Apports hyperprotéiques chez le sujet âgé: bénéfices et risques

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McGill

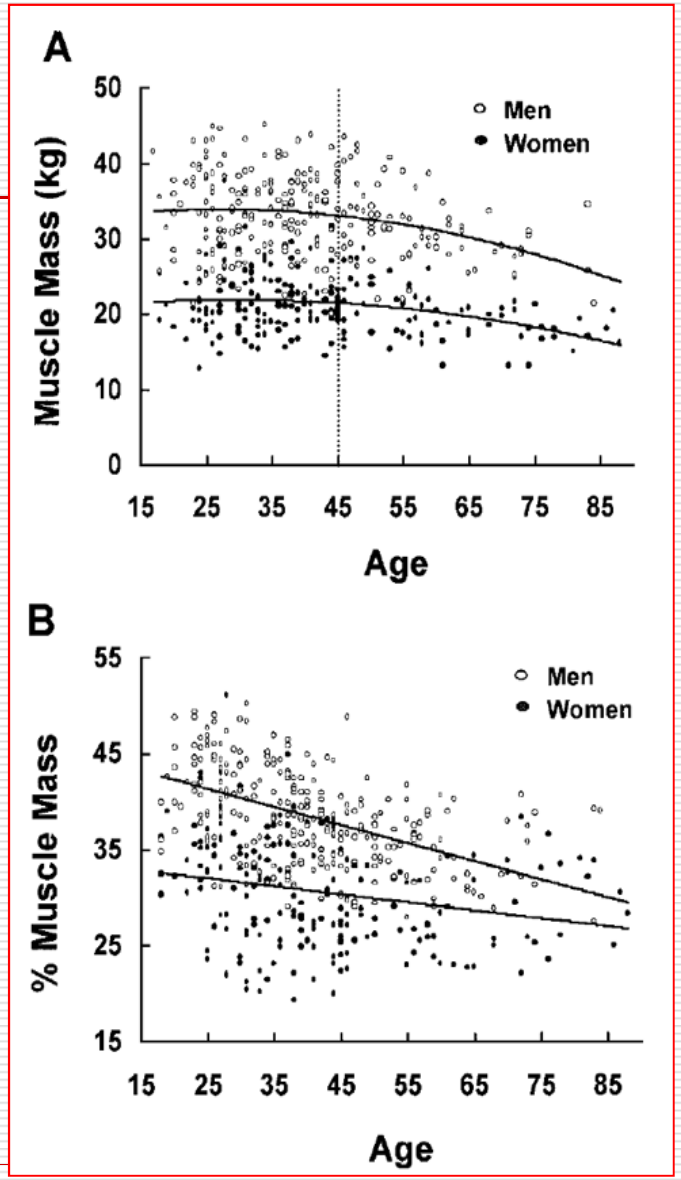
Centre universitaire de santé McGill
McGill University Health Centre

Divulgation

- Membre du Comité aviseur Pfizer
- Reçu des honoraires de Pfizer pour des présentations
- Membre du Comité d'experts sur l'implentation du Plan Alzheimer Québec du MSSS

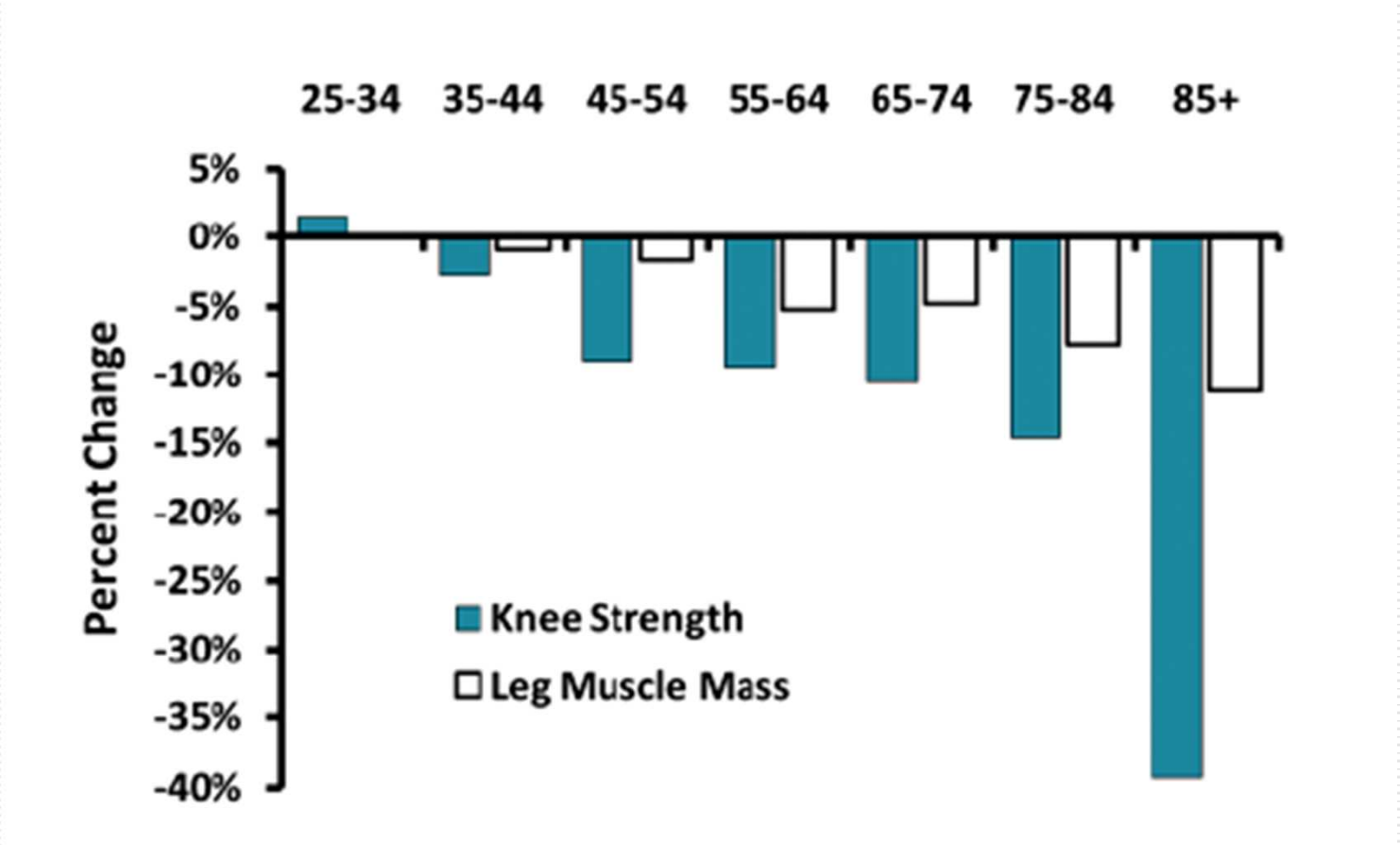
Diminution de la masse musculaire avec l'âge

20 y.o 70 y.o 85 y.0



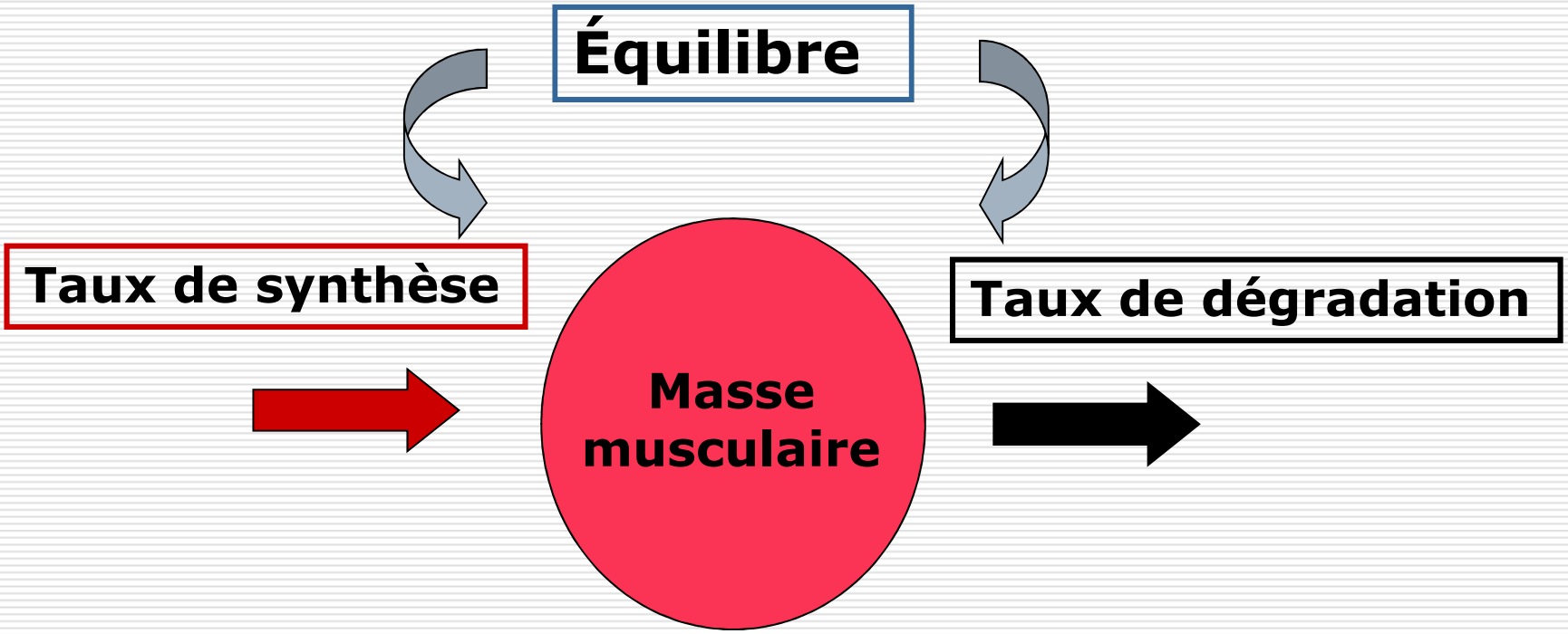
Janssen et al *J Appl Physiol* 88, 2000

Perte musculaire versus perte de la force

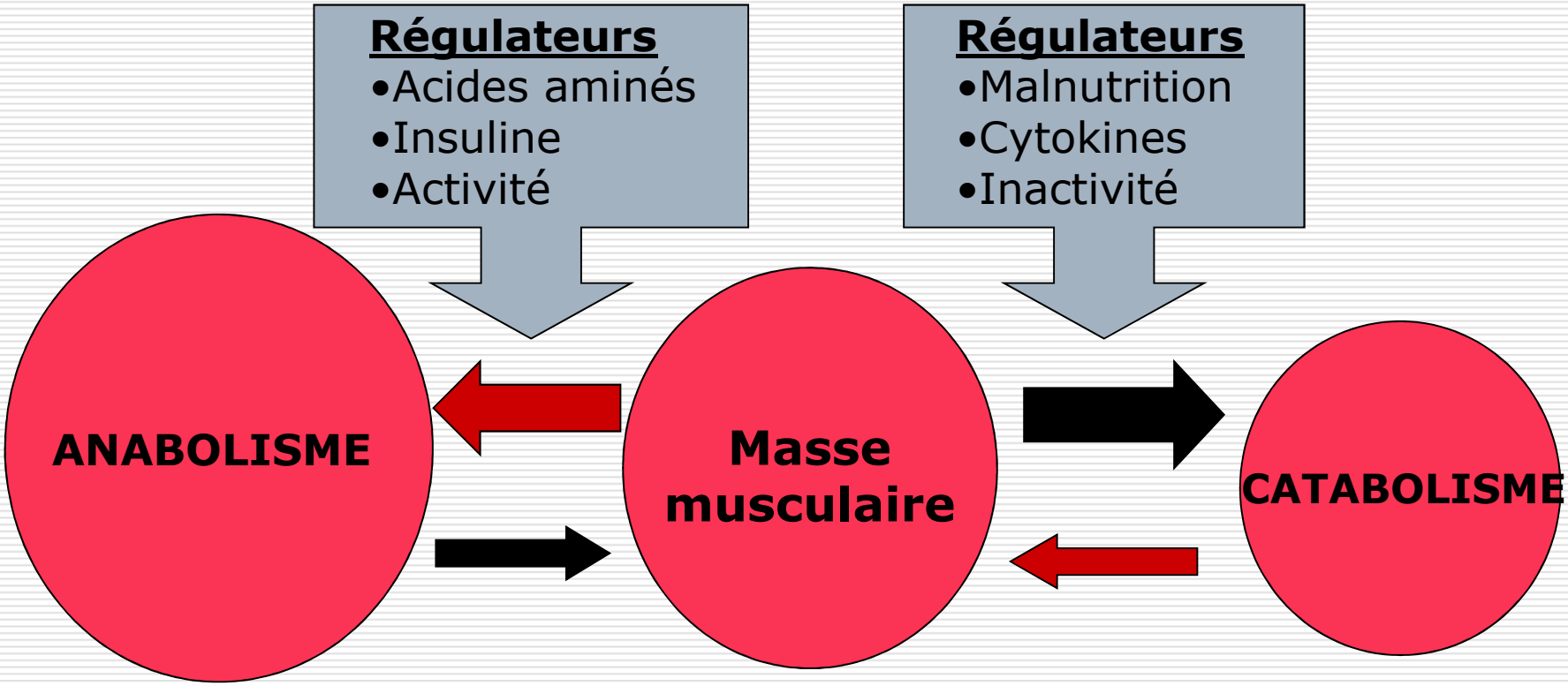


Ferrucci *et al.*, *J. Gerontology*, 2012

Maintien de la masse musculaire



Contrôle de la masse musculaire



Taux de renouvellement protéique corporel

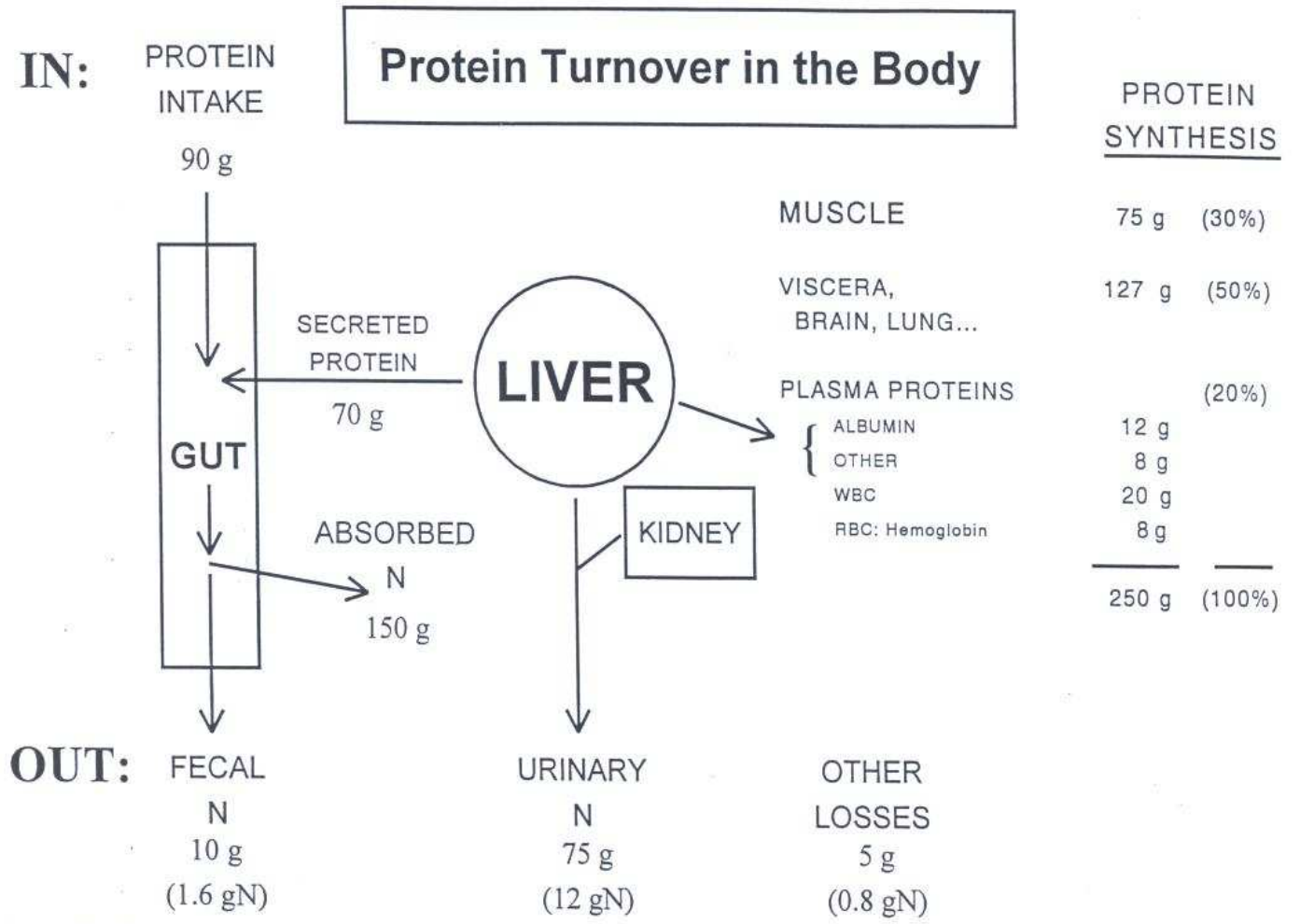
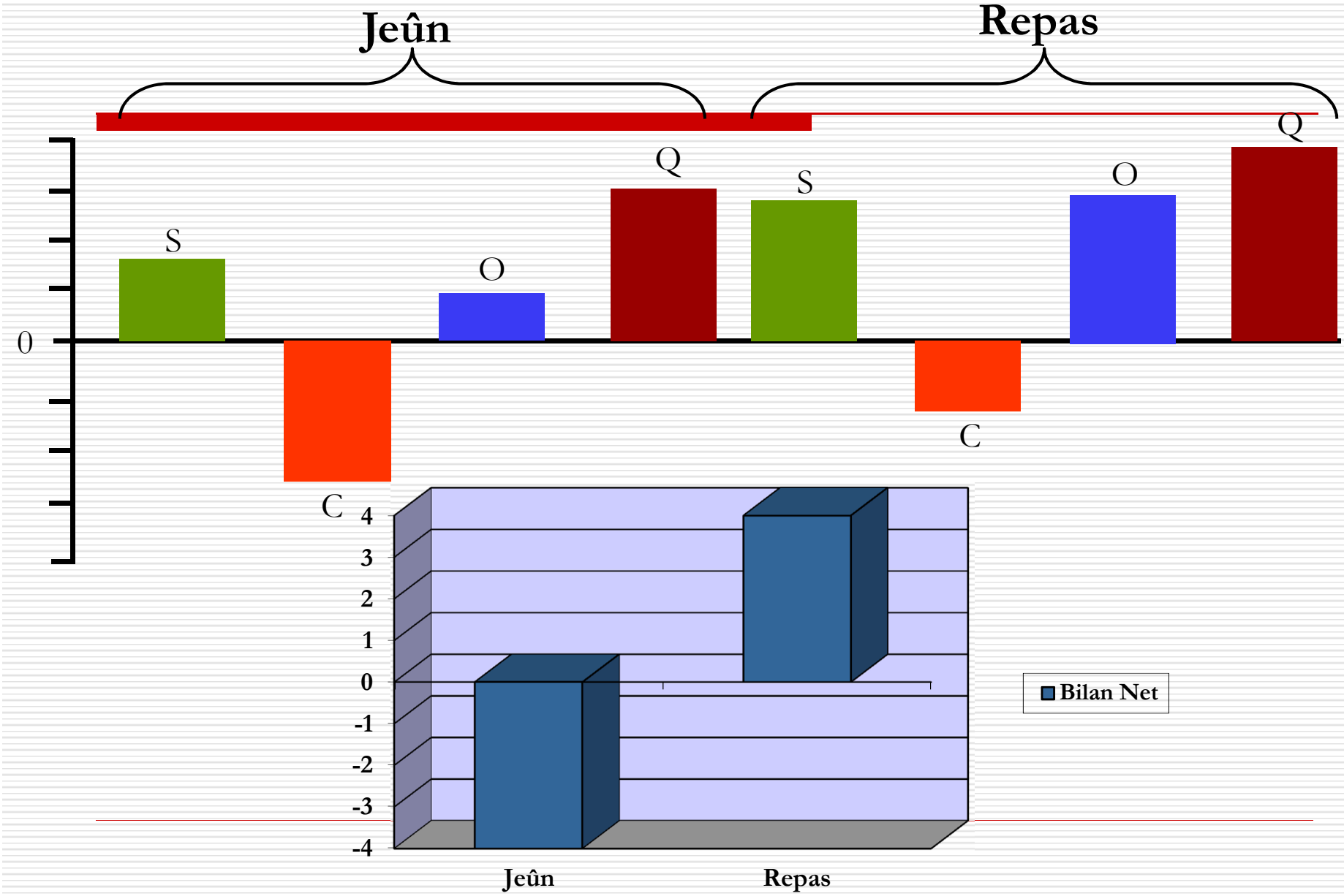
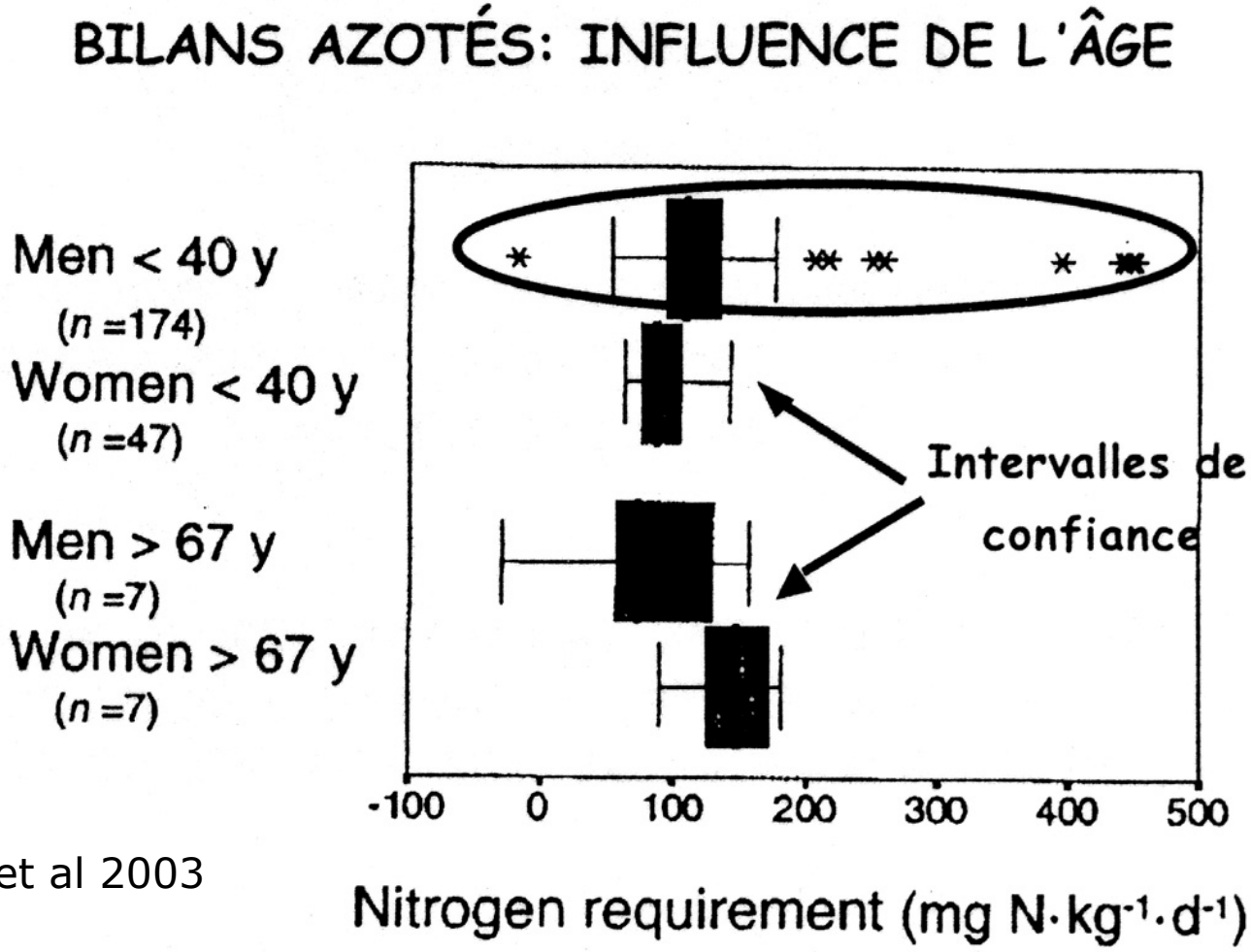


Figure 2.6. Relative rates of protein turnover and intake in a healthy 70-kg human. Under normal circumstances, dietary intake (IN = 90 g) matches N losses (OUT = 90 g). Protein breakdown then matches synthesis. Protein intake is only 90/(90 + 250) ≈ 25% of total turnover of N in the body per day. (Redrawn from Hellerstein MK, Munro HN. Interaction of liver and muscle in the regulation of metabolism in response to nutritional and other factors. In: Arias IM, Jakoby WB, Popper H, et al., eds. The liver: biology and pathobiology. 2nd ed. New York: Raven Press, 1988;965–83.)

Le cycle journalier des protéines corporelles



Besoins en protéines des adultes



Rand WM et al 2003

PAS DE RECOMMANDATIONS SPÉCIFIQUES POUR LES PERSONNES ÂGÉES

= 0,8 g/kg/j

Détermination des besoins protéiques par la méthode de l'IAAO

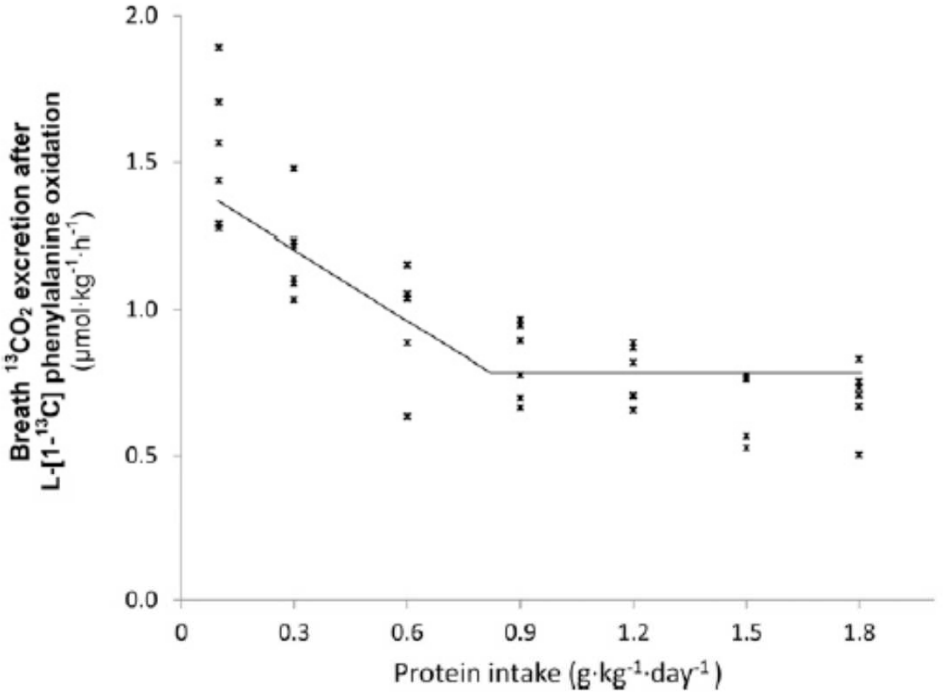


FIGURE 1. The relation between protein intake and breath $^{13}CO_2$ production in 6 octogenarian women. The data points represent the $^{13}CO_2$ excretion of individual subjects at each protein intake. The breakpoint represents the estimated mean protein requirement. The breakpoint was determined by using a nonlinear mixed model. The estimate for the mean protein requirement is 0.85 g · kg^{-1} · d^{-1}, and the corresponding adequate protein allowance is 1.15 g · kg^{-1} · d^{-1}.

Tang M. Am J Clin Nutr 2014;99:891–8

Enquête néerlandaise

Table 2 Energy and protein intake in community-dwelling, frail, and institutionalized elderly people

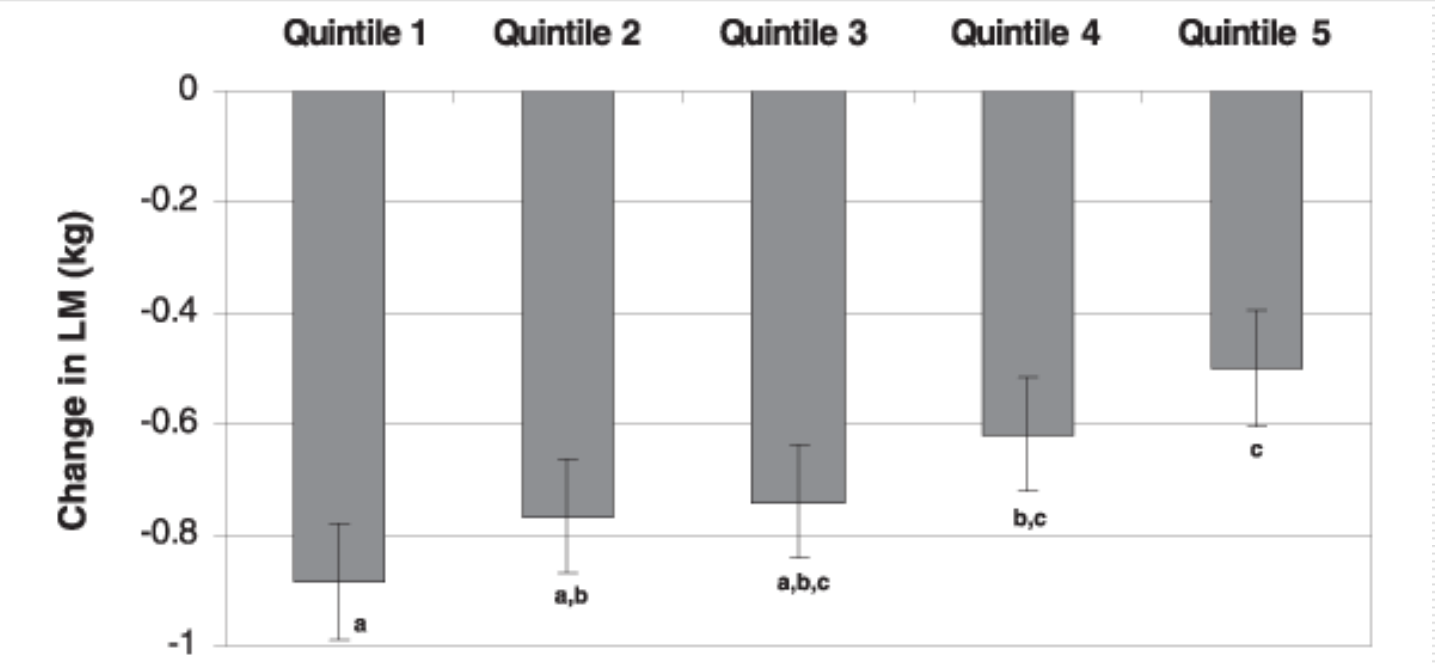
	Community-dwelling		Frail	Institutional	
	DNFCS (n = 400) 65–74 years	DNFCS (n = 307) 75–97 years	FRAIL (n = 194)	INST-1 (n = 60)	INST-2 (n = 216)
Energy intake (MJ/day)					
Men	9.4 ± 2.4^{a}	9.2 ± 2.5^{a}	8.7 ± 2.0^{a}	8.2 ± 1.6^{a}	5.8 ± 1.5^{b}
Women	7.5 ± 1.9^{a}	7.5 ± 1.8^{ab}	7.0 ± 1.5^{bc}	6.2 ± 1.5^{cd}	5.9 ± 1.6^{d}
Protein intake (g/day)					
Men	85.9 ± 23.9^{a}	81.9 ± 25.2^{ab}	75.4 ± 21.3^{b}	66.9 ± 18.8^{bc}	56.3 ± 17.1^{c}
Women	72.9 ± 18.2^{a}	71.6 ± 18.8^{a}	62.4 ± 14.9^{b}	54.0 ± 12.9^{c}	55.5 ± 15.4^{c}
Protein intake (g/kg-bw/day)					
Men	1.11 ± 0.31^{a}	1.07 ± 0.35^{ab}	1.04 ± 0.29^{ab}	0.86 ± 0.22^{bc}	0.78 ± 0.28^{c}
Women	1.03 ± 0.35^{a}	1.05 ± 0.32^{a}	1.00 ± 0.27^{a}	0.85 ± 0.20^{b}	0.81 ± 0.29^{b}
Protein intake (en%)					
Men	15.8 ± 3.5^{ab}	15.3 ± 3.2^{ab}	14.8 ± 2.9^{a}	13.9 ± 2.8^{a}	16.4 ± 2.6^{b}
Women	16.9 ± 3.9^{a}	16.5 ± 3.5^{ab}	15.3 ± 2.7^{c}	15.0 ± 3.0^{bc}	16.3 ± 2.5^{ac}

10%

35%

Tieland M Eur J Nutr 2012

Données de l'étude de cohorte Health ABC



Median total protein intake as a percentage of total energy intake (g.kg-^{1}.d-^{1}) by quintile (from quintile 1 to quintile 5) was 11.2% (0.7 g.kg-^{1}.d-^{1}), 12.7% (0.7 g.kg-1.d-1), 14.1% (0.8 g.kg-1.d-1), 15.8% (0.9 g.kg-1.d-1), and 18.2% (1.1 g.kg-1.d-1)

Houston DK AJCN 2008

Apports protéiques et force

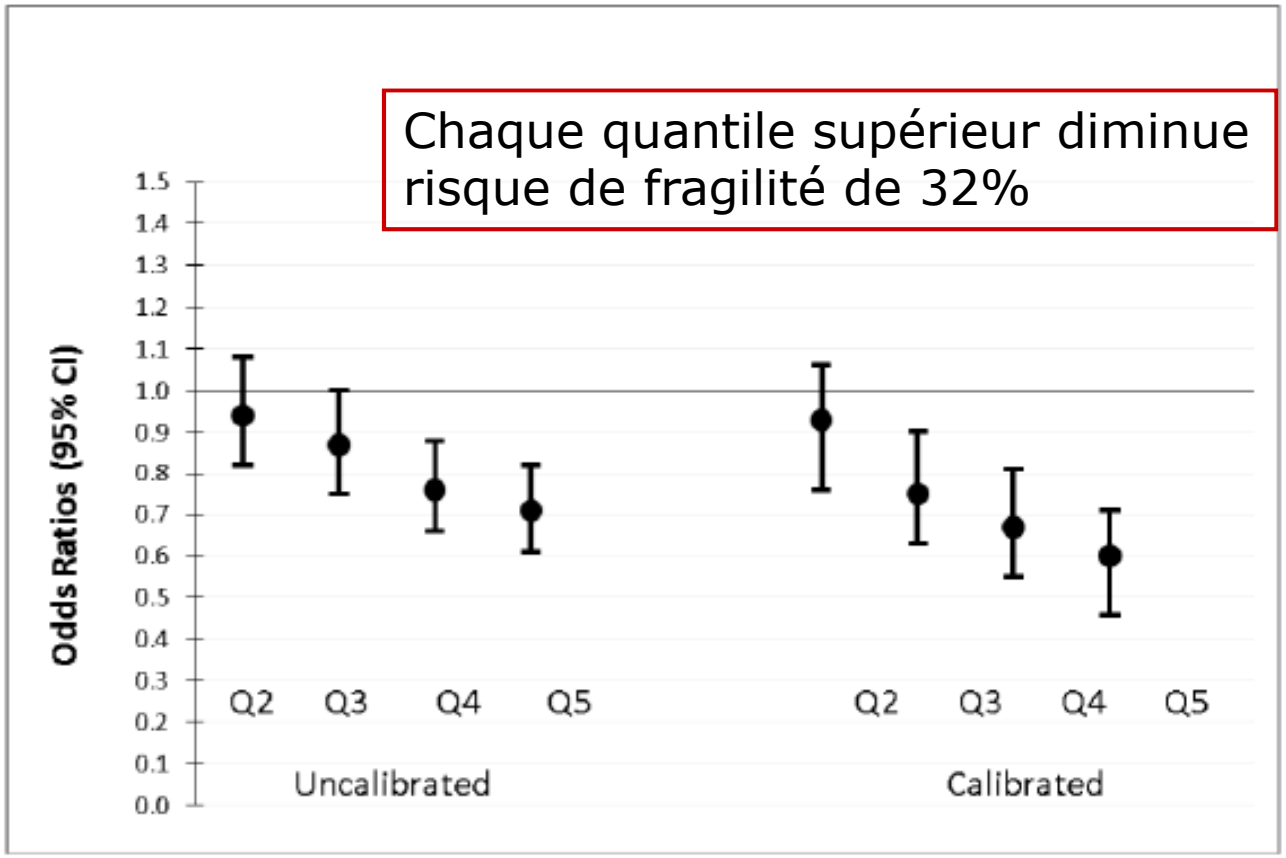
	Handgrip strength (kg/BW)			
	Non-dynapenic n=20	Type I dynapenic n=23	Type II dynapenic n=30	P
Lean body mass (%)	25.4±2.9	25.0±3.4	23.9±2.2	NS
Protein intake (g/d)	86.7±23.0	83.8±18.1	77.6±19.7	NS
Protein intake (%)	17.4±4.1 †	16.4±2.6	15.2±2.8	0.05
Protein intake (g/d/BW)	1.44±0.46 †	1.30±0.36 *	1.05±0.24	0.001

Devis: Cas-témoins

♀ postmenopausées

Filion ME et al. JNHA 2012

Apport protéiques et fragilité (WHS)



Beasley JM JAGS 2010

Études d’expérimentales

From: **Effect of 10 Days of Bed Rest on Skeletal Muscle in Healthy Older Adults**

JAMA. 2007;297(16):1769-1774. doi:10.1001/jama.297.16.1772-b

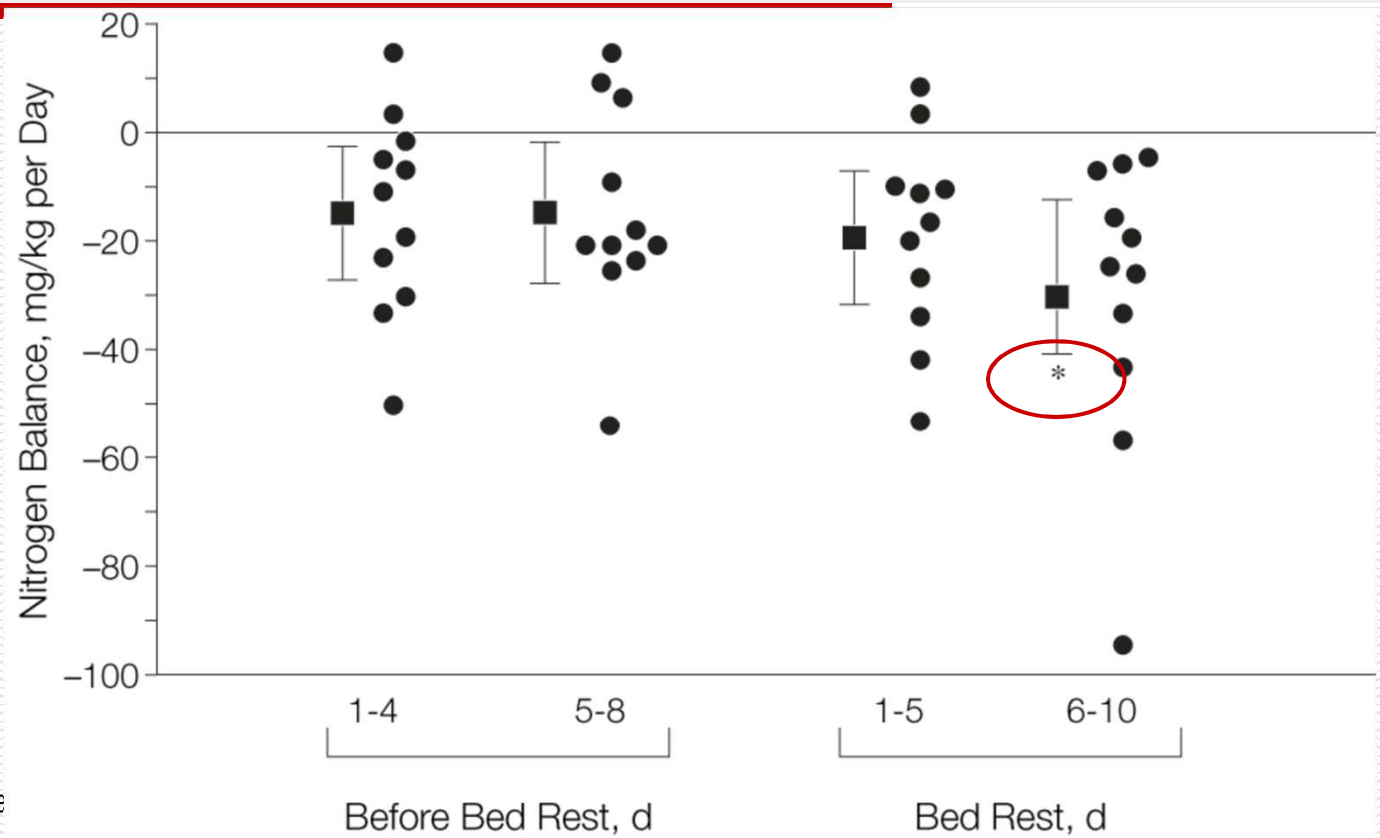


Figure Lege

Squares with error bars represent means and 95% confidence intervals for the time period. *Significantly different from days 1 through 4 and days 5 through 8 before bed rest (repeated measures analysis of variance with post hoc Tukey test, P = .02).

From: **Effect of 10 Days of Bed Rest on Skeletal Muscle in Healthy Older Adults**

JAMA. 2007;297(16):1769-1774. doi:10.1001/jama.297.16.1772-b

Table. Effects of 10 Days of Bed Rest in Older Adults

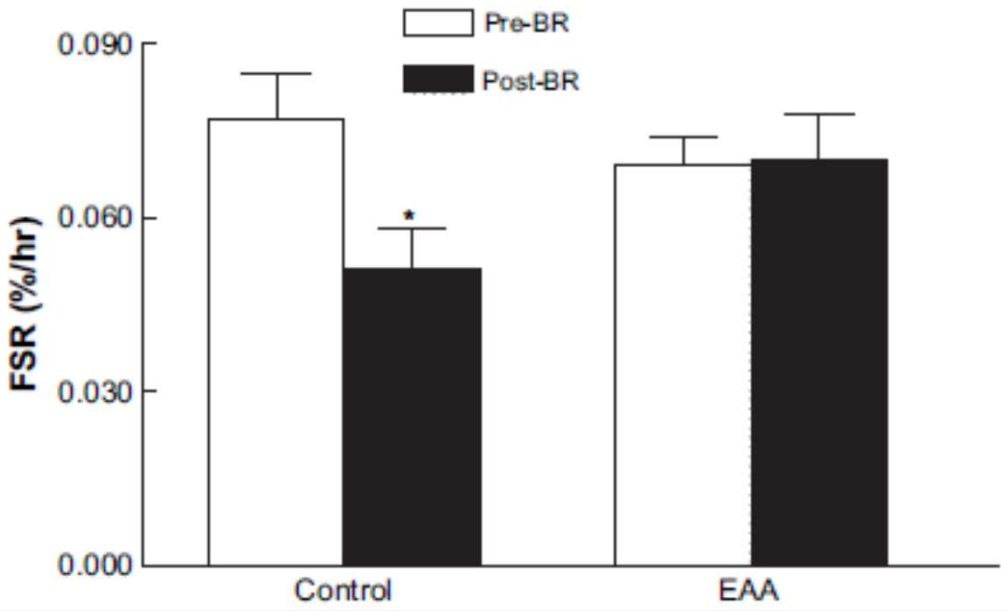
	No. of Participants (N = 12)*	Mean (95% Confidence Interval)			*P* Value
		Bed Rest			
		Before	After	Change	
Muscle fractional synthetic rate, % per h†	10	0.077 (0.059 to 0.095)	0.051 (0.035 to 0.067)	−0.027 (−0.007 to −0.047)	.02
% Change				−30.0 (−7.0 to −54.0)	
DEXA lean mass, kg‡	10				
Whole body		48.05 (40.61 to 55.49)	46.51 (39.57 to 53.45)	−1.50 (−0.62 to −2.48)	.004
% Change				−3.2 (−1.4 to −5.0)	
Lower Extremity		15.01 (12.41 to 17.61)	14.06 (11.85 to 16.27)	−0.95 (−0.42 to −1.48)	.003
% Change				−6.3 (−3.1 to −9.5)	
Isokinetic muscle strength, Nm per s§	11	120 (96 to 145)	101 (81 to 121)	−19 (−11 to −30)	.001
% Change				−15.6 (−8.0 to −23.1)	

Abbreviation: DEXA, dual-energy x-ray absorptiometry; Nm, Newton meter.
*One participant was excluded from all analyses because of insufficient protein intake.
†Because of a technical error, the muscle fractional synthesis rate measurement was excluded for 1 participant.
‡One participant was excluded from the DEXA analysis because the scan before bed rest was not administered.
§Isokinetic knee extension at 60° per second.

Effet d'une supplémentation AAE durant le repos au lit de 10 jours

Body mass and muscle function outcomes.

Parameter/group	Pre-bed rest		Post-bed rest		% Change		P^1
	Control	EAA	Control	EAA	Control	EAA	
Total lean mass (kg)	46.8 (0.3), $N=9$	43.0 (0.2), $N=11$	45.3 (0.3)	42.1 (0.2)	−2.9 (0.9)	−2.0 (0.7)	0.29
Leg lean mass (kg)	14.5 (0.1), $N=9$	13.3 (0.07), $N=11$	13.6 (0.1)	12.5 (0.07)	−5.9 (1.6)	−6.3 (1.8)	0.77
Total fat mass (kg)	27.0 (0.3), $N=9$	27.3 (0.1), $N=11$	27.0 (0.3)	27.3 (0.3)	0	0	0.86
Standing plantar flexion (rep/30 s)	21.8 (3.4), $N=7$	21.8 (1.4), $N=12$	20.9 (2.8)	21.4 (2.5)	−0.19 (0.04)	−0.019 (0.10)	0.054
Stair ascent power (Nm/s)	407.2 (69.9), $N=8$	293.5 (37.2), $N=11$	336.5 (47.6)	284.2 (43.0)	−14 (4)	−2 (5)	0.029
Stair descent power (Nm/s)	440.5 (75.7), $N=8$	320.6 (43.1), $N=12$	339.6 (50.6)	290.3 (45.9)	−21 (4)	−8 (4)	0.026
Floor transfer (s)	8.3 (1.1), $N=11$	9.6 (1.6), $N=12$	12.8 (2.3)	10.5 (1.7)	51 (17)	13 (7)	0.027



15g AAE 3x/j

Ferrando JAMA 2007

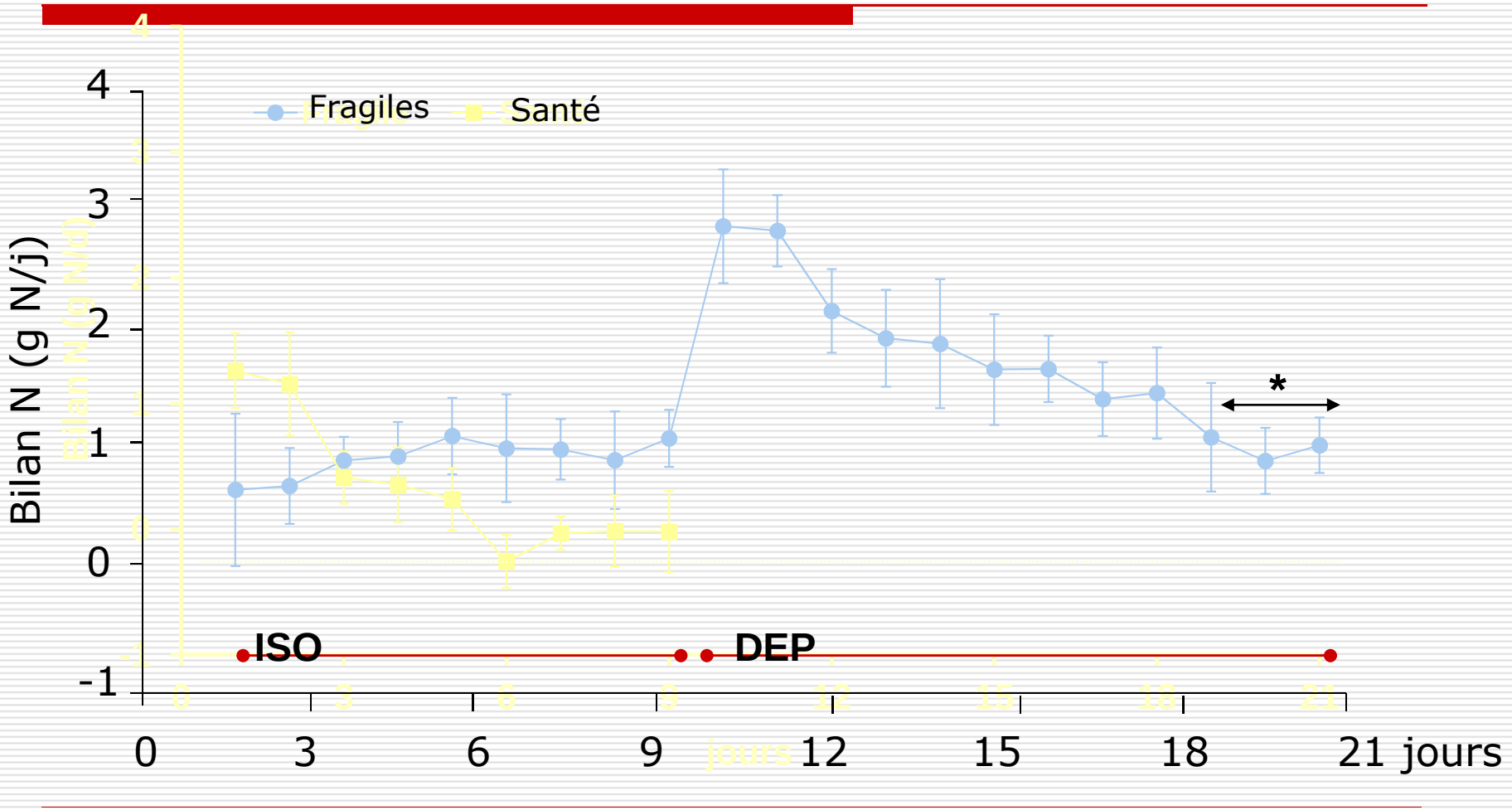
Apport protéique

	Fragile ISO	Fragile DEP	Santé ISO
Apport protéique			
(g/d)	38 ± 3 *	54 ± 5 *†	68 ± 3
(g/kg PC.d)	0.87 ± 0.03 *	1.23 ± 0.02 †	1.25 ± 0.08
(g/kg MM·d)	1.25 ± 0.09 *	1.78 ± 0.12 †	1.95 ± 0.10
(% de l'énergie)	12 ± 1 *	17 ± 1 †	15 ± 1

*Moyenne ± ETM. *P<0.005 vs Santé ISO †P<0.05 vs Fragile ISO*

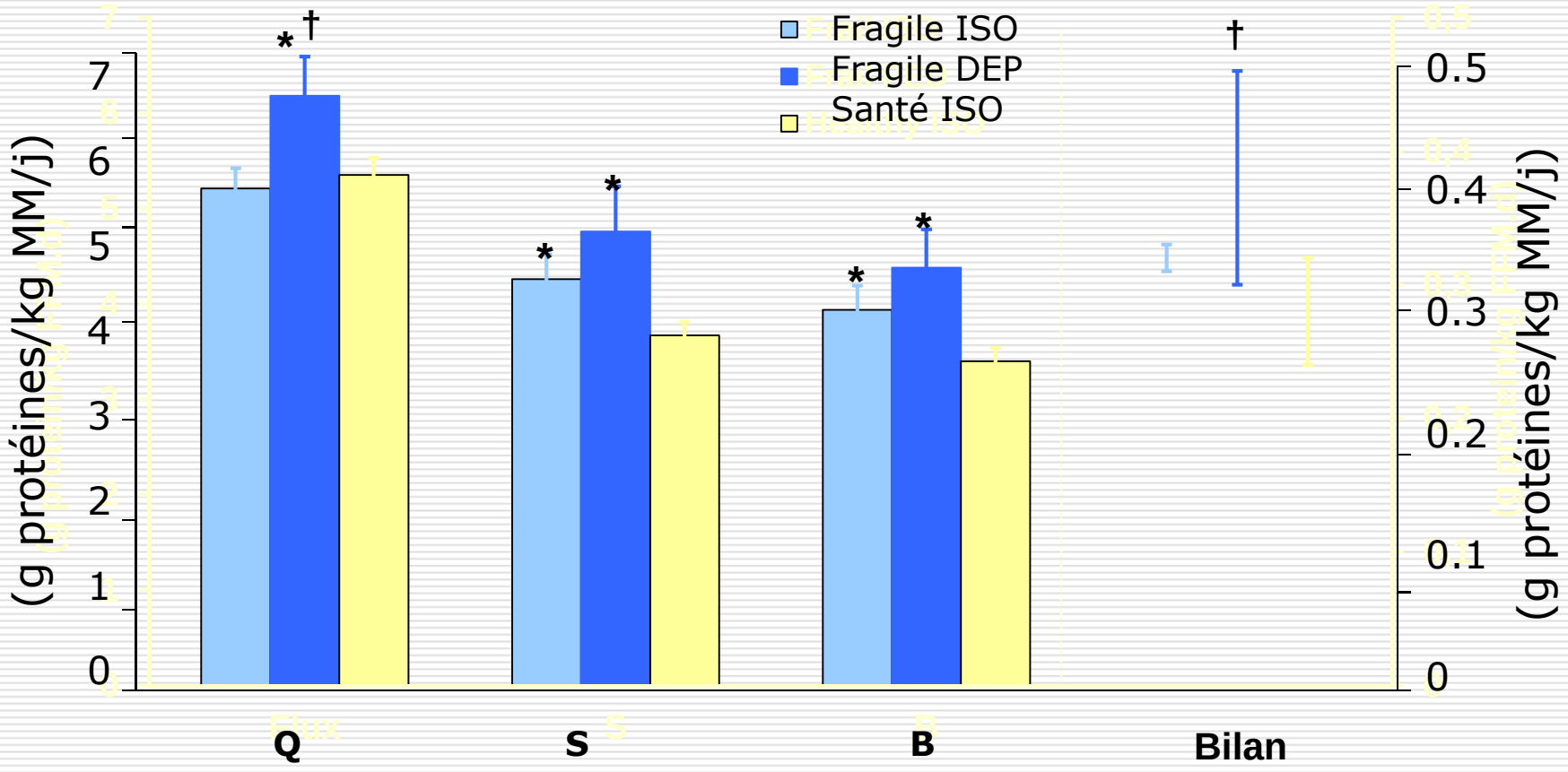
Chevalier S Morais JA JACN 2003

Bilan azoté



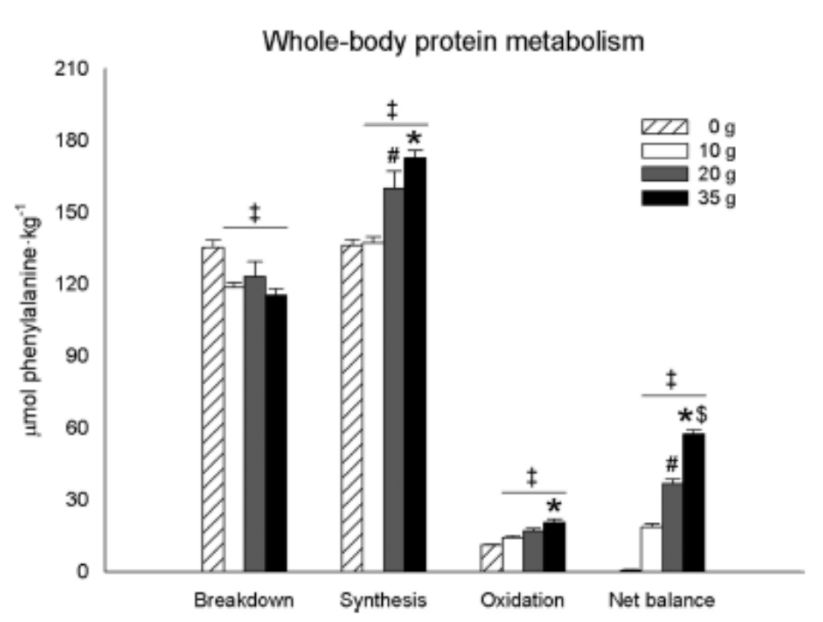
** différent de 0, P<0.05*

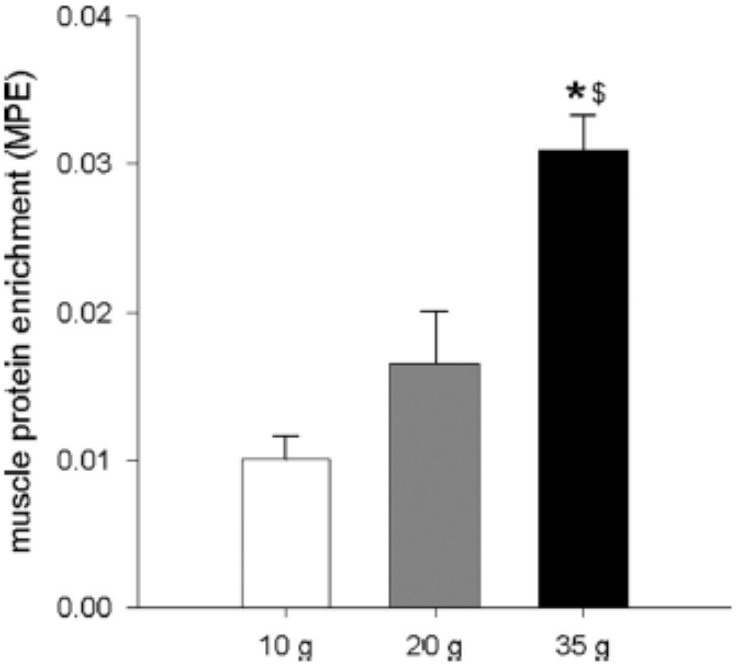
Cinétique des protéines corporelles



Mean ± SEM. *P<0.05 vs Healthy ISO †P<0.05 vs Frail ISO

Effets des apports protéiques de petit lait





Effets aigus d'un repas

N = 11/groupe

Penings B Am J Physiol Endocrinol Metab 2012

Synthèse protéique est un système saturable

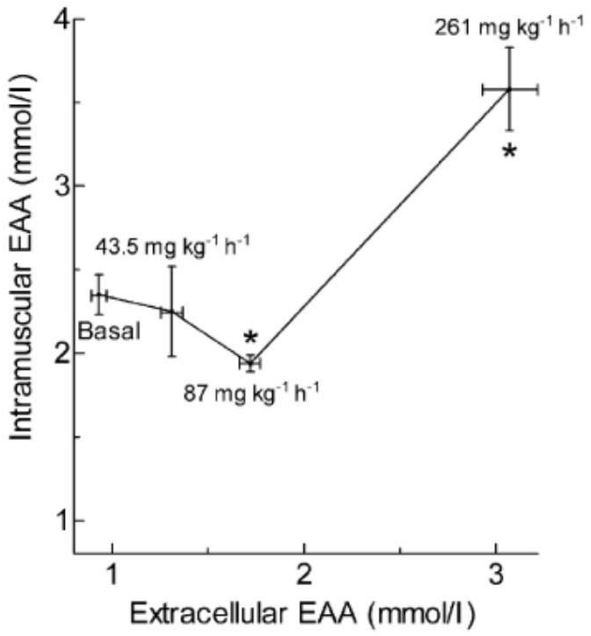
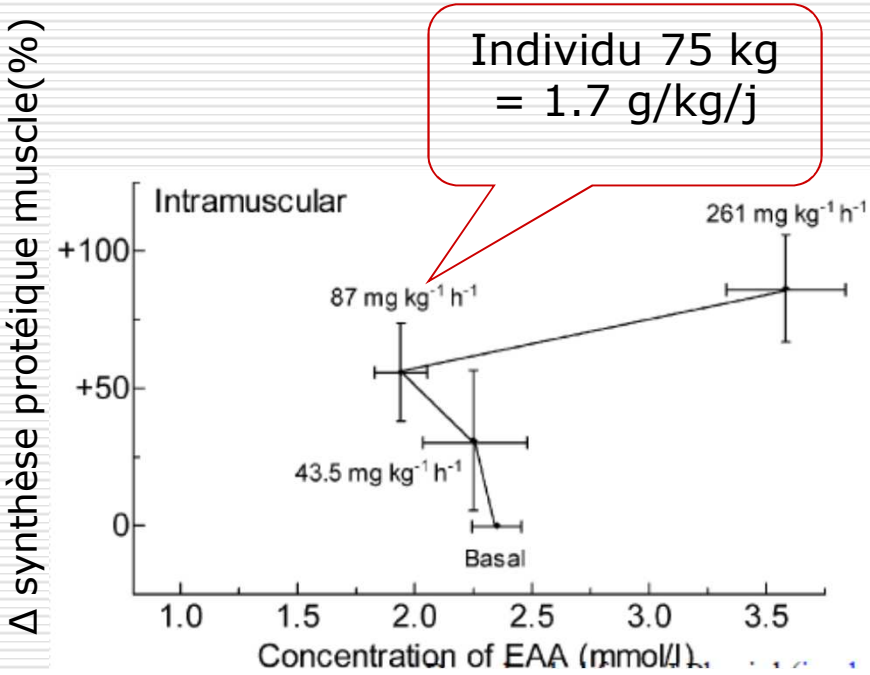
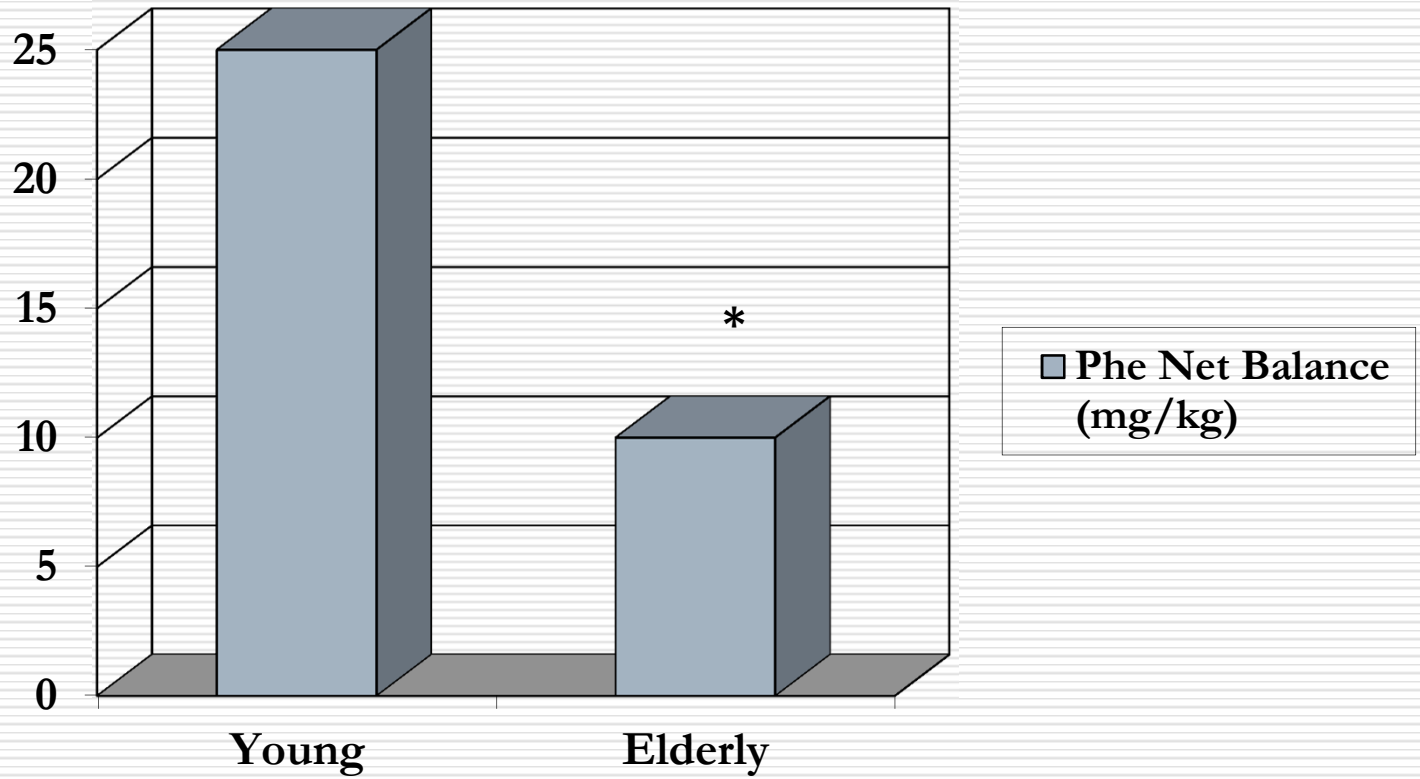


Figure 3. Relationship between extracellular and intramuscular concentrations of EAAs during infusion of mixed amino acids at different rates



Bohé JJ J Physiol 2003

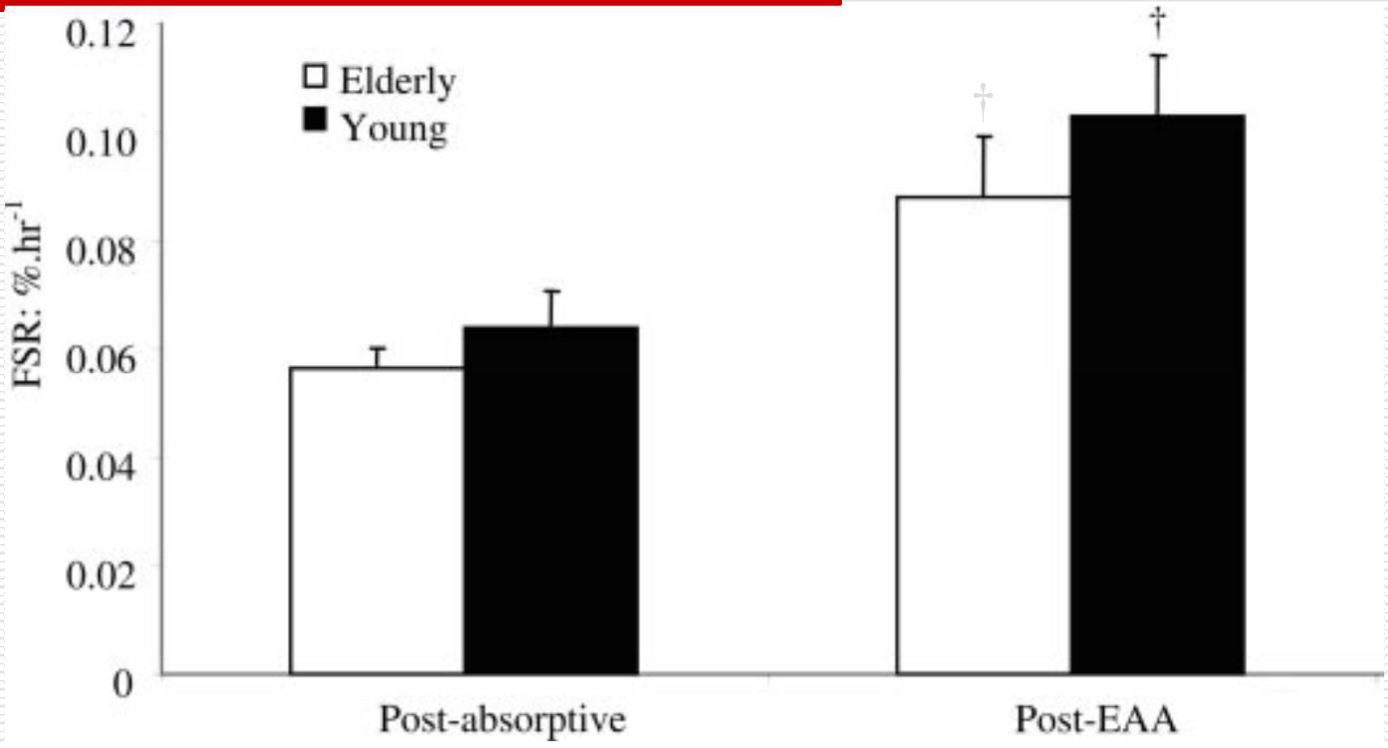
Réponse musculaire moindre avec un petit bolus AAE



Mean (SEM) leg phenylalanine net balance 3.5 h after the ingestion of 7g EAA calculated by measuring the area under the phenylalanine net balance response curve in the elderly (*n*11) and the young (*n*8). Data were analyzed with a *t* test. *Significantly different from the young, *P* 0.010.

Katsanos CS AJCN 2005

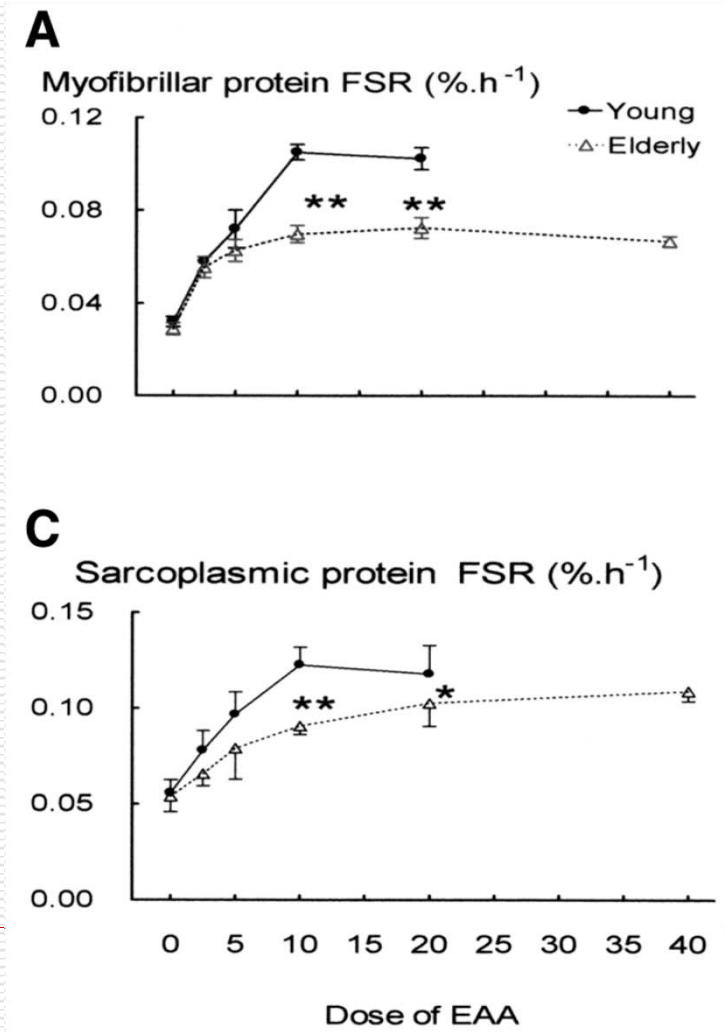
Une quantité suffisante d'AAE améliore la synthèe protéique musculaire



Mixed muscle fractional synthetic rate (FSR) in young and elderly before and after ingestion of 15 g of EAA. †Significant difference from corresponding postabsorptive values: young, *P* 0.012; elderly, *P* 0.029.

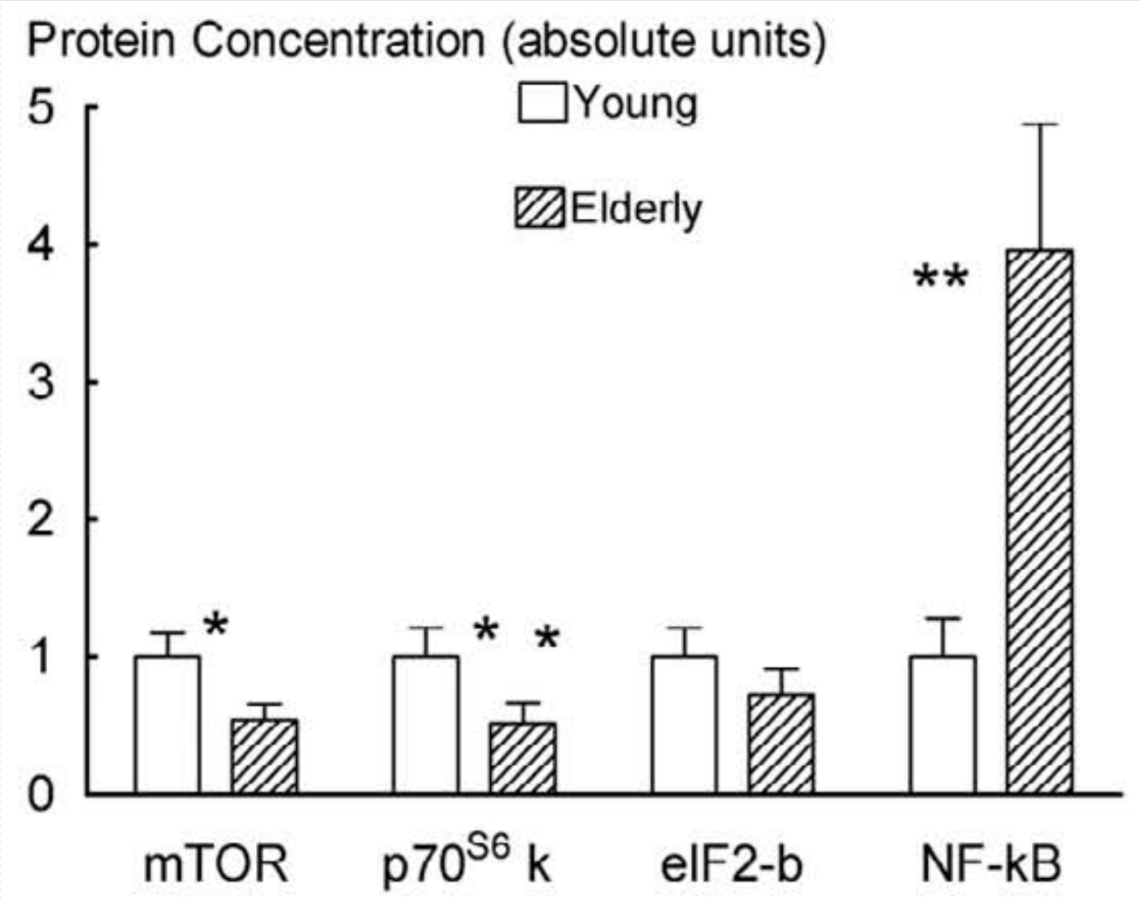
Paddon-Jones D Am J Physiol Metab 2004

Résistance anabolique



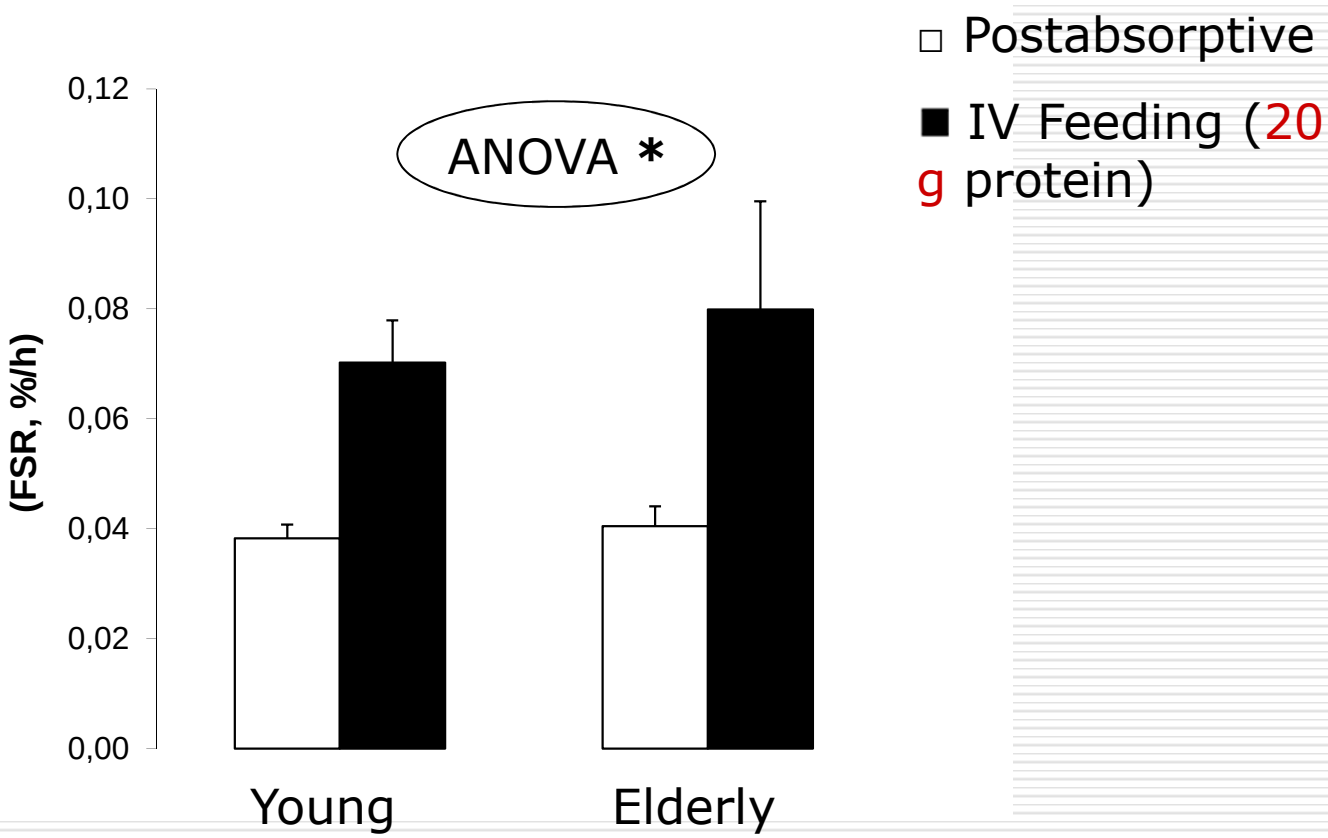
Cuthbertson D FASEB 2005;19:422-4

Causes de résistance anabolique



Cuthbertson D FASEB 2005;19:422-4

Réponse musculaire au repas intraveneux chez la femme âgée



*Feeding effect, P<0.01

Chevalier S, Morais et al J Gerontol A Biol Sci Med Sci, 2011

Distribution étalée et pulsée des protéines

N=8; dévis chassé-croisé

Étalé: 30-30-30 g

Pulsé: 10-16-64 g

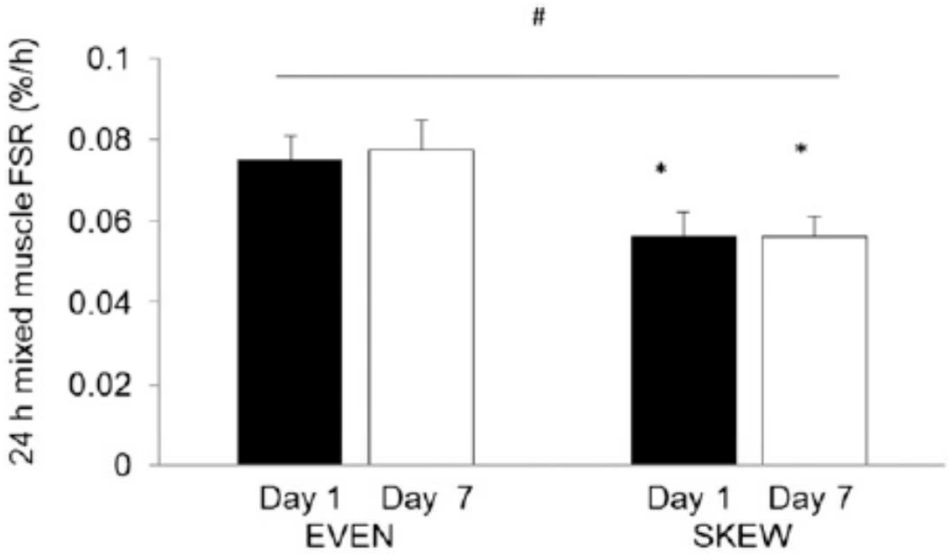
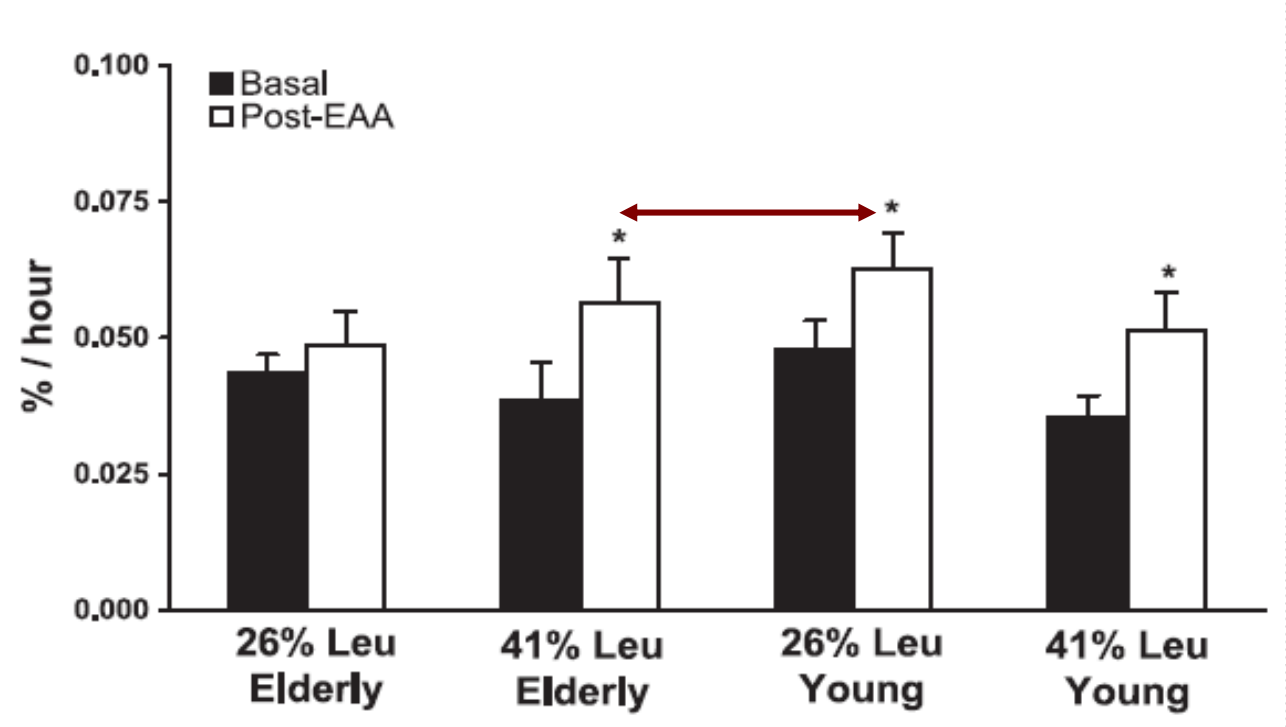


FIGURE 3 Twenty-four-hour mixed muscle protein FSRs in healthy adults on days 1 and 7 after the ingestion of diets with an EVEN or SKEW protein distribution. Values are means ± SEMs; $n = 8$. *Different from EVEN at that time point, $P < 0.05$. #Main effect of group between EVEN and SKEW, $P < 0.05$. EVEN, even daily protein distribution; FSR, fractional synthesis rate; SKEW, skewed daily protein distribution.

Mamerow MM. J. Nutr. 2014 doi: 10.3945/jn.113.185280

Synthèse protéique musculaire: hommes âgés vs. jeunes

En réponse à l'ingestion d'une boisson d'acides aminés essentiels +/- enrichie en leucine



Katsanos et al. Am J Physiol-Endo & Metab 2006

Effet à long terme de la supplémentation en leucine

Intervention: 2.5 g leucine/repas x 3 mois

Body composition[1]

	Placebo ($n = 14$)		Leucine ($n = 15$)	
	Before	After	Before	After
Lean mass (kg)	55.8 ± 0.9	56.2 ± 1.1	54.6 ± 1.0	55.0 ± 1.5
Fat mass (kg)	19.8 ± 1.7	19.2 ± 2.0	20.0 ± 1.4	20.0 ± 1.3
Body fat (%)	24.5 ± 1.7	23.9 ± 1.9	25.3 ± 1.2	25.4 ± 1.2
Leg lean mass (kg)	17.6 ± 0.4	18.0 ± 0.4	17.1 ± 0.5	17.6 ± 0.4
Leg fat (%)	18.9 ± 1.5	19.4 ± 1.6	19.6 ± 1.2	19.8 ± 1.2
CSA (cm^2)	71 ± 3	71 ± 3	71 ± 2	71 ± 2
Leg volume (L)	7.5 ± 1.9	7.5 ± 1.7	8.1 ± 3.0	7.8 ± 4.1

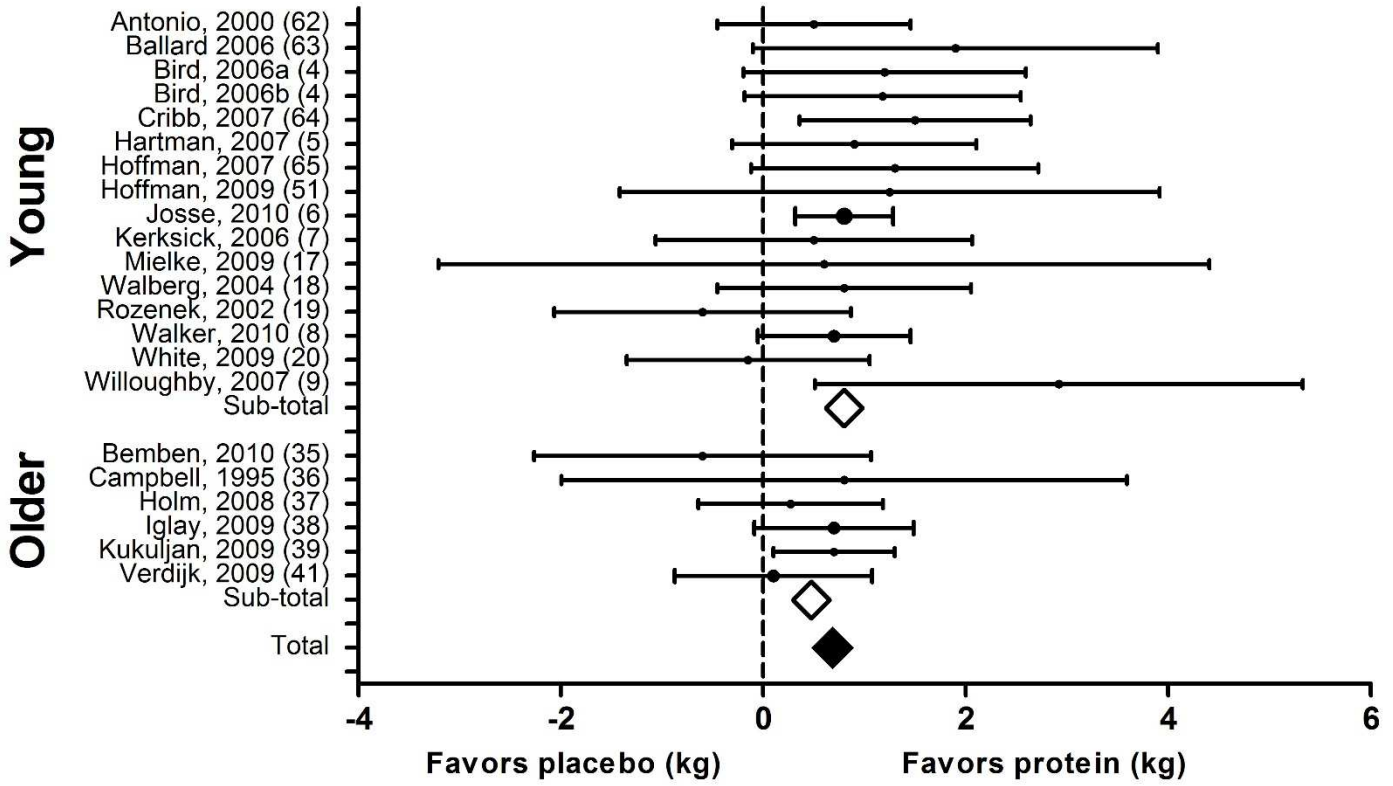
[1] All values are means ± SEMs. CSA, cross-sectional area. Data were analyzed by using repeated-measures ANOVA. No significant differences were observed between groups or over time.

Verhoeven S Am J Clin Nutr 2009;89:1468–75

Measures contrer la perte de la massse et de la force musculaire

Olga Kotelko, 93 y.o

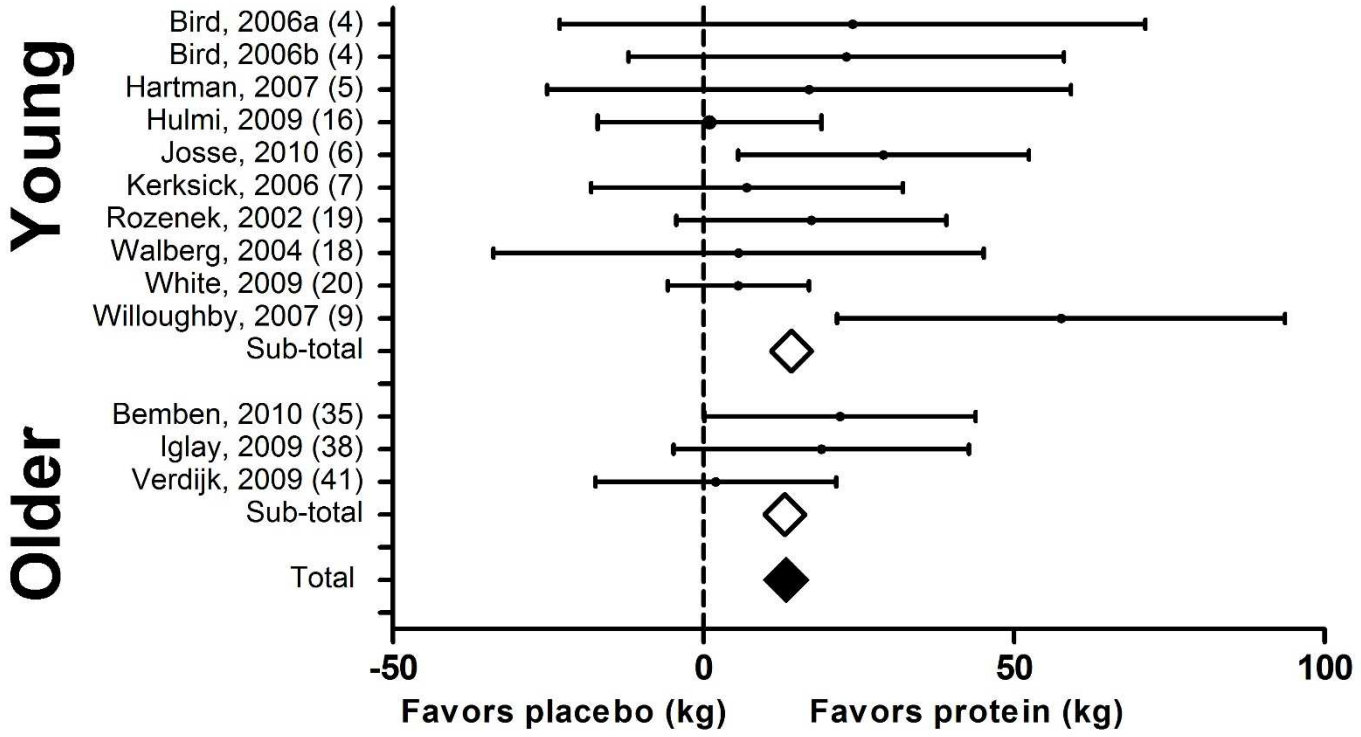
Programme d'exercice et supplémentation protéique - effet sur la masse maigre



Weighted mean difference: 0.69 kg; 95% CI: 0.47, 0.91 kg; P < 0.00001

Cermak *et al., Am J Clin Nutr, 2012.*

Programme d'exercice et supplémentation protéique - effet sur 1-RM leg press

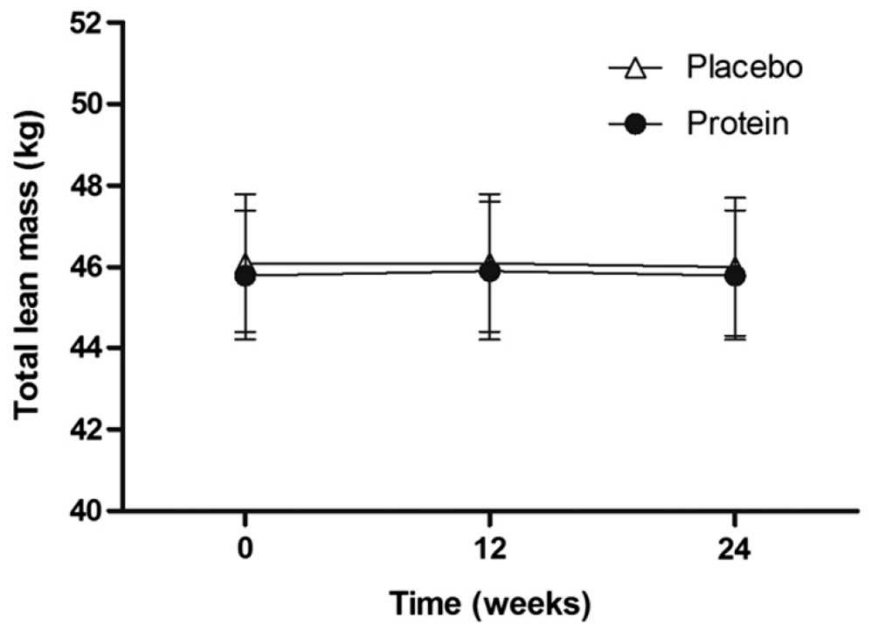


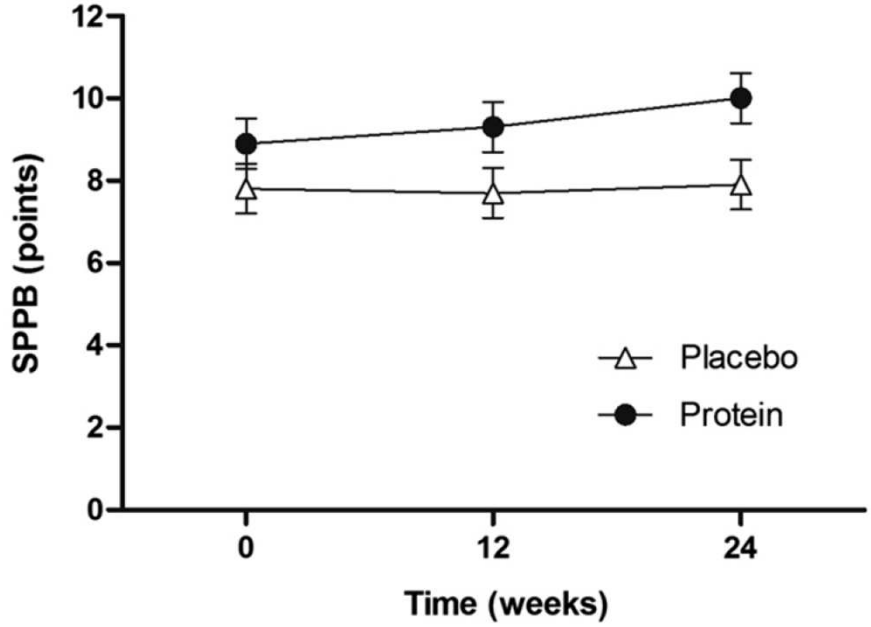
Weighted mean difference: 13.5 kg; 95% CI: 6.4, 20.7 kg; P < 0.005

Cermak *et al., Am J Clin Nutr, 2012.*

Supplémentation protéique chez la PA fragilisée

RCT of 15 g of protein supplementation BID, n=65



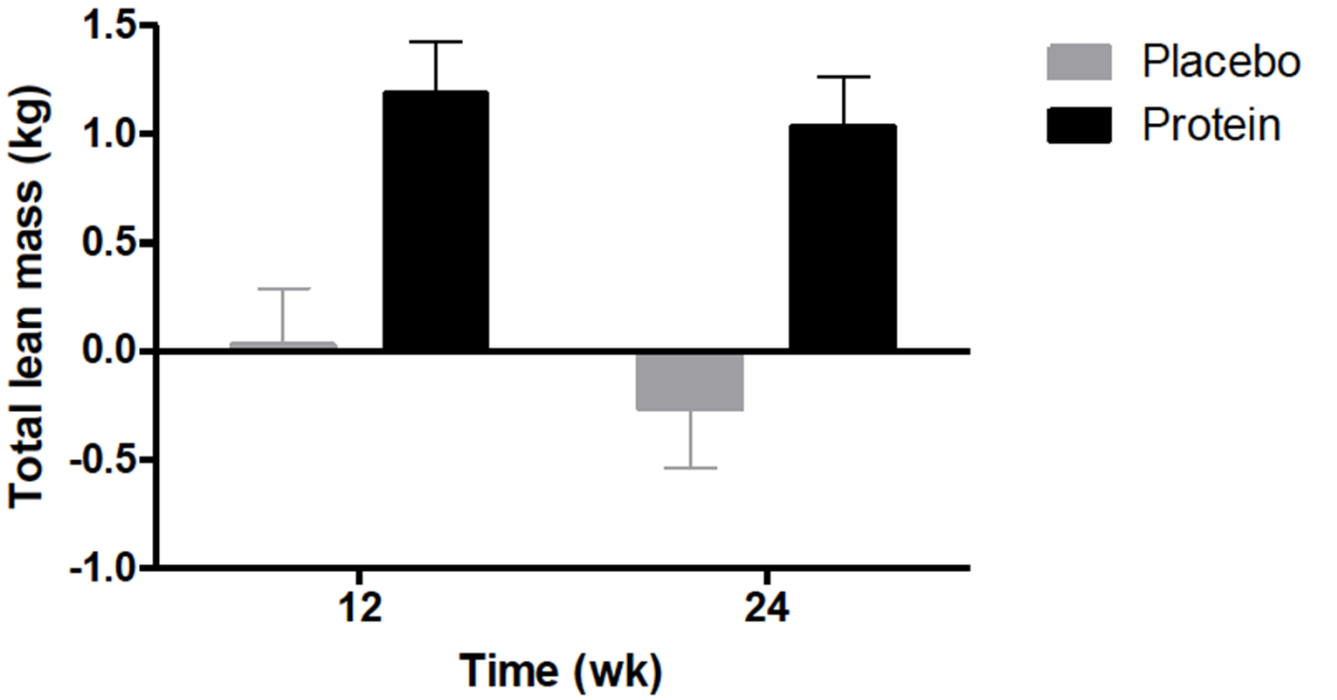


Treatment x Time interaction effect p<0.02

Tieland *et al., JAMDA, 2012-A*

Supplémentation protéique chez la PA fragilisée

RCT of Resistance EX 2 sessions / week ± 15 g of protein BID



Tieland *et al., JAMDA, 2012-B*

Risques de la diète hyperprotéique

Y-a-t-il des risques?

- Il y a potentiellement 3
  - Effet suppresseur de l'appétit (satiété)
    - Diète hyperprotéique: réputéée efficace pour faire maigrir (Whycherley TP AJCN 2012)
  - Bilan phospho-calcique
    - Protéines en moyenne sont acides et augmentent l'excrétion de Ca^{+} (Kurtz I Kidney Intern 1983)
  - Atteinte rénale
    - Protéines augmentent le flow sanguin causant des blessures glomérulaires considérées comme pathogénèse de la sclérose glomérulaire progressive (Brenner BM NEJM 1982)

Protéines et bilan énergétique

	Percentage of energy from protein		
	5%	15%	30%
Energy intake (MJ/d)			
Total	9.33 ± 3.52[2,a]	9.62 ± 3.51[a]	7.21 ± 3.08[b]
Snacks	2.15 ± 2.09[a]	2.44 ± 2.35[a]	1.16 ± 1.13[a]
Meals	7.18 ± 2.38[a]	7.13 ± 2.39[a]	6.04 ± 2.12[b]
Breakfast	2.56 ± 0.91[a]	2.38 ± 0.91[b]	2.19 ± 0.93[c]
Lunch	2.10 ± 0.90[a]	2.02 ± 0.88[a]	1.56 ± 0.68[b]
Dinner	2.52 ± 0.99[a]	2.73 ± 1.03[b]	2.29 ± 0.94[c]
Protein intake, meals			
(MJ/d)	0.36 ± 0.12[a]	1.07 ± 0.36[b]	1.81 ± 0.64[c]
($g \cdot kg\ BW^{-1} \cdot d^{-1}$)	0.3 ± 0.1[a]	0.9 ± 0.3[b]	1.6 ± 0.5[c]
Carbohydrate intake, meals			
(MJ/d)	4.31 ± 1.43[a]	3.57 ± 1.20[b]	2.12 ± 0.74[c]
($g \cdot kg\ BW^{-1} \cdot d^{-1}$)	3.7 ± 1.2[a]	3.1 ± 1.1[b]	1.8 ± 0.6[c]
Fat intake, meals			
(MJ/d)	2.51 ± 0.83[a]	2.50 ± 0.84[a]	2.12 ± 0.74[b]
($g \cdot kg\ BW^{-1} \cdot d^{-1}$)	1.0 ± 0.3[a]	1.0 ± 0.3[a]	0.8 ± 0.3[b]
Protein:carbohydate + fat			
Meals (% of energy)	5:95[3]	15:85	30:70
Total (% of energy)	5:95	12:88	23:77
$\Delta BW_{day12\ -\ day1}$ (kg)	−0.9 ± 1.1	−0.8 ± 1.0	−1.0 ± 1.0
Energy balance (MJ/d)	−2.48 ± 2.92[a]	−2.20 ± 2.84[a]	−4.61 ± 4.64[b]

N = 79

Durée: 12 j

Age: 34 ans

VAS: même

Martens EA AJCN 2013

Apports protéiques et perte pondérale dans l'étude dee cohorte NuAge

TABLE 3 Unadjusted and fully adjusted conditional regression models for weight loss by protein-intake category in community-dwelling older adults

	Unadjusted model		Fully adjusted model[1]	
Protein-intake category	OR (95% CI)	Parameter estimate *P* value	OR (95% CI)	Parameter estimate *P* value
Low: <0.8 g/(kg · d)	1.92 (1.12, 3.31)	0.018	2.56 (1.01, 6.50)	0.048
Moderate: 0.8–<1.0 g/(kg · d)	1.71 (1.04, 2.80)	0.039	2.15 (1.02, 4.56)	0.045
High: 1.0–<1.2 g/(kg · d)	1.33 (0.77, 2.28)	0.31	1.60 (0.81, 3.15)	0.17
Very high: ≥1.2 g/(kg · d)	Reference		Reference	

[1] Adjusted for energy intake, BMI, smoking, physical activity, physical function, dieting to lose weight, appetite, number of medications, number of chronic diseases, depressive symptoms, and serum albumin concentrations. All covariates were simultaneously forced in this multivariable conditional logistic regression model. In this model, except for protein intake, categorical variables were treated as continuous. Model likelihood ratio test: chi-square = 31.797, df = 14, $P = 0.004$, $n = 183$ pairs.

Gray-Donald K, Morais JA. J Nutr 2014

Effet de la diète hyperprotéique sur le métabolisme du Ca^{+}

Excrétion urinaire

	wk 0[2]	wk 1	wk 2	wk 3	wk 5	wk 7	Pooled SD	Diet
Calcium, *mmol/d*							1.7	0.005
LPLP	4.2	3.9	3.6	3.9	4.2	4.0		
HPHP	5.3	5.0	5.2	4.9	5.3	5.0		
Magnesium, *mmol/d*							0.9	0.03
LPLP	2.9	4.1	3.8	3.8	4.0	3.9		
HPHP	3.6	3.3	3.5	3.1	3.5	3.6		
Phosphorus, *mmol/d*							5	<0.0001
LPLP	23	19	17	17	19	17		
HPHP	26	30	30	27	30	32		

	LPLP	HPHP	Pooled SD	*P*-value
^{47}Ca retention at d 21,[2] %	16.9	19.7	3.8	0.05
Absorption,[3] %	22.3	26.5	5.4	0.05
Ca absorbed, *mg/d*	200	227	46	0.12

Devis: croisé

N=16

Sujets: ♀ en postménopause

Cao JJ J Nutr 2011

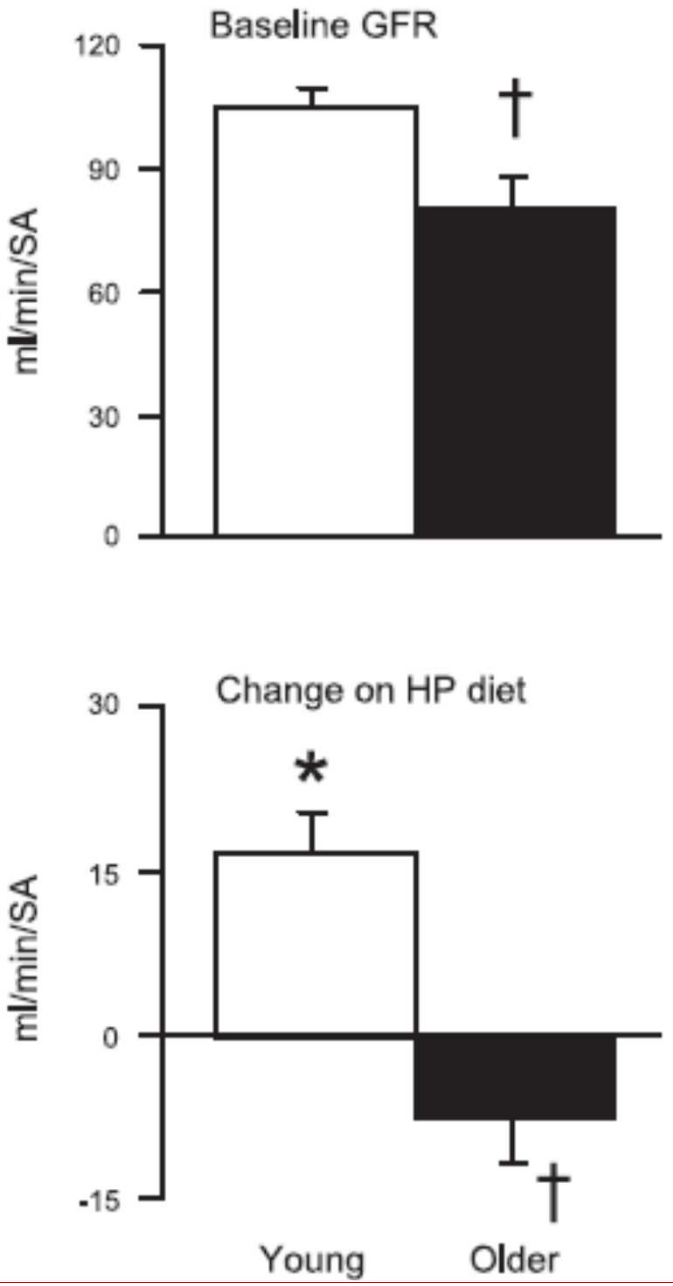
Apport protéique et changement DMO (Framingham Offspring Study)

Variable	Femoral Neck BMD				Trochanter BMD				Lumbar Spine BMD			
Protein intake%	*n*	*β*	*SE*	*p-value*	*n*	*β*	*SE*	*p-value*	*n*	*β*	*SE*	*p-value*
Men												
Model 1[b]	497	−0.0216	0.017	0.19	497	−0.0359	0.018	0.04*	489	0.00007	0.017	0.99
Model 2[c]	493	−0.0052	0.019	0.78	493	−0.0498	0.020	0.01*	485	−0.0062	0.019	0.75
Women												
Model 1	680	−0.0001	0.016	0.99	680	−0.0090	0.021	0.68	678	0.01439	0.016	0.38
Model 2	673	−0.0131	0.017	0.44	673	−0.0288	0.023	0.21	671	0.0042	0.018	0.81

Chez la femme, apport protéique élevé est protecteur pour celles qui ont des apports bas en Ca^{+}.

Shani S. Public Health Nutr 2014

Apport protéique et Fct rénale



Devis croisé
N=10 jeunes vs 9 âgés
0.9 vs 1.8 g/kg/j
Durée: 10 j

Walrand S Am J Physiol Endocrinol Metab 2008

Conclusions

- Les évidences s'accumulent à l'effet que les personnes âgées requièrent plus de protéines dans leur diète par kg de PC que les jeunes gens
  - Nouvelles techniques le confirment (IAAO)
  - Démonstration de la résistance anabolique aux AA
  - Études épidémiologiques à l'appui
- Les apports recommandés se situent entre 1-1.2 g/kg/j et devraient même être de 1.3-1.5 g/kg/j si malnutrition et mal. chroniques
  - Endossé par la **EUGMS et PROT-AGE Study group** (Bauer J JAMDA 2013), **ESPEN Expert Group** (Deutz N E P Clin Nutr 2014)

Conclusions

- Le but est de prévenir la perte de la masse et de la force musculaire avec l'âge
- L'exercice physique demeure un atout et devrait être encouragé
  - Un peu activité vaut mieux que rien!
- Les effets néfastes, i.e., diminution des apports énergétiques, perte de la masse osseuse, et atteinte de la fct. rénale, ne se sont avérés vrais que pour la fct. rénale
  - On devrait se restraindre à 1 g/kg/j si TFG <30 mL/min.


Merci