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The Influence of Nutrient Timing & Distribution on Body Composition

By Alan Aragon

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ALAN ARAGON'S RESEARCH REVIEW
Unbiased critical analysis of the latest research on nutrition, training, & supplementation.
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Agenda

- Acute effects of meal frequency & protein distribution
- Chronic effects of meal frequency & protein distribution
- Chronic effects of carbohydrate distribution
- Closing notes on individual variation
- Q/A

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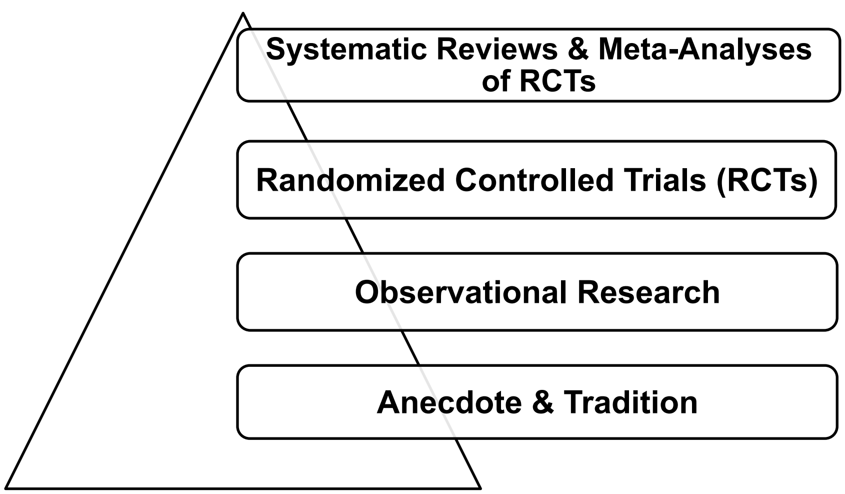
Hierarchy of Evidence



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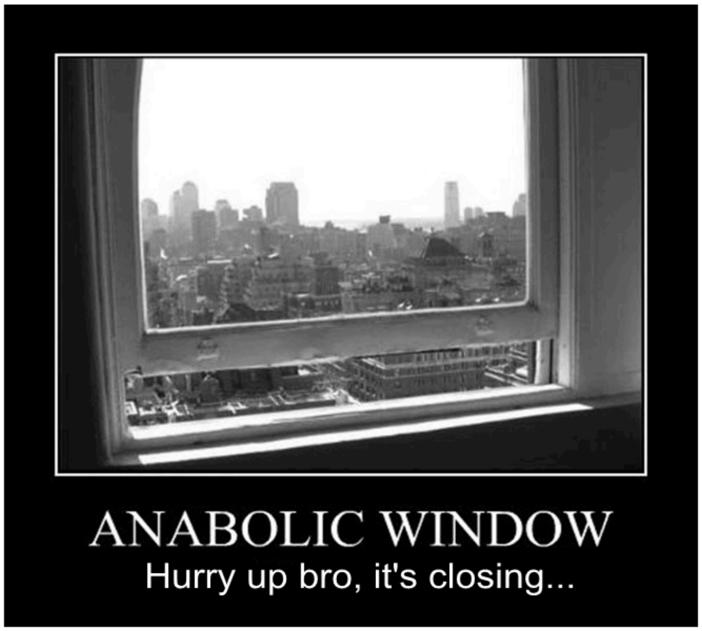

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Acute (short-term) effects

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Acute (short-term) effects: Meal frequency

24-hour energy expenditure

- Tightly-controlled metabolic chamber studies have failed to detect differences in 24-hour thermogenesis in isocaloric comparisons of a *nibbling pattern* (6-7 meals) and a *gorging pattern* (2 meals) [1,2].

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Acute (short-term) effects: Protein distribution

Muscle protein synthesis (MPS)

- 80 g protein consumed over 4 feedings through the day were superior to 2 or 8 feedings for raising MPS over a 12-hr period [3,4]. This has been attributed to meeting the "leucine threshold" necessary to significantly elevate MPS above resting levels.
- Mamerow et al [5] found that a moderate amount of protein at each meal (roughly 30 g in 3 meals) stimulated 24-hr MPS more effectively than skewing the majority of protein intake toward the evening meal (10.7 , 16.0, and 63.4 g breakfast, lunch, and dinner, respectively).

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Acute (short-term) effects: Protein distribution

"Leucine threshold" as a possible explanation

- The leucine threshold for triggering MPS at rest is thought to be approximately 1 g in younger subjects and about 2 g in older subjects [6].
- Maximizing (as opposed to merely initiating) the acute anabolic response in the trained state may require 2-3 g leucine [7], which in practical terms amounts to roughly 20-40 g protein.

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Acute (short-term) effects: Protein distribution

Leucine and BCAA content of foods

Source	Leucine	BCAA
Whey protein isolate	14%	26%
Milk protein	10%	21%
Egg protein	8.5%	20%
Muscle protein	8%	18%
Soy protein isolate	8%	18%
Wheat protein	7%	15%
Pea protein	**6%**	**14%**

Millward DJ, Layman DK, Tomé D, Schaafsma G. Protein quality assessment: impact of expanding understanding of protein and amino acid needs for optimal health. m J Clin Nutr. 2008 May;87(5):1576S-1581S.

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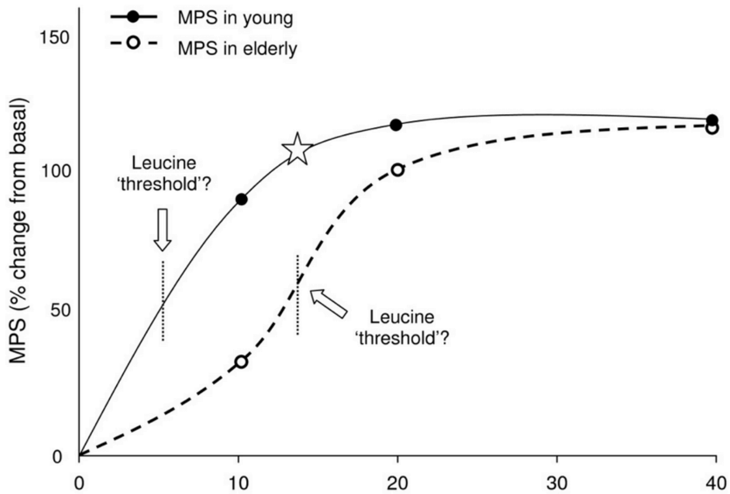
Dose-response curve of MPS



Breen L, Phillips SM. Skeletal muscle protein metabolism in the elderly: Interventions to counteract the 'anabolic resistance' of ageing. Nutr Metab (Lond). 2011 Oct 5;8:68.

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Optimizing MPS with body mass-based doses

- MPS reached a plateau in older men after ingestion of **0.40 g/kg BW** or **0.6 g/kg LBM**
- MPS reached a plateau in younger men after ingestion of **0.24 g/kg BW** or **0.25 g/kg LBM**

Moore DR, et al. Protein ingestion to stimulate myofibrillar protein synthesis requires greater relative protein intakes in healthy older versus younger men. J Gerontol A Biol Sci Med Sci. 2015 Jan;70(1):57-62.

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Optimizing MPS with body mass-based doses

"Additionally, it should be noted that the breakpoint observed in the present study would reflect the **estimated average requirement** to maximize MPS and, as such, the acute protein intake may be as high as **~0.60 g/kg for some older men** (depending on the presence of potential contributing factors to the "anabolic resistance" of MPS) and **~0.40 g/kg for some younger men**."

Moore DR, et al. Protein ingestion to stimulate myofibrillar protein synthesis requires greater relative protein intakes in healthy older versus younger men. J Gerontol A Biol Sci Med Sci. 2015 Jan;70(1):57-62.

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Optimizing MPS with body mass-based doses

"To account for inter-individual variability we propose the addition of two standard deviations to our estimate, yielding a dose of protein that would optimally stimulate MPS at intake of **0.4 g/kg/meal.** In our view, ingestion of protein beyond this dose would result in no further stimulation of MPS."

Moore DR, et al. Protein ingestion to stimulate myofibrillar protein synthesis requires greater relative protein intakes in healthy older versus younger men. J Gerontol A Biol Sci Med Sci. 2015 Jan;70(1):57-62.

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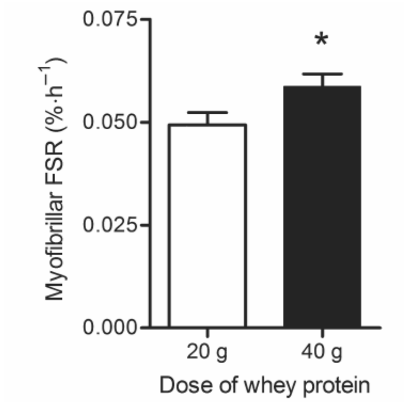
Optimizing MPS: Breaking Research Using Whole-Body Exercise



Macnaughton LS, et al. The response of muscle protein synthesis following whole-body resistance exercise is greater following 40 g than 20 g of ingested whey protein. Physiol Rep. 2016 Aug;4(15). pii: e12893.

Acute (short-term) effects: Protein distribution

Recent data challenging the "even & capped" protein distribution model

- Kim et al [8] found that net protein balance (PS minus PB) was greater with protein dosed at 1.5 g/kg vs. 0.8 g/kg, regardless of distribution pattern through the day (33/33/33% vs 15/20/65%).
- Kim et al [9] found a greater net protein balance (equal MPS, less **PB**) with a 70 vs 40 g protein dose: "Stimulation of gut protein synthesis is potentially beneficial, particularly in a situation where MPS has been already maximized."

Acute (short-term) effects: Protein distribution

Limitations of the acute studies

- low overall protein intake (80-90 g within a 12-hour period), roughly half of what is typically consumed in the athletic population focused on size/strength gains.
- Absence of other macronutrients, which may influence outcomes (except Mamerow et al [5] and Kim et al who had conflicting findings).
- Most importantly: acute MPS response does not reliably correlate with long-term adaptations such as strength and hypertrophy [10-14].

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Chronic (long-term) effects

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Protein Timing Meta-analysis

Chronic (long-term) effects: Protein timing meta-analysis with Brad Schoenfeld & James Krieger [10]

Purpose of our meta-analysis:

- The purpose (mention general) was to conduct a multi-level meta-regression of randomized controlled trials to determine whether protein timing is a viable strategy for enhancing post-exercise muscular adaptations.

Inclusion criteria:

- At least one treatment group consumed a minimum of 6 g essential amino acids (EAAs) ≤ 1 hour pre- and/or post-resistance exercise and at least one control group did not consume protein < 2 hours pre- and/or post-resistance exercise.
- Minimum 6-week trial duration.

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Chronic (long-term) effects: Protein timing meta-analysis with Brad Schoenfeld & James Krieger [10]

Strengths of our meta-analysis:

- A total of 23 studies were analyzed comprising 525 subjects.
- Quality of studies was high (8.7 on PEDro scale).
- Studies were separately coded and recoded by two different investigators.
- Basic analysis carried out to see if there was an effect of protein timing.
- Regression sub-analysis was then performed to assess whether other factors might explain variances.

Chronic (long-term) effects: Protein timing meta-analysis with Brad Schoenfeld & James Krieger [10]

Results of our meta-analysis:

- Basic analysis showed a small effect (0.2 ES) for protein timing on hypertrophy.
- Regression analysis found that virtually the entire effect was explained by greater total daily protein consumption in treatment group (1.66 vs. 1.33 g/kg).
- A sub-analysis of the protein-matched studies failed to detect a timing effect. Why? It's likely due to the sufficiently high/optimized total daily protein intakes (1.91 g/kg in the treatment groups vs 1.81 g/kg in the control groups).

Chronic (long-term) effects: Protein timing meta-analysis with Brad Schoenfeld & James Krieger [10]

Limitations of our meta-analysis:

- Only 5 studies that were initially considered for analysis matched protein intake between groups. 2 showed an effect, 3 did not.
- Only 2 studies evaluated trained subjects with matched intake. 1 showed and effect, 1 did not.
- Only 1 study assessed the timing effect of an ample dose of carbohydrate as coingested with ample protein.

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Meal Frequency Meta-analysis

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Chronic (long-term) effects: Meal frequency meta-analysis with Brad Schoenfeld & James Krieger [11]

Purpose of our meta-analysis:

- To quantitatively analyze the available (& relevant) body of controlled studies on meal frequency's effect on body composition.

Inclusion criteria:

- RCTs directly comparing feeding frequencies of $\leq$ 3 meals a day with $\geq$ 3 meals a day in human adults.
- Minimum 2-week trial duration.
- Reported body composition change.
- Excluded post-bariatric surgery patients.

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Chronic (long-term) effects: Meal frequency meta-analysis with Brad Schoenfeld & James Krieger [11]

Results (15 studies met inclusion criteria):

- Meal frequency did not significantly affect total body weight change.
- Higher meal frequencies were associated with greater losses of fat mass and greater retention of lean mass.
- Sensitivity analysis revealed that the removal of a single study (Iwao et al) completely eliminated the significant effect of meal frequency on changes in body composition.

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Chronic (long-term) effects: Meal frequency meta-analysis with Brad Schoenfeld & James Krieger [11]

Limitations:

- Sedentary subjects (except Iwao et al).
- Low daily protein intakes (except Arciero et al).
- Our findings are specific to body composition. Other health-related outcomes (i.e., glucose control, lipids, appetite, etc) or performance-related outcomes (i.e., muscle strength or endurance) were not analyzed.

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The Fasted Cardio Study

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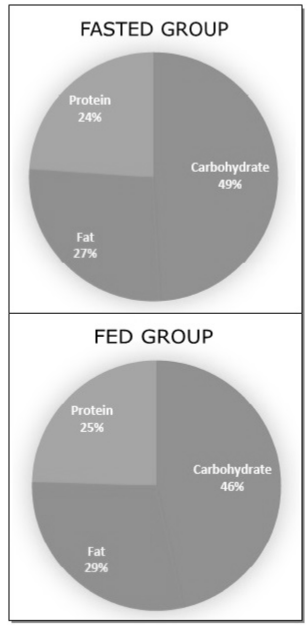
Chronic effects: Fasted versus fed cardio with Schoenfeld, Wilborn, & Krieger

Purpose & design:

- To investigate changes in body composition following 4 weeks of fasted versus fed aerobic exercise (50 min @ 70% MHR + 5 min warm-up & 5-min cool-down) in young women (n=20, 22.4 y/o, normal-weight) in hypocaloric conditions.

Dietary intervention:

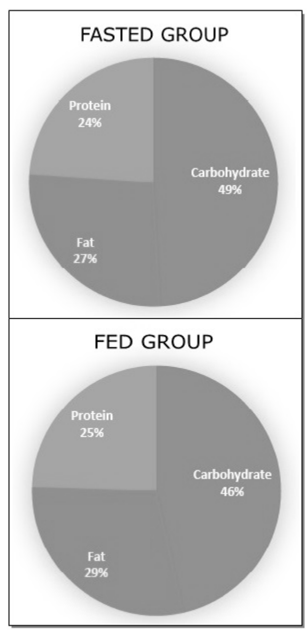
- BMR was estimated by the Mifflin-St. Jeor equation, activity factor was 1.5, 500 kcal was subtracted.
- Dietary protein intake was set at 1.8 g/kg of body mass, Fat was 25-30% of total kcals, and carbohydrate comprised the remainder.
- Sample meal plans were provided to guide the participants in acceptable food choices.



Chronic effects: Fasted versus fed cardio with Schoenfeld, Wilborn, & Krieger

Dietary intervention (continued):

- Nutritional counseling was provided throughout the study period to help ensure dietary adherence and self-reported food intake was monitored on a regular basis.
- Food records using MyFitnessPal.com were collected and analyzed daily to ensure that intake was not based on recall.
- A meal replacement shake (20g P, 40g C, 0.5g F) was provided either immediately prior to exercise for the FED group or immediately following exercise for the FASTED group, under the supervision of a research assistant.



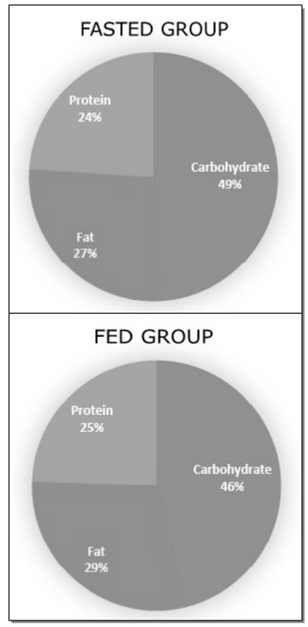
Chronic effects: Fasted versus fed cardio with Schoenfeld, Wilborn, & Krieger

Results & conclusion:

- Both groups showed a significant loss of weight (P = 0.0005) and fat mass (P = 0.02) from baseline, but no significant between-group differences were seen in any outcome measure. Lean mass was retained in both groups.
- As long as total daily nutrition is equated, body composition changes from aerobic exercise & chronic hypocaloric conditions are similar regardless of fasted versus fed training.

Limitations:

- Testing period was fairly short (4 weeks).
- Intake was self-reported.
- Subjects were young, normal-weight women.



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Chronic (long-term) effects: Protein distribution

No clear advantage to evenly spread protein intake

- Previous research by Arnal et al found no difference in nitrogen retention & FFM between young women consuming a “pulse-feeding” pattern with 79% of the day’s protein needs (~54 g) in one meal, versus protein evenly spread across four meals in young subjects [13].
- In elderly women, a “pulse” pattern resulted in more positive nitrogen balance and better FFM retention than an evenly spread feeding pattern [14].
- Adechian et al [15] found no significant between-group differences in body composition change in a 6-week comparison of whey vs casein consumed in a 'pulse' meal pattern (8/80/4/8%) vs a 'spread' pattern (25/25/25/25%).
- Arciero et al [16] found that protein intake spread over 6 meals increased LBM and lost more FM than 3 meals under hypocaloric conditions.

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Protein Timing Study (Pre-Publication)

Pre- versus Post-Exercise Protein Intake (Pre-Publication)

Purpose & design:

- To test the hypothesis of the "anabolic window of opportunity," by comparing the 10-wk effects of immediate pre- vs post-resistance exercise protein consumption (24 g) on trained young men (RT at least 3 x wk for 1 yr).
- RT was progressive & supervised, 9 exercises per session hitting all major muscle groups, 3 sets per exercise, 8-12 reps (appx 75% of 1 RM), 90 sec interset rest , 3 sessions per week.
- DXA assessed body composition, ultrasound assessed muscle thickness.
- Upper and lower body strength was assessed by 1RM testing in the bench press the back squat.
- Protein intake was set at 1.8 g/kg, fat 25-30% of total kcals, with the remaining CHO set to create a caloric surplus.

Pre- versus Post-Exercise Protein Intake (Pre-Publication)

Results:

- Both PRE-SUPP and POST-SUPP groups significantly increased maximal squat strength.
- There was a trend toward increased maximal bench press strength for both groups.
- Neither group showed significant gains in lean mass. However, the PRE-SUPP trended toward greater left arm lean mass compared to the POST-SUPP group.
- There was a trend for a greater increase in biceps thickness in the PRE-SUPP than the POST-SUPP group.
- Both groups significantly lost body fat.

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Pre- versus Post-Exercise Protein Intake (Pre-Publication)

Limitations

- Both groups substantially reduced their energy intake from baseline; by ~400 kcal. This is the opposite of what they were supposed to do; hypocaloric conditions were sustained despite hypercaloric conditions being assigned.
- Intake was self-reported, which widens the door for inaccuracy.

Perspective:

- Although conditions were not optimal for size and strength gains, it's possible that our study served to challenge the common presumption that protein timing in the post-exercise anabolic window is more crucial in an energy deficit.

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Carbohydrate Distribution & Body weight/Body Comp

Chronic effects of carbohydrate distribution: 8-study saga [17-24]

- 1 study shows a fat oxidation advantage of eating later in the day .
- 1 study shows no significant difference in weight or fat loss .
- 1 study shows a greater preservation of lean mass from eating more calories later in the day .
- 1 study shows a greater weight loss, fat loss, and waist reduction from eating more carbs later in the day .
- 4 studies show essentially the opposite - favorable weight and/or body composition effects of front-loading caloric intake).

Scorecard:

- **Carbs earlier in the day is better: 4 studies**
- **Carbs later in the day is better: 3 studies**
- **No difference either way: 1 study**

(Limitations, Practical application)

Putting It All Together: Practical Application

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Practical Application

Meal frequency & nutrient distribution

- Number of meals can be tailored to the individual's goal, personal preference, tolerance, and schedule.
- Acute studies show that higher frequency does not equal greater thermogenesis or increased metabolic rate.
- Chronic studies overall show no meaningful advantage of a higher frequency (> 3 meals/d) on body composition.
- CAUTION, there's still a lack of meal frequency research on athletic subjects undergoing a formal training program, and consuming an optimal level of protein.

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Practical Application

Meal frequency & nutrient distribution

- Fed versus fasted cardio makes no significant difference as long as total macronutrition is matched (at least with our subject profile).
- The research on carb distribution does not lean strongly in favor of any particular direction, so place carbs according personal preference, tolerance, & goal.
- Focus primarily on hitting **total daily macronutrient targets**, but for maximizing muscle gain or muscle retention, make sure at least 3 meals per day contain at least 20-40 g high-quality protein, depending on age [25-28].

Protein Rec's in Recent Reviews & Position Stands[29-36]

Source	Population	Recommendation
Pencharz et al (2016)	General population	1.5-2.2 g/kg
Phillips et al (2014)	Athletes in hypocaloric conditions	1.3-1.8 g/kg
Helms et al (2013)	Lean, resistance-trained athletes in hypocaloric conditions	2.3-3.1 g/kg FFM
Churchward-Venne (2013)	Resistance trainees in a hypocaloric conditions	1.2-2.3 g/kg
Phillips & Van Loon (2011)	Athletes in hypocaloric conditions	1.8-2.7 g/kg
ADA/DC/ACSM Position Stand (2009)	Endurance & strength athletes	1.2-1.7 g/kg
JISSN Position Stand (2007)	Exercising individuals	1.4-2.0 g/kg
Wilson & Wilson (2006)	Strength-training athletes	1.2-2.2 g/kg

Protein Rec's in Recent Reviews & Position Stands[29-36]

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JISSN Position Stand (2007)	Exercising individuals	1.4-2.0 g/kg
Wilson & Wilson (2006)	Strength-training athletes	1.2-2.2 g/kg

Studies Challenging the Presumed Maximally Effective Daily Dose of 1.6 g/kg

1. **Candow et al, 2006:**
   3 g/kg outperformed 1.7 g/kg for improving bench & squat strength. PMID:16948480
2. **Willoughby et al, 2007:**
   2.8 g/kg outperformed 2.3 g/kg for increasing lean mass and bench & leg press strength. PMID:16988909
3. **Cribb et al, 2007:**
   3.1 g/kg outperformed 1.6 g/kg for increasing contractile protein and bench, squat, & pulldown strength. PMID:17277594

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Practical application

Nitpicking towards optimal protein distribution

- The goal of maximizing muscle gain may require a higher frequency of protein-rich meals than the goal of retaining muscle while dieting (e.g., 4-6 meals versus 2-3 meals).
- Minimal protein feeding distribution for optimizing muscle gain: 4 meals containing protein that meets or exceeds the leucine threshold (at least 20-40 g, depending on age, or just simplify it to a *minimum of 0.5 g/kg LBM) at the following time points – at minimum*:

  - Waking/early meal

  - Pre-workout

  - Post-workout

  - Pre-bed/late meal
- Minimal carbohydrate feeding distribution for optimizing muscle gain: It depends (individualize to training program & goals).

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Postworkout Protein + Carbs Versus Protein Only – for GAINZ

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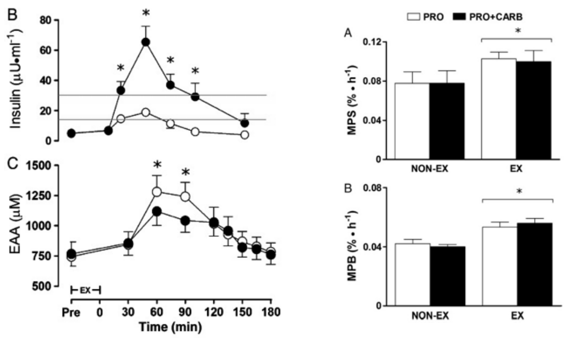
Carbs Fail to Acutely Increase MPS Given Sufficient Protein



- Staples & colleagues (charts above) [35] found that 50g maltodextrin added to 25g whey protein ingested after resistance training was unable to further increase postexercise net muscle protein balance compared to the protein dose without carbs .
- Hamer et al saw no effect of 40 g CHO + 20 g whey in older men [36].
- Both of these studies echoed earlier work by Koopman et al [37], who found no additional effect of CHO (up to 0.6 g/kg/hr) on MPS when ample protein (0.3 g/kg/hr) was consumed post-exercise That's 3 strikes, too bad it's all acute data.

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First-ever longitudinal study comparing post-exercise PRO-only with PRO + CHO

Design : 12-week comparison of post-exercise CHO (34.5 g maltodextrin), PRO (37.5 g whey containing 30 g protein), and CHO-PRO (a combination of the treatments) on untrained subjects.

Results:

- Significant and similar increases in lean mass and muscle thickness (CSA) were seen the protein-containing treatments, but not in CHO-only.
- Significant & similar decreases in leg and trunk fat mass were seen the protein-containing treatments, but not in CHO-only.
- Increases in maximal & isometric strength were not differently affected by any of the interventions (possibly due to novice trainee status).

Limitation: only a single time point of dietary journal assessment.

Hulmi JJ, et al. The effects of whey protein with or without carbohydrates on resistance training adaptations. J Int Soc Sports Nutr. 2015 Dec 16;12:48.

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Carb Timing & Performance

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Curvilinear dose-response relationship of carbohydrate & performance.

- **Protocol:** Cyclists & triathletes did a 2-hr constant load at 70.8% VO2max followed by a 20-km time trial, to be completed as quickly as possible. 12 CHO-electrolyte doses (10-120 g per hour) were tested) A 1:1:1 glucose-fructose-maltodextrin mix per hour during the 2-h constant load ride.
- **Results:** incremental performance improvements occurred until 78 g/hr, with diminishing performance enhancement seen at CHO levels >78 g/hr.
- **My comment:** This study improves upon previous designs with its wide range of dosages its use of multiple transportable CHO. It's a good example of how more can be better – only to a point, after which diminishing returns are seen.

Smith JW, et al. J. Curvilinear dose-response relationship of carbohydrate (0-120 g·h(-1)) and performance. Med Sci Sports Exerc. 2013 Feb;45(2):336-41.

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On a related note to the previous study…

RESEARCH GEM: Colombani et al recently did a systematic review and found that under real-world race conditions (i.e., non-fasted subjects tested via TT instead of TTE), CHO ingested near or during exercise have:

"…an unlikely effect with bouts up to perhaps 70 min and a possible but not compelling ergogenic effect with performance durations longer than about 70 min."

Colombani PC, et al. Carbohydrates and exercise performance in non-fasted athletes: a systematic review of studies mimicking real-life. Nutr J. 2013;12:16.

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Recent Meta-analysis of Fed-State Conditions

- **Purpose:** to expand on Colombani's findings via an updated literature search in to yield an extended number studies to conduct a meta-analysis.
- **Inclusion criteria:** endurance-trained subjects, tested in real-world conditions (between 2 h and 4 h after ingesting last meal), no TTE (only TT or a submaximal exercise followed by a TT).
- **Results:** 16 studies were included in the meta-analysis. A 6-8 % carbohydrate solution just before and/or while exercising longer than 90 minutes benefitted male trained cyclists (there were insufficient data to draw conclusions for women).
- **Limitations:** the results may be limited to trained male cyclists, other populations & conditions had insufficient data.

Pöchmüller M, et al. A systematic review and meta-analysis of carbohydrate benefits associated with randomized controlled competition-based performance trials. J Int Soc Sports Nutr. 2016 Jul 11;13:27.

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Practical application

Nitpicking towards optimality: carbohydrate for performance (approaching/exceeding 2 hrs)

- **Intra-workout:** endurance-oriented training sessions that approach or exceed 2 hours of continuous exhaustive work (or training in a fasted state for more than an hour) can typically benefit from intra-workout nutrition, which I've boiled down to 10-20 g P, 40-80 g C per hour of training.
- **Post-workout:** endurance-oriented training sessions that approach or exceed 2 hours of continuous exhaustive work - separated by less than ~8 hours: CHO at 1.2g/kg, or 0.5g/lb per hour for up to 5 hours postexercise should restock glycogen at a maximal rate. A practical and equally effective alternative is to consume CHO at 0.8 g/kg in plus 0.4 g/kg protein or essential amino acids per hour of recovery.

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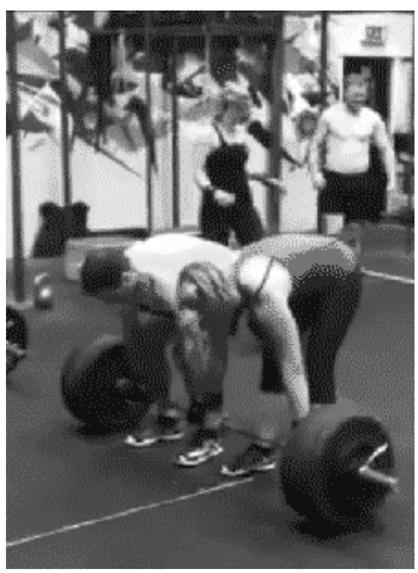
The Importance of Individual Variation



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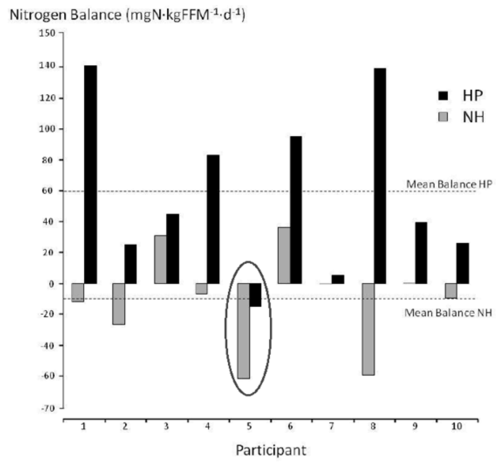
Example of Individual Variation



Normal/habitual intake of 85 g/d (1.39 g/kg) was compared with a high intake of 166 g/d (2.72 g/kg) in well-trained female cyclists in caloric maintenance. In order to preserve N-balance, subject #5 was estimated to require 2.83 g/kg.

Houltham SD, Rowlands DS. A snapshot of nitrogen balance in endurance-trained women. Appl Physiol Nutr Metab. 2014 Feb;39(2):219-25.

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References

1. Taylor MA, Garrow JS. Compared with nibbling, neither gorging nor a morning fast affect short-term energy balance in obese patients in a chamber calorimeter. Int J Obes Relat Metab Disord 2001, 25:519-528.
2. Verboeket-van de Venne WP, Westerterp KR. Influence of the feeding frequency on nutrient utilization in man: consequences for energy metabolism. Eur J Clin Nutr 1991, 45:161-169.
3. Moore DR, Areta J, Coffey VG, Stellingwerff T, Phillips SM, Burke LM, Cleroux M, Godin JP, Hawley JA: Daytime pattern of post-exercise protein intake affects whole-body protein turnover in resistance-trained males. Nutr Metab (Lond) 2012, 9:91.
4. Areta JL, Burke LM, Ross ML, Camera DM, West DW, Broad EM, Jeacocke NA, Moore DR, Stellingwerff T, Phillips SM, et al: Timing and distribution of protein ingestion during prolonged recovery from resistance exercise alters myofibrillar protein synthesis. J Physiol 2013, 591:2319-2331.
5. Mamerow MM, et al. Dietary protein distribution positively influences 24-h muscle protein synthesis in healthy adults. J Nutr. 2014 Jun;144(6):876-80.
6. Breen L, Phillips SM. Skeletal muscle protein metabolism in the elderly: Interventions to counteract the 'anabolic resistance' of ageing. Nutr Metab (Lond). 2011 Oct 5;8:68.

References

7. Norton LE, Wilson GJ: Optimal protein intake to maximize muscle protein synthesis: examinations of optimal meal protein intake. Agro Food Industry Hi-Tech 2009, 20:54–57.
8. Kim IY, et al. Quantity of dietary protein intake, but not pattern of intake, affects net protein balance primarily through differences in protein synthesis in older adults. Am J Physiol Endocrinol Metab. 2015 Jan 1;308(1):E21-8.
9. Kim IY, et al. The anabolic response to a meal containing different amounts of protein is not limited by the maximal stimulation of protein synthesis in healthy young adults. Am J Physiol Endocrinol Metab. 2016 Jan 1;310(1):E73-80.
10. Schoenfeld BJ, Aragon AA, Krieger JW. The Effect of Protein Timing on Muscle Strength and Hypertrophy: A Meta-Analysis. J Int Soc Sports Nutr. 2013 Dec 3;10(1):53.
11. Schoenfeld BJ, Aragon AA, Krieger JW. Effects of meal frequency on weight loss and body composition: a meta-analysis. Nutr Rev. 14 Jan 2015;73(2):69–82. Aragon AA, Schoenfeld BJ. Nutrient timing revisited: is there a post-exercise anabolic window? J Int Soc Sports Nutr. 2013 Jan 29;10(1):5.
12. Schoenfeld BJ, Aragon AA, Wilborn CD, Krieger JW. Body composition changes associated with fasted versus non-fasted aerobic exercise. J Int Soc Sports Nutr. 2014 Nov 18;11(1):54.
13. Arnal MA, et al. Protein feeding pattern does not affect protein retention in young women. J Nutr. 2000 Jul;130(7):1700-4.

References

14. Arnal MA, et al. Protein pulse feeding improves protein retention in elderly women. Am J Clin Nutr. 1999 Jun;69(6):1202-8.
15. Adechian S, et al. Protein feeding pattern, casein feeding, or milk-soluble protein feeding did not change the evolution of body composition during a short-term weight loss program. Am J Physiol Endocrinol Metab. 2012 Oct 15;303(8):E973-82.
16. Arciero PJ, et al. Increased protein intake and meal frequency reduces abdominal fat during energy balance and energy deficit. doi: 10.1002/oby.20296. Epub 2013 May 23.
17. Sensi S, Capani F. Chronobiological aspects of weight loss in obesity: effects of different meal timing regimens. Chronobiol Int. 1987;4(2):251-61.
18. Schlundt DG, Hill JO, Sbrocco T, Pope-Cordle J, Sharp T. The role of breakfast in the treatment of obesity: a randomized clinical trial. Am J Clin Nutr. 1992 Mar; 55(3):645-51.
19. Keim NL, Van Loan MD, Horn WF, Barbieri TF, Mayclin PL. Weight loss is greater with consumption of large morning meals and fat-free mass is preserved with large evening meals in women on a controlled weight reduction regimen. J Nutr. 1997 Jan;127(1):75-82.
20. Sofer S, Eliraz A, Kaplan S, Voet H, Fink G, Kima T, Madar Z. Greater weight loss and hormonal changes after 6 months diet with carbohydrates eaten mostly at dinner. Obesity (Silver Spring). 2011 Oct;19(10):2006-14.
21. Jakubowicz D, Froy O, Wainstein J, Boaz M. Meal timing and composition

References

22. Garaulet M, Gómez-Abellán P, Alburquerque-Béjar JJ, Lee YC, Ordovás JM, Scheer FA. Timing of food intake predicts weight loss effectiveness. Int J Obes (Lond). 2013 Apr;37(4):604-11.
23. Jakubowicz D, Barnea M, Wainstein J, Froy O. High caloric intake at breakfast vs. dinner differentially influences weight loss of overweight and obese women. Obesity (Silver Spring). 2013 Dec;21(12):2504-12.
24. Lombardo M, et al. Morning meal more efficient for fat loss in a 3-month lifestyle intervention. J Am Coll Nutr. 2014;33(3):198-205.
25. Moore DR, Robinson MJ, Fry JL, Tang JE, Glover EI, Wilkinson SB, Prior T, Tarnopolsky MA, Phillips SM. Ingested protein dose response of muscle and albumin protein synthesis after resistance exercise in young men. Am J Clin Nutr. 2009 Jan;89(1):161-8.
26. Yang Y, Breen L, Burd NA, Hector AJ, Churchward-Venne TA, Josse AR, Tarnopolsky MA, Phillips SM. Resistance exercise enhances myofibrillar protein synthesis with graded intakes of whey protein in older men. Br J Nutr. 2012 Nov 28;108(10):1780-8.
27. Pennings B, Groen B, de Lange A, et al. Amino acid absorption and subsequent muscle protein accretion following graded intakes of whey protein in elderly men. Am. J. Physiol. 2012; 302:E992–9.
28. Moore DR, Churchward-Venne TA, Witard O, Breen L, Burd NA, Tipton KD, Phillips SM. Protein Ingestion to Stimulate Myofibrillar Protein Synthesis Requires Greater Relative Protein Intakes in Healthy Older Versus Younger

References

29. Pencharz PB. Recent developments in understanding protein needs - How much and what kind should we eat? *Applied Physiology, Nutrition, and Metabolism*, Published on the web 16 March 2016, 10.1139/apnm-2015-0549
30. Phillips SM. A brief review of higher dietary protein diets in weight loss: a focus on athletes. Sports Med. 2014 Nov;44 Suppl 2:S149-53.
31. Helms ER, et al. A Systematic Review of Dietary Protein During Caloric Restriction in Resistance Trained Lean Athletes: A Case for Higher Intakes. Int J Sport Nutr Exerc Metab. 2013 Oct 2. [Epub ahead of print]
32. Churchward-Venne TA, Murphy CH, Longland TM, Phillips SM. Role of protein and amino acids in promoting lean mass accretion with resistance exercise and attenuating lean mass loss during energy deficit in humans. Amino Acids. 2013 Aug;45(2):231-40.
33. Phillips SM, Van Loon LJ. Dietary protein for athletes: from requirements to optimum adaptation. J Sports Sci. 2011;29 Suppl 1:S29-38.
34. Rodriguez NR, DiMarco NM, Langley S; American Dietetic Association; Dietitians of Canada; American College of Sports Medicine: Nutrition and Athletic Performance. Position of the American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and athletic performance. J Am Diet Assoc. 2009 Mar;109(3):509-27.
35. Campbell B, Kreider RB, Ziegenfuss T, La Bounty P, Roberts M, Burke D, Landis J, Lopez H, Antonio J. nal Society of Sports Nutrition position stand: protein and exercise. J Int Soc Sports Nutr. 2007 Sep 26;4:8.

References

36. Wilson J, Wilson GJ. Contemporary issues in protein requirements and consumption for resistance trained athletes. J Int Soc Sports Nutr. 2006 Jun 5;3:7-27.
37. Staples AW, et al. Carbohydrate does not augment exercise-induced protein accretion versus protein alone. Med Sci Sports Exerc. 2011 Jul;43(7): 1154-61.
38. Hamer HM, et al. Carbohydrate co-ingestion with protein does not further augment post-prandial muscle protein accretion in older men. Nutr Metab (Lond). 2013 Jan 25;10(1):15.
39. Koopman R, Beelen M, Stellingwerff T, Pennings B, Saris WH, Kies AK, Kuipers H, van Loon LJ. Coingestion of carbohydrate with protein does not further augment postexercise muscle protein synthesis. Am J Physiol Endocrinol Metab. 2007 Sep;293(3):E833-42.

The Influence of Nutrient Timing & Distribution on Body Composition

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Unbiased critical analysis of the latest research on nutrition, training, & supplementation.
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October 20 – 22, 2016