Role of nutrition in promoting muscle health for healthy aging

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Key highlights

- Importance of muscle mass and strength for healthy aging
- Nutritional factors to promote muscle health

Main functions of muscle

SKELETAL MUSCLE

METABOLIC FUNCTIONS
- Main reservoir of proteins
- Regulator of glucose levels

STRUCTURAL FUNCTIONS
- Physical movement
- Maintenance of posture and balance

Progressive Loss of Muscle With Age

Agrilas J et al. JAMDA 2016: 789-796

Reduced physical activity and bed rest increase loss of muscle

Healthy Elders
14 days reduced activity

Healthy Elders
10 Days inactivity

-0.4 kg (3.9%) loss of leg fat-free mass
≈ 2 kg (4.8%) loss of lean mass

How does loss of lean mass affect patients?

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

Healthy Elders
14 days reduced activity

Healthy Elders
10 Days inactivity

≈ 0.4 kg (3.9%) loss of leg fat-free mass
≈ 2 kg (4.8%) loss of lean mass

Why is muscle strength important?

Prospective cohort study (n = 8762, 20-80 y) with 18.9 y follow up showed significantly lower mortality rate in the upper third of muscular strength among individuals >60 y.

‘Sarcopenia’=
Low Muscle Mass + Low Strength &/or Function

OR (95% CI)

Mortality 3.59 (2.96-4.37)
Functional decline 3.03 (1.80 – 5.12)
Fall 3.45 (1.68-7.09)
Facture* 3.79 (2.65-5.41) for men
2.27 (1.37-3.76) for women
Length of hospital stay* 1.84 (1.32-2.58)


Demling RH.


*S One study was included
Strategies Towards Optimized Muscle Health

For optimal maintenance with aging, it is important to build muscle when young, maintain it in mid-life, and minimize loss in older adulthood.

Integrated approach to address muscle loss


Protein, HMB, Vitamins (Vitamin D), Minerals

Exercise

Decline in muscle mass despite adequate protein intake according to RDA

Protein intake at 0.8g/kg/day was associated with a decline in thigh muscle area after 14 weeks.

**Dietary protein intake evidence**

A prospective analysis including 2000+ elderly adults in the health, aging, and body composition (Health ABC) study

Overall lean body mass (LM) by quintile of protein intake

<table>
<thead>
<tr>
<th>Quintile</th>
<th>Change in LM (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-0.2</td>
</tr>
<tr>
<td>2</td>
<td>-0.3</td>
</tr>
<tr>
<td>3</td>
<td>-0.4</td>
</tr>
<tr>
<td>4</td>
<td>-0.5</td>
</tr>
<tr>
<td>5</td>
<td>-0.6</td>
</tr>
</tbody>
</table>

p<0.05 for Quintile 1 vs 2 vs 3, and Quintile 4 vs 5.

Appendicular (ARM+LEG) lean mass (aLM) by quintile of protein intake

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<td>3</td>
<td>-0.5</td>
</tr>
<tr>
<td>4</td>
<td>-0.6</td>
</tr>
<tr>
<td>5</td>
<td>-0.7</td>
</tr>
</tbody>
</table>

p<0.05 for Quintiles 1 vs 4 and 5, and Quintiles 2 and 3 vs 5, and Quintile 4 vs 5.

Subjects in the highest protein quintile lost 40% less lean mass (LM) than did those in the lowest protein quintile (p<0.01).


**2RDA protein intake results in significantly greater protein synthesis – a randomized controlled trial**

![Graph showing changes in whole body protein turnover](chart)

RCT (n = 20, 52–75 y) showed significantly greater increase in NB and PS in those consuming 2RDA protein vs. 1 1RDA protein, regardless of distribution pattern.


**2RDA protein intake has beneficial effects on lean body mass and leg power in elderly men**

![Graphs showing changes in whole body and trunk lean mass](chart)


**2RDA protein intake has beneficial effects on lean body mass and leg power in elderly men**

![Table showing effects of RDA and 2RDA protein intake](table)

<table>
<thead>
<tr>
<th></th>
<th>Pre</th>
<th>Post</th>
<th>RDA</th>
<th>2RDA</th>
<th>Effect1</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPB score</td>
<td>112.9</td>
<td>111.0</td>
<td>9.7</td>
<td>11.6</td>
<td>0.058</td>
</tr>
<tr>
<td>TUG, s</td>
<td>83.4</td>
<td>82.8</td>
<td>6.9</td>
<td>10.1</td>
<td>0.234</td>
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<tr>
<td>Grip strength, kg</td>
<td>75.8</td>
<td>75.2</td>
<td>0.6</td>
<td>1.0</td>
<td>0.435</td>
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<tr>
<td>Knee extension MVC, N</td>
<td>179.6</td>
<td>180.4</td>
<td>0.2</td>
<td>0.8</td>
<td>0.223</td>
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<tr>
<td>Knee extension peak power, W</td>
<td>271</td>
<td>272</td>
<td>0.1</td>
<td>0.2</td>
<td>0.212</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>RDA</th>
<th>2RDA</th>
<th>Effect2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>Post</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>0.586</td>
<td>0.249</td>
<td>0.185</td>
</tr>
<tr>
<td>Diet</td>
<td>0.915</td>
<td>0.777</td>
<td>0.313</td>
</tr>
<tr>
<td>Time x Diet</td>
<td>0.729</td>
<td>0.400</td>
<td>0.042*</td>
</tr>
</tbody>
</table>

Notes: Pre = before, Post = after. The RDA is 0.8 g protein/kg body weight/day, and the 2RDA is 1.6 g protein/kg body weight/day. *Significant main effect on protein intake (p<0.05). **Significant protein x time interaction in some groups (p<0.05). "Significant main effect on protein intake (p<0.05)." Significant protein x time interaction in some groups (p<0.05). Data are shown as means ± SEM. Physical performance was assessed using the Short Physical Performance Battery (SPB), timed sit to stand test (TUG), and grip strength. The data were analyzed using two-way analysis of variance for repeated measures (SPB, TUG, grip strength). All data were analyzed using repeated measures ANOVA. Significant main effects were followed by paired t-tests. Post hoc tests were conducted using Bonferroni correction. Data are shown as means ± SEM.
Recommendations for higher protein intake in older adults

- Minimum protein intake: 0.8g/kg, previous target intake level
- New target intake levels:
  - 30% increase: 1.0-1.2 g/kg
  - 88% increase: 1.2-1.5 g/kg
  - 150% increase: Up to 2.0 g/kg

Caution needed among those with severe kidney disease [i.e. estimated Glomerular Filtration Rate <30mL/min/1.73 m², calculating their needs differently]


Effects of 1,25 vitamin D on muscle cells

Older adults with low vitamin D level had lower appendicular lean mass and leg strength

Tasmanian older adult cohort study including 686 community-dwelling older adults

- ~5% lower appendicular lean mass
- ~9% lower leg strength

Vitamin D supplementation has a positive impact on muscle strength

Meta analysis including 30 RCTs (n=5615) showed vitamin D supplementation had a small positive impact on muscle strength

(A) Heterogeneity: $Q$-value 125.37; $I^2$=28%; $p$-value 0.001


Vitamin D supplementation reduces the odds of falling

High dose vitamin D (700 to 1000 IU vitamin D per day) reduced the odds of falling (OR=0.66 [0.53-0.82] $p=0.0002$)

Bischoff-Ferrari HA. Geriatr Psychol Neuropsychiatr Vieil, vol. 15, n 1, mars 2017

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HMB

β-hydroxy-β-methylbutyrate (HMB)

Active metabolite of amino acid leucine
Occurrences naturally in human muscle cells
Found in small quantities in some foods
1.5 g CaHMB is equal to ~3,000 avocados

QUICK FACTS
Leucine - HMB Metabolic Pathway


Mechanism of action of HMB on muscle

Giron et al (2015) PloS one, 10(2), e0117520
Wilkinson DJ et al. J. Physiol. 2013:591.11: 2911-23

Blood HMB Concentration Declines with Aging

HMB concentrations were significantly lower with increasing age groups
- Could be one contributing factor of muscle loss with aging

HMB contributes to preservation of muscle mass in older adults - Meta analysis of effectiveness of HMB

Greater muscle mass gain with HMB

Wu et al, Arch Gerontol Geriatr. 2015;61(2):168-75
Exercise!

- "Aging muscle does respond to exercise, especially resistance exercise"
- ESPEN expert group encourage: continued participation in routine exercise or physical activities.

Summary

Muscle mass and strength is vital for healthy aging. Loss of muscle mass and strength (sarcopenia) can be due to aging, physical inactivity and disease-related, leading to loss of independence and poor quality of life.

Sarcopenia is preventable with exercise and adequate nutrition.

Regular exercise
Adequate protein and vitamin D intake
HMB supplementation