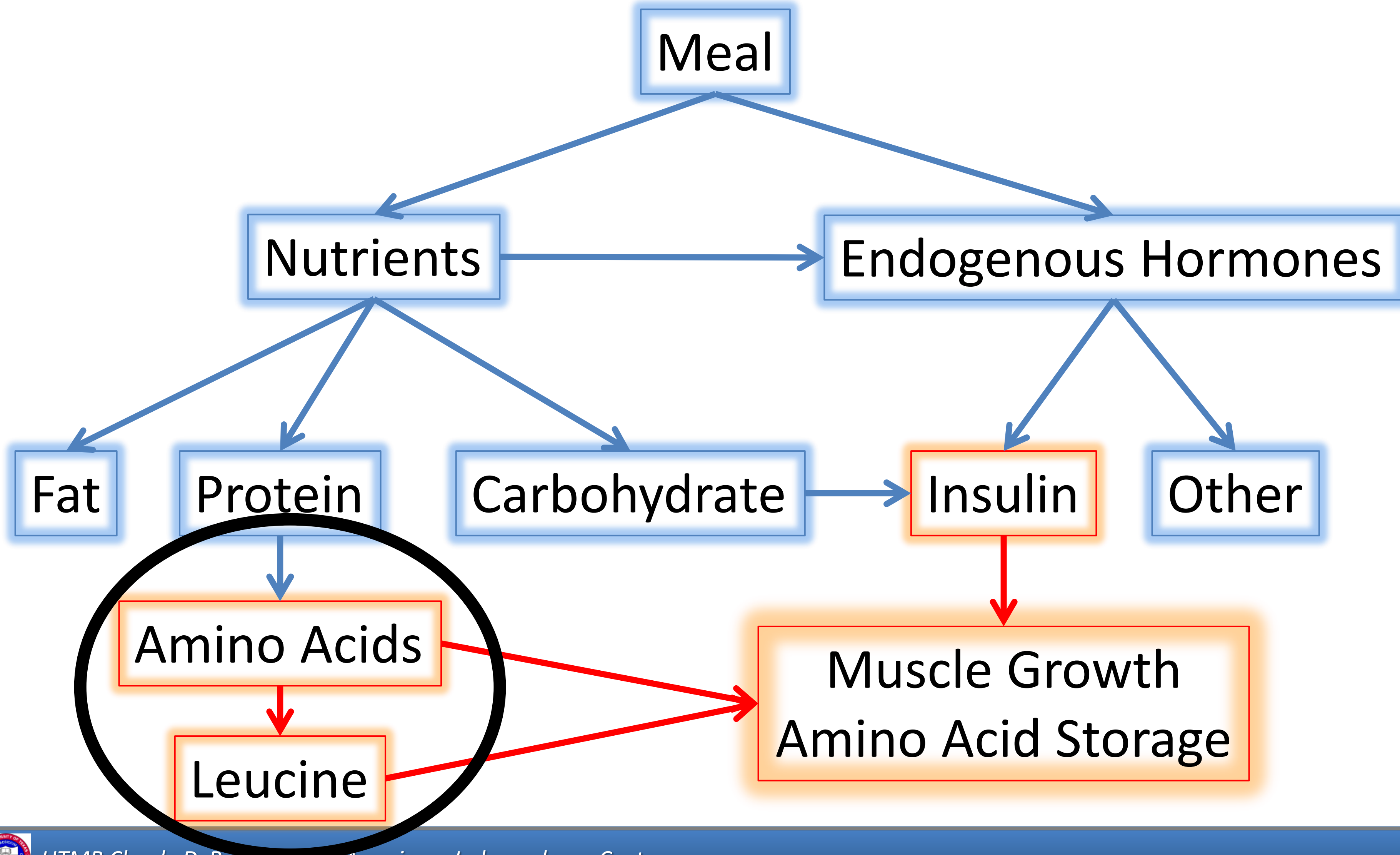
Aerobic Exercise Restores the Muscle Protein Anabolic Response to a Mixed Meal in Elders



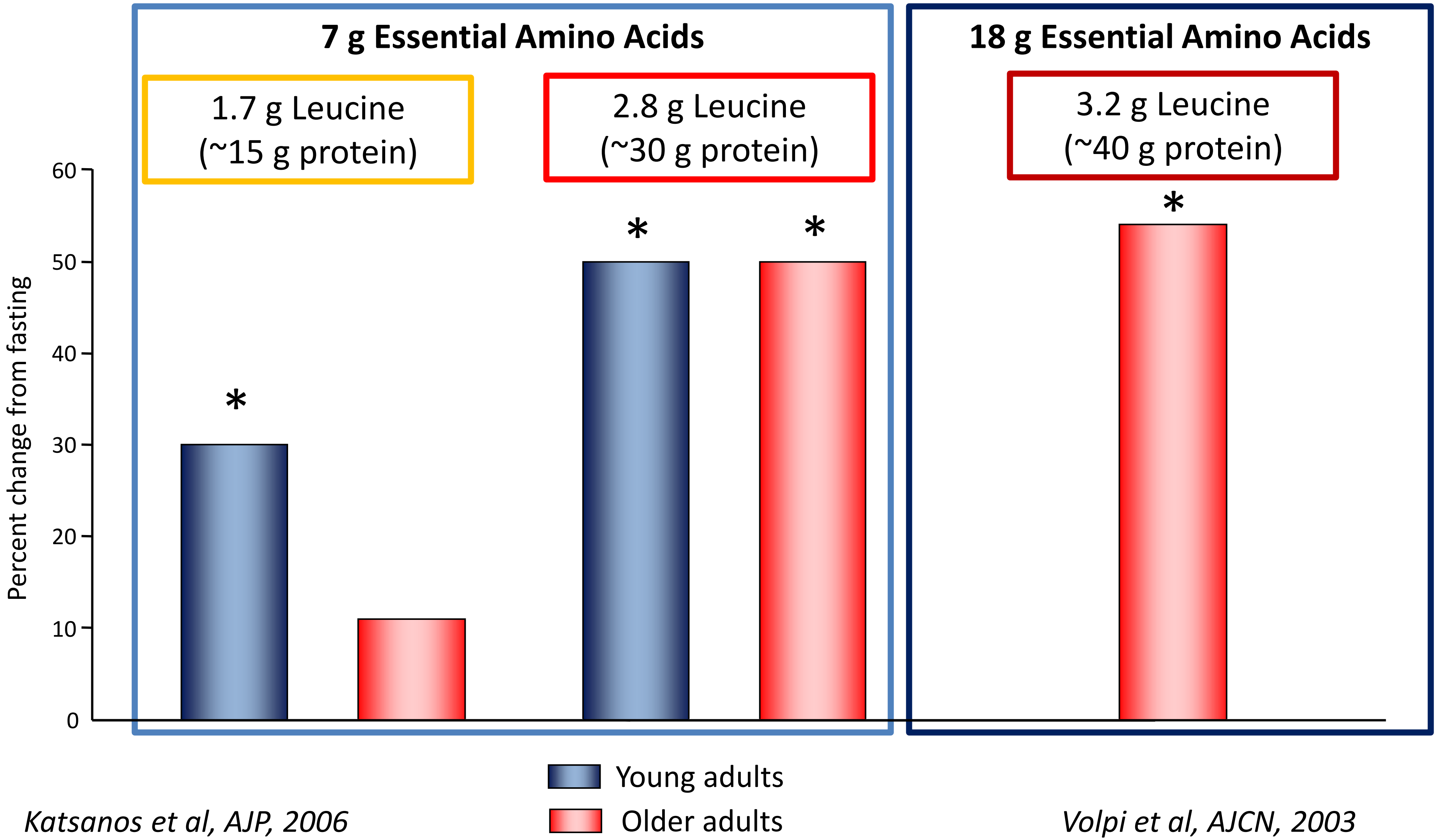
* P<0.05 vs. Basal
† P<0.05 vs. Control

Timmerman et al., AJCN 2012

What Are the Mechanisms of Anabolic Resistance to a Meal with Aging?



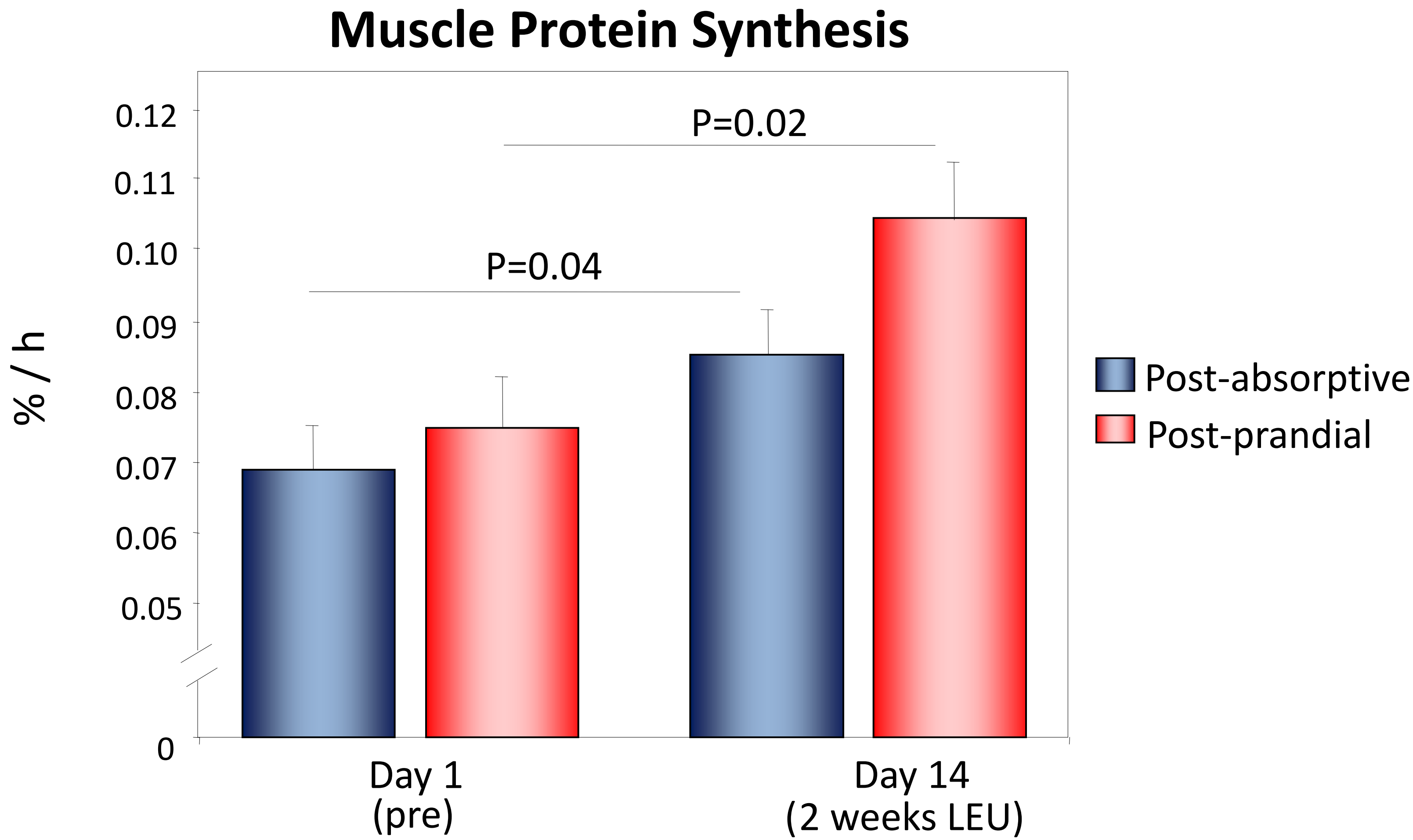
Response of Muscle Protein Synthesis To Essential Amino Acids Depends on Leucine Dose



Katsanos et al, AJP, 2006

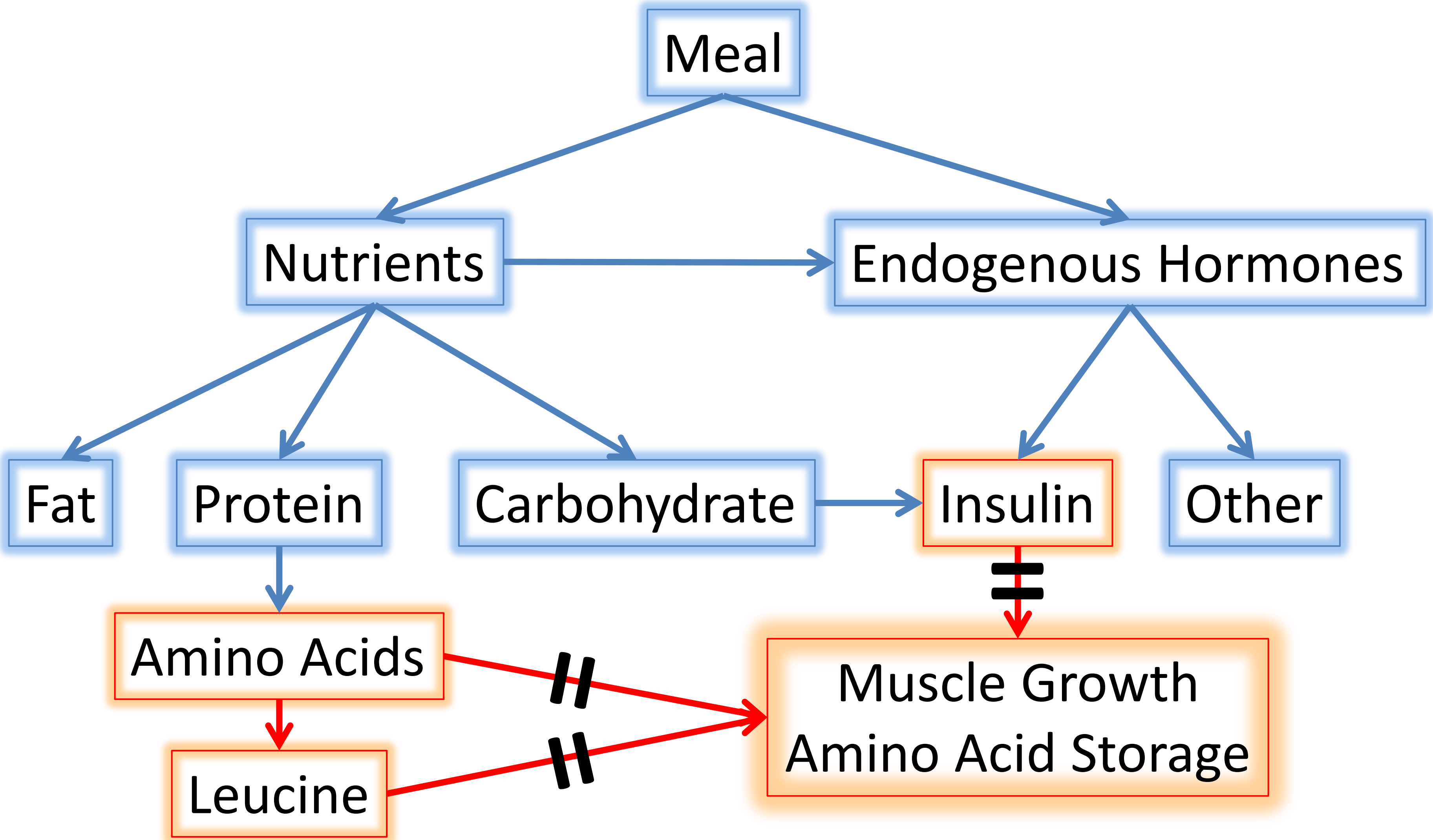
Volpi et al, AJCN, 2003

Supplemental Leucine Optimizes Meal Protein Anabolism in Older Adults



Casperson et al. Clin Nutr, 2012

What Are the Mechanisms of Anabolic Resistance to a Meal with Aging?



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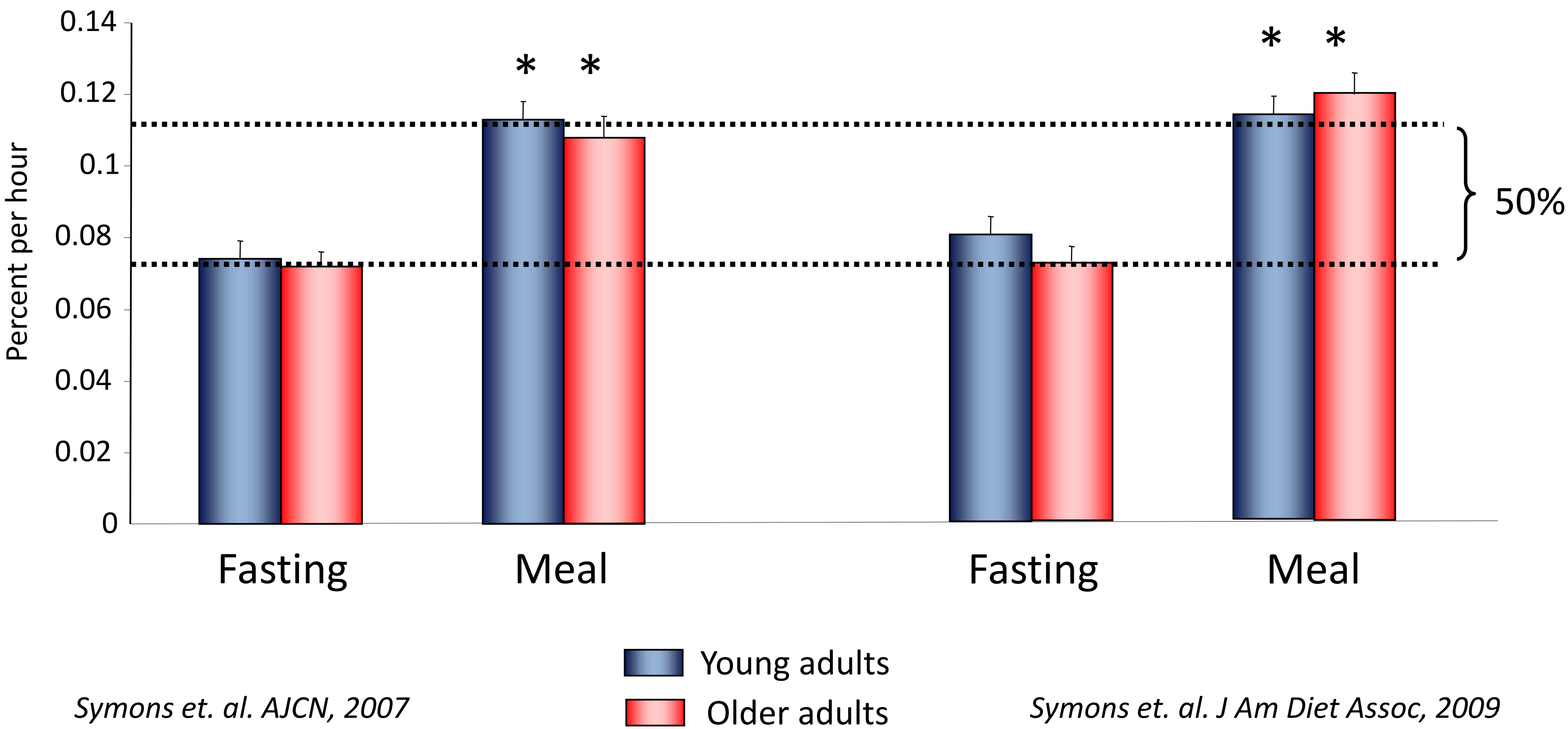
Muscle Protein Synthesis in Older Adults: Protein Meal

30 g of Protein
4 oz beef patty
(~320 kcal)

90 g of Protein
12 oz beef patty
(~960 kcal)



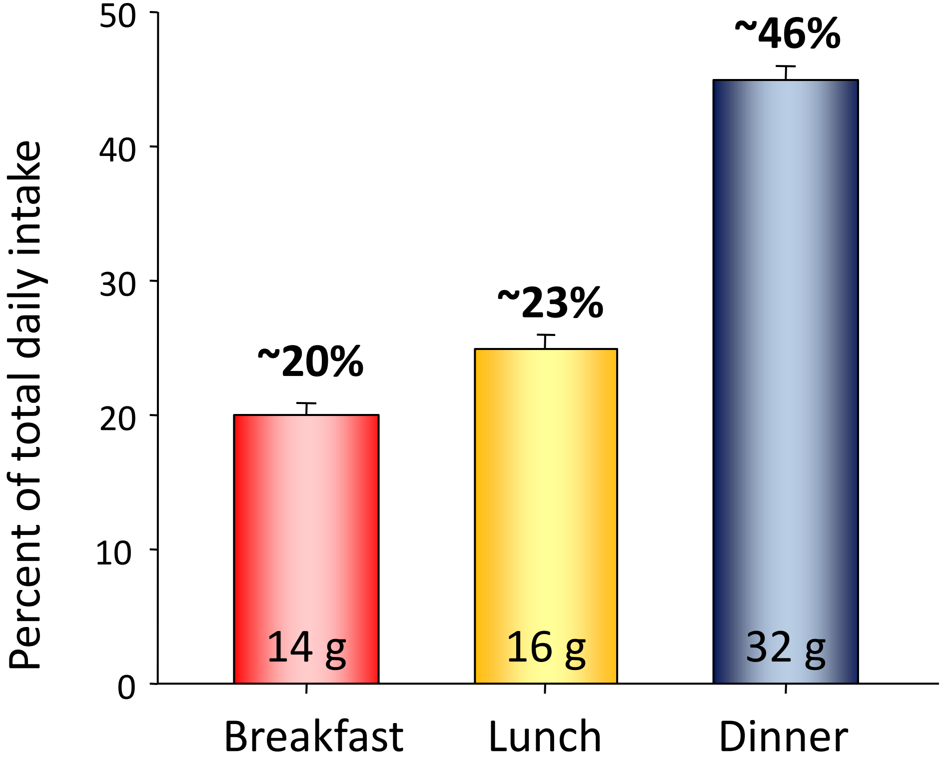
Symons et. al. AJCN, 2007

Symons et. al. J Am Diet Assoc, 2009

Protein Intake Pattern Across Meals in Adults 70 yr and Older

Reported Distribution

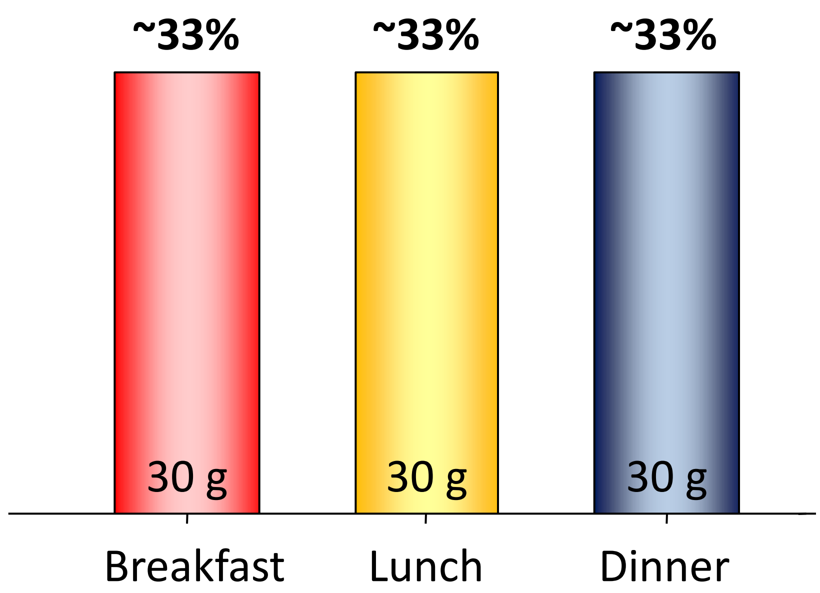
Average reported intake ~1 g/kg



Ideal Distribution

Max. Muscle Protein Synthesis

Calculated ideal intake ~1.3 g/kg

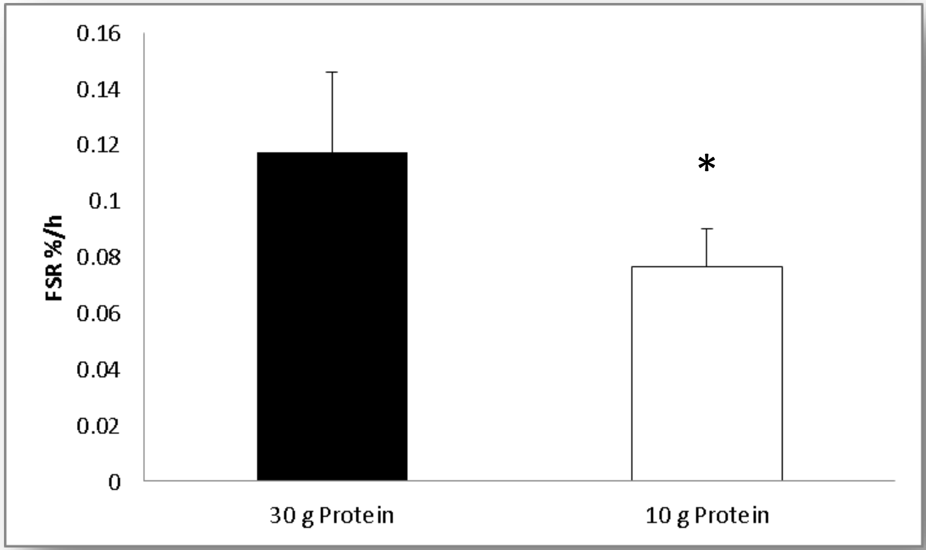


Source: NHANES 2007-2008

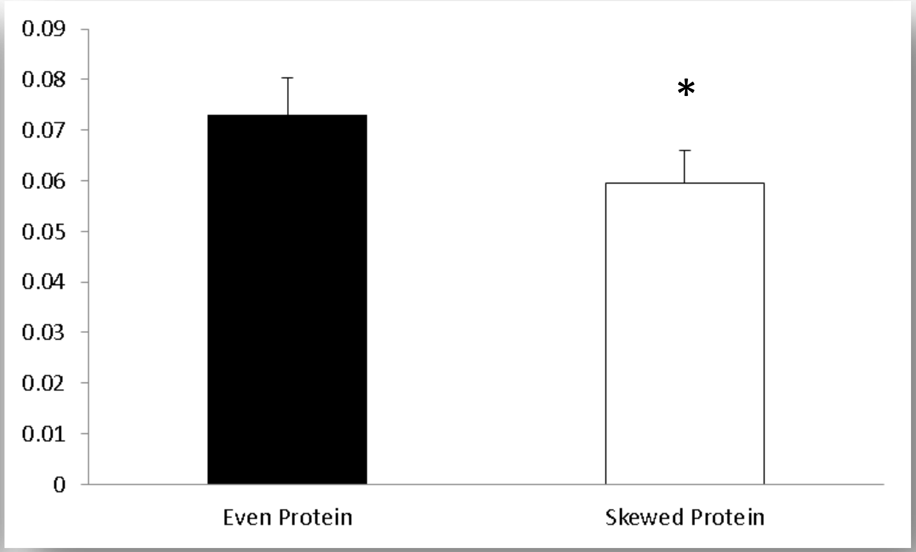
Paddon-Jones & Rasmussen, Curr Op Clin Nutr Metab Care 2009

Protein Intake Pattern Across Meals Significantly Impacts Muscle Protein Anabolism in Older Adults

Breakfast Response



24-hour Response



Mamerow, et.al. EB 2012

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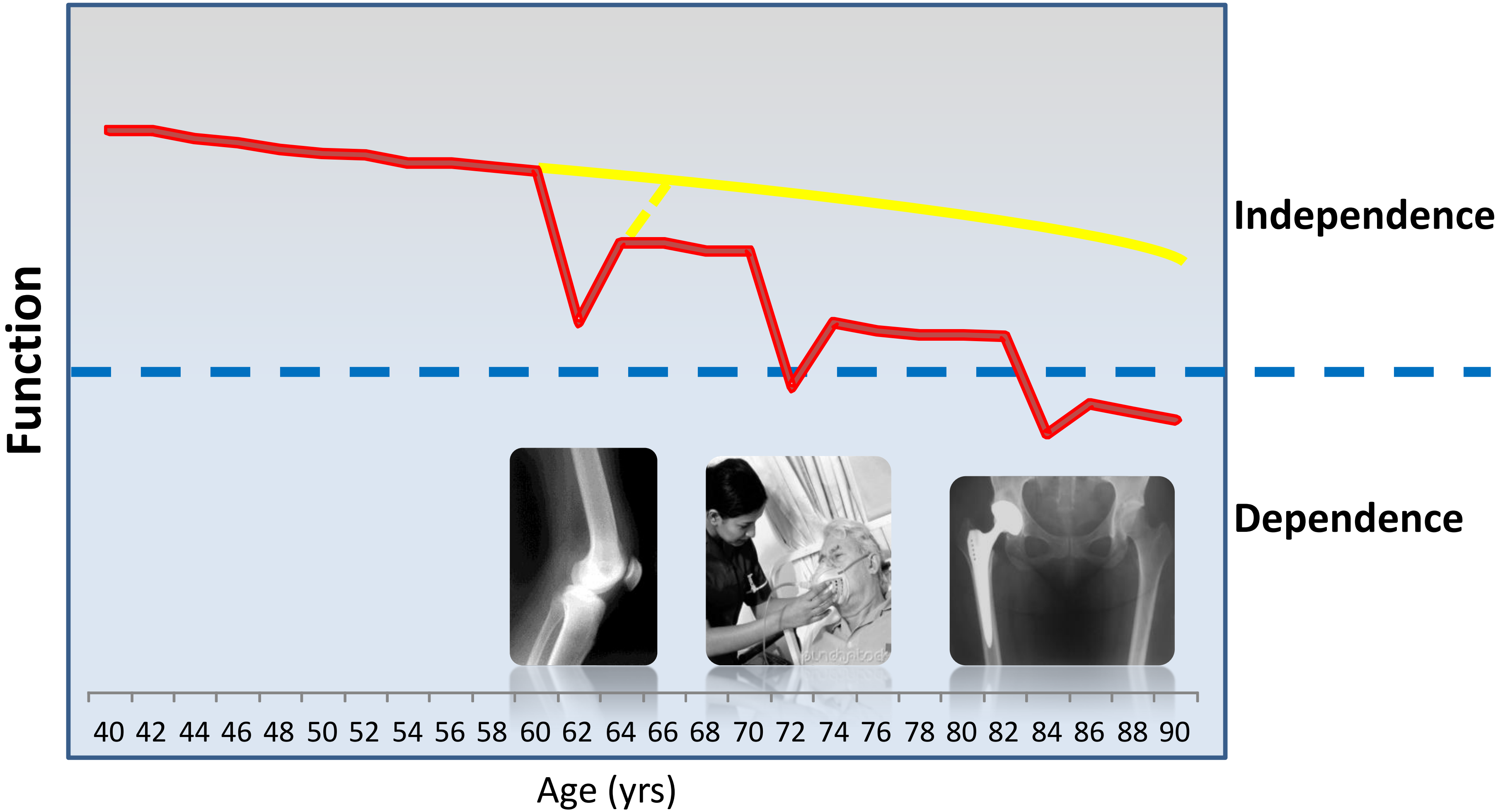
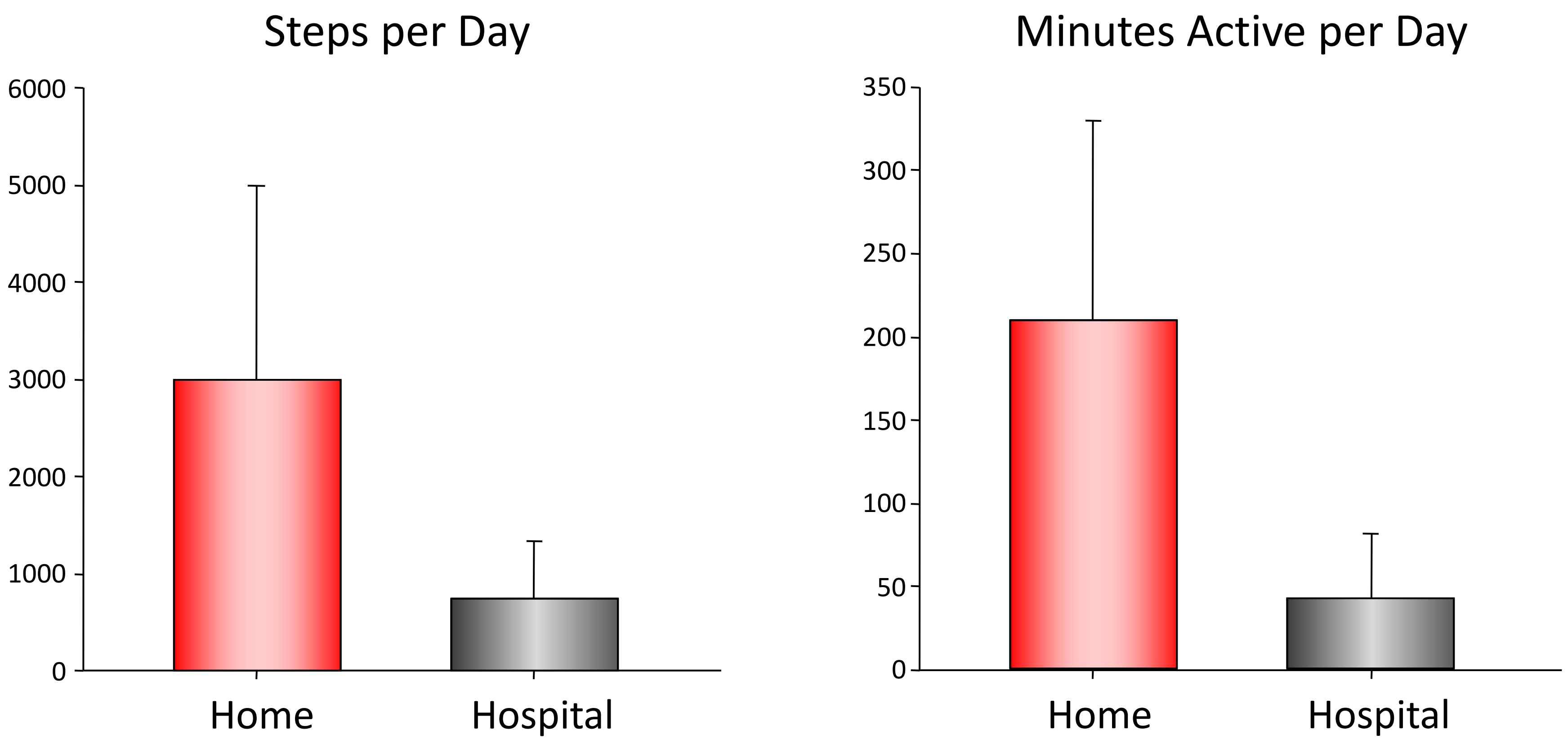
Patterns of Functional Loss and Disablement



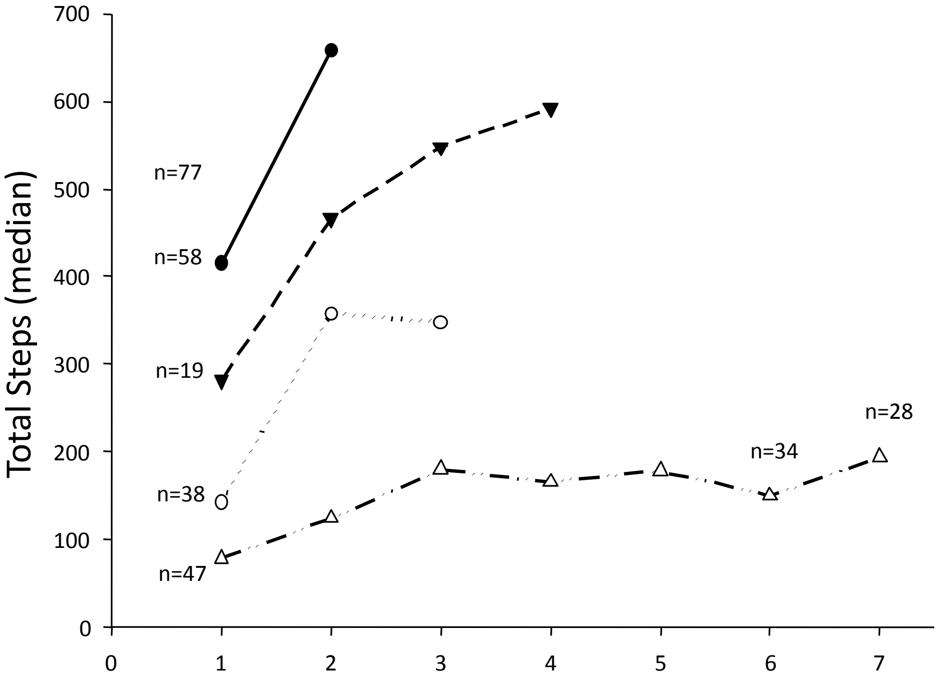
Hospitalized Older Adults Are Very Inactive



Fisher et al. JAGS 2011

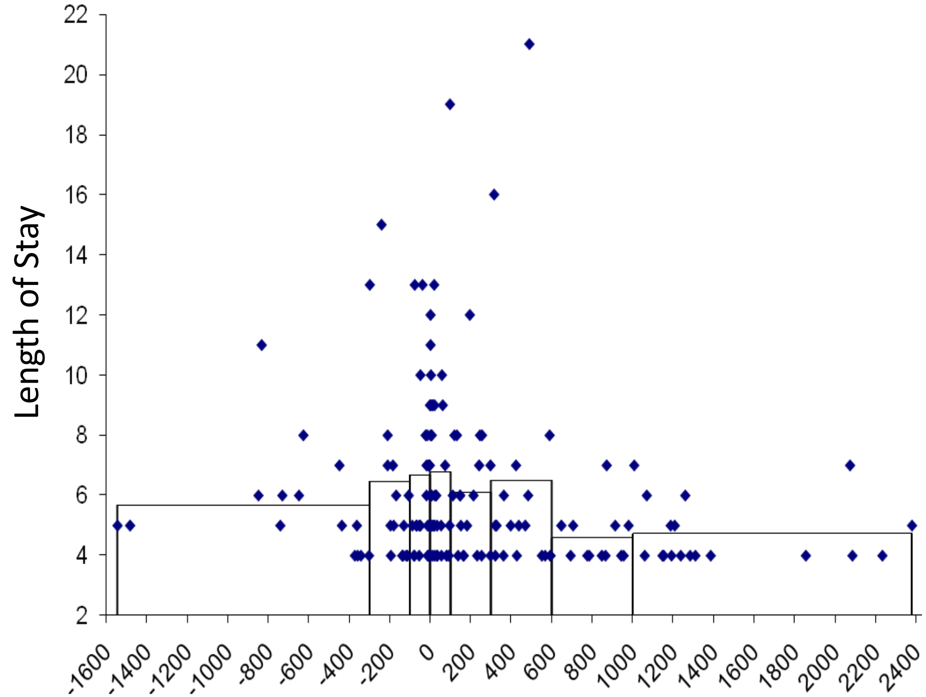
Total Daily Steps and Early Mobilization Predict Hospital Length of Stay in Older Adults

Number of Steps and LOS



Complete Hospital Days

Early Mobilization and LOS

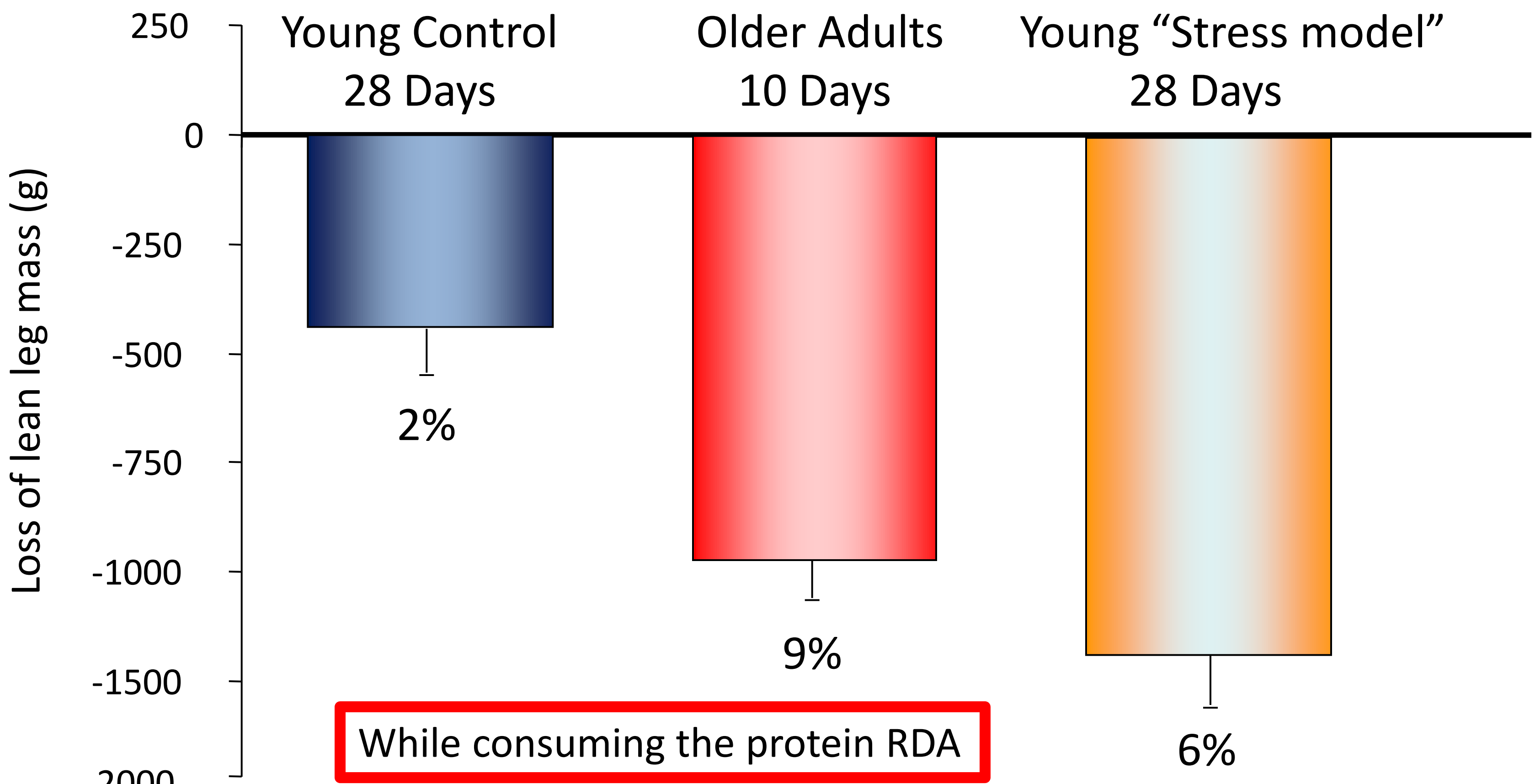


Step Change from 1st to 2nd Hospital Day

Fisher et al. JAGS 2011

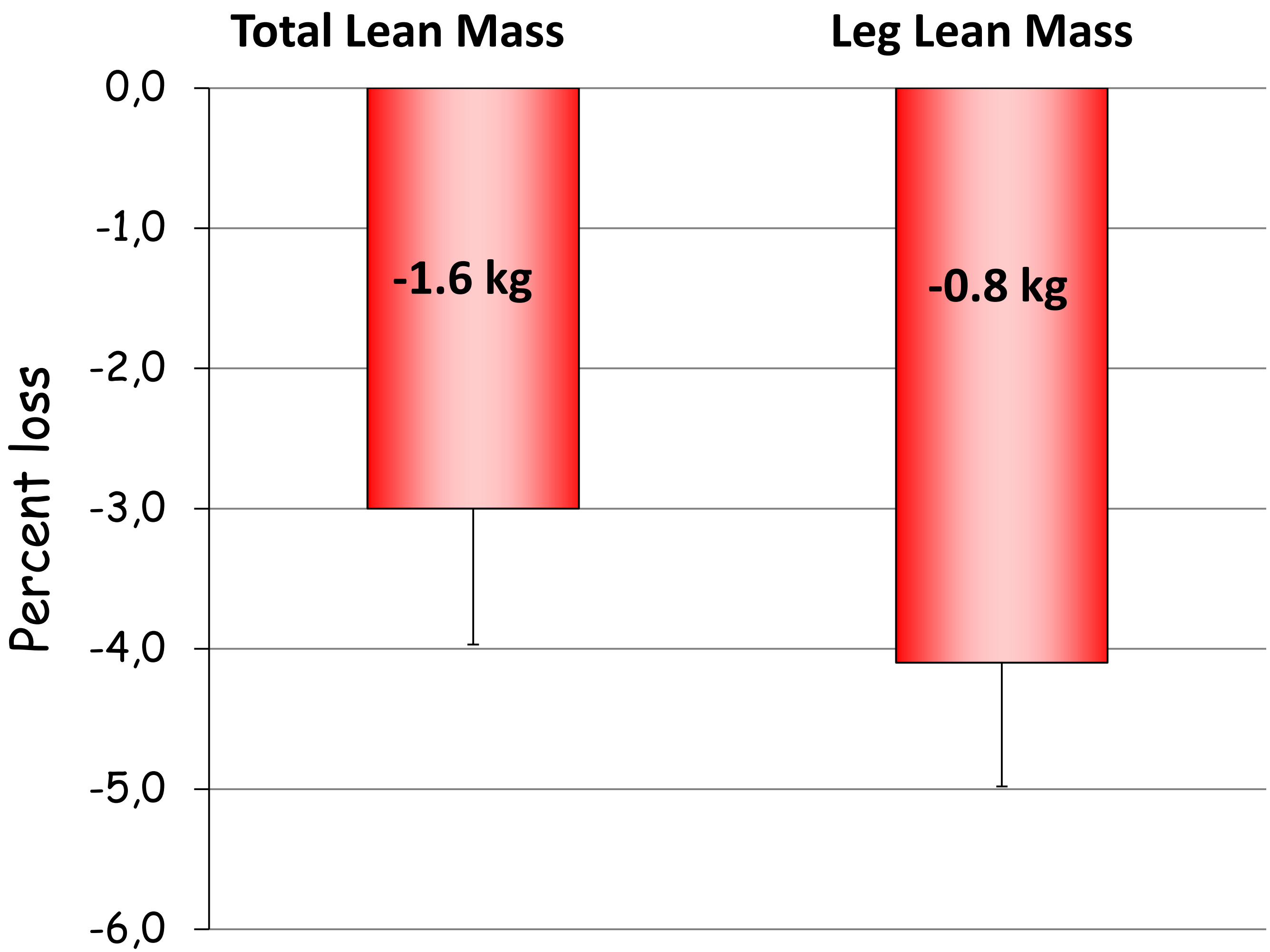
Fisher et al. Arch Int Med 2010

Inactivity Induces Significant Muscle Loss in Older Adults



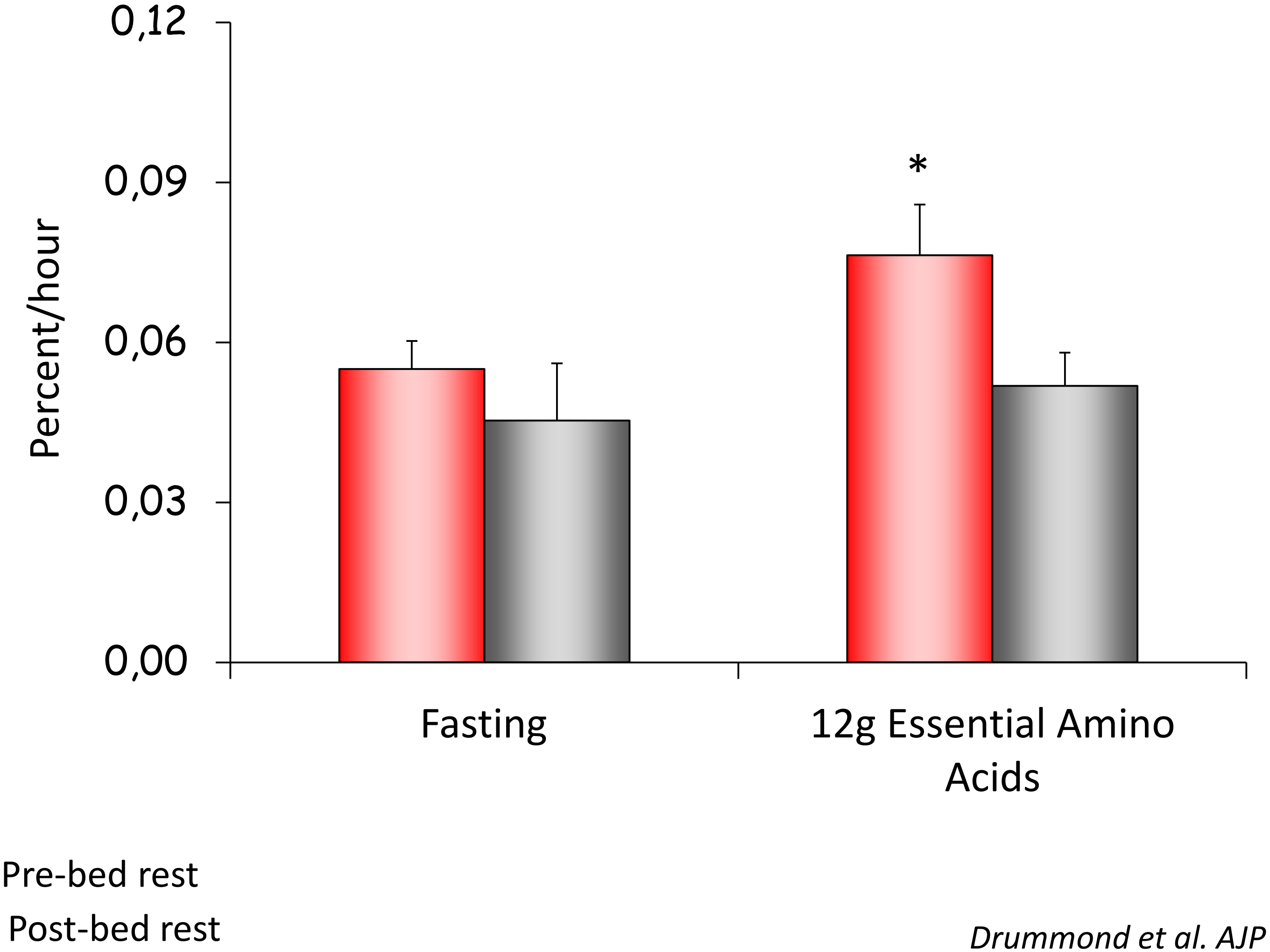
Paddon-Jones et al. J Clin Endcrinol Metab, 2004
Kortebein et al. J Gerontology, 2008

Shorter (7-Day) Bed Rest Induces Muscle Loss in Older Adults



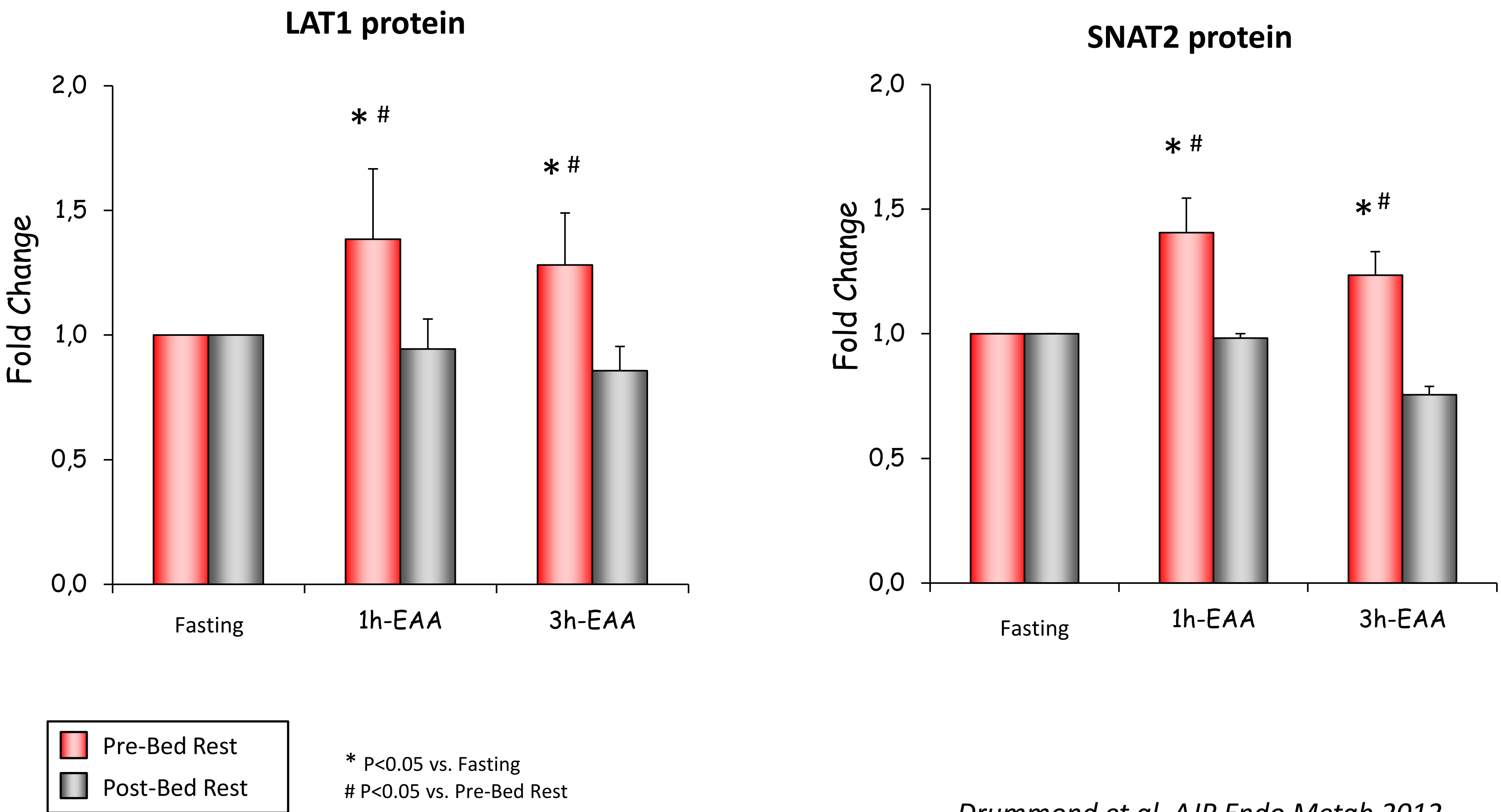
Drummond et al. AJP Endo Metab 2012

Bed Rest Reduces the Response of Muscle Protein Synthesis to Amino Acids in Older Adults



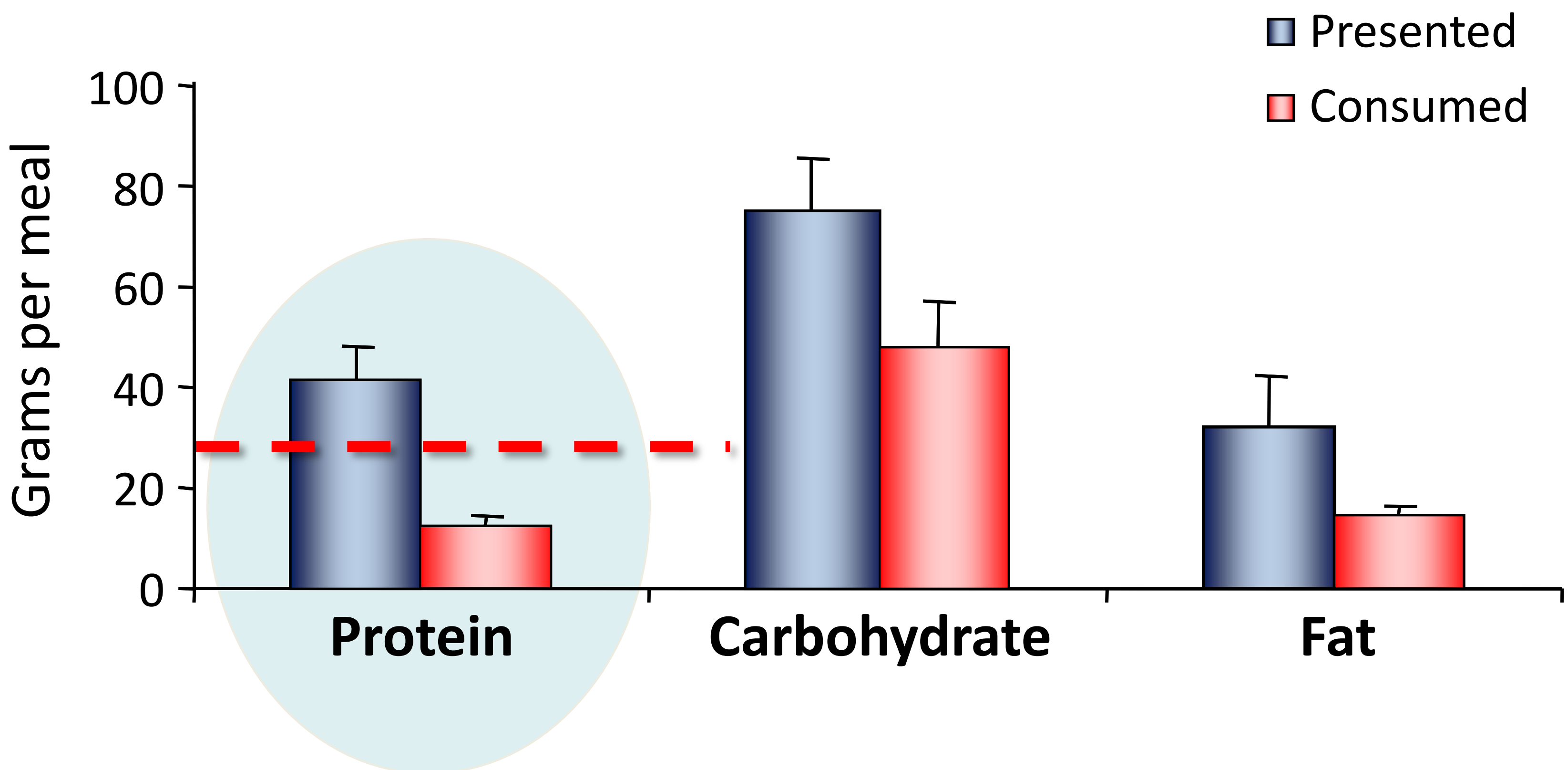
Drummond et al. AJP Endo Metab 2012

Bed Rest Reduces the Response of Amino Acid Transporters to Amino Acids in Older Adults



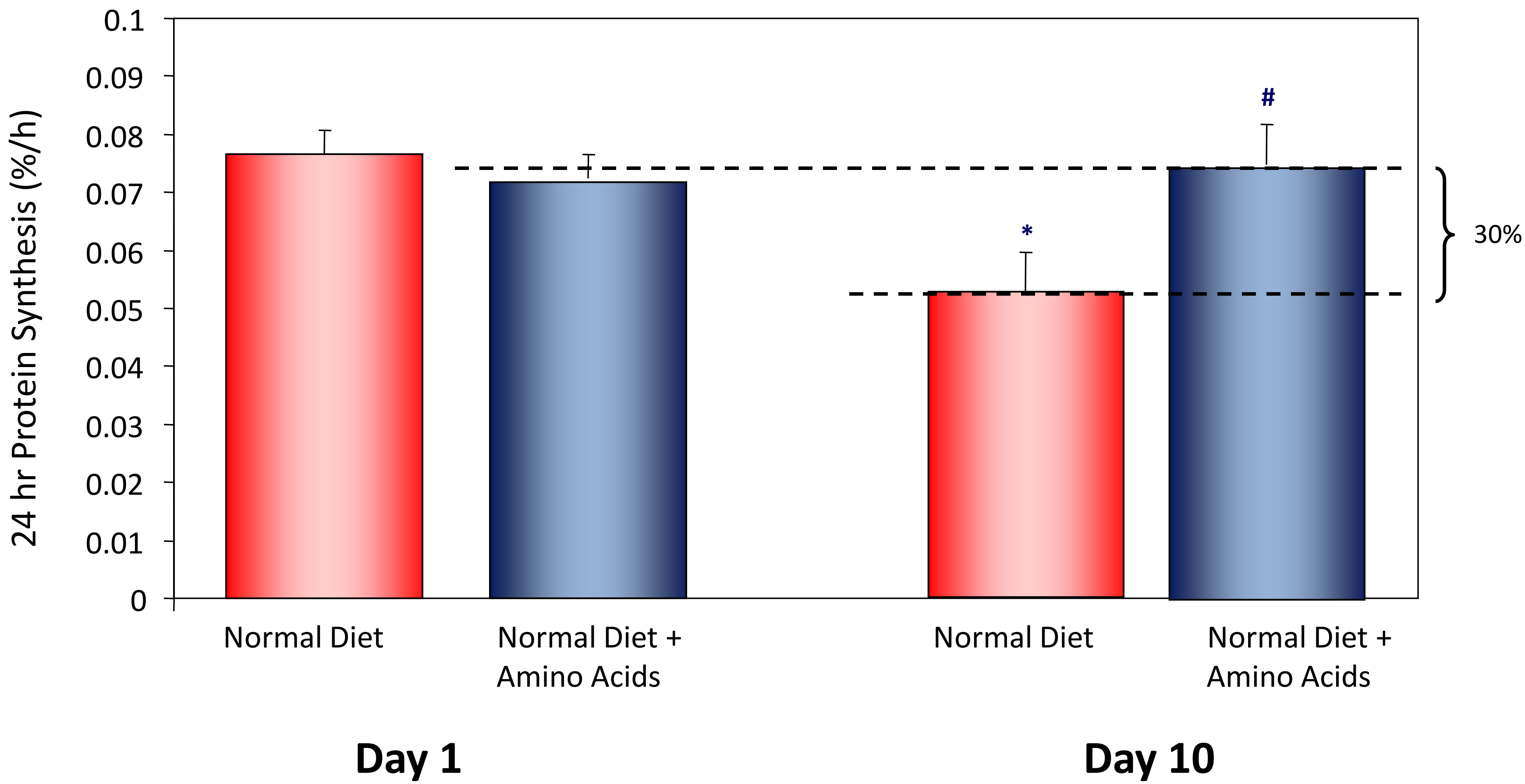
Drummond et al. AJP Endo Metab 2012

Hospitalized Older Patients May Not Eat Adequate Amounts of Protein



Paddon-Jones, ACE Unit pilot data

Excess Dietary Amino Acids Can Prevent Inactivity-Induced Reductions in Muscle Protein Synthesis



Normal diet protein content: 0.8 g/kg/day

Ferrando et al. Clin Nutr 2010

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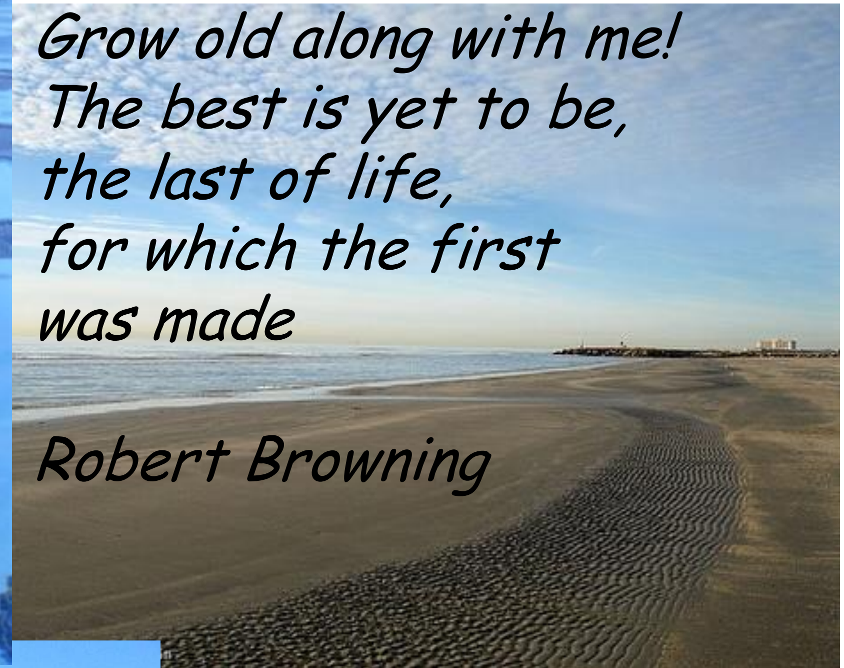
Summary

In older adults:

- Total daily protein intake is a predictor of sarcopenia
- Response to mixed nutrient is impaired due to:
  - Insulin resistance and endothelial dysfunction
  - Reduced response of muscle protein synthesis to amino acids at lower intakes
- Aerobic exercise can reduce anabolic resistance
- Maximal stimulation of muscle protein synthesis is achieved at intakes of ~3 g of leucine corresponding to ~30 g of whole protein
- Immobilization reduces appetite, protein/energy intake and the response of muscle to anabolic stimulation by nutrients
- Supplementation with amino acids can improve muscle protein anabolism in response to feeding and during immobilization

Conclusions

- Adequate protein intake is essential to maintain muscle mass and function in older adults
- Protein is the only macronutrient that has no inactive reservoir (i.e. it is stored in active tissues, mainly muscle, or converted to energy)
  - The current DRI for protein is often inadequate to maintain muscle mass and function in older adults.
  - Data in the literature support higher intakes (1 - 1.2 g/kg/day)
  - Protein intake distribution over meals should be considered
- Protein intake should be adjusted according to health status and activity level
  - What is the optimal protein intake for hospitalized/inactive older adults?
  - What is the optimal protein intake for active older persons?



Grow old along with me!
The best is yet to be,
the last of life,
for which the first
was made

Robert Browning

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www.utmb.edu/scoa/pepper/index.asp