Aging and Muscle Loss: Too Young to Worry? Think Again!
Welcome

Matthew Pikosky, PhD, RD
Vice President
Nutrition Marketing and Affairs
National Dairy Council
Overview

- Recognize that the transition from pre-sarcopenia to sarcopenia is progressive and can start after age 30.

- Leverage the latest research on sarcopenia and muscle maintenance to elevate the importance of proper exercise and protein intake among middle-aged Americans.

- Review the gradual domino-effect decline in health that accompanies muscle loss.

- Identify the best dietary and exercise approaches for middle-aged Americans to adopt in order to maintain muscle and reduce their risk for sarcopenia.
Aging and Muscle Loss: Too Young to Worry? Think Again!

Hope Barkoukis PhD, RD, LD
Associate Professor and Interim Chair, Department of Nutrition
Case Western Reserve University

Susan Kundrat MS, RD, CSSD
Clinical Assistant Professor of Kinesiology
University of Wisconsin-Milwaukee
Polling Question #1

Which of these celebrities likely had the greatest RATE of muscle mass & strength loss? (compared to their peak years)
LEAN MASS LOSS accompanies fat increase, even if unchanged body weight
Mid-thigh of a 25 year old versus a 75 year old

Light gray is muscle mass area, darker gray area is subcutaneous fat, via Magnetic Resonance Imagery

Roubenoff, 2003
Sarcopenia International Consensus Conference Definition:

• Diagnosis consistent with 2 SD below the average Appendicular Mass/Ht² for reference sample of 35 year old healthy individuals or
  - ≤ 7.23 kg/m² for men
  - ≤ 5.67 kg/m² for women

• Gait speed < 0.8 meters per second

Fielding, 2011
Sarcopenia Definitions

European Working Group on Sarcopenia in Older People (EWGSOP)

**Diagnosis is based on documentation of criterion 1 plus 2 or 3**

1. Low muscle mass
2. Low muscle strength
3. Low physical performance

<table>
<thead>
<tr>
<th>Stage</th>
<th>Muscle Mass</th>
<th>Muscle Strength</th>
<th>Muscle Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presarcopenia</td>
<td>↓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sarcopenia</td>
<td>↓</td>
<td>↓</td>
<td>OR</td>
</tr>
<tr>
<td>Severe sarcopenia</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
</tr>
</tbody>
</table>

### Assessment Techniques

<table>
<thead>
<tr>
<th>Muscle Mass</th>
<th>Muscle Strength</th>
<th>Physical Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEXA</td>
<td>Handgrip strength</td>
<td>Gait speed</td>
</tr>
<tr>
<td>BIA</td>
<td>Knee flexion/extension</td>
<td>Short Physical Performance Battery</td>
</tr>
<tr>
<td>Total body potassium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anthropometry</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cruz-Jentoft et al. 2010
Algorithm to SCREEN for Sarcopenia - EWGSOP

- GAIT SPEED
  - >0.8m/sec
    - 4 meter walking test
    - Normal:
      - Monitor
      - No need to quantify Muscle mass
  - <0.8m/sec
    - Low:
      - Quantify Muscle Mass

Cruz-Jentoft Age Aging 2010
Intervention Challenges

- Etiology is complex & multi-dimensional
- No gold standard treatment
- Lifestyle risk factors can be modified

Maze between diagnosis and effective treatment!!
If no clinical symptoms, does pre-sarcopenia really matter?
Lean Mass Loss: Clinical Consequences

↓ Mobility & Strength
↑ Frailty & Fall risk

↓ Functional Independence
↑ Morbidity

↓ Wound Healing & Immune Function

↓ Resting Metabolic Rate & Kcal need

↓ Glucose disposal

Roubenoff, 2003
Blue Zones – National Geographic Study of 263 Centenarians

Age 109: still gardening - mobility impacts longevity
Sardinia, Italy; Okinara, Japan; Loma Linda, CA; Ikaria, Greece; Nicoya, Costa Rica
Transition to Sarcopenia and Determinants of Transitions in Older Adults: A Population-Based Study

Rachel A. Murphy,1 Edward H. Ip,2 Qiang Zhang,2 Robert M. Boudreau,3 Peggy M. Cawthon,4 Anne B. Newman,2 Frances A. Tylavsky,5 Marjolein Visser,6,7 Bret H. Goodpaster,8 Tamara B. Harris,1

Background. Diagnostic criteria for sarcopenia from appendicular lean mass (ALM), strength, and performance have been proposed, but little is known regarding the progression of sarcopenia. We examined the time course of sarcopenia and determinants of transitioning toward and away from sarcopenia.

Methods. ALM, gait speed, and grip strength were assessed seven times over 9 years in 2,928 initially well-functioning adults aged 70–79. Low ALM was defined as less than 7.95 kg/m² (men) or less than 6.24 kg/m² (women), low performance as gait speed less than 1.0 m/s, low strength as grip strength less than 30 kg (men) or less than 20 kg (women). Presarcopenia was defined as low ALM and sarcopenia as low ALM with low performance or low strength. Hidden Markov modeling was used to characterize states of ALM, strength, and performance and model transitions leading to sarcopenia and death. Determinants of transitioning toward and away from sarcopenia were examined with logistic regression.

Results. Initially, 54% of participants had normal ALM, strength, and performance; 21% had presarcopenia; 5% had sarcopenia; and 20% had intermediate characteristics. Of participants with normal ALM, strength, and performance, 1% transitioned to presarcopenia and none transitioned to sarcopenia. The greatest transition to sarcopenia (7%) was in presarcopenic individuals. Low-functioning and sarcopenia states were more likely to lead to death (12% and 13%). Higher body mass index (p < .001) and pain (p = .05) predicted transition toward sarcopenia, whereas moderate activity predicted transition from presarcopenia to more normal states (p = .02).
Lean mass loss has functional implications on overall mortality risk

Figure 2. Kaplan-Meier survival curves for mortality according to walking speed (WS) and body mass index (BMI) groups.
Modifiable lifestyle risk factors, but need to understand a bit of background...
Lean Mass Status Depends on NPB

**Net Protein Balance (NPB)**

difference between rates of muscle protein synthesis (MPS)
and muscle protein breakdown (MPB)

**Positive Net Balance**
MPS > MPB = lean body mass gain

**Negative Net Balance**
MPB > MPS = lean body mass loss
Net Muscle Protein Balance: Interplay Between MPS & MPB
Maintaining Muscle Mass

Muscle synthesis

Hormones
Activity
Protein

↓ nutrition
Inactivity
Illness/Injury

Muscle loss

Synthesis
Balance
Breakdown

The University of Texas Medical Branch
Inactivity impacts muscle mass loss!
Leisure Time: Inactivity!

Percentage of total leisure time that people age 55 and over spent doing selected leisure activities on an average day, by age group, 2008

- **Watching TV**: 58% (55–64), 57% (65–74), 56% (75 and over)
- **Socializing and communicating**: 13% (55–64), 11% (65–74), 9% (75 and over)
- **Reading**: 9% (55–64), 11% (65–74), 14% (75 and over)
- **Relaxing and thinking**: 5% (55–64), 7% (65–74), 10% (75 and over)
- **Participation in sports, exercise, and recreation**: 4% (55–64), 4% (65–74), 3% (75 and over)
- **Other leisure activities (including related travel)**: 11% (55–64), 12% (65–74), 11% (75 and over)

Reference population: These data refer to the civilian noninstitutionalized population.
Bedrest!

- Muscle dis-use & immobilization = daily loss of 0.5-0.6% total muscle mass

- Loss daily of ~0.3-4.2% in strength!

Drummond, J Phy Endocrin & Metab, 2012
Paddon-Jones et al. 2004; Kortebein et al. 2007
Middle-age Adults: Increased Muscle Loss Risk During Periods of Physiologic Stress

Table 1. Comparison of leg lean mass loss per day during bed rest for young [25], middle-aged [27] and older adults [28].

<table>
<thead>
<tr>
<th>Bed rest (days)</th>
<th>Age (years)</th>
<th>Muscle loss (kg)</th>
<th>Rate of loss (g/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young</td>
<td>28</td>
<td>38±8</td>
<td>−0.40±0.10</td>
</tr>
<tr>
<td>Middle-age</td>
<td>14</td>
<td>52±4</td>
<td>−1.16±0.14</td>
</tr>
<tr>
<td>Elderly</td>
<td>10</td>
<td>67±5</td>
<td>−0.95±0.15</td>
</tr>
</tbody>
</table>

Paddon-Jones, 2004; English, 2013; Kortebein, 2008
Inactivity Reduces Muscle Protein Synthesis

24 h muscle protein synthesis during 10 day of inactivity in elders (stable isotope methodology)

Kortebein et al. 2007
Inactivity Blunts Anabolic Stimuli (Oral EAA)

Drummond et al. 2012

Fig. 3. Mixed-muscle protein synthesis in skeletal muscle of older adults (n = 6) in the postabsorptive state and during the EAA ingestion period (3 h; 0–3 h post-EAA). #Different from post-bed rest during the 3-h EAA period (P = 0.05). Values are presented as means ± SE.
FOCUS: Maximizing Exercise and Optimal Nutrition

• Maintain an active lifestyle as we age – exercise is beneficial to help slow muscle loss

• Optimize nutrition

• Focus on function – keep moving!
Exercise and Muscle Protein Balance

Exercise alters both protein synthesis and breakdown

Nutrition strategies can maximize muscle response to exercise
Exercises Strategies to Prevent Sarcopenia

- Most effective Resistance training 2-3 times/week
- Optimal Full body, closed chain, multi-joint movements that stress the axial skeleton
- Age appropriate
- Training intensities must be adequate to stimulate desired adaptations (i.e. muscle hypertrophy)
- Maintain aerobic fitness
It’s All About Muscle

- Weight management
- Improved response to exercise
- Better response to injury
- Reduced muscle wasting and increased vitality as we age
- Improved bone health and reduced risk of osteoporosis

Polling Question #2

What percentage of people say they’re trying to get more protein in their diet vs. a year ago:

33
Protein: Consumers are Paying Attention

55%
Say they’re trying to get more protein in their diet vs. a year ago, slightly more than in previous years*

26%
Say they’re actually consuming more protein than 2 years ago**

47%
Say the message “good source of protein” is very important on product labels**

* The NPD Group Dieting Monitor 2010
** The 2009 Health Focus Trend Report
Protein and Bone Health

• Protein + Calcium + Vitamin D = essential combination

• Higher-protein diets = > bone mass and fewer fractures with adequate calcium

• Moderate protein intakes (1.0-1.5 g/kg) = calcium homeostasis

Resistance Exercise and Protein Work Together to Promote Muscle Gain

Phillips SM., *Nutrition*, 2004
Benefits of a Higher Protein Diet During Energy Restriction

2x-RDA and 3x-RDA protein diets help preserve fat-free mass during energy restriction

2 x and 3 x RDA were able to maintain the anabolic response to a protein-rich meal during energy restriction; while RDA group had a decline

Pasiakos et al. FASEB J, 2013
Proportion of Calories From Protein is Similar For Gender and Age Groups

There is room to increase protein intake within AMDR
Americans Average Protein Intake is Above the RDA

RDA for Adults
0.8 g/kg/day
0.36 g/lbs/day

G/kg/day

Ages, yrs.  28 Y  9-18 Y  19-30 Y  31-50 Y  51-70 Y  71+ Y  2+ Y
Males  3.1  1.8  1.5  1.3  1.1  1.0  1.6
Females  2.9  1.5  1.1  1.0  1.0  0.9  1.3

Dairy Research Institute, NHANES 2003-2006
Optimal Amount of Protein

<table>
<thead>
<tr>
<th>Activity Level/Goals</th>
<th>Protein Intake (150 lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recreational Exercise: 0.5-0.7 grams*</td>
<td>75-105 grams/day</td>
</tr>
<tr>
<td>Endurance Athletes: 0.5-0.8 grams*</td>
<td>75-120 grams/day</td>
</tr>
<tr>
<td>Strength Training: 0.5-0.8 grams*</td>
<td>75-120 grams/day</td>
</tr>
<tr>
<td>Weight Loss/Calorie Restriction: 0.8-0.9 grams*</td>
<td>120-135 grams/day</td>
</tr>
</tbody>
</table>

- RDA: 0.8 g/kg for adults (0.36 g/lb)

- Acceptable Macronutrient Distribution Range (AMDR): 10-35% of daily calorie intake

- Who could benefit from more protein? Active adults and athletes; aging adults; weight-conscious individuals

* Per pound of body weight/day

0.5-0.9 g pro/lb BW/d:

- Muscle protein repair and resynthesis
- Increases in LBM
- “Remodeling” protein in muscle, bone, tendons, ligaments
- Maintain optimal function of metabolic pathways that use amino acids
- Support a healthy immune system
- Produce plasma proteins
- Aids in weight management
Current Protein Intake at Lower End of the AMDR

- 10% kcal
- 16% kcal: ~83 g
- 35% kcal: ~125 g
- ~25% kcal

Protein intake
Satiety benefits

Dairy Research Institute NHANES, 2001-2008
### Top 5 Food Sources that Contribute About Half of Children's and Adult’s Total Protein Intake

<table>
<thead>
<tr>
<th>Children</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk 13.2%</td>
<td>Poultry 14.4%</td>
</tr>
<tr>
<td>Poultry 12.8%</td>
<td>Beef 14.0%</td>
</tr>
<tr>
<td>Beef 11.5%</td>
<td>Cheese 8.5%</td>
</tr>
<tr>
<td>Cheese 9.7%</td>
<td>Milk 6.9%</td>
</tr>
<tr>
<td>Yeast bread/rolls 6.4%</td>
<td>Yeast bread/rolls 6.4%</td>
</tr>
</tbody>
</table>

Dairy Research Institute, NHANES 2003-2006, 2-18 and 19+ years
20 g = *maximum* protein synthesis stimulation

Moore et al. AJCN, 2009
Maximizing Protein Intake

• Include 1-2 protein sources with every meal.

• Choose **high-quality** proteins: those that contain all of the essential amino acids the body needs to build proteins.

• Try to enjoy 20-35 grams of protein per meal, including breakfast.

Emerging research suggests potential benefit of even distribution of protein throughout the day for older adults.

Paddon-Jones, Curr Op in Clin Met Care, 2009
• Even out the intake throughout the day
• Example: 120 grams of protein per day =

- **Breakfast**: 30g
- **Lunch**: 30g
- **Dinner**: 30g
- **Snack***: 30g

* Target goal for cumulative protein intake from snacks throughout the entire day
Lowest Protein Intake at Breakfast and Snacks

Daily total: 82.6 g

Percent of daily protein
Breakfast: 15%
Lunch: 31%
Dinner: 42%
Snacks: 12%

Dairy Research Institute, NHANES 2001-2008
Breakfast #1: 2 slices of whole wheat toast with 2 tablespoons of peanut butter + 1 banana + 2 cups low-fat chocolate milk

Breakfast #2: 2-egg omelet with 1 oz low-fat cheese and 1 oz chopped ham wrapped in 1 medium whole grain tortilla + 1 cup of 100% grapefruit juice

Breakfast #3: Smoothie with ½ cup low-fat vanilla Greek yogurt + ½ cup grape juice + ½ cup frozen berries + 1 scoop vanilla whey protein powder + ice

Breakfast #4: 1 turkey and cheese sandwich (3 oz turkey) on whole wheat bread + 1 cup OJ

Breakfast #5: 1 Canadian bacon, egg and cheese bagel + 1 low-fat milk (McDonald’s)
Dairy’s Contribution to Protein Consumption

<table>
<thead>
<tr>
<th>Dairy Food</th>
<th>Protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whey Protein Isolate Powder (1 scoop, 36 g)</td>
<td>~20 grams</td>
</tr>
<tr>
<td>Low-fat Greek Yogurt (6 oz)</td>
<td>14 – 18 grams</td>
</tr>
<tr>
<td>Low-fat Cottage Cheese (4 oz)</td>
<td>14 grams</td>
</tr>
<tr>
<td>Low-fat Milk (regular or lactose-free dairy milk) (8 oz)</td>
<td>8 grams</td>
</tr>
<tr>
<td>Low-fat Cheese (1 oz)</td>
<td>7 grams</td>
</tr>
</tbody>
</table>

• Low-fat dairy foods are rich in protein
• Milk protein, such as whey and casein, contribute to protein consumption over the course of the day
• Getting the recommended 3 servings of low-fat and fat-free dairy a day can provide a significant contribution to help meet protein needs
Protein Quality is Critical

• Protein quality is determined by its specific amino acid composition and digestibility

• Animal sources of protein are considered the highest sources of quality protein

• Plant sources of protein are limited in their amount of protein content and many are incomplete sources
# Protein Quality Ratings

<table>
<thead>
<tr>
<th>Protein Type</th>
<th>PDCAAS</th>
<th>Biological Value</th>
<th>Net Protein Utilization</th>
<th>Protein Efficiency Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whey Protein</td>
<td>1.00</td>
<td>104</td>
<td>92</td>
<td>3.2</td>
</tr>
<tr>
<td>Milk</td>
<td>1.00</td>
<td>91</td>
<td>82</td>
<td>2.5</td>
</tr>
<tr>
<td>Casein</td>
<td>1.00</td>
<td>77</td>
<td>76</td>
<td>2.5</td>
</tr>
<tr>
<td>Egg</td>
<td>1.00</td>
<td>100</td>
<td>94</td>
<td>3.9</td>
</tr>
<tr>
<td>Soy Protein</td>
<td>1.00</td>
<td>74</td>
<td>61</td>
<td>2.2</td>
</tr>
<tr>
<td>Beef</td>
<td>0.92</td>
<td>80</td>
<td>73</td>
<td>2.9</td>
</tr>
<tr>
<td>Black Beans</td>
<td>0.75</td>
<td>N/A</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Peanuts</td>
<td>0.52</td>
<td>N/A</td>
<td>N/A</td>
<td>1.8</td>
</tr>
<tr>
<td>Wheat Gluten</td>
<td>0.25</td>
<td>64</td>
<td>92</td>
<td>0.8</td>
</tr>
</tbody>
</table>

*Journal of Sports Science and Medicine, 2004*
Key Benefits of Whey Protein

- Protein synthesis
- Healthy weight
- Satiety

- Body composition
- Exercise recovery
- Healthy aging
Whey Protein

- Whey protein, found in dairy products, is great for post-exercise recovery, as it digests quickly and is highest in branch chain amino acid content.

- Whey protein isolate contains 0.1 gram lactose per 20 gram serving, making it LI-friendly.
  - Unique role in muscle metabolism (branched chain amino acids, BCAA).

<table>
<thead>
<tr>
<th>Protein Source</th>
<th>BCAA Content</th>
<th>Leucine Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whey</td>
<td>26%</td>
<td>14%</td>
</tr>
<tr>
<td>Egg</td>
<td>20%</td>
<td>9%</td>
</tr>
<tr>
<td>Soy</td>
<td>18%</td>
<td>8%</td>
</tr>
<tr>
<td>Wheat</td>
<td>15%</td>
<td>7%</td>
</tr>
</tbody>
</table>
# Leucine in Food

<table>
<thead>
<tr>
<th>FOOD</th>
<th>LEUCINE (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whey protein isolate, 25 grams</td>
<td>2.15</td>
</tr>
<tr>
<td>Beef, 3 oz</td>
<td>2.15</td>
</tr>
<tr>
<td>Chicken, 3 oz</td>
<td>2.00</td>
</tr>
<tr>
<td>Tuna, 3 oz</td>
<td>1.75</td>
</tr>
<tr>
<td>Salami, 3 oz</td>
<td>1.45</td>
</tr>
<tr>
<td>Milk, 8 oz</td>
<td>0.85</td>
</tr>
<tr>
<td>Peanuts, 1/3 cup</td>
<td>0.75</td>
</tr>
<tr>
<td>Lentils, 1/2 cup</td>
<td>0.65</td>
</tr>
<tr>
<td>Egg, 1 large</td>
<td>0.60</td>
</tr>
<tr>
<td>Almonds, 1/3 cup</td>
<td>0.40</td>
</tr>
<tr>
<td>Soybeans, 1/2 cup</td>
<td>0.40</td>
</tr>
<tr>
<td>Asparagus, 1/2 cup</td>
<td>0.10</td>
</tr>
<tr>
<td>Breakfast</td>
<td>Total Protein (g)</td>
</tr>
<tr>
<td>-----------</td>
<td>------------------</td>
</tr>
<tr>
<td>1 slice whole wheat toast 2 Tbsp peanut butter 1 banana 1 cup grapefruit juice</td>
<td>22</td>
</tr>
<tr>
<td>Smoothie: 1 cup low-fat vanilla Greek yogurt, 1/2 cup grape juice, 1/2 cup frozen blueberries, ice</td>
<td>12.5</td>
</tr>
<tr>
<td>1 cup oatmeal 1/4 cup raisins 1/4 cup chopped walnuts 1/4 cup low-fat milk</td>
<td>21</td>
</tr>
<tr>
<td>1 hard boiled egg 1 cup low-fat plain yogurt 1 cup strawberries 1 cup orange juice</td>
<td>20.5</td>
</tr>
</tbody>
</table>
Ideal Meal and Snack Breakdown

• Determine total daily calories (RMR + activity factor + exercise calories + calorie change for weight gain/loss)

• Determine protein needs (0.5 to 0.9 grams protein/# body weight for most athletes and active people and to boost satiety)
  ➢ **Breakfast** = 1/5 calories and protein
  ➢ **Lunch** = 1/5 calories and protein
  ➢ **Dinner** = 1/5 calories and protein
  ➢ **Snack** = 1/5 calories and protein
  ➢ **Pre- and Post-Workout** = 1/5 calories and protein (between the two meals)
Case Study: 140# Exerciser

• Calorie / Protein needs to reach 130 # = 1,800 calories / 135 grams protein per day (30% of calories)

• Typical Plan = Eat very little during the day, workout at 2 pm, overeat from 5pm throughout the night

• Concern: Eating too many times during the day will increase hunger
  - Breakfast = 360 calories and 25-30 g protein
  - Lunch = 360 calories and 25-30 g protein
  - Dinner = 360 calories and 25-30 g protein
  - Snacks = 360 calories and 25-30 g protein
  - Pre-/Post-Workout = 360 calories and 25-30 g protein
Breakfast: 3 egg whites, scrambled with ½ cup mushrooms + 1 slice whole grain toast/butter + 1 cup 1% milk + 1 orange (400 calories / 30 grams protein)

Lunch: 3 oz lean ground turkey patty on a whole grain bun + 1 cheese stick + 1 cup grapes + 1 cup baby carrots (450 calories / 30 grams protein)

Pre-workout: 1 protein bar + 1 plum (200 calories / 15 grams protein)

Post-workout: 1 scoop whey protein powder + 16 oz sports drink (200 calories / 20 grams protein)

Dinner: 1 big salad/veggies with 3 oz sliced ham + ½ cup quinoa + 2 cups watermelon (400 calories / 30 grams protein)

Snack: 1 light yogurt cup + ½ cup high-protein whole grain cereal (150 calories / 15 grams protein)

TOTAL = 1,800 calories / 140 grams protein
Sarcopenia is a *progressive process* that can start as young as 30 years of age.

A well-planned *nutrition program* and *exercise plan* are both essential for optimizing muscle mass and preventing sarcopenia, even in young adults.

Consuming *the right amount of high quality* protein (30 g) *frequently enough* (at least 3 times a day) is important.

Focusing *away* from total protein intake and moving *towards* a meal-driven approach when educating clients is critical!
www.NationalDairyCouncil.org/WheyProtein