PROTEINS IN CLINICAL NUTRITION

QUALITATIVE NEEDS IN CLINICAL SITUATIONS

Y. Boirie (FR)
Proteins in clinical nutrition: Qualitative needs in clinical situations

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Protein intake and exercise for optimal muscle function with aging: Recommendations from the ESPEN Expert Group

Nicolaas E.P. Deutz a,*, Jürgen M. Bauer b, Rocco Barazzoni c, Gianni Biolo c, Yves Boirie d, Anja Bosy-Westphal e, Tommy Cederholm f,g, Alfonso Cruz-Jentoft h, Zeljko Krznarić i, K.Sreekumaran Nair j, Pierre Singer k, Daniel Teta l, Kevin Tipton m, Philip C. Calder n.o

Dietary protein intake
- Older adults have greater protein needs to compensate for anabolic resistance and hypermetabolic disease.
- Older adults may also have decreased intake due to age-related appetite loss, medical conditions, financial limits.
- Optimal intake of at least 1.0 to 1.5 g protein/kg BW/day is recommended; individual needs depend upon the severity of malnutrition risk.

Exercise
- Regular exercise helps maintain skeletal muscle strength and function in older adults.
- Resistance training has limited but positive effects on recovery of muscle in older people.
- A combination of resistance training and adequate dietary protein/amino acid intake for healthy muscle aging is recommended.

Fig. 3. Recommendations for maintaining healthy muscle with aging.
PROTEIN INTAKE FALLS BELOW 0.6 G·KG⁻¹·D⁻¹ IN HEALTHY, OLDER PATIENTS ADMITTED FOR ELECTIVE HIP OR KNEE ARTHROPLASTY

= 101 patients (age: 67 ± 10 y)

Average 6d: 0.59 ± 0.18 (M) and 0.50 ± 0.21 (F) g·kg⁻¹·d⁻¹

![Protein Intake Diagram]

**Plant-based** 34 ± 7%

**Animal-based** 66 ± 7%
Qualitative needs in clinical situations

• Protein intake beyond RDA for optimal health, but qualitative aspects of protein intake underestimated and relevant when intakes are limited

• Traditionally, quality=ability of food proteins to achieve defined actions:
  – Ability to provide specific patterns of amino acids (AA)
  – Capacity to sustain N balance, growth or maintain body protein mass

• Necessity to expand the concept to integrate newly emerging actions of dietary protein modulating metabolic issues (cell signaling, oxidative stress, inflammation, digestive functions, microbiota, glucose homeostasis, satiety, …)

• New challenges regarding sustainability of food production systems and climate change (vegetable vs animal protein production/utilization)
Qualitative needs in clinical situations

• Why to define qualitative needs? to respond to specific qualitative changes in protein metabolism

• How to define qualitative needs? in relation to dietary proteins characteristics but not only (food matrix, timing, speed of absorption, non-protein nutritional compounds...)

• Which qualitative needs for which clinical situations? to respond to qualitative needs of the individuals as influenced by age, health status, physiological status, energy balance
Cyclic pattern of muscle protein metabolism in response to meal intake in healthy adults

Net synthesis \((S > C)\)

Muscle protein balance

Net catabolism \((S < C)\)

Postabsorptive
Postprandial
Postabsorptive
Postprandial
Postabsorptive

MEAL

MEAL
Impaired protein metabolism response to meal intake in older adults: **anabolic resistance**

Muscle protein balance

Blunted muscle response to regular protein intakes

Postabsorptive  Postprandial  Postabsorptive  Postprandial  Postabsorptive

MEAL  MEAL

Mosoni L, AJP 1995
Volpi E, JCEM 2000
Guillet C, FASEB J 2004
Cuthbertson D, FASEB J 2005
Katsanos K, AJCN 2005
Burd NA, ESSR 2013
Wall BT, PlosOne 2015
Moore DR, J Gerontol 2015
Dirks ML, JAP 2017
Defect in postprandial availability and/or action of dietary amino acids for body tissues?

Protein intake: amount/quality
Postprandial availability of dietary amino acids for tissues: **splanchnic extraction** of dietary amino acids

**Intake**
- Meal
  - Proteins
  - Carbohydrates
  - Lipids

**Digestion**
- **AA**

**Absorption**
- Inflammatory proteins
- Tissue/secreted gut proteins
- AA availability
- Liver

**Splanchnic « first pass »**
- Tissue/secreted liver proteins
- Muscle

† AA use in the splanchnic area ⇒ μ AA availability for muscle

Boirie Y, AJCN 1997
Volpi E, AJP 1999
Jourdan M, PlosOne 2011
Moreau K, JAMDA 2013
Postprandial availability of dietary amino acids for body tissues: lower response of muscle protein synthesis to nutrients intake.

Intake

Meal

Proteins
Carbohydrates
Fat

Digestion
Absorption

AA pattern, transport, kinetics, signaling

↓ Muscle protein response

Insulin resistance
Mitochondrial dysfunction
Inflammation
Lipotoxicity
Inactivity

Muscle
Anabolic Resistance of Muscle Protein Synthesis with Aging

Protein Meal

- Anabolic signaling proteins
- Digestion and absorption
- Muscle uptake of dietary amino acids
- Splanchnic amino acid sequestration
- Postprandial amino acid delivery
- Postprandial muscle perfusion
- Postprandial amino acid availability

Anabolic resistance of muscle protein synthesis with aging

Burd NA, Exercise and Sport Sciences Reviews 2013
Characteristics of dietary protein

- Protein sources
- Food matrix
- Cooking
- Speed of absorption
- Timing
- Meal Distribution
- Biopeptides production
- Nutrient interactions
2 major aspects of protein qualitative needs

Characteristics of dietary protein
- Protein sources
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- Nutrient interactions

Characteristics and specific needs of the individuals
- Age
- Gender
- Health status
- Physiological status
- Energy balance

Qualitative needs in food protein?
Qualitative needs in clinical situations

• Why to define qualitative needs? to respond to specific qualitative changes in protein metabolism

• How to define qualitative needs? in relation to dietary proteins characteristics but not only (food matrix, timing, speed of absorption, non-protein nutritional compounds...)

• Which qualitative needs for which clinical situations? to respond to qualitative needs of the individuals as influenced by age, health status, physiological status, energy balance
The food quality of a protein: the classic criteria

### Protein content

**Protein content (g / 100g dry matter):**
- Meat / fish > 70
- Eggs = 50
- Cheeses 40-50
- Milk / yogurts 28-30
- Oleaginous seeds 30-35
- Protein Seeds 20-30
- Cereals = 15
- Green vegetables = 10

### EAA content

**Profile in EAA**

- **Lysine**
- **Methionine**

![Graphs showing EAA content and Lysine profile]
The food quality of a protein: the classic criteria

**Digestibility**

**Vegetable protein sources:**
- Network of indigestible carbohydrate constituents
- Protein structure
- Presence of antinutritional factors

**Lower digestibility and increased gut endogenous losses**

**Digestible Indispensable Amino Acids Score (DIAAS)**

\[
\text{DIAAS} \% = \frac{[\text{limiting digestible AA}] (\text{mg/g tested protein}) \times 100}{[\text{same AA}] (\text{mg/g reference protein})}
\]

**Digestibility in small intestine**

<table>
<thead>
<tr>
<th>Protein Source</th>
<th>True Protein Digestibility (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pea (yellow, split)</td>
<td>87.9</td>
</tr>
<tr>
<td>Pea (green, split)</td>
<td>85.2</td>
</tr>
<tr>
<td>Lentil (green, whole)</td>
<td>87.9</td>
</tr>
<tr>
<td>Lentil (red, split)</td>
<td>90.6</td>
</tr>
<tr>
<td>Chickpeas</td>
<td>85.0</td>
</tr>
<tr>
<td>Pinto Beans</td>
<td>76.2</td>
</tr>
<tr>
<td>Kidney Beans</td>
<td>78.6</td>
</tr>
<tr>
<td>Black Beans</td>
<td>70.0</td>
</tr>
<tr>
<td>Navy Beans</td>
<td>80.0</td>
</tr>
<tr>
<td>Soy Flour</td>
<td>83.5</td>
</tr>
<tr>
<td>Wheat Flour*</td>
<td>92.3</td>
</tr>
<tr>
<td>Rice Flour*</td>
<td>92.0</td>
</tr>
<tr>
<td>Lentil-Wheat (25:75) Blend*</td>
<td>91.0</td>
</tr>
<tr>
<td>Lentil-Rice (20:80) Blend*</td>
<td>90.0</td>
</tr>
<tr>
<td>Black Bean-Rice (25:75) Blend*</td>
<td>93.0</td>
</tr>
<tr>
<td>Pea-Wheat (30:70) Blend*</td>
<td>90.0</td>
</tr>
<tr>
<td>Casein</td>
<td>96.6</td>
</tr>
</tbody>
</table>

*Millward DJ, AJCN 2008; Tomé D, Br J Nutr 2012; FAO report 2014*
2 major aspects of protein qualitative needs

Characteristics of dietary protein
• **Protein sources**
• Food matrix
• Cooking
• Speed of absorption
• Timing
• Meal Distribution
• Biopeptides production
• Nutrient interactions

Characteristics and specific needs of the individuals
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Peripheral and Splanchnic Metabolism of Dietary Nitrogen Are Differently Affected by the Protein Source in Humans as Assessed by Compartmental Modeling

Nitrogen losses by deamination or intestinal loss are higher with vegetable proteins.

N splanchnic retention is greater with plant proteins.

Peripheral availability of nitrogen is lower with plant proteins.

Redistribution of nitrogen flux in the body

=> The metabolic orientations of amino acids derived from vegetable and animal proteins are different

What are the consequences on muscle protein metabolism?

Model-predicted kinetics of the distribution of retained dietary N and lost dietary N after the ingestion of a meal composed of sucrose with either milk protein (SMP, n = 9, panel A) or soy protein (SSP, n = 10, panel B).

Fouillet H, J Nutr 2002
Differential Effects of Cooked Beans and Cooked Lentils on Protein Metabolism in Intestine and Muscle in Growing Rats

Tatjana Pirman\textsuperscript{a} Etienne Combe\textsuperscript{b} Marie Claude Ribeyre\textsuperscript{b} Jacques Prugnaud\textsuperscript{b} Jasna Stekar\textsuperscript{a} Philippe Patureau Mirand\textsuperscript{b}

- growing rats
- 20 days
- Isoproteic diets

### Synthesis and protein content

#### Skeletal muscle

<table>
<thead>
<tr>
<th>Diet group</th>
<th>cooked beans</th>
<th>cooked lentils</th>
<th>casein</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soleus</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protein mg</td>
<td>9.22 ± 1.34\textsuperscript{a}</td>
<td>10.91 ± 1.26\textsuperscript{b}</td>
<td>14.51 ± 1.42\textsuperscript{c}</td>
</tr>
<tr>
<td>ASR mg·day\textsuperscript{-1}·100 g BM\textsuperscript{-1}</td>
<td>0.81 ± 0.16\textsuperscript{a}</td>
<td>1.02 ± 0.19\textsuperscript{b}</td>
<td>1.21 ± 0.18\textsuperscript{c}</td>
</tr>
</tbody>
</table>

#### Intestine

<table>
<thead>
<tr>
<th>Diet group</th>
<th>cooked beans</th>
<th>cooked lentils</th>
<th>casein</th>
</tr>
</thead>
<tbody>
<tr>
<td>intestine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protein mg</td>
<td>388 ± 42\textsuperscript{a}</td>
<td>302 ± 64\textsuperscript{b}</td>
<td>163 ± 18\textsuperscript{c}</td>
</tr>
<tr>
<td>ASR mg·day\textsuperscript{-1}·100 g BM\textsuperscript{-1}</td>
<td>161.8 ± 17.8\textsuperscript{a}</td>
<td>130.8 ± 31.4\textsuperscript{b}</td>
<td>34.6 ± 3.4\textsuperscript{c}</td>
</tr>
</tbody>
</table>

Pirman T, Ann Nutr Metab 2006
Differential metabolic effects of casein and soy protein meals on skeletal muscle in healthy volunteers

Yvette C. Luiking\textsuperscript{a,b}, Mariëlle P.K.J. Engelen\textsuperscript{a,b}, Peter B. Soeters\textsuperscript{a,b}, Yves Boirie\textsuperscript{c}, Nicolaas E.P. Deutz\textsuperscript{a,*}

- young men
- isonitrogenous
- 0.21 g protein/(kg.
  4 h) protein-based test meals

Group 1 \textbf{Milk proteins}

Group 2 \textbf{Soy protein}

Luiking Y, Clin Nutr. 2011
Consumption of fluid skim milk promotes greater muscle protein accretion after resistance exercise than does consumption of an isonitrogenous and isoenergetic soy-protein beverage\(^1\)\(^-\)\(^3\)

Sarah B Wilkinson, Mark A Tarnopolsky, Maureen J MacDonald, Jay R MacDonald, David Armstrong, and Stuart M Phillips

### Table 3

<table>
<thead>
<tr>
<th></th>
<th>Leu</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mmol/kg dry wt</td>
<td>60 min</td>
</tr>
<tr>
<td>Milk</td>
<td>0.57 ± 0.05</td>
<td>0.69 ± 0.06(^2)</td>
</tr>
<tr>
<td>Soy</td>
<td>0.54 ± 0.03</td>
<td>0.59 ± 0.04</td>
</tr>
<tr>
<td>(\Sigma)EAA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milk</td>
<td>7.80 ± 0.80</td>
<td>8.72 ± 0.49(^2)</td>
</tr>
<tr>
<td>Soy</td>
<td>7.68 ± 0.60</td>
<td>7.77 ± 0.60</td>
</tr>
</tbody>
</table>

Ingestion of whey hydrolysate, casein, or soy protein isolate: effects on mixed muscle protein synthesis at rest and following resistance exercise in young men

Tang JE, J Appl Physiol 2009
Dietary protein intake is not associated with 5-y change in mid-thigh muscle cross-sectional area by computed tomography in older adults: the Health, Aging, and Body Composition (Health ABC) Study

Amely M Verreijen,1 Mariëlle F Engberink,1 Denise K Houston,2 Ingeborg A Brouwer,3 Peggy M Cawthon,4,5 Ann B Newman,6 Frances A Tylavsky,7 Tamara B Harris,8 Peter JM Weis,1,9 and Marjolein Visser3

TABLE 2 Association between protein intake and thigh muscle area at year 6, adjusted for baseline thigh muscle area and potential confounders in 1561 older participants of the Health ABC study

<table>
<thead>
<tr>
<th></th>
<th>Mean 5-y change in muscle CSA was −9.8 cm².</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean protein intake was 0.90 g ·kg−1· d−1</td>
</tr>
</tbody>
</table>

No association was observed between energy adjusted total, animal or plant protein intake and muscle CSA at year 6

Conclusions: This study suggests that a higher total, animal, or vegetable protein intake is not associated with 5-y change in mid-thigh muscle CSA in older adults. This conclusion contradicts some, but not all, previous research.

Verreijen AM, Am J Clin Nutr 2019
How to improve the nutritional quality of vegetable proteins for muscle proteins?

1) Increasing protein intake

2) Fortify protein intake by some AAs: limiting AA of foods *(methionine, lysine, and/or leucine)*

3) Mixing multiple protein sources to provide a more balanced amino acid profile

4) Selective breeding of plant sources to improve amino acid profiles

**Improvement of the peripheral bioavailability of amino acids**

*Van Vliet S, J Nutr 2015*
Increasing protein intake

In Older Men, 60g of wheat protein increases muscle protein synthesis more than 35g of milk proteins but increase in the oxidation rate of amino acids (and urea synthesis)

Gorissen SHM, J Nutr 2016

Fortify protein intake by some AAs: limiting AA of foods

Fortifying wheat proteins with leucine increases postprandial muscle protein synthesis

Norton LE, Nutr Metab 2012

Supplementation of soy protein with branched-chain amino acids alters protein metabolism in healthy elderly and even more in patients with chronic obstructive pulmonary disease

Fortification of soy protein with branched chain amino acids reduces splanchnic extraction and increases postprandial protein balance

Engelen MPKJ, Am J Clin Nutr. 2007
Mixing multiple sources

Nutritional evaluation of mixed wheat–faba bean pasta in growing rats: impact of protein source and drying temperature on protein digestibility and retention

The mixture of wheat and faba bean flour helps to balance the Essential AA profile

Laleg K, Br J Nutr 2018

A meal with mixed soy/whey proteins is as efficient as a whey meal in counteracting the age-related muscle anabolic resistance only if the protein content and leucine levels are increased

Jarzaguet M, Food & Function, 2018
2 major aspects of protein qualitative needs

Characteristics of dietary protein
- Protein sources
- Food matrix
- Cooking
- **Speed of absorption**
- Timing
- Meal Distribution
- Biopeptides production
- Nutrient interactions

Specific needs of the individuals
- Age
- Gender
- Health status
- Physiological status
- Energy balance
Faster and higher!

Fast digestive proteins and sarcopenia of aging

Yves Boirie\textsuperscript{a} and Christelle Guillet\textsuperscript{b}

Boirie Y, Curr Opin Clin Nutr Metab Care 2018
**Fast Protein** concept:

- Postprandial protein anabolism
  - With the same protein intake
  - Independently of AA composition

**Boirie Y, PNAS 1997**

**Dangin M, Am J Physiol 2001**

---

Boirie Y., Curr Opin Clin Nutr Metab Care 2018
Postprandial whole-body protein metabolism after a meat meal is influenced by chewing efficiency in elderly subjects\(^1\) -\(^3\)

**Chewing**

Plasma Leucine

- Healthy natural dentition
- Complete dental prosthesis

Remond D, AJCN 2007

Acid and rennet gels exhibit strong differences in the kinetics of milk protein digestion and amino acid bioavailability

**Plasma Leucine**

matrix

Barbé F, Food Chem 2014

Effects of Meat Cooking, and of Ingested Amount, on Protein Digestion Speed and Entry of Residual Proteins into the Colon: A Study in Minipigs

**Cooking**

Plasma post-P EAA

Bax ML, PlosOne 2013

In the elderly, meat protein assimilation from rare meat is lower than that from meat that is well done

Plasma Leucine

Cooking

Buffière C, AJCN 2018
Whey protein stimulates postprandial muscle protein accretion more effectively than do casein and casein hydrolysate in older men\(^1\)\(^2\)\(^3\)

Bart Pennings, Yves Boirie, Joan MG Senden, Annemie P Gijsen, Harm Kuipers, and Luc JC van Loon

«peak» plasma AA (depending on the speed of absorption) is key for muscle protein synthesis

Beneficial effect of fast protein on muscle anabolism, strength and fatigue in elderly

10 days « Fast protein »

Fast-digestive protein supplement for ten days overcomes muscle anabolic resistance in healthy elderly men

Stéphane Walrand a, b, Céline Gryson a, b, Jérôme Salles a, b, Christophe Graudet a, b, Carole Migne a, b, Cécile Bonhomme d, Pascale Le Ruyet d, Yves Boirie a, b, c, *

a INRA, UMR 1019, UMR-CNRS, F-38300 Clermont-Ferrand, France
b Clermont Université, Université d’Auvergne, Unité de Nutrition Humaine, BP 11448, F-63000 Clermont-Ferrand, France
c CNUL Clermont-Ferrand, Clinical Nutrition Department, Clermont-Ferrand F-63000, France
d Université, Université d’Auvergne, Unité de Nutrition Humaine, BP 11448, F-63000 Clermont-Ferrand, France

10 days « Fast protein »

Four-Month Course of Soluble Milk Proteins Interacts With Exercise to Improve Muscle Strength and Delay Fatigue in Elderly Participants

Céline Gryson PhD a, b, Sébastien Ratel PhD c, Mélanie Rance PhD c, Stéphane Penando MS c, Cécile Bonhomme PhD a, b, Pascale Le Ruyet PhD d, Martine Duclos MD, PhD e, Yves Boirie MD, PhD a, b, c, Stéphane Walrand PhD a, b, c

4 months « Fast protein » + Exercise
2 major aspects of protein qualitative needs

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Protein pulse feeding improves protein retention in elderly women

Application in patients

Randomized control trials

Impact of protein pulse feeding on lean mass in malnourished and at-risk hospitalized elderly patients: A randomized controlled trial

Bouillanne O, Clin Nutr 2012
Dietary protein distribution and timing?

**FIGURE 2** Protein consumption per meal for adults (aged ≥19 y) in the United States shows a skewed intake pattern. Data were adapted from NHANES 2001–2008 (30). The dotted line approximates the amount of protein required per meal to maximally stimulate muscle protein synthesis.

Muscle anabolic threshold? (young vs elderly?)

-evening?

Mamerow MM, J Nutr 2014
Paddon-Jones D, Am J Clin Nutr 2015
Farsijani, Am J Clin Nutr 2016
Farsijani, Am J Clin Nutr 2017
Supplementing Breakfast with a Vitamin D and Leucine-Enriched Whey Protein Medical Nutrition Drink Enhances Postprandial Muscle Protein Synthesis and Muscle Mass in Healthy Older Men

Muscle gain as appendicular and leg lean mass after 6 weeks supplementation

Chanet A, J Nutr 2017
Timing of protein ingestion and exercise

<table>
<thead>
<tr>
<th>Meal</th>
<th>Appearance of amino acids in blood</th>
<th>Meal timing to hit peak anabolic window</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amino Acids Isolated Proteins (whey, soy, etc.)</td>
<td>10-20 minutes</td>
<td>Consume meal 0-60 minutes post exercise</td>
</tr>
<tr>
<td>Intact Proteins: beef, eggs, dairy</td>
<td>120+ minutes</td>
<td>Consume meal ~90 minutes before exercise</td>
</tr>
</tbody>
</table>

**FIGURE 4** The timing of protein ingestion and exercise to optimize the potential for muscle protein anabolism should also consider practical issues such as exercise performance, satiety, gastric comfort, and hunger.

*Paddon-Jones D, Am J Clin Nutr 2015*
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Sequential release of milk protein-derived bioactive peptides in the jejunum in healthy humans\textsuperscript{1–4}

\textit{Boutrou R, AJCN 2013}

\textbf{Figure 2.} Mean (±SD) numbers of peptides in the jejunum of subjects after the ingestion of casein (n = 7) and whey proteins (n = 6). Peptides are classified according to their molecular weight.

\textbf{Central and/or peripheral actions}
- CN system
- Immune system
- Cardiovascular system
- Metabolism

\textbf{Figure 3.} Milk peptides released from β-casein that were identified by using liquid chromatography-tandem mass spectrometry in jejunal effluents of humans fed casein (n = 7). Peptides having a biological activity are presented as angiotensin-converting enzyme inhibitory peptides (open bars), opioid peptides (gray bars), immunomodulatory peptides (dotted bar), and antihypertensive peptides (left diagonally hatched bars).
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Qualitative needs in food protein?
Multimodal approach to counteract sarcopenia

Effects of a Vitamin D and Leucine-Enriched Whey Protein Nutritional Supplement on Measures of Sarcopenia in Older Adults, the PROVIDE Study: A Randomized, Double-Blind, Placebo-Controlled Trial

Jürgen M. Bauer MD, PhD a,⁎, Sjors Verlaan MSc b,⁎, Ivan Bautmans PhD d,

Whey protein, amino acids, and vitamin D supplementation with physical activity increases fat-free mass and strength, functionality, and quality of life and decreases inflammation in sarcopenic elderly1,2

Mariangela Rondanelli,3⁎ Catherine Klerys,6 Gilles Terraco,7 Jacopo Talluri,8 Roberto Mauger,7 Davide Guido,4 Milena A Faliva,3 Bruno S Solerte,3 Marisa Fioravanti,3 Henry Lukaski,9 and Simone Perna3

A high whey protein, vitamin D and E supplement preserves muscle mass, strength, and quality of life in sarcopenic older adults: A double-blind randomized controlled trial

Yacong Bo a,¹, Changfeng Liu b,¹, Zhe Ji c, Ruihong Yang c, Qianqian An c, Xueyuan Zhang a, Jie You a, Dandan Duan a, Yafei Sun a, Yiwei Zhu a, Han Cui a, Quanjun Lu a,⁎

JAMDA, 2015
AJCN, 2016
Clin Nutr 2018
Qualitative needs in clinical situations

• Why to define qualitative needs? to respond to specific qualitative changes in protein metabolism

• How to define qualitative needs? in relation to dietary proteins characteristics but not only (food matrix, timing, speed of absorption, non-protein nutritional compounds...)

• Which qualitative needs for which clinical situations? to respond to qualitative needs of the individuals as influenced by age, health status, physiological status, energy balance
Cod and soy proteins compared with casein improve glucose tolerance and insulin sensitivity in rats

Lavigne C, AJP 2000

Effect of whey on blood glucose and insulin responses to composite breakfast and lunch meals in type 2 diabetic subjects

Anders H Frid, Mikael Nilsson, Jens Juul Holst, and Inger ME Björck

Am J Clin Nutr 2005

The acute effects of four protein meals on insulin, glucose, appetite and energy intake in lean men

Pal S, Br J Nutr 2010

Jakubowicz D, J Nutr Biochem 2013
Casein and whey exert different effects on plasma amino acid profiles, gastrointestinal hormone secretion and appetite


Whey Proteins in the Regulation of Food Intake and Satiety

Bohdan L. Luhovyy, PhD, Tina Akhavan, MSc, and G. Harvey Anderson, PhD  J Am Coll Nutr 2007

Peptide YY mediates the satiety effects of diets enriched with whey protein fractions in male rats

Rizaldy C. Zapata,* Arashdeep Singh,* and Prasanth K. Chelikani*,+,1  FASEB J, 2018

Effect of a Whey Protein Supplement on Preservation of Fat Free Mass in Overweight and Obese Individuals on an Energy Restricted Very Low Caloric Diet

Anne Ellegaard Larsen 1,*#, Bo Martin Bibby 2 and Mette Hansen 1,*  Nutrients, 2018
2 major aspects of protein qualitative needs

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The nutritional quality of a protein is primarily determined by its essential amino acid composition and bioavailability (DIAAS), but many other aspects of protein nutrition have to be considered (timing, food pattern, meal distribution, nutrients interactions).

The speed of digestion is an interesting criterion to consider, it is usually not assessed. It depends on food physicochemical criteria, interactions with culinary preparation methods, and individual physiology (chewing capacity).

Specific 'health' effects could be related to the release of bioactive peptides during digestion (important field of investigation).

Qualitative needs might be tailored according to the clinical situations (preventive vs recovery conditions) and according to the health impact expected (anabolism, immune, glucose homeostasis, satiety...).
Thank you

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