2. kongres
kliniče prehrane in presnovne podpore
z mednarodno udeležbo

2nd Congress of clinical nutrition and metabolic care

with international participation

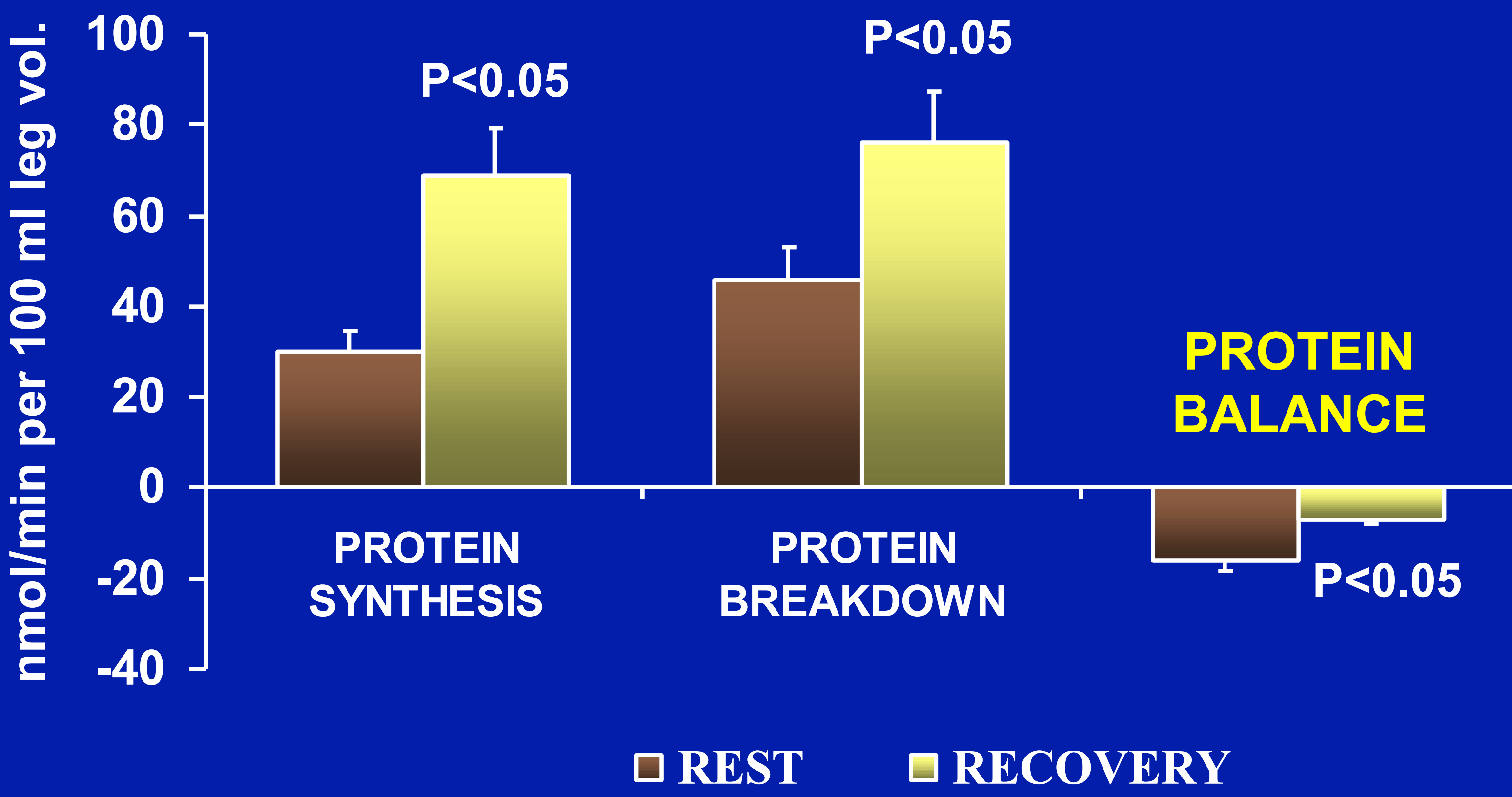
Grand Hotel Bernardin Portorož, 15th to 17th November 2013

Proteins and physical activity: specificities in different age groups

Gianni Biolo

Department of Medical Sciences
Clinica Medica AOUTS
University of Trieste - Italy

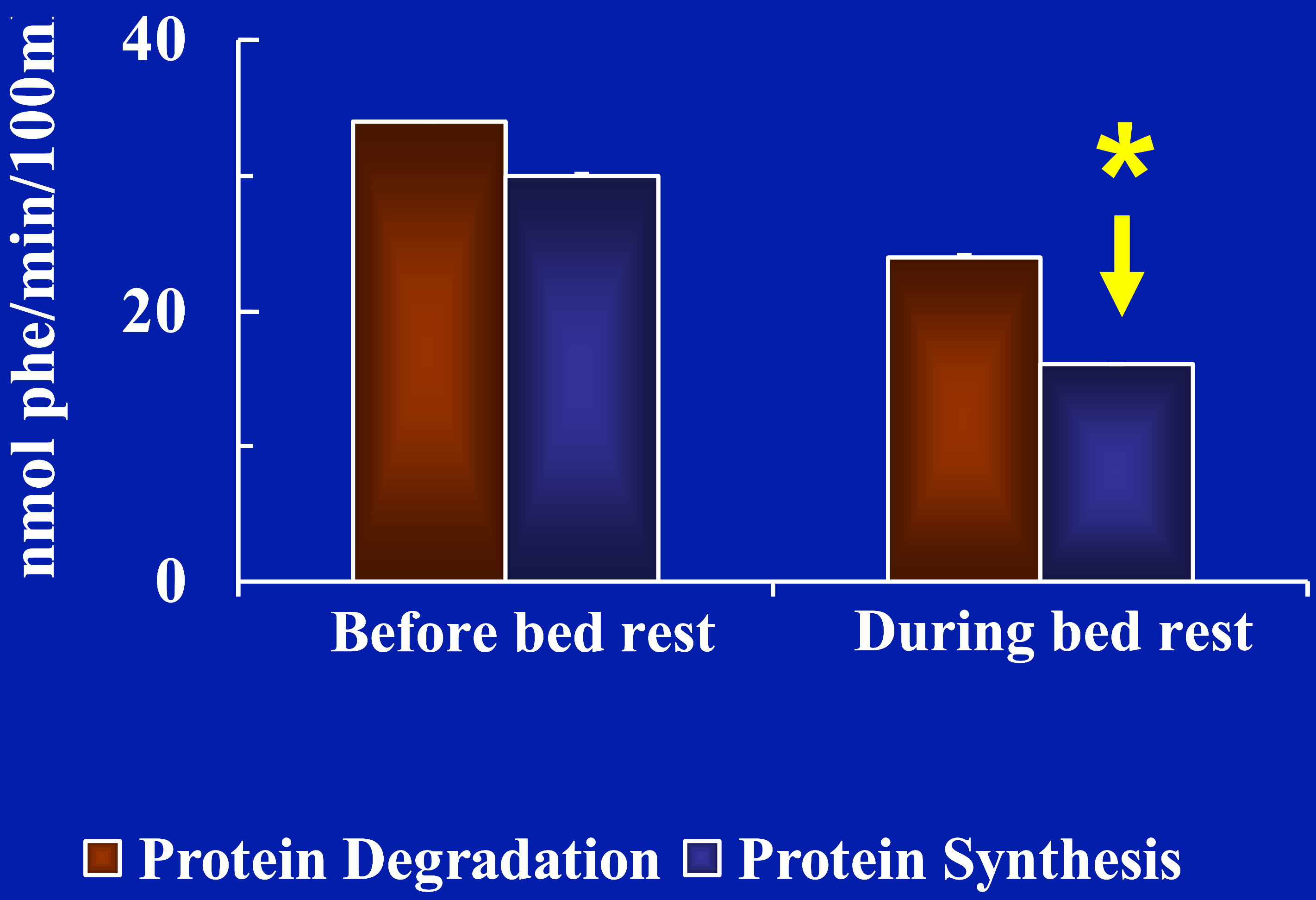
Muscle protein kinetics during post-exercise recovery



Biolo & Wolfe AJPENDO 1995

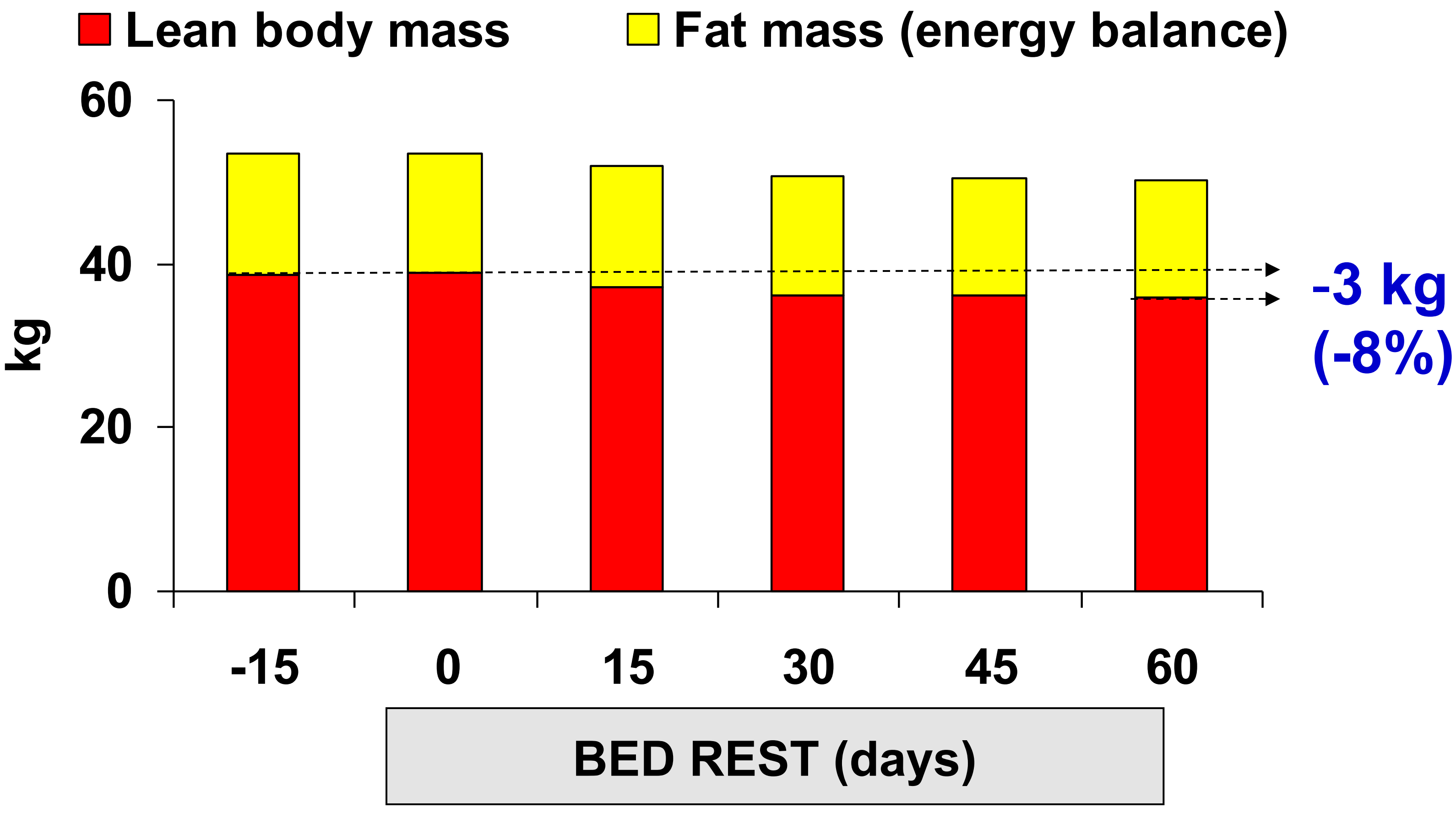
Prolonged Bed Rest Decreases Skeletal Muscle and Whole Body Protein Synthesis

A. Ferrando AJPENDO 1996



Dual energy X-ray absorptiometry (DXA)

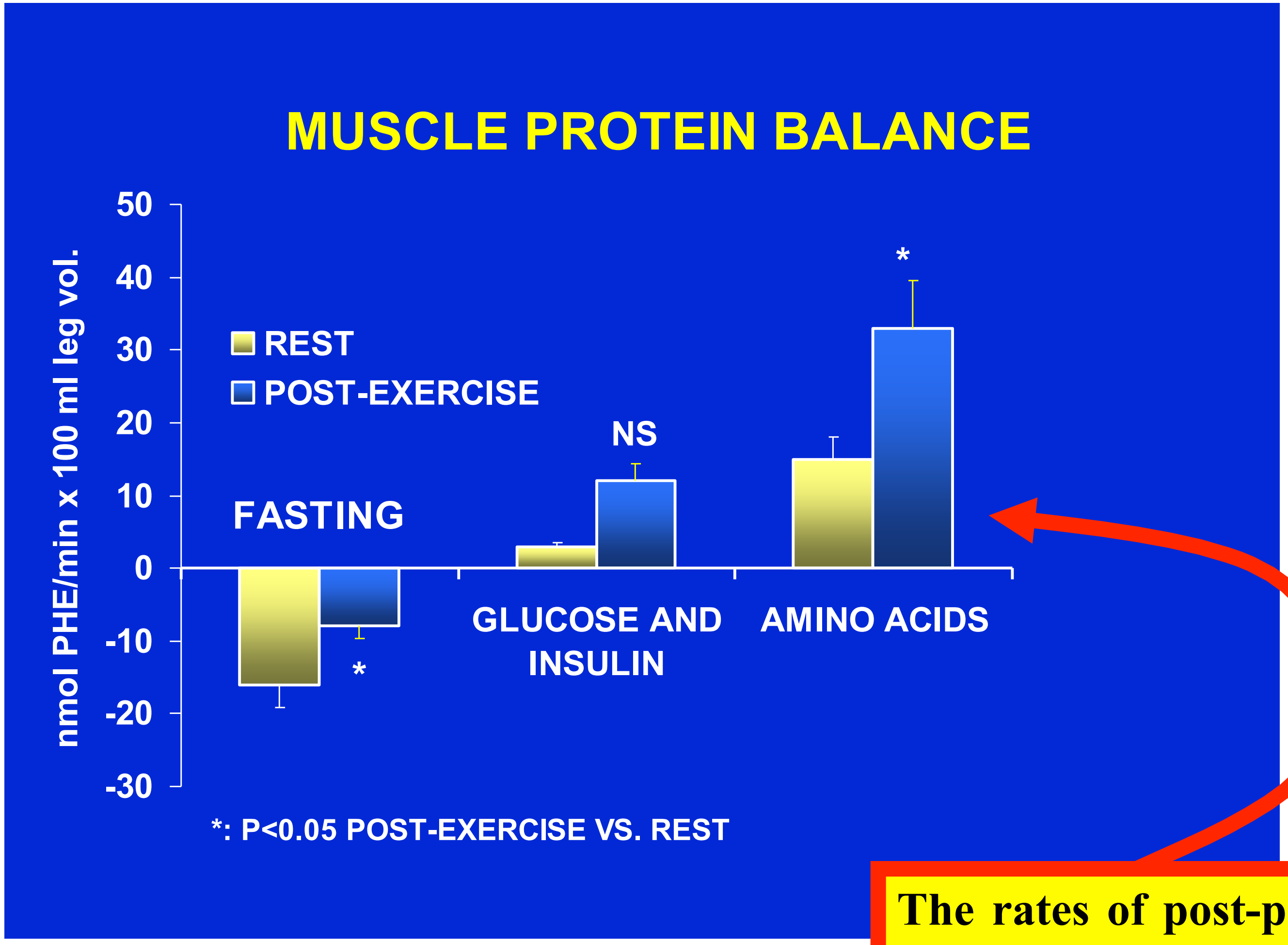
CHANGES IN BODY COMPOSITION
DURING TWO-MONTH EXPERIMENTAL BED REST IN WOMEN (n=8)



ESA/NASA/CNES WISE-study

EFFECTS OF EXERCISE AND BED REST ON POSTPRANDIAL ANABOLIC EFFICIENCY

NUTRITION AND POST-EXERCISE MUSCLE ANABOLISM



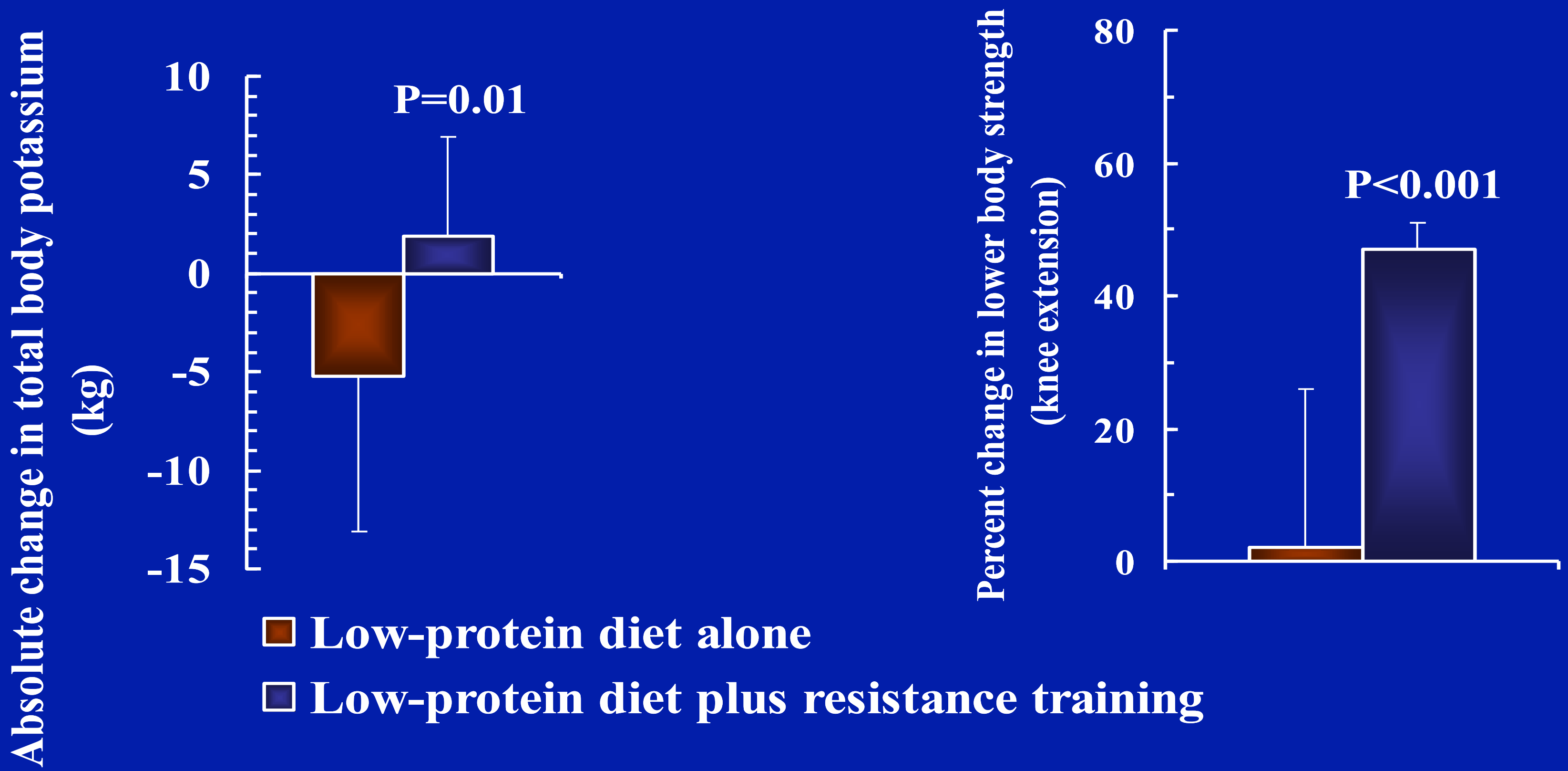
The rates of post-prandial amino acid deposition into body protein is greatly accelerated after resistance exercise.

AJPENDO 1995; AJPENDO 1997; Diabetes 1999

RESISTANCE TRAINING TO COUNTERACT THE CATABOLISM OF A LOW-PROTEIN DIET IN PATIENTS WITH CHRONIC RENAL INSUFFICIENCY

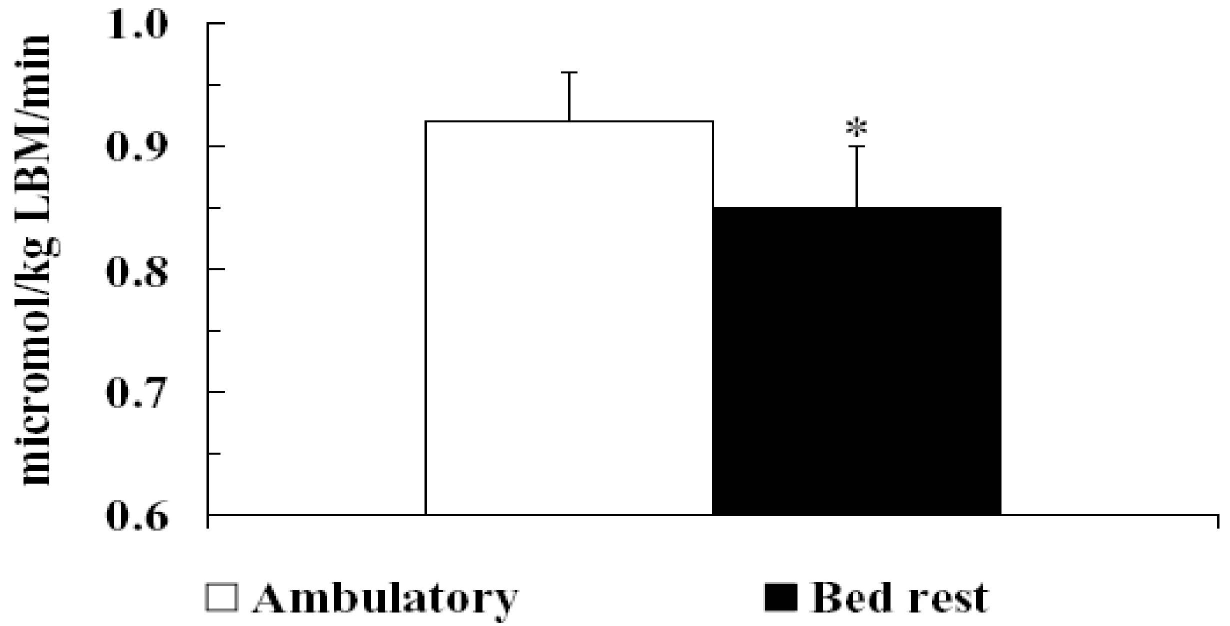
Castaneda et al., Ann Intern Med 2001

26 OLDER PATIENTS (ABOUT 65 YR) WITH MODERATE RENAL INSUFFICIENCY WHO HAD ACHIEVED STABILIZATION ON A LOW-PROTEIN DIET (0.6 G/KG/DAY) WERE RANDOMLY ASSIGNED TO RESISTANCE EXERCISE TRAINING OR NO INTERVENTION FOR 12 WEEKS.



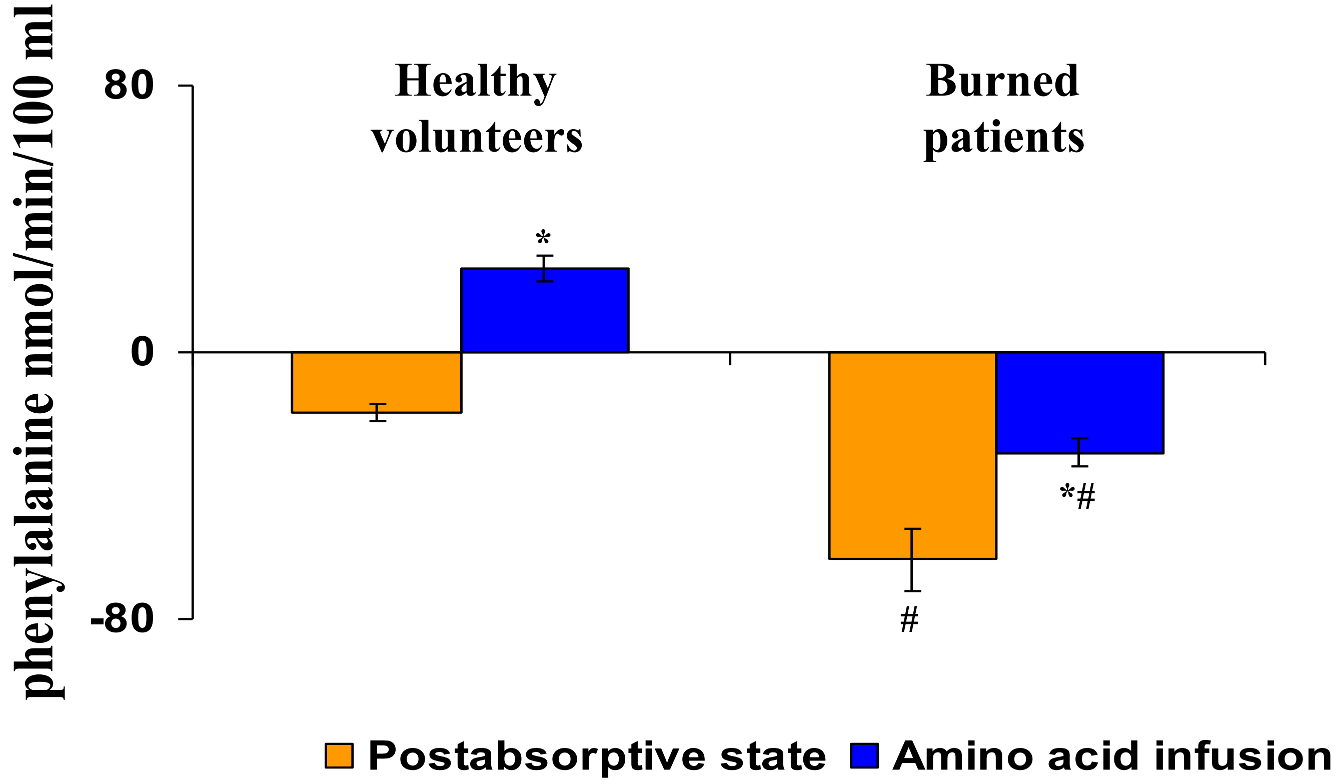
SHORT-TERM BED REST IMPAIRS AMINO ACID-INDUCED PROTEIN ANABOLISM IN HUMANS

Biolo et al., J Physiol 2004



The rates of post-prandial amino acid deposition into body protein is impaired in bed rest conditions.

EFFECTS OF AMINO ACID INFUSION ON SKELETAL MUSCLE PROTEIN BALANCE IN SEVERELY BURNED PATIENTS



*, P<0.05 vs. postabsorptive state #, P<0.05 vs. healthy volunteers

Aging is associated with diminished accretion of muscle proteins after the ingestion of a small bolus of essential amino acids[1–3]

Christos S Katsanos, Hisamine Kobayashi, Melinda Sheffield-Moore, Asle Aarsland, and Robert R Wolfe

Am J Clin Nutr 2005;82:1065–73.

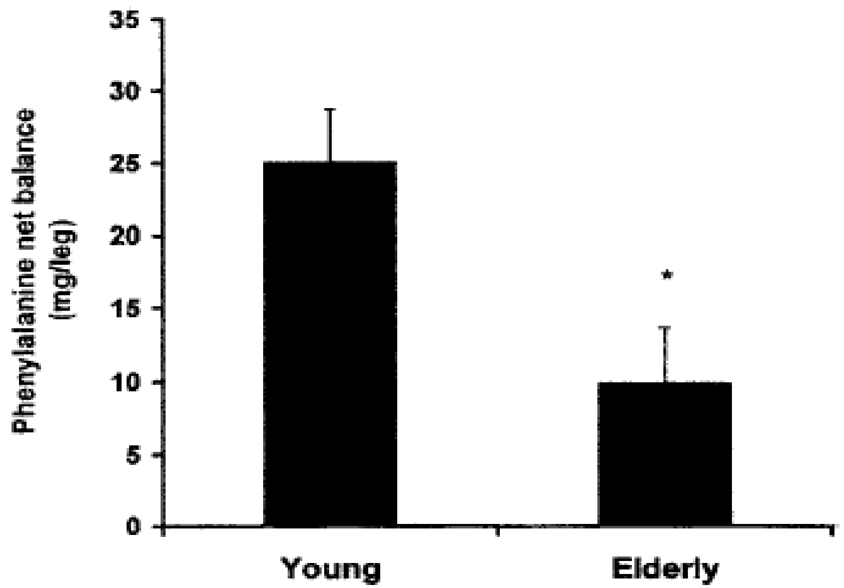
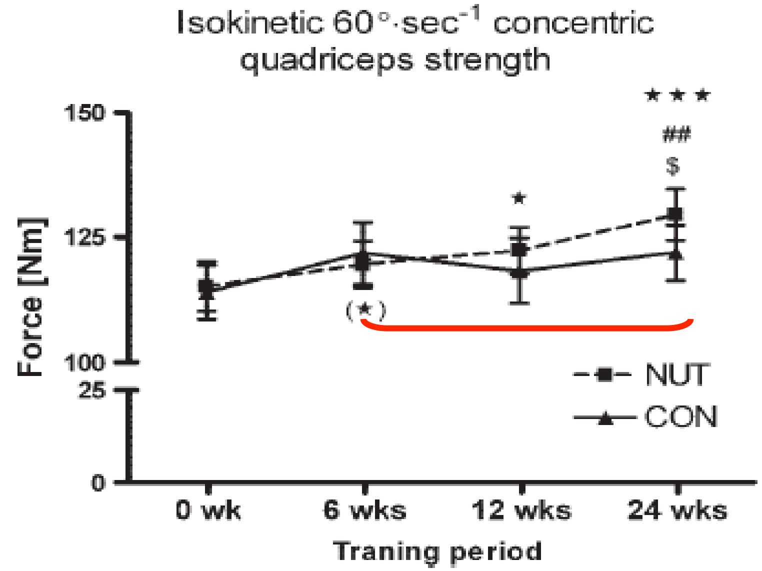


FIGURE 5. Mean (±SEM) leg phenylalanine net balance 3.5 h after the ingestion of essential amino acids calculated by measuring the area under the phenylalanine net balance response curve (in the calculations, basal net balance was taken as zero) in the elderly ($n = 11$) and the young ($n = 8$). Data were analyzed with a t test. *Significantly different from the young, $P = 0.010$.

Protein-containing nutrient supplementation following strength training enhances the effect on muscle mass, strength, and bone formation in postmenopausal women

J Appl Physiol 105: 274–281, 2008.



Strength improvements from 6 to 24 wk, a significant difference was apparent between groups: nutrient group, 9±3% vs. control, 1±2% ($P < 0.05$).

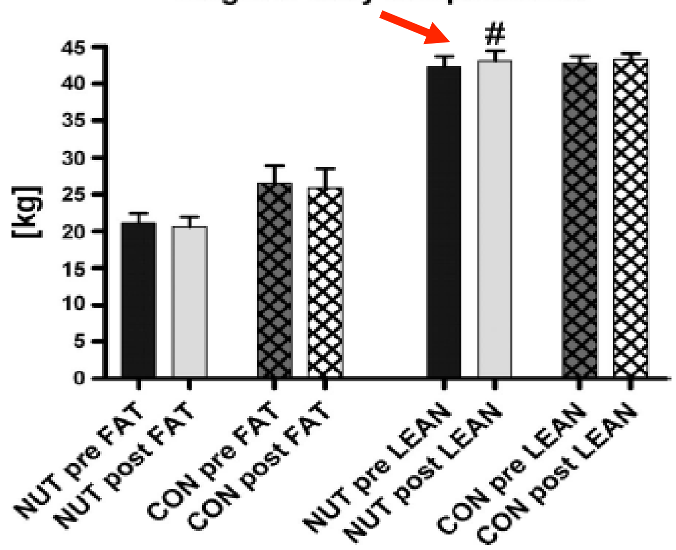
Table 4. *Bone mineral density*

	Control Group	Nutrient Group
Total BMD, g/mm³		
0 wk	1.117±0.022	1.113±0.027
24 wk	1.122±0.023	1.116±0.027
Femoral neck BMD, g/mm³		
0 wk	0.943±0.028	0.953±0.051
24 wk	0.930±0.024	0.978±0.043
L2–L4 BMD, g/mm³		
0 wk	1.043±0.032	1.084±0.053
24 wk	1.068±0.038*	1.108±0.049*

Values are means ± SE of bone mineral density (BMD) at whole body, femoral neck, and lumbar spine (L2–L4). *$P < 0.05$ compared with 0 wk.

Adjusting for covariates (age at inclusion, BMI at inclusion, and BMD of the femoral neck at inclusion) a significant ($P < 0.05$) difference was seen in the response to training between the two groups.

Weight of body compartments



Dietary omega-3 fatty acid supplementation increases the rate of muscle protein synthesis in older adults: a randomized controlled trial[1–3]

Gordon I Smith, Philip Atherton, Dominic N Reeds, B Selma Mohammed, Debbie Rankin, Michael J Rennie, and Bettina Mittendorfer

Am J Clin Nutr 2011;93:402–12.

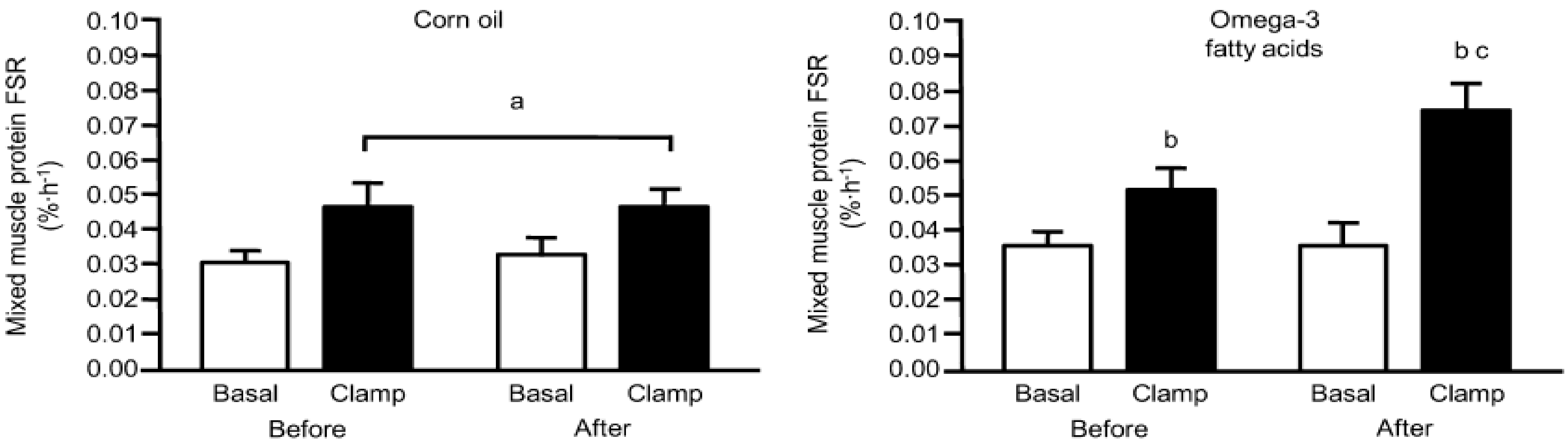


FIGURE 1. Mean (±SEM) mixed skeletal muscle protein fractional synthesis rate (FSR), calculated by using the average plasma free phenylalanine enrichment as the precursor pool enrichment, during basal, postabsorptive conditions and during the hyperaminoacidemic-hyperinsulinemic clamp before and after 8 wk of supplementation with either corn oil (n = 7) or omega-3 fatty acids (n = 8). There was no difference in the muscle protein FSR between the omega-3 fatty acid and corn oil groups before the intervention [ANOVA showed a significant effect of clamp ($P < 0.001$), no significant effect of group ($P = 0.47$), and no interaction ($P = 0.60$)]. [a]In the corn oil group, ANOVA showed a significant main effect of clamp ($P < 0.01$). In the omega-3 fatty acid group, ANOVA showed a significant effect of clamp ($P < 0.01$) and an interaction ($P < 0.001$), which was followed by Tukey's post hoc analysis. [b]Significantly different from the corresponding basal value, $P < 0.01$. [c]Significantly different from the corresponding value before omega-3 fatty acid supplementation, $P < 0.01$. Furthermore, the before-after intervention change in the anabolic response (increase in the muscle protein FSR from basal values) was significantly greater in the omega-3 fatty acid group than in the corn oil group ($P = 0.01$, Student's t test for independent samples).

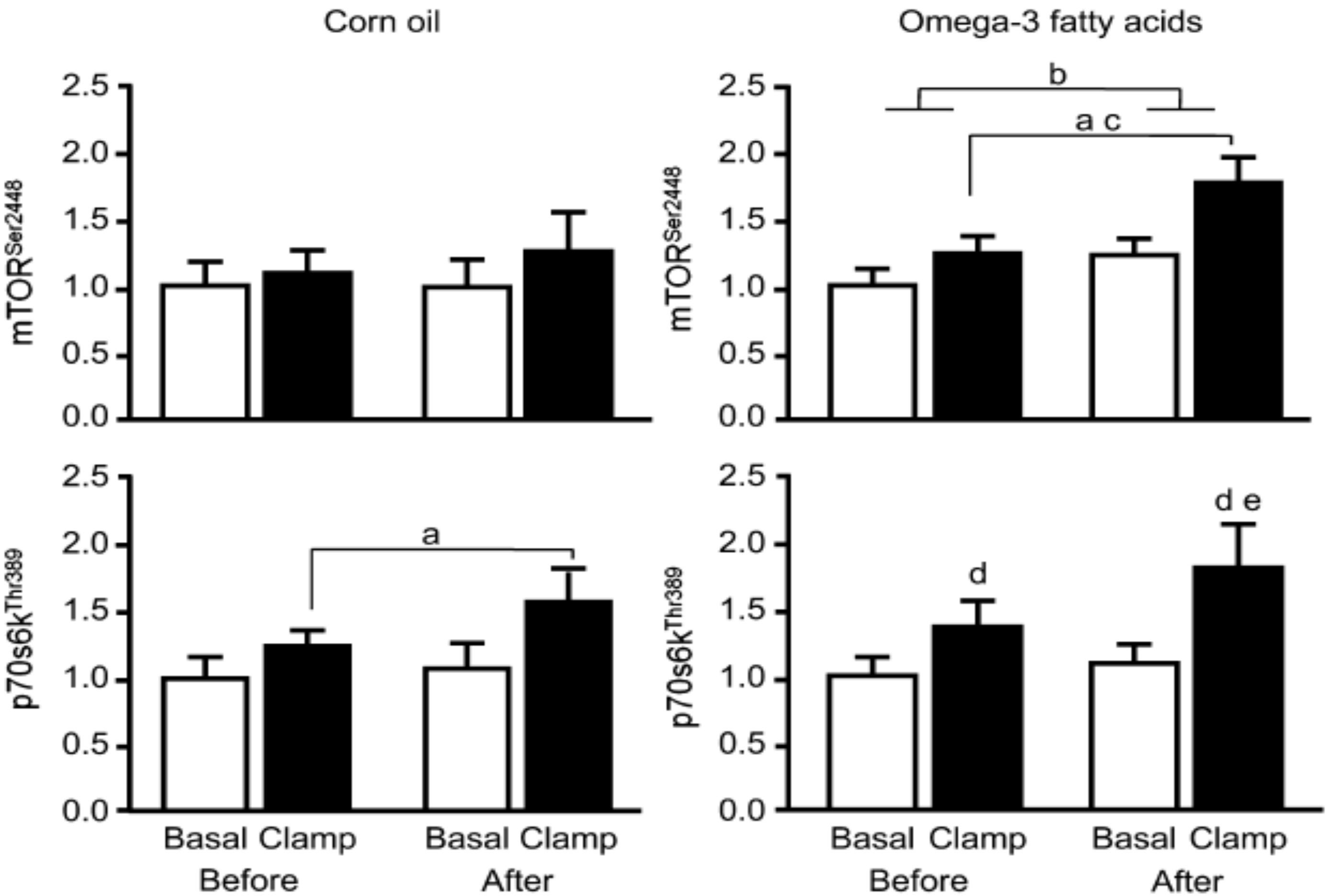
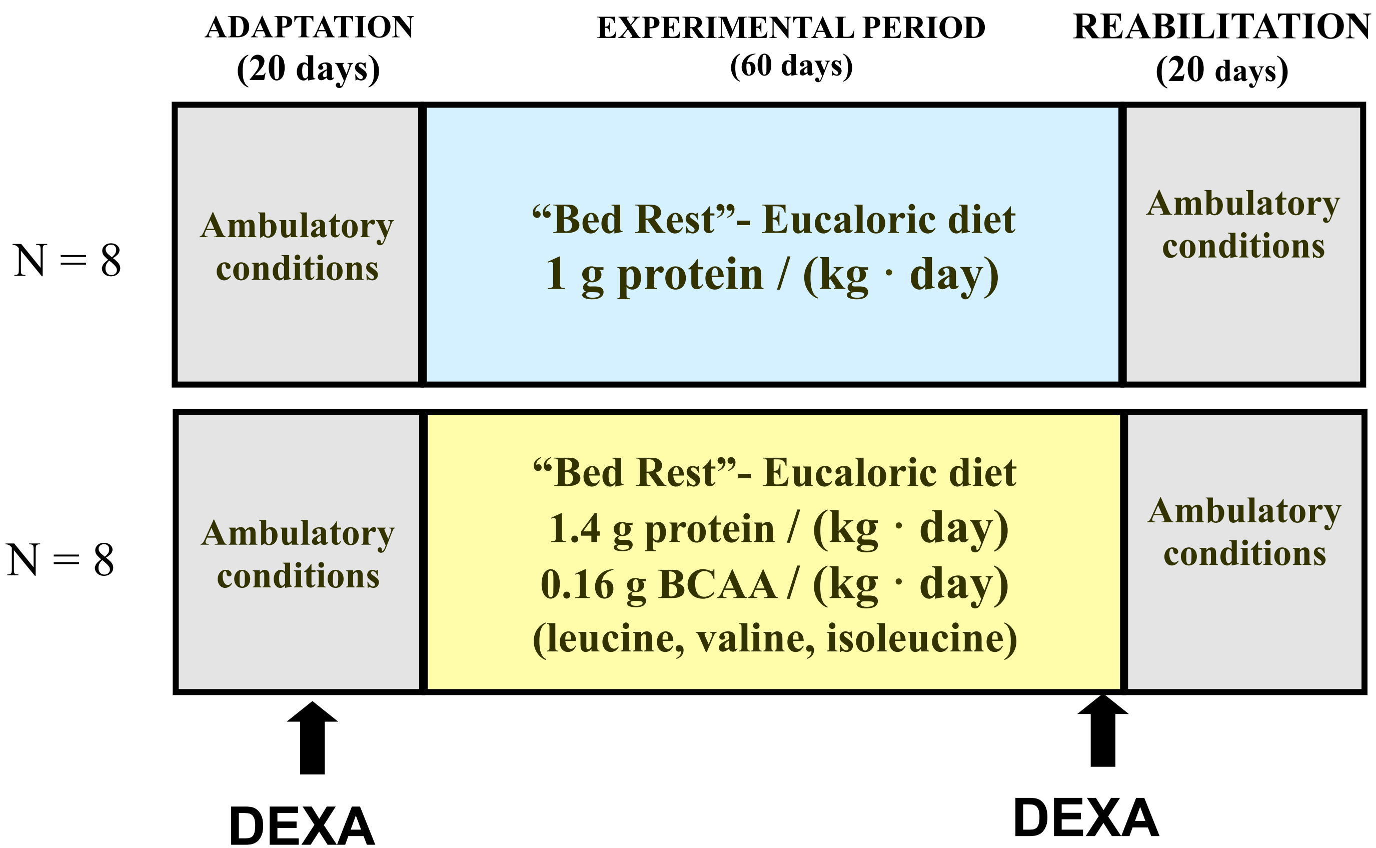


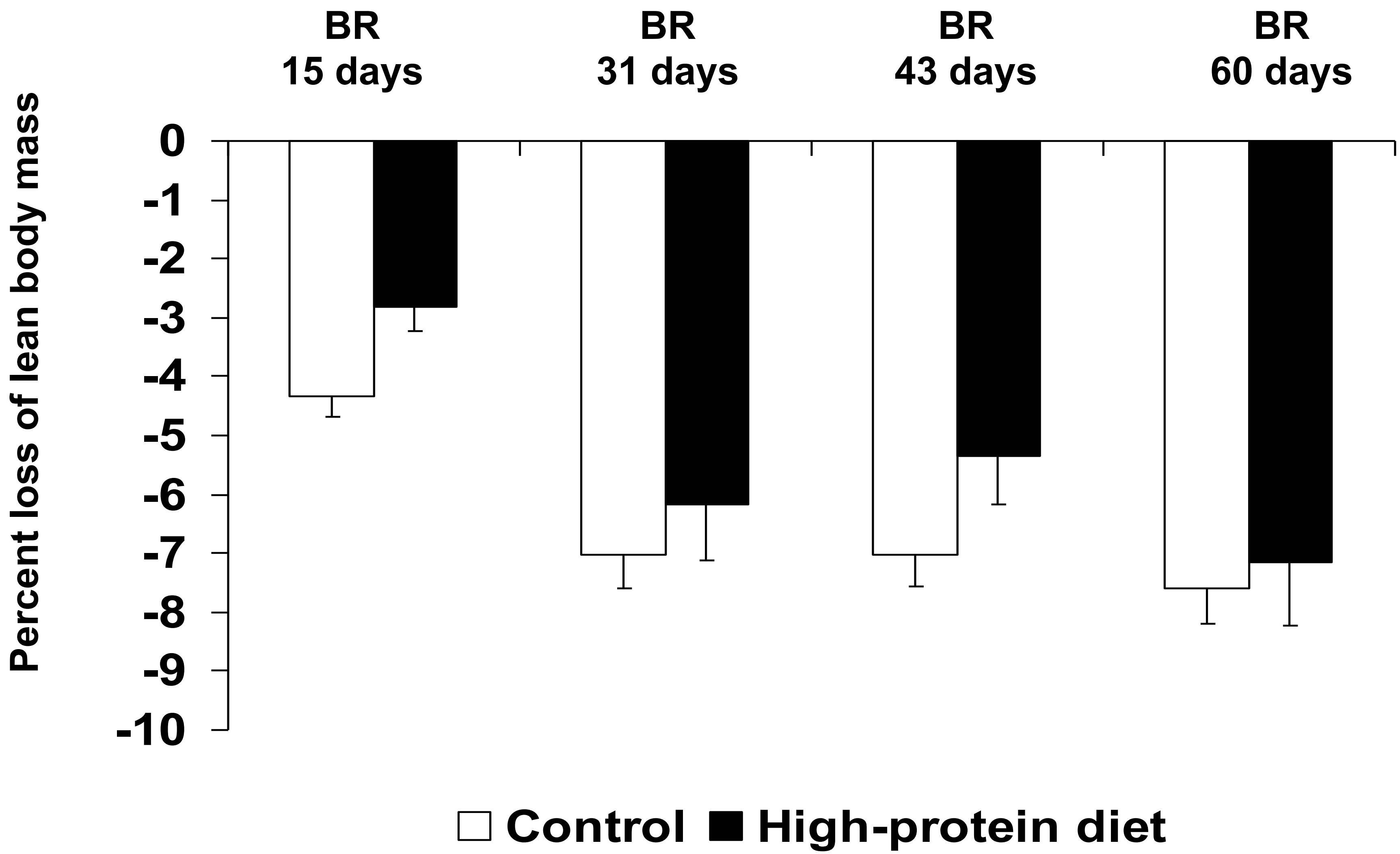
FIGURE 2. Mean (±SEM) concentrations (arbitrary units) of mTOR^{Ser2448} and p70s6k^{Thr389} during basal, postabsorptive conditions and during the hyperaminoacidemic-hyperinsulinemic clamp before and after 8 wk of supplementation with either corn oil (n = 7) or omega-3 fatty acids (n = 8). [a]ANOVA showed a significant main effect of clamp ($P < 0.01$). [b]ANOVA showed a significant main effect of time ($P < 0.05$). [c]There was a trend for a greater clamp-induced increase in mTOR^{Ser2448} after omega-3 fatty acid supplementation than before supplementation (interaction: $P = 0.08$). [d,e]ANOVA showed a significant interaction ($P < 0.05$), which was followed by Tukey's post hoc analysis. [d]Significantly different from corresponding basal value, $P < 0.05$. [e]Significantly different from corresponding value before omega-3 fatty acid supplementation, $P < 0.05$. Furthermore, the before-after intervention changes in the insulin/amino acid–mediated increase in p70s6k and mTOR phosphorylation above basal values were greater in the omega-3 fatty acid group than in the corn oil group ($P < 0.05$ and $P = 0.07$, respectively; Mann-Whitney U test).

Long-term Bed-rest

WISE 2005 (Women International Space Simulation for Exploration) ESA/CNES/NASA/CSA

Toulouse France





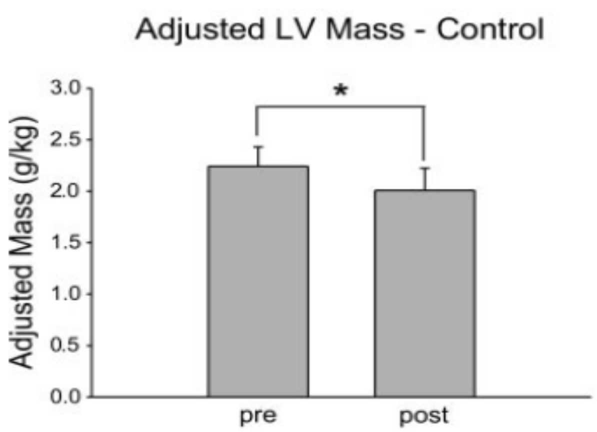
Bed rest effect: p = 0.01; bed rest × diet interaction: p = 0.01 (repeated measures ANCOVA)

J Appl Physiol 103: 8–16, 2007.
First published March 22, 2007; doi:10.1152/japplphysiol.01162.2006.

Cardiac atrophy in women following bed rest

Todd A. Dorfman,[1,2] Benjamin D. Levine,[1,2]* Tommy Tillery,[2] Ronald M. Peshock,[2] Jeff L. Hastings,[1,2] Suzanne M. Schneider,[3] Brandon R. Macias,[5] Gianni Biolo,[4] and Alan R. Hargens[5]*
[1]Institute for Exercise and Environmental Medicine, Presbyterian Hospital of Dallas, and [2]Division of Cardiology, Department of Internal Medicine, University of Texas Southwestern Medical Center, Dallas, Texas; [3]Division of Physical Performance and Development, University of New Mexico, Albuquerque, New Mexico; [4]Department of Clinical, Technological and Morphological Sciences, and Division of Internal Medicine, University of Trieste, Trieste, Italy; and [5]Department of Orthopaedic Surgery, University of California, San Diego, California

CONTROL



HIGH-PROTEIN

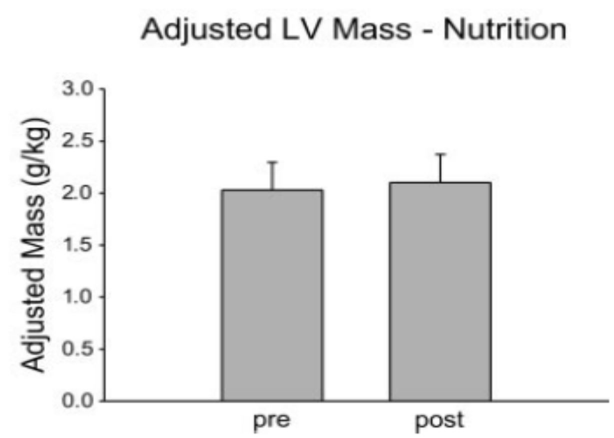
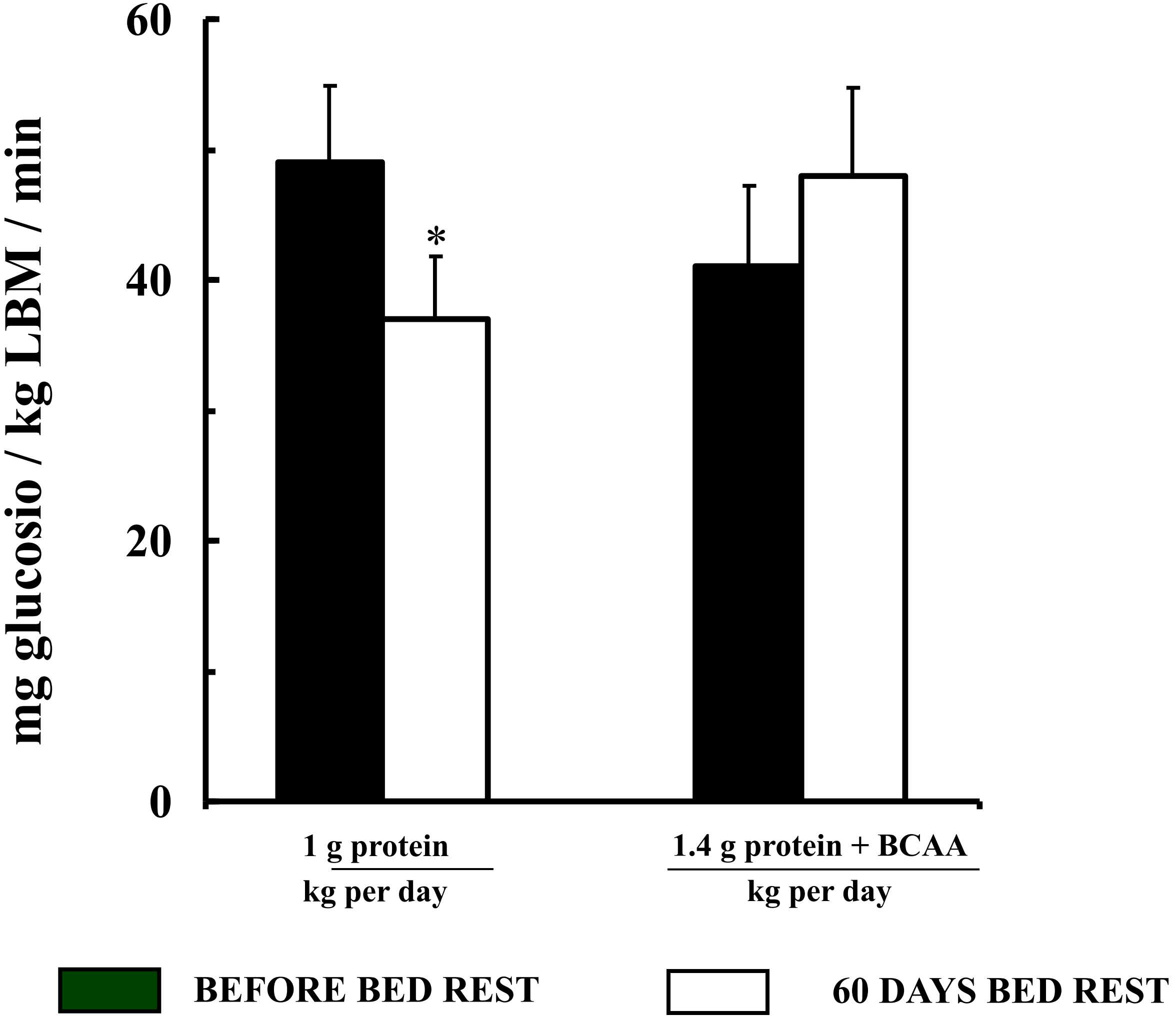


Fig. 2. *A*: adjusted left ventricular (LV) mass at baseline (pre) and after sedentary prolonged bed rest (post). *B*: adjusted LV mass at baseline and following protein supplementation during bed rest. $^*P < 0.05$.

Rate of glucose disappearance during euglycemic hyperinsulinemic clamp



Bed rest effect p = 0.74
Bed rest × diet p = 0.01

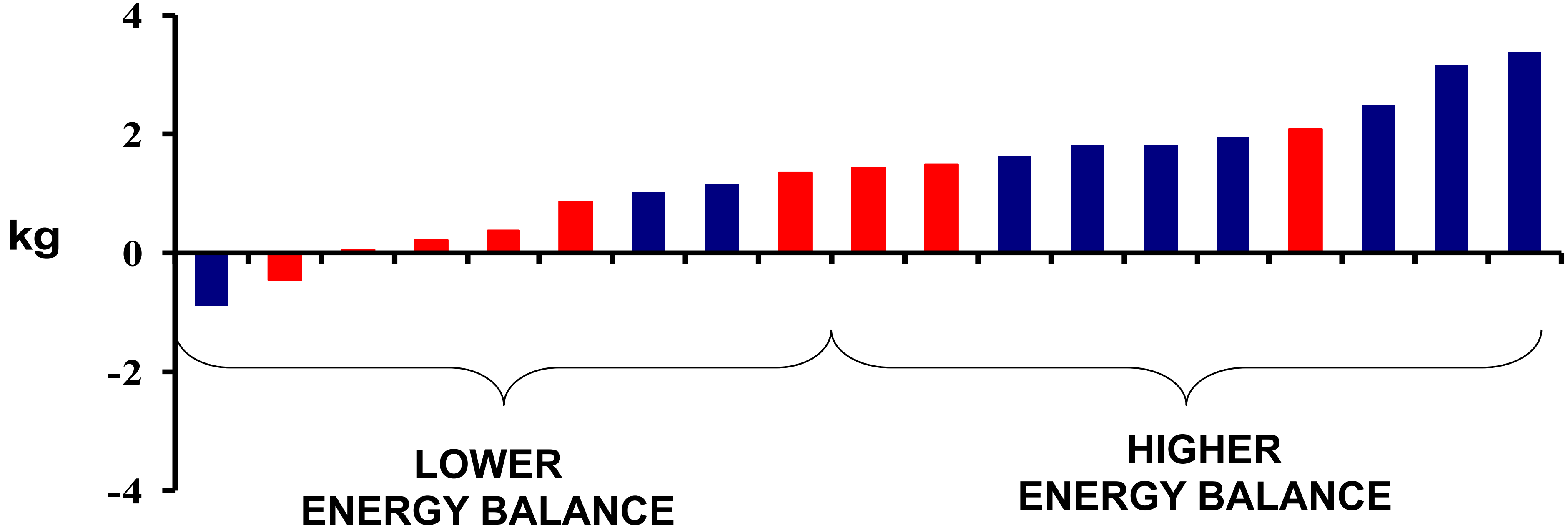
PROTEIN KINETICS IN RELATION TO ENERGY AVAILABILTY

VALDOLTRA Bed Rest Studies 2006 & 2007

INDIVIDUAL CHANGES IN FAT MASS

Study A (spontaneous adaptation to decreased energy requirements)

Study B (activity-matched eucaloric diet)



Biolo, Pišot et al., Am J Clin Nutr, Oct. 2008

Positive energy balance is associated with accelerated muscle atrophy and increased erythrocyte glutathione turnover during 5 wk of bed rest[1–3]

Gianni Biolo, Francesco Agostini, Bostjan Simunic, Mariella Sturma, Lucio Torelli, Jean Charles Preiser, Ginette Deby-Dupont, Paolo Magni, Felice Strollo, Pietro di Prampero, Gianfranco Guarnieri, Igor B Mekjavic, Rado Pišot, and Marco V Narici

Am J Clin Nutr 2008;88:950–8.

Changes in fat-free mass (bioimpedence)

***, p<0.05 significant different from zero;**
§, p<0.05 versus lower energy balance

Positive energy balance is associated with accelerated muscle atrophy and increased erythrocyte glutathione turnover during 5 wk of bed rest[1–3]

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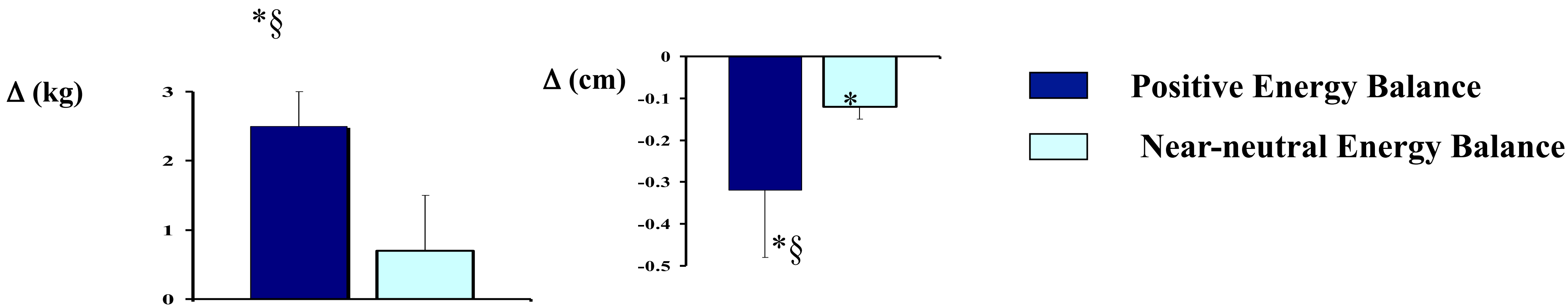
Am J Clin Nutr 2008;88:950–8.

Changes in fat-free mass (bioimpedence)

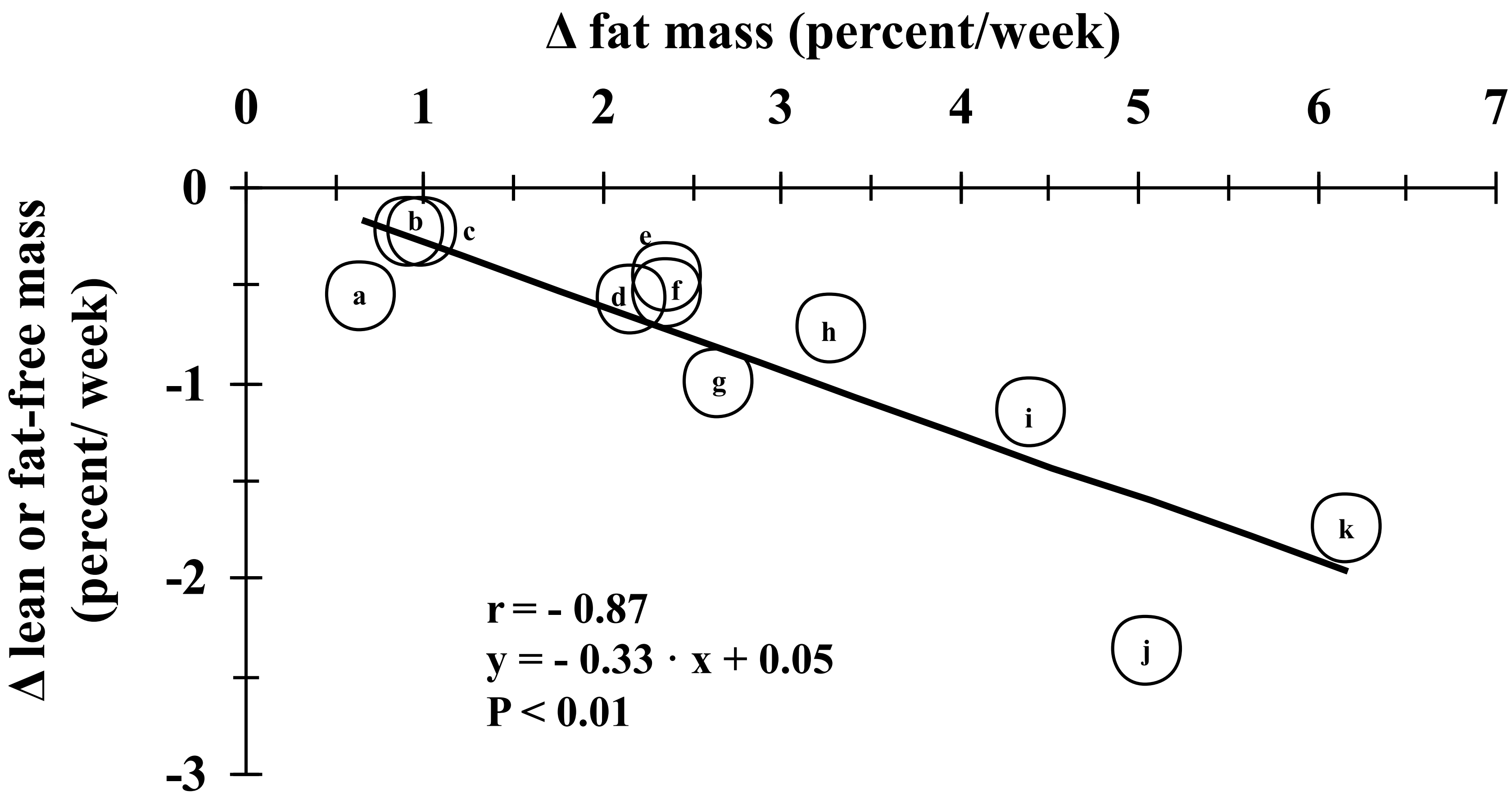
Changes in vastus lateralis thickness (ultrasounds)



***, $p<0.05$ significant different from zero;**
§, $p<0.05$ versus lower energy balance

RELATIONSHIP BETWEEN CHANGES IN FAT AND LEAN MASS IN BED REST STUDIES (1-17 weeks) AT POSITIVE ENERGY BALANCE

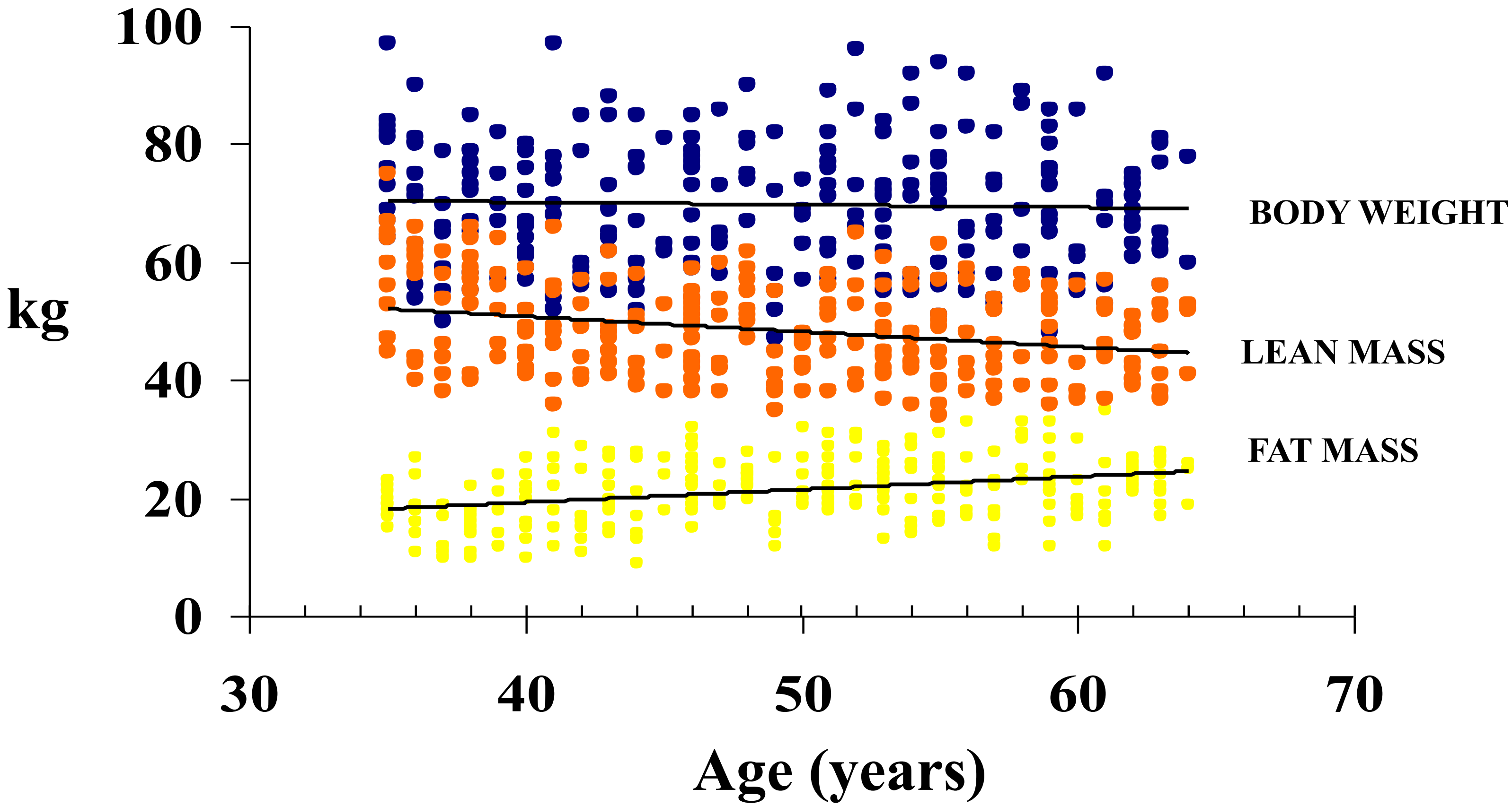
(a) Lovejoy et al., Am J Physiol 1999; (b) Shackelford et al., J Appl Physiol 2004 ; (c) Scheld et al., Clin Chem 2001; (d) NNEB; (e) Krebs et al., Aviat Space Environ Med 1990 ; (f) Gretebeck et al., J Appl Physiol 1995 ; (g) Stein et al., Am J Physiol 1999; (h) Ferrando et al., Am J Physiol 1996; (i) PEB ; (j) Barbe et al., J Appl Physiol 1999 ; (k) Blanc et al., Am J Physiol Regul Integr Comp Physiol 2000.



CROSS-SECTIONAL STUDY

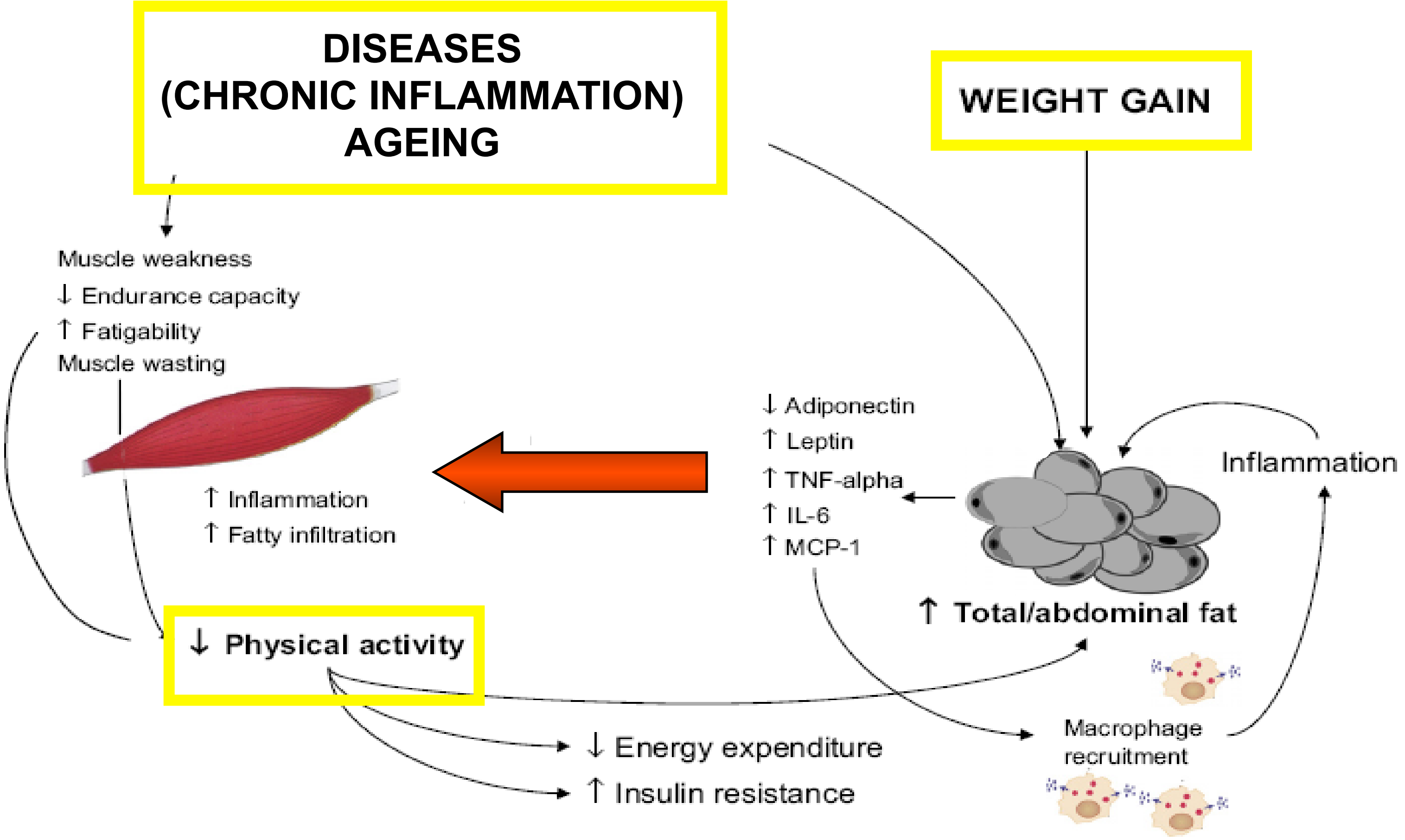
252 healthy subjects with normal body mass index, 35 to 65 years

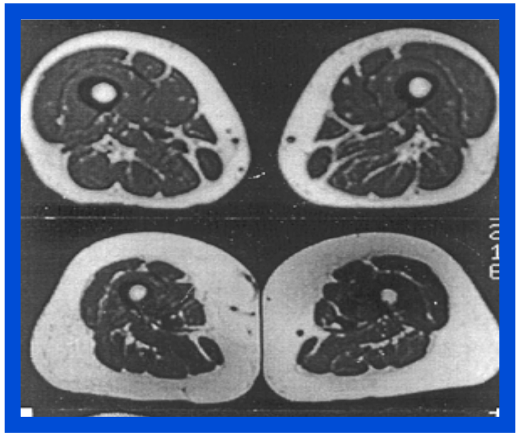
BODY WEIGHT AND COMPOSITION



Clinica Medica – University of Trieste

Inter-relationships between adipose tissue and muscle
A mechanism leading to sarcopenic obesity
(Ageing, Critical illness, Chronic inflammatory diseases, Cancer)





Zamboni et al., Nutrition, Metabolism & Cardiovascular Diseases 2008

Positive energy balance is associated with accelerated muscle atrophy and increased erythrocyte glutathione turnover during 5 wk of bed rest[1–3]

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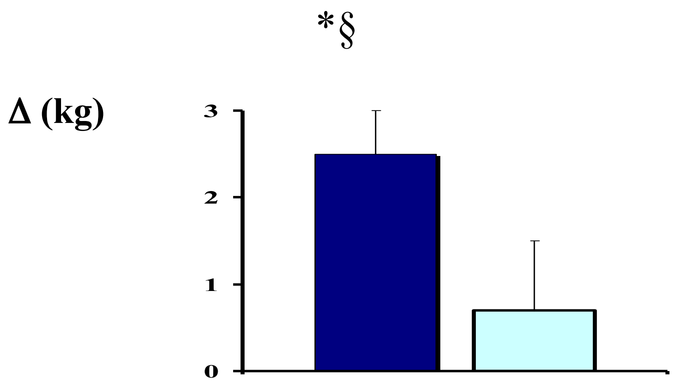
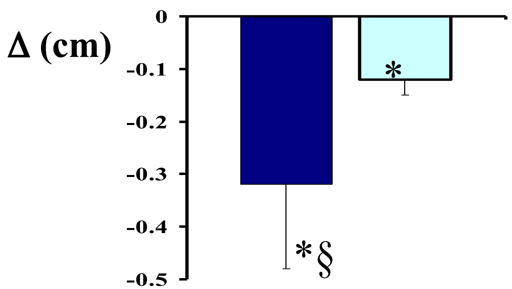
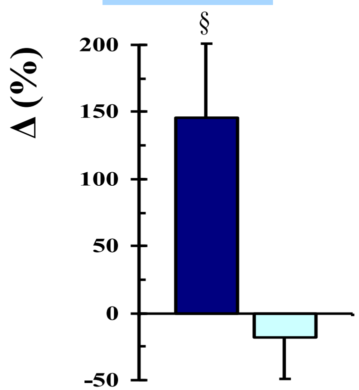


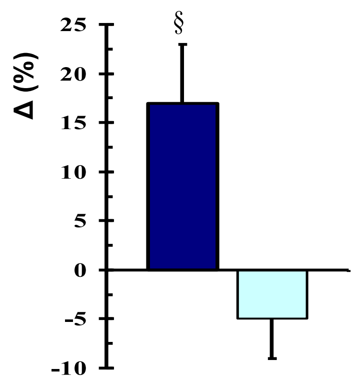
Changes in vastus lateralis thickness (ultrasounds)



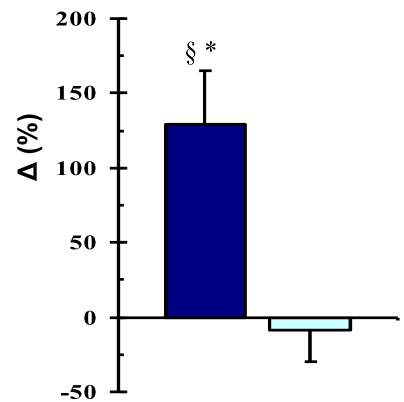
PLASMA CRP



PLASMA MYELOPEROXIDASE



ERYTHOCYTE GLUTATHIONE SYNTHESIS RATE



***, p<0.05 significant different from zero;**
§, p<0.05 versus lower energy balance

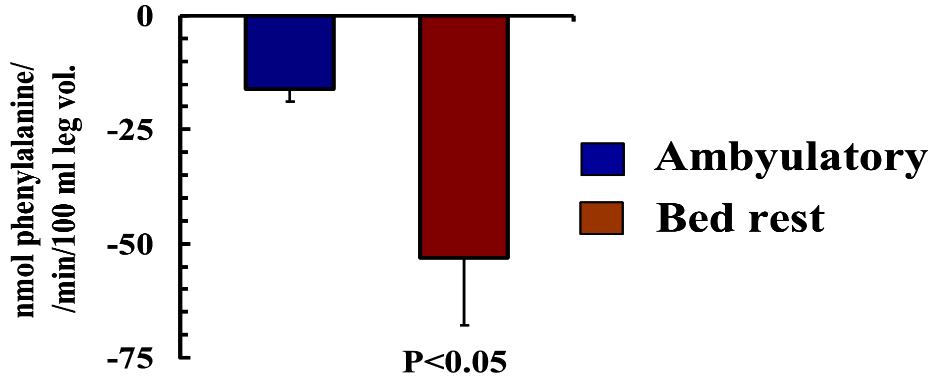
Inactivity Amplifies the Catabolic Response of Skeletal Muscle to Cortisol

Ferrando et al., J Clin Endocrinol & Metab, 1999

12-h hydrocortisone infusion
(120 microg/kg/h)

Ambulatory 5-days	Bed rest 14-days

MUSCLE PROTEIN BALANCE



EXPERIMENTAL PROTOCOL

STBR study DLR – Cologne – Germany

9 NORMAL MALE VOLUNTEERS

Randomized Cross-Over

14 days

Ambulatory-Eucaloric
(100% of total energy expenditure)

Bed Rest-Eucaloric
(100% of total energy expenditure)

Ambulatory-Hypocaloric
(80% of total energy expenditure)

Bed Rest-Hypocaloric
(80% of total energy expenditure)

DEXA

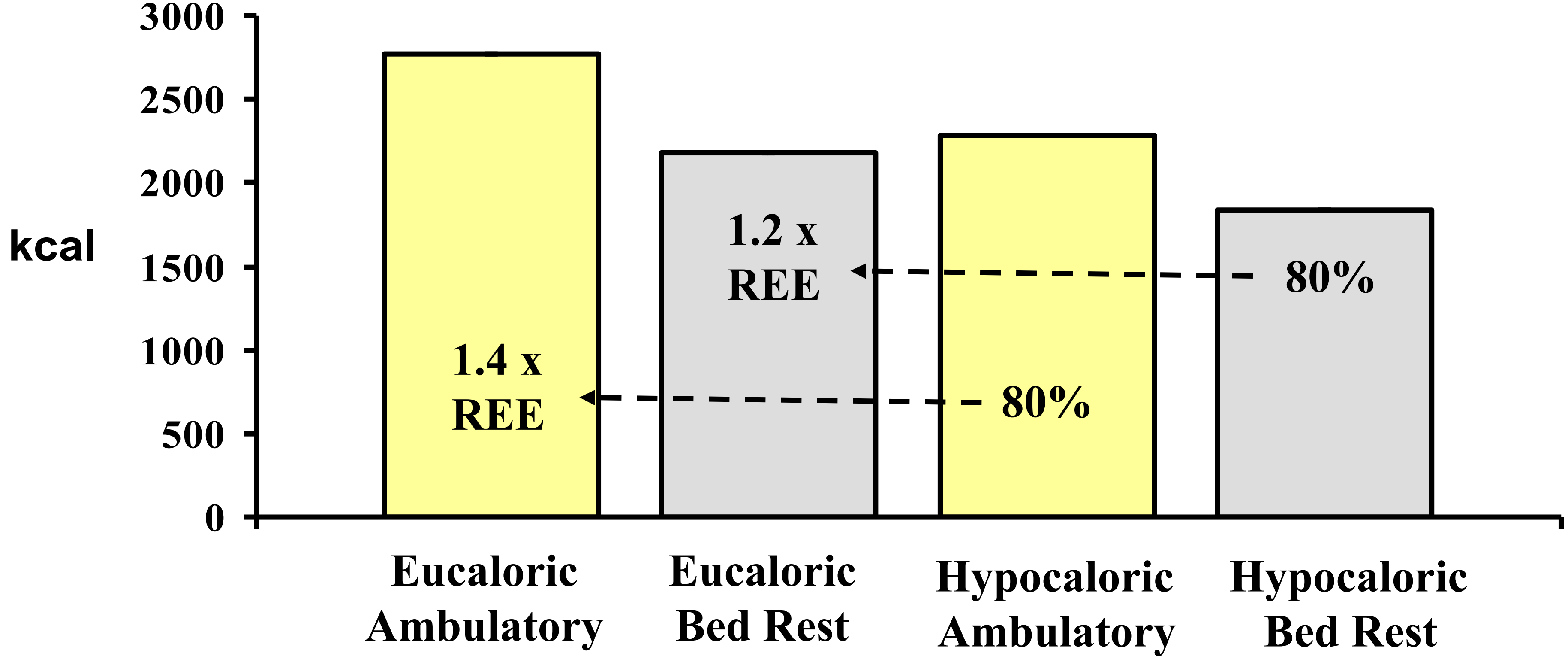
Whole body protein kinetics

Inflammatory markers

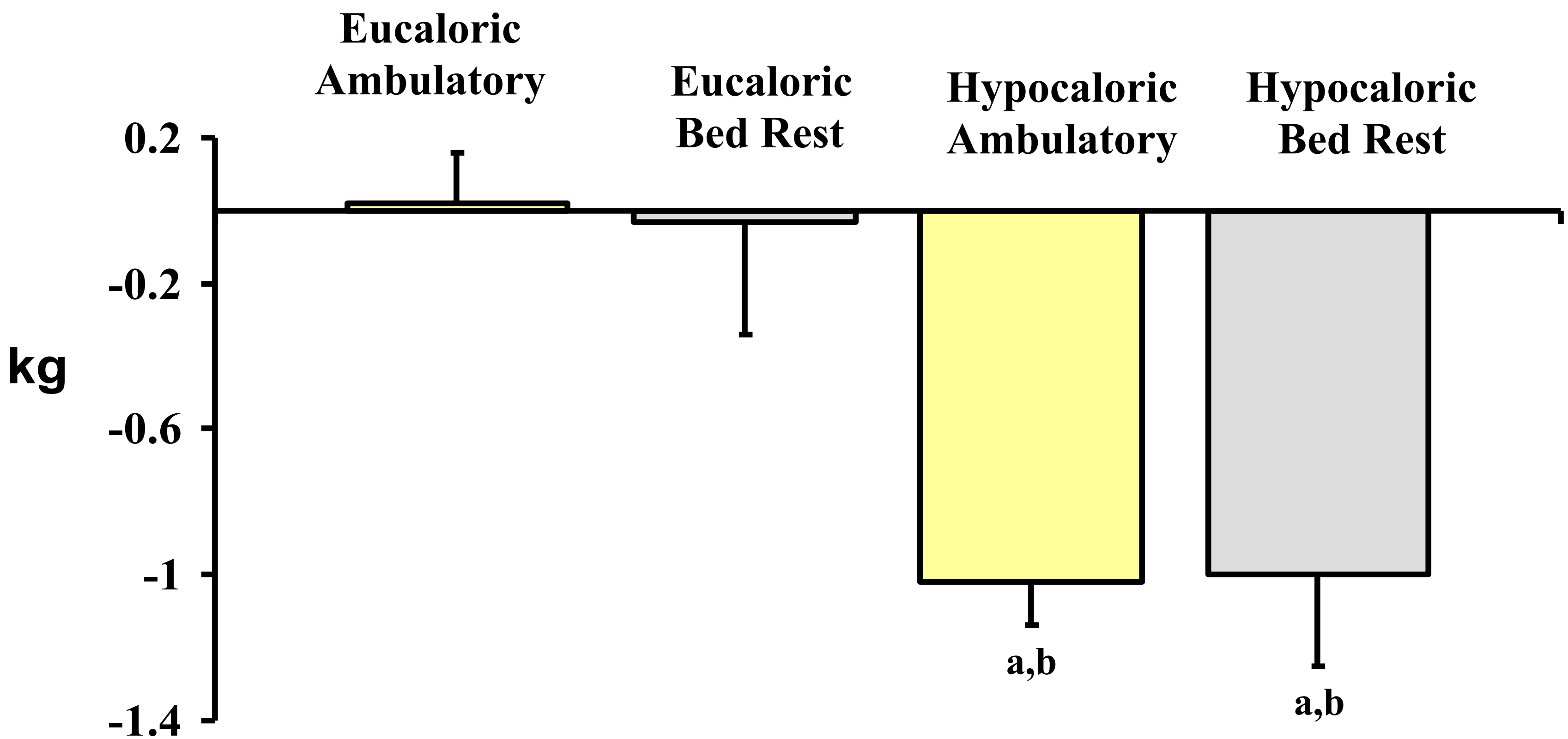
DEXA

J Physiol 2005; Am J Clin Nutr 2007; J Clin Endocrinol Metab 2008

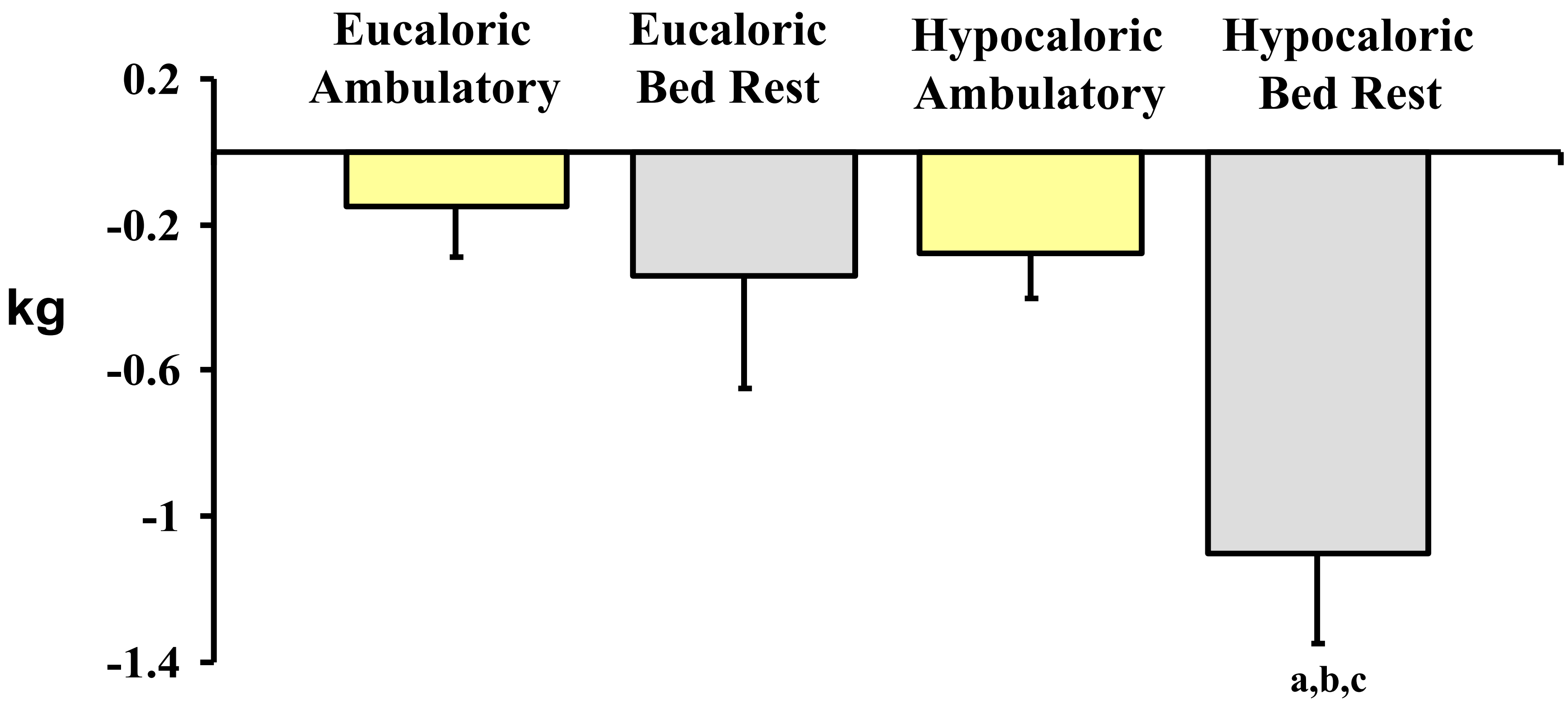
ENERGY INTAKE



CHANGES IN FAT MASS (DXA)
DURING THE 14-DAY EXPERIMENTAL PERIODS
(ENERGY BALANCE)



CHANGES IN LEAN MASS (DXA)
DURING THE 14-DAY EXPERIMENTAL PERIODS

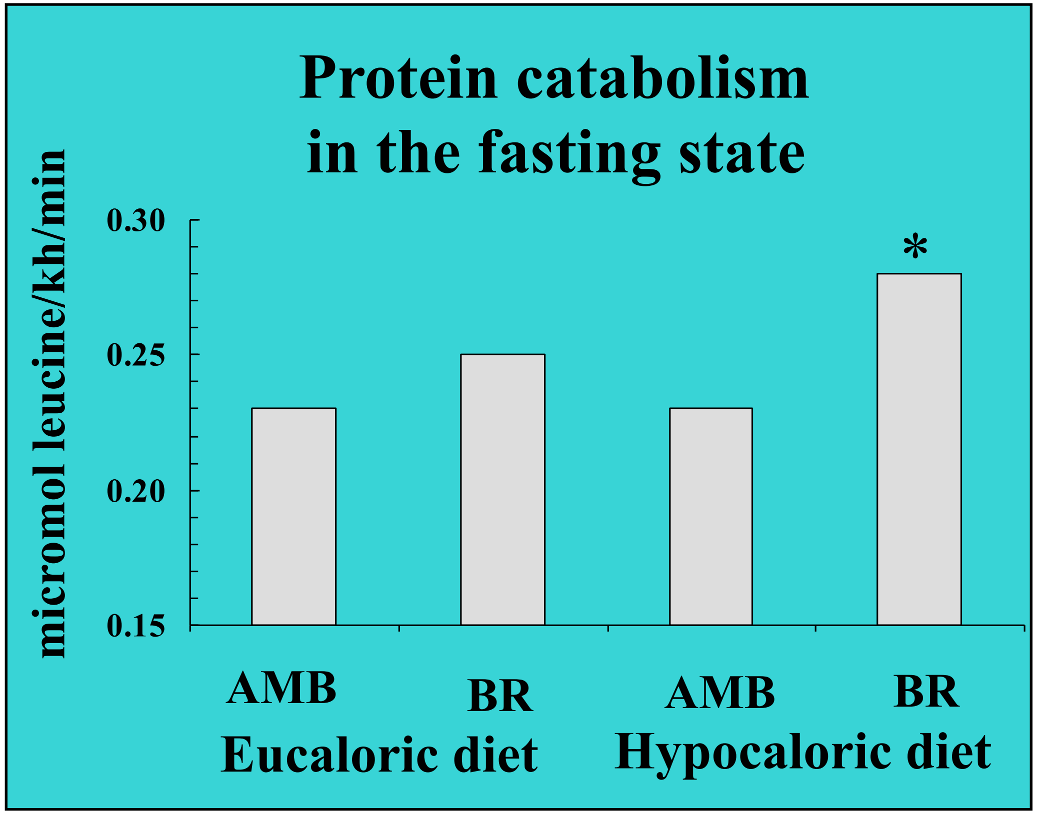


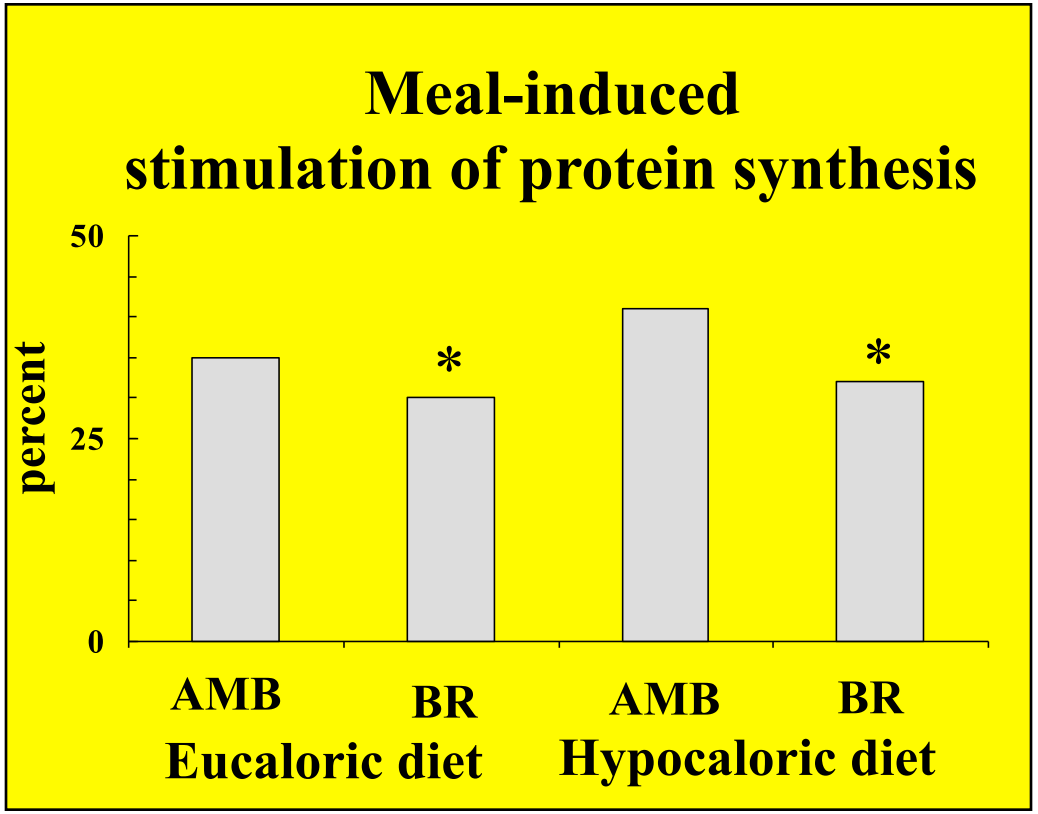
Am J Clin Nutr 2007

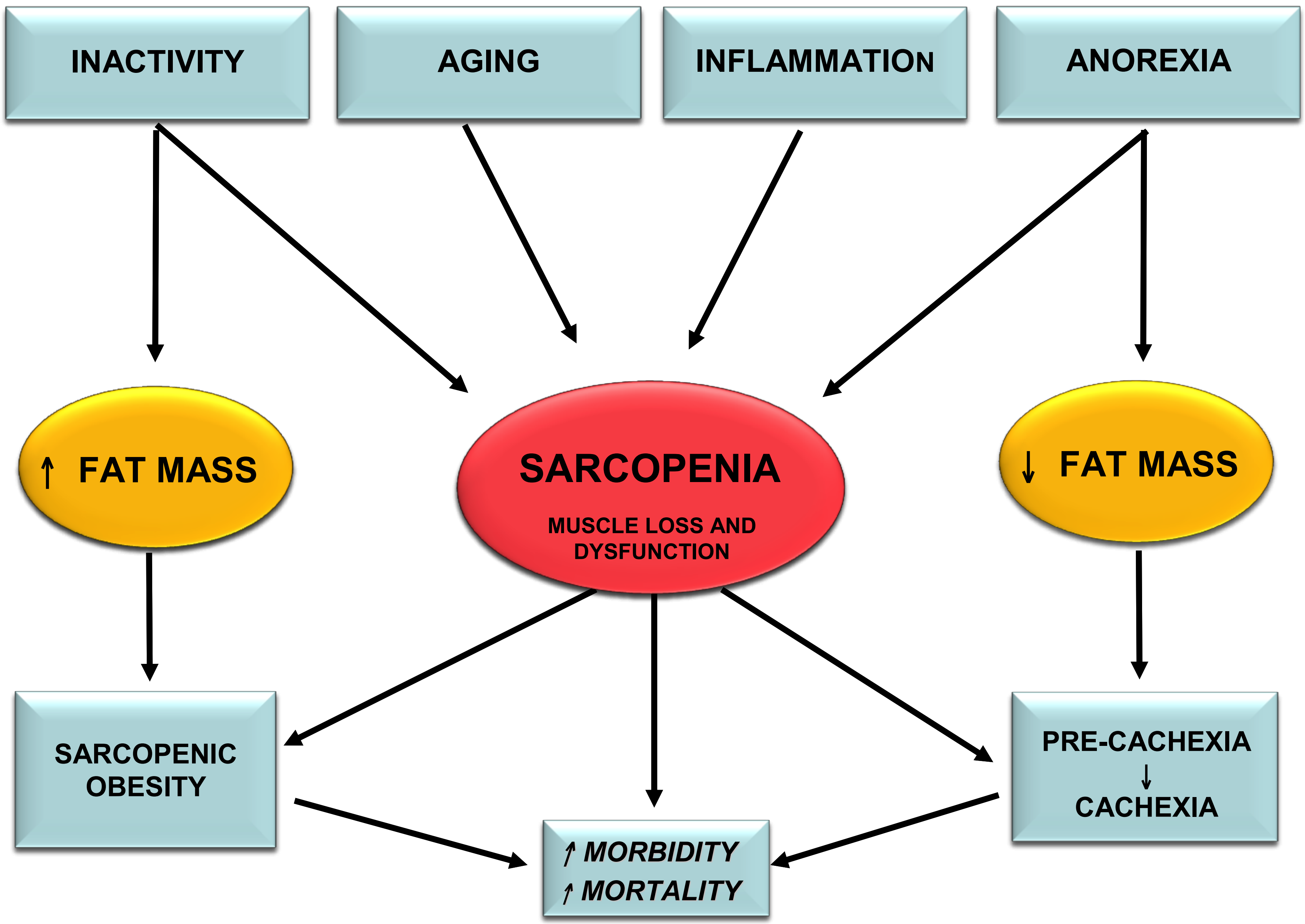
Calorie restriction accelerates the catabolism of lean body mass during 2 wk of bed rest[1-3]

Gianni Biolo, Beniamino Ciocchi, Manuela Stulle, Alessandra Bosutti, Rocco Barazzoni, Michela Zanetti, Raffaella Antonione, Marion Lebenstedt, Petra Platen, Martina Heer, and Gianfranco Guarnieri

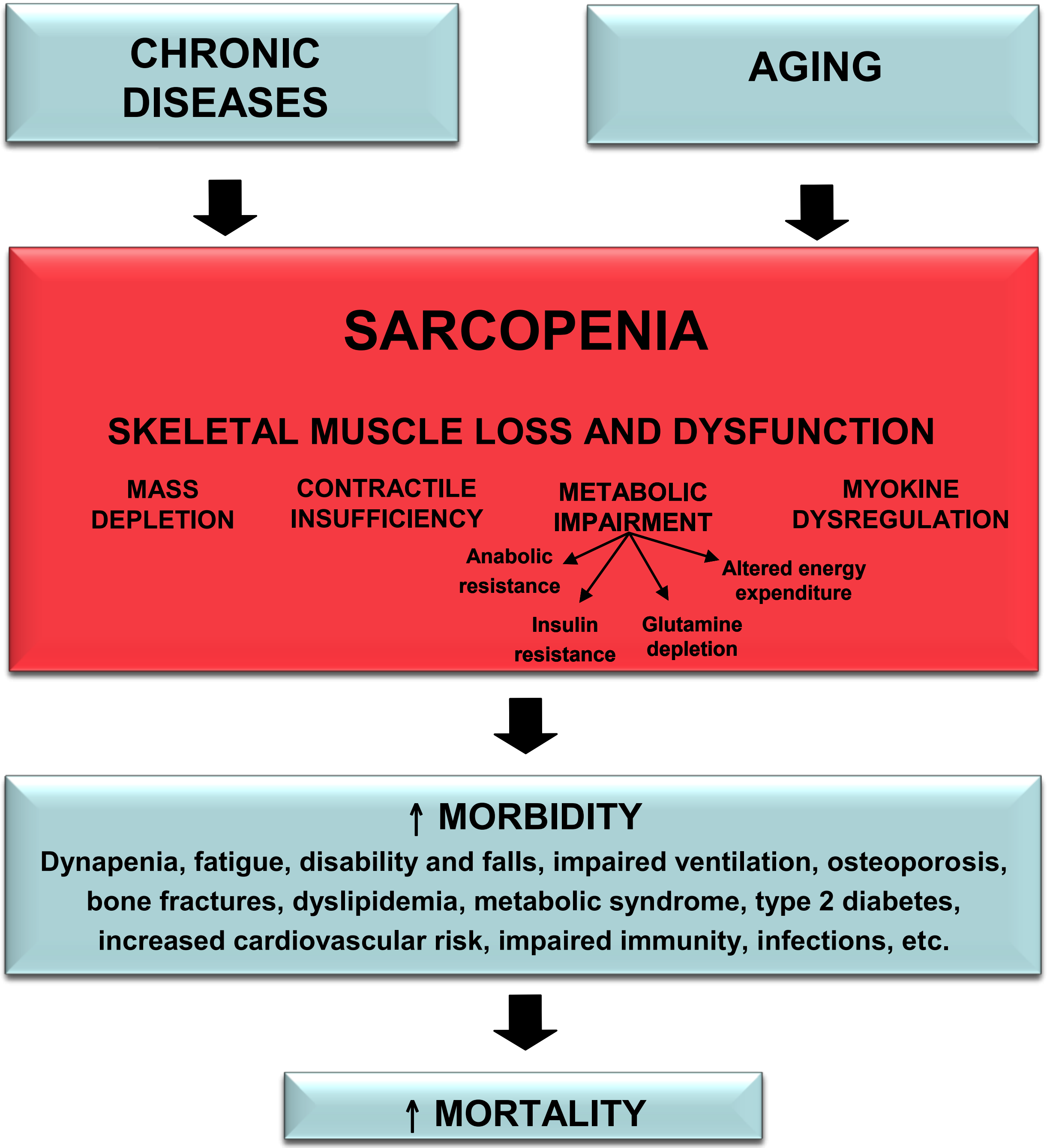
Am J Clin Nutr 2007;86:366–72.







Biolo & Muscaritoli



Biolo & Muscaritoli

SUMMARY

1. **Inactivity impairs amino acid-induced protein anabolism.**

2. **Physical activity enhances anabolic utilization of amino acids.**

3. **High protein-BCAA intake decreases inactivity-mediated loss of lean body and myocardial mass as well as prevents inactivity-mediated insulin resistance.**

4. **Overfeeding and underfeeding accelerate inactivity-mediated muscle atrophy.**