Protein and Skeletal Muscle: Why Timing Matters

Presented by:
Douglas Paddon-Jones, Ph.D., FACSM

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The webinar will begin shortly.
Protein and Skeletal Muscle: Why Timing Matters

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- US Dairy Export Council
- National Cattlemens Beef Association
- Abbott Nutrition
- Agropur
- Leprino Foods
- Sabra Wellness  -- None pose any conflict of interest for this presentation --

The opinions reflected in this presentation are those of the speaker and independent of Nutricia North America.
Learning Objectives

- Review major factors impacting skeletal muscle metabolism in adults.
- Highlight changes in skeletal muscle during aging and inactivity.
- Understand the impact and benefit of optimal protein distribution.
Conceptual Model:

- Inactivity
- Disease
- Inflammation
- Mitochondrial Dysfunction
- Inadequate Nutrition
- Aging
- Blood Flow

Muscle Loss
Conceptual Model:

- Inactivity
- Disease
- Inflammation
- Mitochondrial Dysfunction
- Inadequate Nutrition
- Aging
- Blood Flow

Muscle Loss

Protein

Activity

Pharmacology
How much protein do we need?

RDA: “estimate of the minimum daily average dietary intake level that meets the nutrient requirements of 97-98% of healthy individuals”
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How much protein per meal do we need?

Symons TB et al. AJCN 2007; Symons TB et al. JADA 2009
How much protein per meal do we need?

-- a positive message of moderation --

Symons TB et al. AJCN 2007; Symons TB et al. JADA 2009
Synergistic effect of protein + exercise

Anabolic resistance: age-related dose response

Muscle Protein Synthesis (mg Phe/leg) > 25 g protein

Katsanos CS et al. AJCN 2005
Anabolic resistance: age-related dose response

Muscle Protein Synthesis (mg Phe/leg) for Young vs. Elderly.

Katsanos CS et al. AJCN 2005
Anabolic resistance: age-related dose response

Muscle Protein Synthesis (mg Phe/leg)

Young
Elderly

> 25 g protein
< 15 g protein

Katsanos CS et al. AJCN 2005
Anabolic resistance: age-related dose response

Muscle Protein Synthesis (mg Phe/leg)

> 25 g protein
< 15 g protein

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Anabolic resistance: age-related dose response

Muscle Protein Synthesis (mg Phe/leg)

> 25 g protein

< 15 g protein

Young

Elderly

Katsanos CS et al. AJCN 2005
Concept: skewed vs. optimal protein distribution

Catabolism

10 g

Anabolism

15 g

~ maximum rate of protein synthesis

65 g

Consumed Protein

90 g

Concept: skewed vs. optimal protein distribution

- Consumed Protein 90 g
- Usable Protein 55 g

Concept: skewed vs. optimal protein distribution

Anabolism

Catabolism

~ maximum rate of protein synthesis

Consumed Protein: 90 g

Usable Protein: 90 g ?

Study: Even vs. skewed protein distribution

Sarcopenia

...... a syndrome characterized by progressive and generalized loss of skeletal muscle mass and strength with a risk of adverse outcomes such as physical disability, poor quality of life and death.

Cruz-Jentoft AJ et al. Age Ageing. 2010
Typical “uncomplicated” sarcopenia model?
Catabolic crisis model

Obstacles → Opportunities

Paddon-Jones et al. Curr Opin Nutr Metab Care. 2010
Physical inactivity: clinical settings


- Inactive (0 steps/min)
- Low Activity (< 15 steps/min)
Physical inactivity: research models

Loss of lean leg mass (g)

Young

28 Days

English KL et al. AJCN 2015
Loss of lean leg mass (g)

Young

-250

28 Days

Older

-500

10 Days
Physical inactivity: research models

Loss of lean leg mass (g)

-2000 -1500 -1000 -750 -500 -250 0

Young Middle-aged Older

28 Days 14 Days 10 Days

English KL et al. AJCN 2015
Physical inactivity: research models

English KL et al. AJCN 2015

Loss of lean leg mass (g)

|-------------------- best case situation----------------------|

Young  Middle-aged  Older

- 28 Days  14 Days  10 Days
Physical inactivity: research models

English KL et al. AJCN 2015
Intervention opportunity: inpatient diets

Paddon-Jones pilot data

Presented
Consumed

grams

Protein
Carbohydrate
Fat

per meal

Paddon-Jones pilot data
Intervention opportunity: inpatient diets

Paddon-Jones pilot data

[Bar chart showing the comparison between presented and consumed grams of Protein, Carbohydrate, and Fat per meal.]

Presented
Consumed

Protein
Carbohydrate
Fat

grams

0
20
40
60
80
100

Per meal

Paddon-Jones pilot data
Intervention opportunity: inpatient diets

Paddon-Jones pilot data

Presented vs. Consumed

Protein, Carbohydrate, Fat per meal

grams

[Graph showing comparison between presented and consumed protein, carbohydrate, and fat per meal]

Paddon-Jones pilot data
Physical inactivity: age and sex-specificity

Change in lean leg mass (g)

Disuse

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Middle-age</th>
<th>Older</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>-1000</td>
<td>-1500</td>
</tr>
<tr>
<td>Women</td>
<td>-2500</td>
<td>-3000</td>
</tr>
</tbody>
</table>

Rehabilitation

<table>
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<th>Age Group</th>
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English KL et al. AJCN 2015
Physical inactivity: age and sex-specificity

English KL et al. AJCN 2015
Physical inactivity: responders & non-responders

Paddon-Jones et al. pilot data

Loss in leg lean mass (g): 7-days

-2500
-2000
-1500
-1000
-500
0

Mid: -1207 g
Low: -537 g
High: -1876 g

Tertiles of leg lean mass loss

Count
2
4
6
8
Leucine:
- Branch chain amino acid (BCAA)
- common in most high quality proteins
- key regulatory role in protein synthesis
- overstated benefits?
Leucine (4 g/meal): partially protects muscle function

Healthy middle-age adults
14 days bed rest

English KL et al. AJCN 2015
Leucine: partially / temporarily protects muscle mass

Healthy middle-age adults
14 days bed rest

English KL et al. AJCN 2015
Leucine: partially / temporarily protects muscle mass

Healthy middle-age adults
14 days bed rest
What about physical activity?


- Muscle mass
- Muscle endurance
- Aerobic capacity
- Muscle strength

Percentage change %

7 days bed rest (control)

What about physical activity?


<table>
<thead>
<tr>
<th></th>
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<tr>
<td>7 days bed rest (control)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2018 ± 4 steps/day</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>22 ± 1 minutes/day</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>155 ± 8 minutes/week</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>94 ± 4 steps/minute</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>102 ± 5 bpm</td>
<td></td>
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7 days bed rest + 2000 steps / day
What about physical activity?


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<tr>
<td>7 days bed rest</td>
<td>-10%</td>
<td>-15%</td>
<td>-10%</td>
<td>-20%</td>
</tr>
<tr>
<td>7 days bed rest + 2000 steps / day</td>
<td>-20%</td>
<td>-25%</td>
<td>-20%</td>
<td>-30%</td>
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2018 ± 4 steps/day
22 ± 1 minutes/day
155 ± 8 minutes/week
94 ± 4 steps/minute
102 ± 5 bpm

What about physical activity?


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<tr>
<td>Muscle mass</td>
<td>-15 ± 5 steps/minute</td>
<td>0 steps/minute</td>
</tr>
<tr>
<td>Muscle endurance</td>
<td>-10 ± 2 minutes/day</td>
<td>155 ± 8 minutes/week</td>
</tr>
<tr>
<td>Aerobic capacity</td>
<td>-2 ± 1 minutes/day</td>
<td>102 ± 5 bpm</td>
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2018 ± 4 steps/day
22 ± 1 minutes/day
155 ± 8 minutes/week
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What about physical activity?


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<td>-20 ± 4</td>
<td>-20 ± 5</td>
</tr>
<tr>
<td>Aerobic capacity</td>
<td>-15 ± 1</td>
<td>-15 ± 1</td>
</tr>
<tr>
<td>Muscle strength</td>
<td>-20 ± 2</td>
<td>-20 ± 2</td>
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- 2018 ± 4 steps/day
- 22 ± 1 minutes/day
- 155 ± 8 minutes/week
- 94 ± 4 steps/minute
- 102 ± 5 bpm
Recommendations: **Prevention** and Treatment

For **all** healthy adults….

Establish a dietary framework that includes a **moderate** amount of **high quality** protein at **each meal**.

Modify as necessary to accommodate individual needs:
- **energy requirements**
- **physical activity**
- **health status**
- **body composition goals**
- **dentition, satiety**
During periods of catabolic crisis or inactivity:

- 0.8 g protein/kg/day is insufficient

- Blunt addition of protein/energy is inefficient

- Aggressive support with high quality protein (whey/leucine) and activity may help preserve muscle health
Acknowledgements

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- Don Layman
Questions?

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