2020 LA '84 Foundation:
Presentation II

- **Endurance Athlete Nutrition:** ***An Evidence-Based Perspective On What We Know, What We Need To Know, And What We Can Apply To Student-Athlete Performance Enhancement***

2020 LA '84 Foundation: *Presentation II*

- Endurance Athlete Nutrition

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Presentation Overview

- Part I: Evidence-Based Inquiry
- Part II: Speaker Background
- Part III: What This Presentation Is Not
- Part IV: Dietary Carbohydrate Intake

Presentation Overview

- Part V: Dietary Protein Intake
- Part VI: Post-Training Macronutrient Intake & Adaptation
- Part VII: Post-Training Macronutrient Intake & Performance
- Part VIII: Post-Training Macronutrient Intake & Subsequent Training

Presentation Overview

- **Part IX: Protein Ingestion Prior To Sleep: Potential For Amplifying Post-Training Adaptation**

- **Part X: Novel Research Addressing Protein Requirements For Endurance Athletes**

- **Part XI: Carbohydrate Manipulation & Adaptation**

- **Part XII: (*Purportedly*) Ergogenic Nutritional Supplements: A Perspective**

Presentation Overview

- Part XIII: Acknowledgments
- Part XIV: Questions-&-Discussion

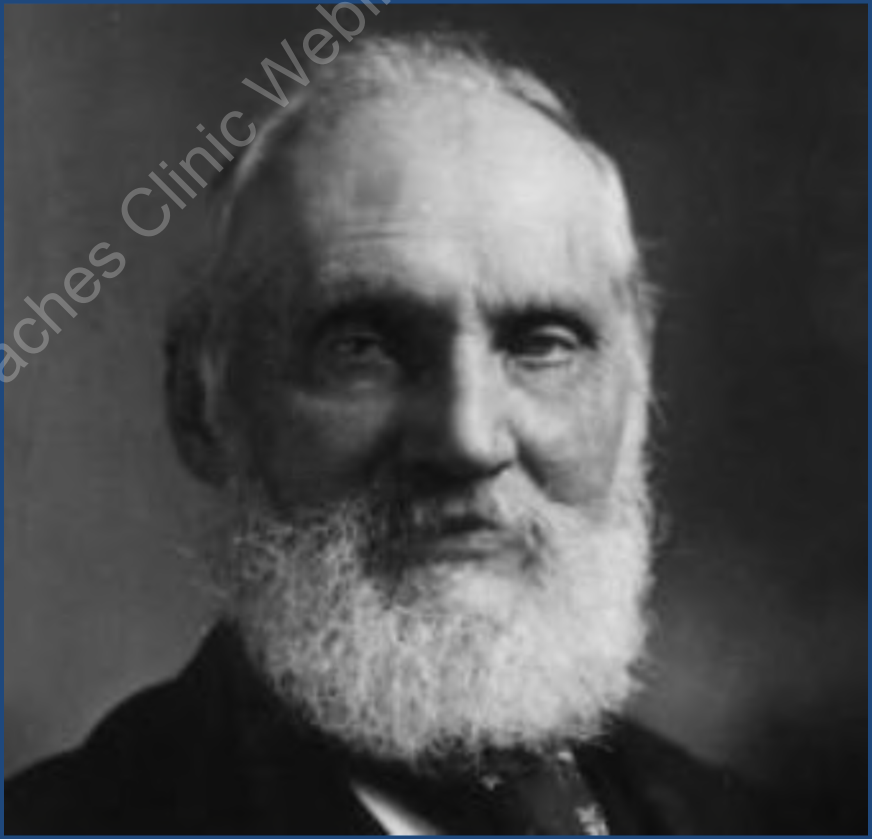
Part I

Evidence-Based Inquiry

Evidence-Based Inquiry

- "I often say that when you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind"

Lord Kelvin



Evidence-Based Inquiry

- "If I have seen further than others, it is by standing upon the shoulders of giants"

Isaac Newton

Evidence-Based Inquiry

Recognizing those contexts …

AND

more specific to our *coaching* interests …

Evidence-Based Inquiry

It is imperative to jog between repetitions rather than to walk between repetitions

REALLY?

Evidence-Based Inquiry

"Doing 200-meter repetitions subsequent to a tempo run is useless!"

REALLY?

Evidence-Based Inquiry

Recognizing those statements …

AND

more specific to our *current* interest …

Evidence-Based Inquiry

"Consumption of a pre-race BCAA-containing beverage enhances endurance performance"

REALLY?

Evidence-Based Inquiry

How do you and I (*attempt to*) accurately answer such questions in order to be more effective coaches and, more specifically, more effective teachers?

Evidence-Based Inquiry

Evidence-based inquiry is the practice of synergizing (*coaching*) experience with attention to and understanding of relevant, peer-reviewed, scientific data in order to inform decision-making and, ultimately, to enhance the quality of student-athlete-centered experiences (*Messer, 2020, personal observations*)

Part II

Speaker Background

Speaker Background

- **Education – Ph.D. in exercise physiology w/ concentration in exercise biochemistry (*Arizona State University, 2004*)**
  - **M.S. Exercise Science (*Arizona State University, 1995*)**
  - **M.B.A. (*Duke University, 1992*)**
  - **B.A. Economics (*Wesleyan University, 1984*)**

- **Experience – Darien High School (*2 Years*), Desert Vista High School (*2.5 Years*), Queen Creek High School (*1.5 Years*), Xavier College Preparatory (*6.5 Years*), & Desert Vista High School (*2013 / 2014 / 2015 / 2016 / 2017 / 2018 / 2019*)**

Speaker Background

- **Coaching Influences**
  - **Chris Hanson / Ellie Hardt / Dave Van Sickle**
  - ***Dan Beeks, Jeff Boele, Michael Bucci, Renato Canova, Robert Chapman, Steve Chavez, Liam Clemons, Jonathan Dalby, Bob Davis, Erin Dawson, Marty Dugard, Jason Dunn, John Hayes, Brad Hudson, Joan Hunter, Dan Iverson, Jay Johnson, Tana Jones, Whitney Lemieux, Arthur Lydiard, Steve Magness, Dean Oullette, Joe Newton, Dan Noble, Jim O' Brien, John O'Malley, Tim O'Rourke, Rene Paragas, Haley Paul, Louie Quintana, Ken Reeves Alberto Salazar, Jerry Schumacher, Tom Schwartz, Brian Shapiro, Scott Simmons, Mando Siquieros, Renee Smith-Williams, Doug Soles, Danna Swenson, Mindy Thatcher, Bill Vice, Joe Vigil, Mark Wetmore, & Chuck Woolridge***

Speaker Background

- Tara Erdmann, 2:14 / 4:54
- Kari Hardt, 2:11 / 10:26
- Baylee Jones 2:16 / 4:55 / 10:36
- Danielle Jones, 2:09 / 4:39 / 10:09
- Haley Paul, 2:13 / 4:51

- Desert Vista High School: 2016, 2014, & 2013 Arizona State High School Girls' Cross-Country Team Champions
- Xavier College Preparatory: 2012, 2011, 2010, 2009, 2008, and 2007 Arizona State High School Girls' Cross-Country Team Champions
- Two (*2*) Foot Locker National (*FLN*) Championship qualifiers

Speaker Background

- Sarah Penney, 2:11 / 10:39
- Mason Swenson, 2:16 / 4:59 / 10:56
- Jessica Tonn, 2:13 / 4:50 / 10:21
- Sherod Hardt, 4:10 / 8:59
- Garrett Kelly, 4:17 / 9:18
- 4 x 1,600-m Relay (20:14 / 20:52 / 21:37 XCP) & 4 x 800-meter Relay (8:57 XCP / 9:01 DVHS)

- Desert Vista High School: 2014 2015, 2016, 2017, & 2018 Arizona State High School Boys' Cross-Country Team Champions
- 2012 Mt. SAC Relays 4 x 1,600-m Event – 3 teams / 12 student-athletes averaged 5:13 per split
- Four (*4*) time NXN team participant across two schools (*XCP, DVHS*) and one (*1*) time NXN individual qualifier

Part III

What This Presentation Is Not

“What this presentation is *not*”

Xavier College Preparatory or Desert Vista High School Training Philosophies or Training Programs

https://www.highschoolrunningcoach.com/

Part IV

Dietary Carbohydrate Intake

Dietary Carbohydrate Intake

Position of the Academy of Nutrition and Dietetics, Dieticians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance, Journal of the Academy of Nutrition and Dietetics, 2016, 116: 501 – 528.

Dietary Carbohydrate Intake

Vitale, K. & Getzin, A., 2019, Nutrition and Supplement Update for the Endurance Athlete: Review and Recommendations, Nutrients, 11(6), E1289.

Dietary Carbohydrate Intake

Burke, L.B., Castell, L.M., Casa, D.J., Close, G.L., Costa, R.J.S., Desbrow, B., Halson, S.L., Lis, D.M., Melin, A.K., Peeling, P., Sanders, P.U., Slater, G.J., Sygo, J., Witard, O.C., Berman, S., & Stellingwerff, T., 2019, International Association of Athletics Federations Consensus Statement 2019: Nutrition for Athletics, International Journal of Sport Nutrition and Exercise Metabolism, 29, 73 – 84.

Dietary Carbohydrate Intake

- Definition of body mass (*kilograms {kg}*)
- Body Mass (*kg*) = Body Weight (*lbs*) / 2.205
- Example: *154.35 lb*. individual has a 70 kg. body mass

Dietary Carbohydrate Intake

- **Definition of body mass (*kilograms {kg}*)**

- **Body Mass (*kg*) = Body Weight (*lbs*) / 2.205**

- **Example: *110.25 lb.* individual has a 50 kg. body mass**

Dietary Carbohydrate Intake

- Moderate daily exercise (*~ one {1} hour / day*) requires carbohydrate intake of five (5) to seven (7) grams of CHO per kilogram body mass per day

- Example – 60 kg (*student*-)athlete

- 60 kg * 5 g CHO / kg BM = *300 grams CHO / day*

- 60 kg * 7 g CHO / kg BM = *420 grams CHO / day*

Dietary Carbohydrate Intake

- **Moderate to high-intensity daily exercise *(~ one {1} to three {3} hours / day*) requires carbohydrate intake of six (*6*) to ten (*10*) grams of CHO per kilogram body mass per day**

- **Example – 60 kg (*student*-)athlete**

- **60 kg * 6 g CHO / kg BM = *360 grams CHO / day***

- **60 kg * 10 g CHO / kg BM = *600 grams CHO / day***

Dietary Carbohydrate Intake

- Resource for Calculating Daily CHO Intake Goal:
- Desert Vista High School (*DVHS*) Macronutrient Intake & Hydration Program
- Example:
- Bryce Schmisseur (*2017 NXN student-athlete*)

Dietary Carbohydrate Intake

Desert Vista High School

Energy Balance Estimation (Boy's Cross-Country)

Fall 2017

Individualized Macronutrient Intake & Hydration Program

First Name	Last Name	Estimated Daily Energy Expenditure (dietary calories)	Daily H_2O Consumption (ounces)	Post-Training CHO Intake (dietary calories)	Post-Training CHO Intake (grams)	Post-Training PRO Intake (dietary calories)	Post-Training PRO Intake (grams)
Bryce	Schmisseur	3,323	141	269	71	71	18
		Total Daily CHO Intake (dietary calories)	Total Daily CHO Intake (grams)	Total Daily PRO Intake (dietary calories)	Total Daily PRO Intake (grams)	Total Daily FAT Intake (dietary calories)	Total Daily FAT Intake (grams)
		2,128	560	424	106	771	83
		64%		13%		23%	

Dietary Carbohydrate Intake

- Resource for Determining Specific Food & Beverage Choices:
- Desert Vista High School (*DVHS*) Endurance Performance Nutrition Resource
- General Principles of Sport Nutrition
- Sample Foods / Beverages – Breakfast
- Sample Foods / Beverages – Lunch
- Sample Foods / Beverages - Dinner

Dietary Carbohydrate Intake

- 90 lb. (*40.8 kg*) student-athlete: 245 grams of carbohydrate intake per day
- 105 lb. (*47.6 kg*) student-athlete: 286 grams of carbohydrate intake per day
- 120 lb. (*54.4 kg*) student-athlete: 327 grams of carbohydrate intake per day

Dietary Carbohydrate Intake

- 135 lb. (*61.2 kg*) student-athlete: 367 grams of carbohydrate intake per day

- 150 lb. (*68.0 kg*) student-athlete: 408 grams of carbohydrate intake per day

Dietary Carbohydrate Intake

- Daily Carbohydrate Intake Strategy for a 120 lb. student-athlete
- Three-hundred-and-twenty-seven (*327*) grams of carbohydrate per day

- Breakfast – 1.4 grams / carbohydrate / kg body mass
- Lunch – 1.4 grams / carbohydrate / kg body mass
- Post-practice Snack –1.2 grams / carbohydrate / kg body mass
- Dinner –1.4 grams / carbohydrate / kg body mass
- Pre-Sleep – 0.6 grams / carbohydrate / kg body mass

Dietary Carbohydrate Intake

- Daily Carbohydrate Intake Strategy for a 120 lb. student-athlete
- Three-hundred-and-twenty-seven (*327*) grams of carbohydrate per day

- Breakfast – 76 grams of carbohydrate
- Lunch – 76 grams of carbohydrate
- Post-practice Snack – 65 grams of carbohydrate
- Dinner – 76 grams of carbohydrate
- Pre-Sleep – 34 grams of carbohydrate

Dietary Carbohydrate Intake

- Interim Presentation Summary
- Carbohydrate Intake Concepts

- We CAN be quantitative with respect to daily macronutrient (*i.e. carbohydrate*) intake
- Emphasize overall daily carbohydrate intake
- Distribution of daily carbohydrate intake is a potential secondary focus

Part V

Dietary Protein Intake

Dietary Protein Intake

Position of the Academy of Nutrition and Dietetics, Dieticians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance, Journal of the Academy of Nutrition and Dietetics, 2016, 116: 501 – 528.

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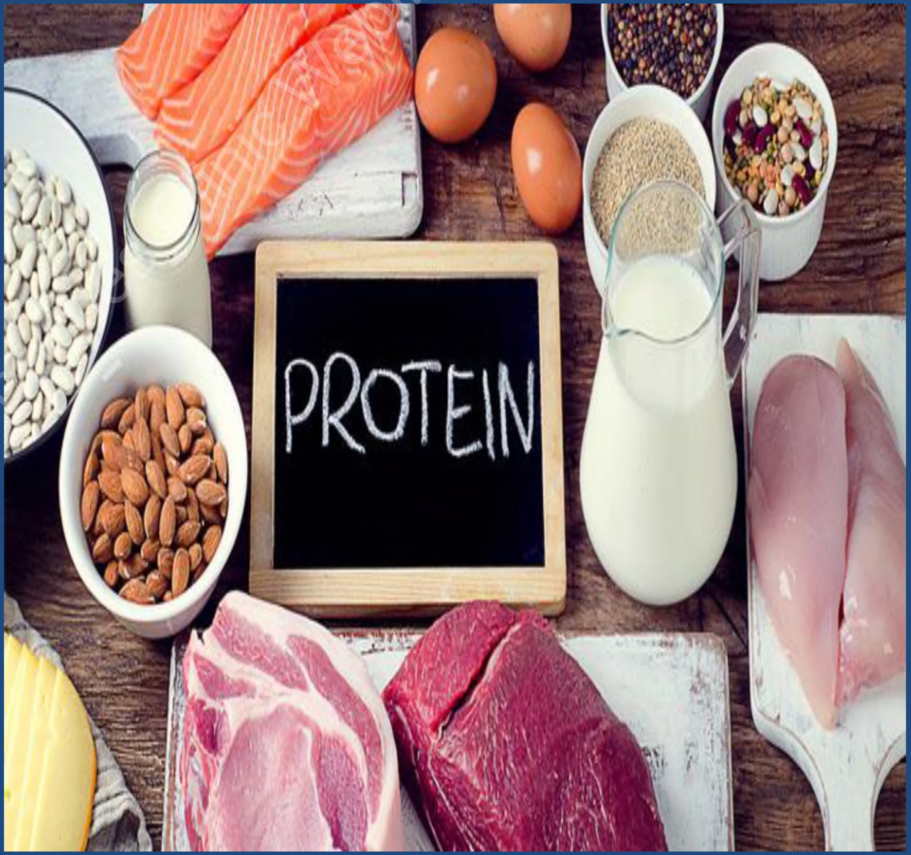
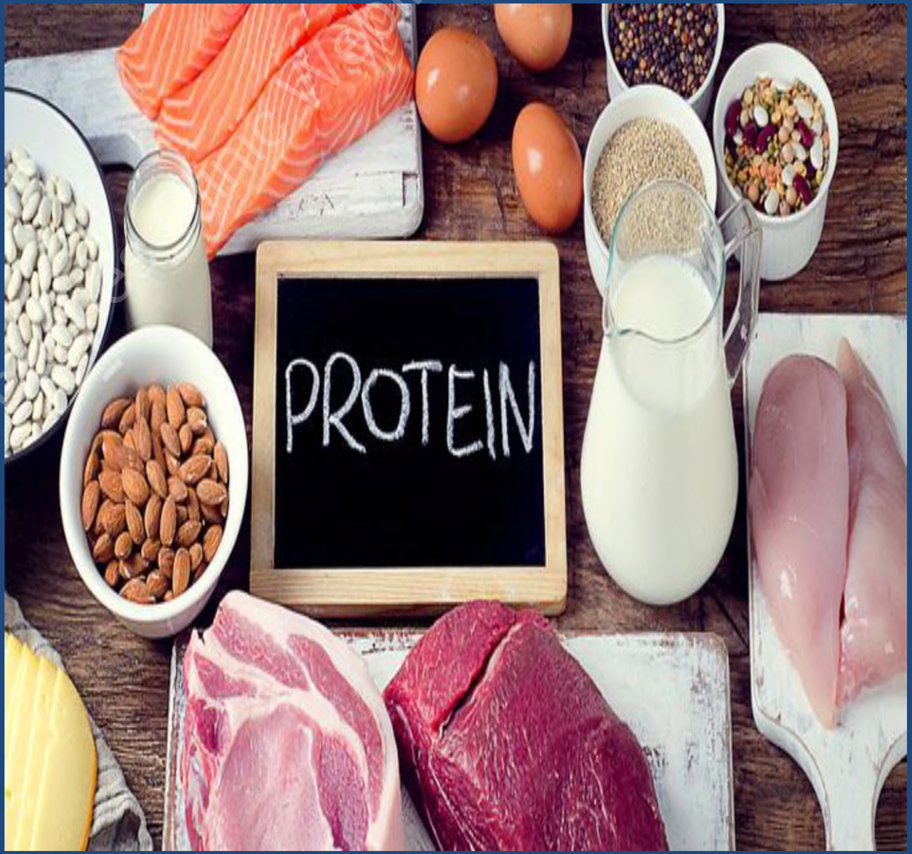
Dietary Protein Intake

- **Definition of body mass (*kilograms {kg}*)**
- **Body Mass (*kg*) = Body Weight (*lbs*) / 2.205**
- **Example: *154.35 lb.* individual has a 70 kg. body mass**



Dietary Protein Intake

- **Definition of body mass (*kilograms {kg}*)**
- **Body Mass (*kg*) = Body Weight (*lbs*) / 2.205**
- **Example: *110.25 lb.* individual has a 50 kg. body mass**



Dietary Protein Intake

- **Moderate daily exercise *(~ one {1} hour / day)* requires protein intake of 1.40 grams of PRO per kilogram body mass per day**

- **Examples – 50 and 70 kg (*student*-)athletes**

- **50 kg * 1.4 g PRO / kg BM = *70 grams PRO / day***

- **70 kg * 1.4 g PRO / kg BM = *98 grams PRO / day***

Dietary Protein Intake

- **Daily endurance exercise *(~ one {1} hour / day)* may require protein intake of 1.80 grams of PRO per kilogram body mass per day**

- **Examples – 50 and 70 kg (*student-*)athletes**

- **50 kg * 1.8 g PRO / kg BM = *90 grams PRO / day***

- **70 kg * 1.8 g PRO / kg BM = *126 grams PRO / day***

Dietary Protein Intake

- 90 lb. (*40.8 kg*) student-athlete: 74 grams of protein intake per day
- 105 lb. (*47.6 kg*) student-athlete: 86 grams of protein intake per day
- 120 lb. (*54.4 kg*) student-athlete: 98 grams of protein intake per day

Dietary Protein Intake

- 135 lb. (*61.2 kg*) student-athlete: 110 grams of protein intake per day

- 150 lb. (*68.0 kg*) student-athlete: 122 grams of protein intake per day

Dietary Protein Intake

- Daily Protein Intake Strategy for a 120 lb. student-athlete
- Ninety-eight (*98*) grams of protein per day

- Breakfast – 0.4 grams / protein / kg body mass
- Lunch – 0.4 grams / protein / kg body mass
- Post-practice Snack – 0.3 grams / protein / kg body mass
- Dinner – 0.4 grams / protein / kg body mass
- Pre-Sleep – 0.3 grams / protein / kg body mass

Dietary Protein Intake

- Daily Protein Intake Strategy for a 120 lb. student-athlete

- Ninety-eight (*98*) grams of protein per day

- Breakfast – 22 grams of protein
- Lunch – 22 grams of protein
- Post-practice Snack – 16 grams of protein
- Dinner – 22 grams of protein
- Pre-Sleep – 16 grams of protein

Dietary Protein Intake

- Interim Presentation Summary
- Protein Intake Concepts

- We CAN be quantitative with respect to daily macronutrient (*i.e. protein*) intake
- Emphasize overall daily protein intake
- Distribution of daily protein intake is a potential secondary focus

Part VI

Post-Training Macronutrient Intake & Adaptation

Post-Training Macronutrient Intake

- **Ferguson-Stegall, L., McCleave, E., Zhenping, D., Doerner III, P.G., Liu, Y., Wang, B., Healy, M., Kleinert, M., Dessard, B., Lassiter, D.G., Kammer, L., & Ivy, J.I. (*2011*). Aerobic Exercise Training Adaptations Are Increased By Postexercise Carbohydrate-Protein Supplementation, Journal of Nutrition and Metabolism, 2011, 1 – 11.**

Post-Training Macronutrient Intake

- Lunn, W.R., Pasiakos, S.M., Colletto, M.R., Karfonta, K.E., Carbone, J.W., Anderson, J.M., & Rodriguez, N.R. (*2012*). Chocolate Milk And Endurance Exercise Recovery: Protein Balance, Glycogen, And Performance, Medicine & Science in Sports & Exercise, 44(*4*), 682 – 691.

Ferguson-Stegall et al. (*2011*)

- **Purpose: To investigate training adaptations subsequent to a 4.5-week aerobic endurance training program when daily, post-training nutrient provision was provided in the form of a carbohydrate-protein containing supplement, an isoenergetic carbohydrate containing supplement, or a placebo**
  - **0.94 g CHO / kg BM plus 0.31 g PRO / kg BM immediately and 1-hour post-training (*Chocolate Milk Supplement*)**
  - **1.25 g CHO / kg BM plus 0.17 g FAT / kg BM immediately and 1-hour post-training (*Carbohydrate Supplement*)**
  - **0.00 g CHO / kg BM plus 0.00 g PRO / kg BM immediately and 1-hour post-training (*Placebo*)**

Ferguson-Stegall et al. (*2011*)

- **Experimental design**
  - Randomized, double-blinded, placebo-controlled design
  - Thirty-two (*32*) healthy, recreationally-active females and males
  - VO_2-max *35.9* $\pm$ 1.9 ml O_2 * kg^{-1} * min^{-1}
  - Macronutrient intake subsequent to five (5) weekly 60-minute bouts of cycle endurance exercise @ 60% (*for the initial 10-minutes*) and 75% (*for the final 50-minutes*) of VO_2-max

Ferguson-Stegall et al. (*2011*)

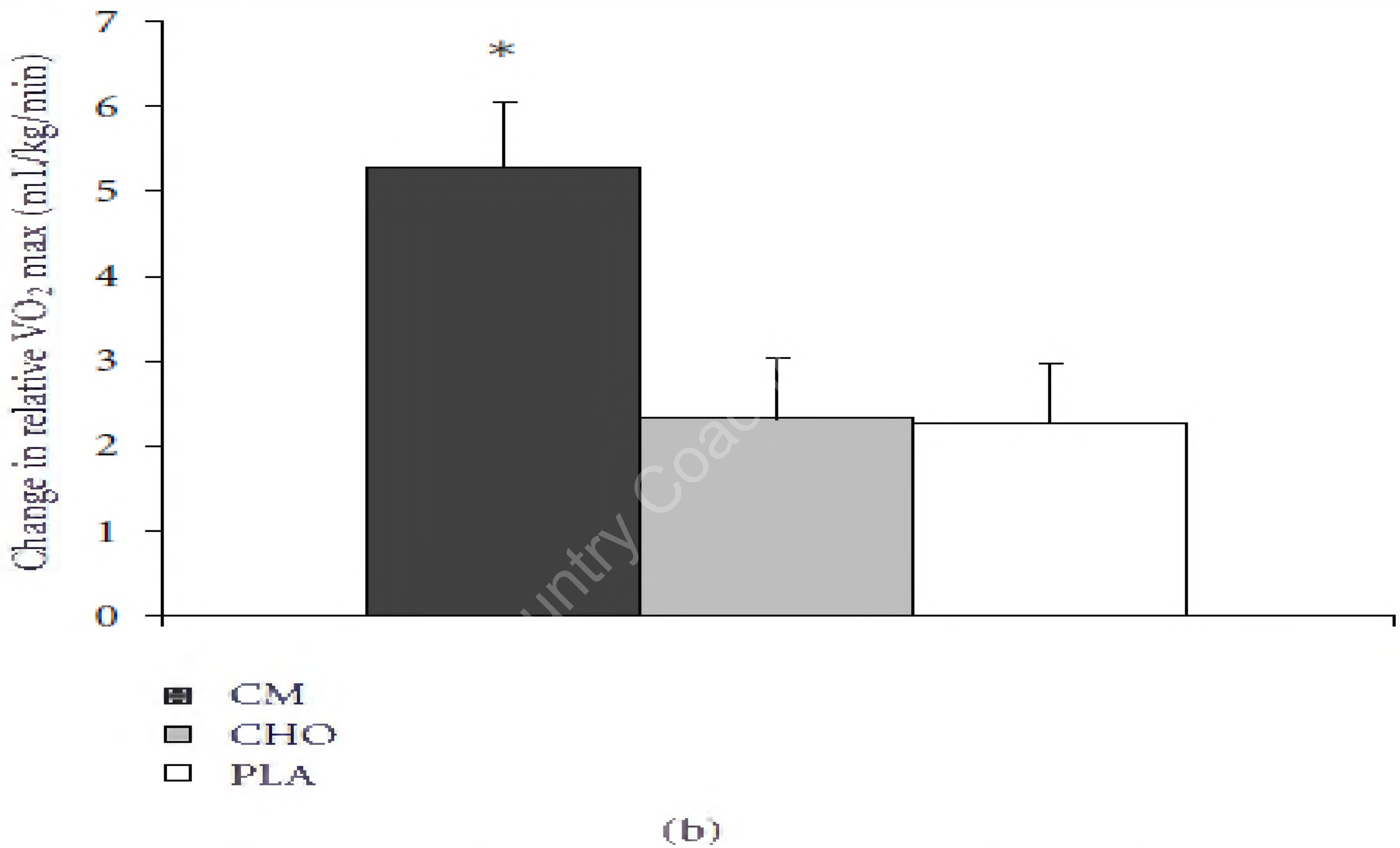
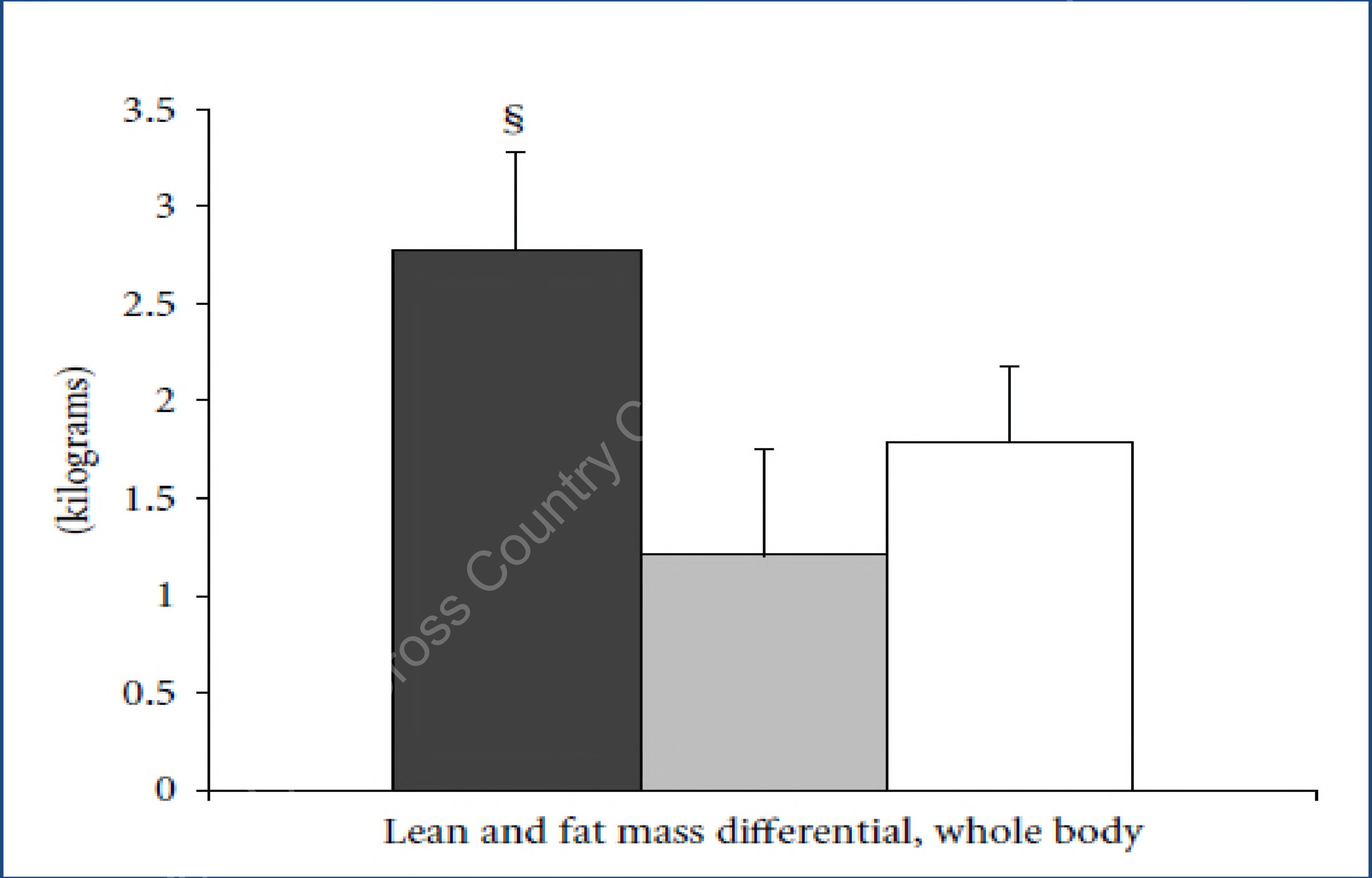


FIGURE 1: VO_2 max changes after 4.5 wks of aerobic endurance training. (a) Change from baseline in absolute VO_2 max. (b) Change from baseline in relative VO_2 max. Values are mean ± SE. Significant treatment differences: *, CM versus PLA and CHO ($P < .05$).

Ferguson-Stegall et al. (*2011*)



Ferguson-Stegall et al. (*2011*)

- Data Interpretation
  - Consumption of a daily, post-training chocolate milk supplement relative to either a carbohydrate-only supplement or a placebo is associated with an approximate two-fold (*2-fold*) greater (*i.e. 100%*) percentage increase in relative VO_2-max
  - Body composition improvements, quantified by a lean and fat mass differential, were significantly greater in the chocolate milk supplement group relative to the carbohydrate supplement group

Ferguson-Stegall et al. (*2011*)

- **Practical Application**
  - **Consume an individualized, mass-specific combination of carbohydrate and protein in the immediate post-training period including approximately 1.20 grams of carbohydrate per kilogram body mass and approximately 0.30 grams of protein per kilogram body mass**

Ferguson-Stegall et al. (*2011*)

Body Weight (lbs.)	Body Mass (kilograms)	Post-Training CHO Intake (grams)	Post-Training CHO Intake (calories)	Post-Training PRO Intake (grams)	Post-Training PRO Intake (calories)	Post-Training Caloric Intake (calories)	Post-Training Chocolate Milk (ounces)
96	43.5	52	199	13	52	251	13.2
98	44.4	53	203	13	53	256	13.5
100	45.4	54	207	14	54	261	13.7
105	47.6	57	217	14	57	274	14.4
107	48.5	58	221	15	58	280	14.7
108	49.0	59	223	15	59	282	14.8
110	49.9	60	227	15	60	287	15.1
112	50.8	61	232	15	61	293	15.4
115	52.2	63	238	16	63	300	15.8
117	53.1	64	242	16	64	306	16.1
120	54.4	65	248	16	65	313	16.5
122	55.3	66	252	17	66	319	16.8
125	56.7	68	259	17	68	327	17.2
126	57.1	69	261	17	69	329	17.3
130	59.0	71	269	18	71	340	17.9
132	59.9	72	273	18	72	345	18.1
134	60.8	73	277	18	73	350	18.4
135	61.2	73	279	18	73	353	18.6
136	61.7	74	281	19	74	355	18.7
138	62.6	75	285	19	75	360	19.0
139	63.0	76	287	19	76	363	19.1
140	63.5	76	290	19	76	366	19.2
142	64.4	77	294	19	77	371	19.5
145	65.8	79	300	20	79	379	19.9
146	66.2	79	302	20	79	381	20.1
150	68.0	82	310	20	82	392	20.6

Part VII

Post-Training Macronutrient Intake & Performance

Chocolate Milk & Recovery

- **Amiri, M., Ghiasvand, R., Kaviani, M., Forbes, S., & Salehi-Abargouei, A. (*2018*). Chocolate Milk for Recovery from Exercise: A Systematic Review and Meta-Analysis of Controlled Clinical Trials, European Journal of Clinical Nutrition.**

Amiri et al. (*2018*)

- Recognition that no prior assessment of the potential efficacy of chocolate milk as a recovery agent and / or ergogenic aid has been undertaken and published

Systematic literature review

Amiri et al. (*2018*)

- PubMed
- SCOPUS
- Google Scholar

- Studies reflecting a controlled experimental design involving trained athletes or participants
- Studies that evaluated the effect of post-exercise chocolate milk consumption on subsequent exercise performance or recovery
- Peer-reviewed publications
- Study quality formally assessed utilizing Cochrane's Collaboration tool for assessment of risk bias

Amiri et al. (*2018*)

- Identification of 1,574 research items for screening
- 23 studies were subsequently selected for full text screening
- Ultimately, twelve (*12*) clinical trials were included in the meta-analysis

Amiri et al. (*2018*)

- Six (*6*) studies with fifty-seven (*57*) participants assessed the potential effects of post-training chocolate milk (*CM*) consumption on subsequent time-trial-to-exhaustion (*TTE*) performance

Amiri et al. (*2018*)

- **A five-study sub-group analysis indicated a statistically significant effect of post-training CM consumption on TTE performance**
- **Approximate effect of 0.80 minutes (*i.e. 48-seconds*) on TTE performance**

Amiri et al. (*2018*)

- The aforementioned statistically significant effect on TTE performance reflects the comparison of CM to both placebo and to carbohydrate (*CHO*) + protein (*PRO*) + fat (*FAT*) beverages

Amiri et al. (*2018*)

- **Meta-analytic results emphasize certain experimental limitations**

  - **Study quality**

  - **Differential measurement of time trial performance**

Amiri et al. (*2018*)

- **Practical Application**
  - **Consume an individualized, mass-specific combination of carbohydrate and protein in the immediate post-training period including approximately 1.20 grams of carbohydrate per kilogram body mass and approximately 0.30 grams of protein per kilogram body mass**
    - ***Body Mass (kg) = Body Weight (lbs.) / 2.205***

Part VIII

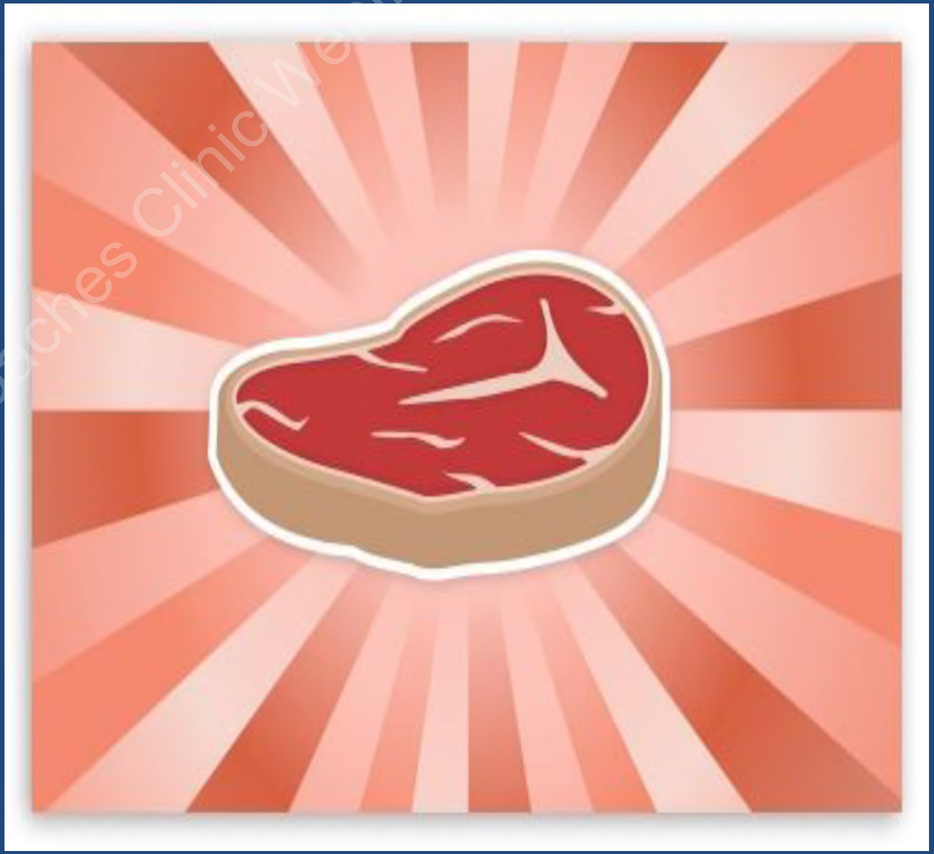
Post-Training Macronutrient Intake & Subsequent Training

Early-Recovery Protein Intake

- **Sollie, O., Jeppesen, P.B., Tangen, D.S., Jerneren, F., Nellemann, B., Valsdottir, D., Madsen, K., Turner, C., Refsum, H., Skalhegg, B.S., Ivy, J.L., & Jensen, J. (*2018*). Protein Intake in the Early Recovery Period after Exhaustive Exercise Improves Performance the Following Day, Journal of Applied Physiology, 125, 1731 – 1742.**

Early-Recovery Protein Intake

- Simultaneous intake of protein (*PRO*) and carbohydrate (*CHO*) post-training / post-exercise has been reported to be superior to CHO-only with respect to skeletal muscle 1) glycogen restoration & 2) protein synthesis

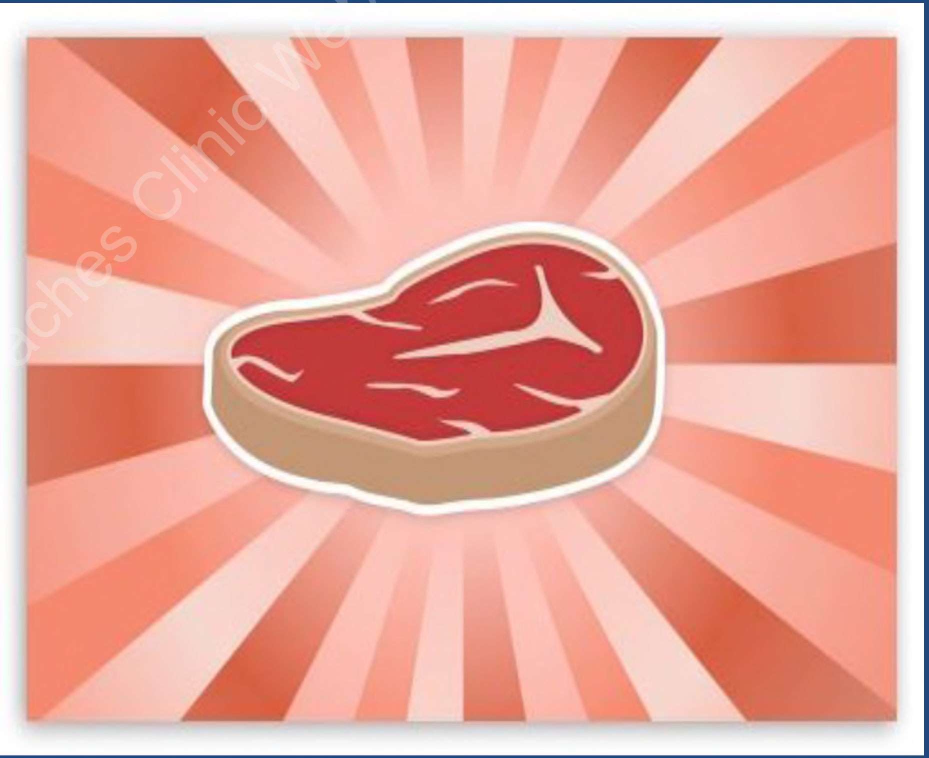


Early-Recovery Protein Intake

- Simultaneous intake of protein (*PRO*) and carbohydrate (*CHO*) post-training / post-exercise has been reported to be superior to CHO-only with respect to subsequent exercise performance

Early-Recovery Protein Intake

- However, the prior experimental finding with respect to subsequent exercise performance has not been unequivocal



Sollie et al. (*2018*)

- **Purpose:** **To evaluate the effect of PRO / CHO co-ingestion on both sprint and time trial (*TT*) performance eighteen (*18*) hours subsequent to an exhaustive training session**
  - **1.20 g CHO / kg BM immediately post- (*exhaustive*) training session (*CHO Supplement*)**
  - **0.80 g CHO / kg BM plus 0.40 g PRO / kg BM immediately post- (*exhaustive*) training session (*CHO + PRO Supplement*)**

Sollie et al. (*2018*)

- **Experimental design**
  - Randomized, double-blinded, balanced, crossover design
  - Eight (*8*) male elite endurance cyclists
  - VO_2-max *74.0* ± 1.6 ml O_2 * kg^{-1} * min^{-1}
  - Two (2) experimental interventions separated by at least six (6) days and consisting of two (2) consecutive days of testing and dietary control

Sollie et al. (*2018*)

- **Notable Data**
  - **Time trial completion was 41-minutes, 53-second in the CHO + PRO trial; time trial completion was 45-minutes, 26-seconds in the CHO trial**
  - **The percentage (%) differential in time trial performance was 8.5%**

Sollie et al. (*2018*)

- **Notable Data**
  - **Ten-second, post-time trial maximal sprint performance was 1,063 ± 54 Watts (*mean power output*) in the CHO + PRO trial; ten-second, post-time trial maximal sprint performance was 1,026 ± 53 Watts in the CHO trial**
  - **The percentage (*%*) differential in 10-second, post-time trial maximal sprint mean power output was 3.7%**

Sollie et al. (*2018*)

- Practical Application
  - Consume an individualized, mass-specific combination of carbohydrate and protein in the immediate post-training period including approximately 1.20 grams of carbohydrate per kilogram body mass and approximately 0.30 to 0.40 grams of protein per kilogram body mass

Part IX

Protein Ingestion Prior to Sleep: Potential for Amplifying Post-Training Adaptation

Protein Ingestion Prior to Sleep

- Protein Ingestion Prior to Sleep: Potential for Optimizing Post-Exercise Recovery, 2013, GSSI Sports Science Exchange, Volume 26, Number 117, 1 – 5.

Protein Ingestion Prior to Sleep

- **In addition to the amount and source(*s*) of protein ingested subsequent to an acute bout of training, associated timing of protein ingestion has been identified and accepted as a key factor in modulating post-exercise muscle anabolism (*Beelen, Burke, Gibala, & van Loon, 2011*)**

Protein Ingestion Prior to Sleep

- **While** immediate post-training protein ingestion **does support enhanced muscle protein synthesis in the acute stages / period of post-training recovery, such a strategy** does not support a sustained increase in muscle protein synthetic rate during subsequent overnight recovery (*Beelen, Tieland, Gijsen, Vandereyt, Kies, Kuipers, Saris, Koopman, & van Loon, 2008*)

Protein Ingestion Prior to Sleep

- Res, P.T., Groen, B., Pennings, B., Beelen, M., Wallis, G.A., Gijsen, A.P., Senden, J.M., & van Loon, L.J. (*2012*). Protein Ingestion prior to Sleep Improves Post-Exercise Overnight Recovery, Medicine and Science in Sports and Exercise, 44: 1560 – 1569.

- Recreational athletes
- Single bout of evening resistance exercise
- All participants were provided standardized post-exercise recovery nutrition
- 30-minutes prior to sleep, participants ingested either a placebo or 40 grams of casein protein

Protein Ingestion Prior to Sleep

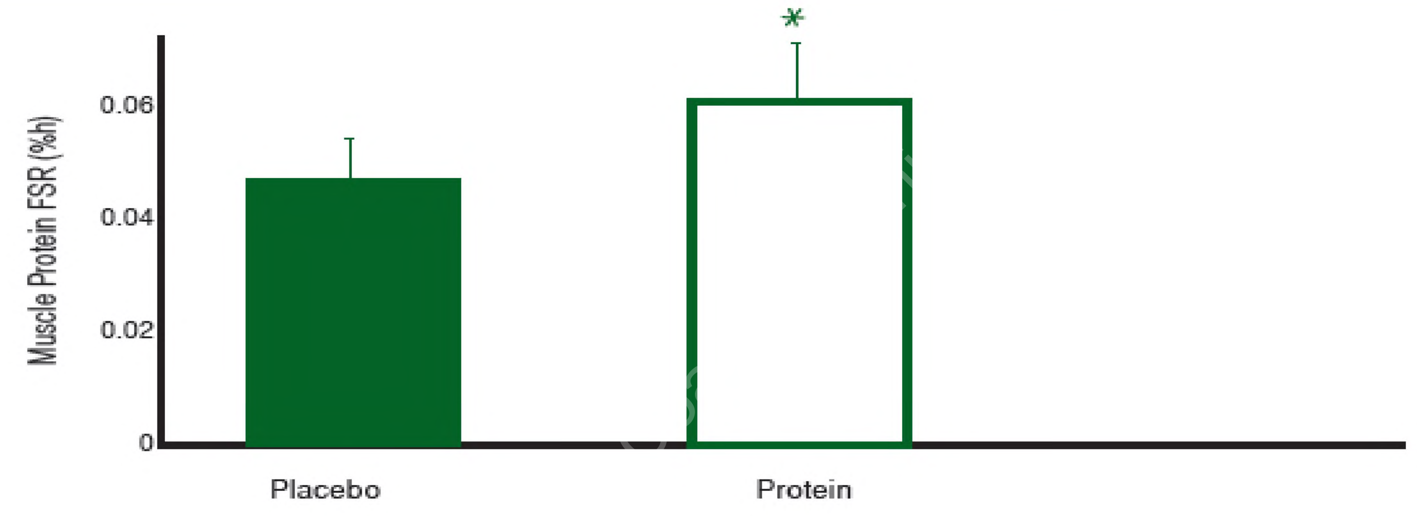


Figure 3. Dietary protein ingestion prior to sleep stimulates muscle protein synthesis during overnight recovery. Fractional synthesis rate (FSR) of mixed muscle protein during overnight recovery from a single bout of resistance type exercise. In the protein trial, 40 g of casein protein were ingested prior to sleep. Values represent means ± SEM. *Significantly different from placebo (P=0.05). Figure redrawn from Res et al. (2012) Med. Sci. Sports Exerc. 44:1560-1569, American College of Sports Medicine.

Protein Ingestion Prior to Sleep

Nutritional Recommendations for the Athlete

Provide sufficient protein (20-25 g) with each main meal

Consider coingesting some protein with carbohydrate during exercise (to optimize protein synthesis. However, protein has also been linked with slowing of delivery of carbohydrate and fluid as well as GI distress, and thus individuals need to determine their own strategy)

Ingest 20-25 g of protein immediately after exercise

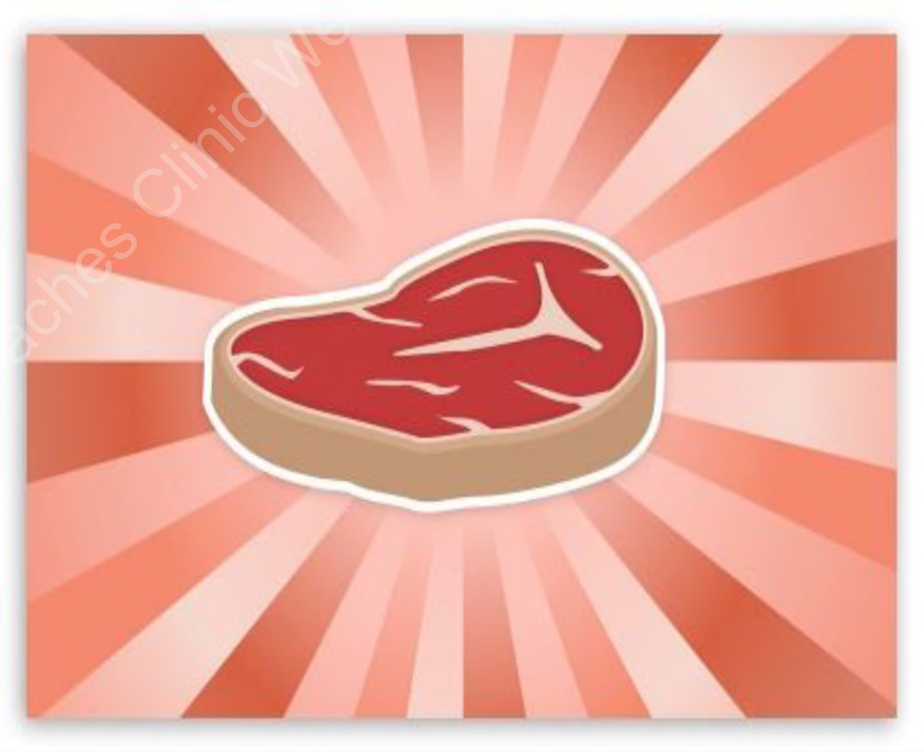
Consume 20-40 g of protein prior to sleep

Part X

Novel Research Addressing Protein Requirements for Endurance Athletes

Protein Requirements in Endurance Athletes

- **Kato, H., Suzuki, K., Bannal, M., & Moore, D. (*2016*). Protein Requirements Are Elevated after Exercise as Determined by the Indicator Amino Acid Oxidation Method, PLoS One, 11(*6*), 1-15.**



Protein Requirements in Endurance Athletes

Objective: To quantify the recommended protein intake in endurance athletes during an acute, three-day training period using the indicator amino acid oxidation (*IAAO*) method

Protein Requirements in Endurance Athletes

- Six male, endurance-trained adults
- Mean VO_2-peak = 60.3 $\pm$ 6.7 ml $*kg^{-1} * min^{-1}$
- Acute training session (*20-km treadmill run*)
- Post-training consumption of variable protein mass

- Utilize labeled phenylalanine method in order to quantify both estimated average protein requirement and recommended protein intake

Protein Requirements in Endurance Athletes

- Current Recommended Dietary Allowance (*RDA*) is 0.8 grams PRO * kg^{-1} body mass * day^{-1}
- Current recommendations for endurance athletes are 1.2 – 1.4 grams PRO * kg^{-1} body mass * day^{-1}

Protein Requirements in Endurance Athletes

- Experimental results yield an estimated, average, post-training protein requirement of 1.65 grams PRO * kg^{-1} body mass * day^{-1}
- Experimental results yield an estimated, average, post-training recommended protein intake of 1.83 grams PRO * kg^{-1} body mass * day^{-1}

Protein Requirements in Endurance Athletes

Potential Interpretation: The metabolic demand for protein intake (*1.83 grams PRO * kg^{-1} body mass * day^{-1}*) in trained endurance athletes engaged in high-volume and / or high-intensity training is not only greater than their sedentary counterparts but also greater than current recommendations for endurance athletes (*1.2 – 1.4 grams PRO * kg^{-1} body mass * day^{-1}*)

Protein Requirements in Endurance Athletes

- **Moderate daily exercise *(~ one {1} hour / day*) requires protein intake of 1.60 to 1.80 grams of PRO per kilogram body mass per day**

- **Examples – 50 and 70 kg (*student*-)athletes**

- **60 kg * 1.60 g PRO / kg BM = *96 grams PRO / day***

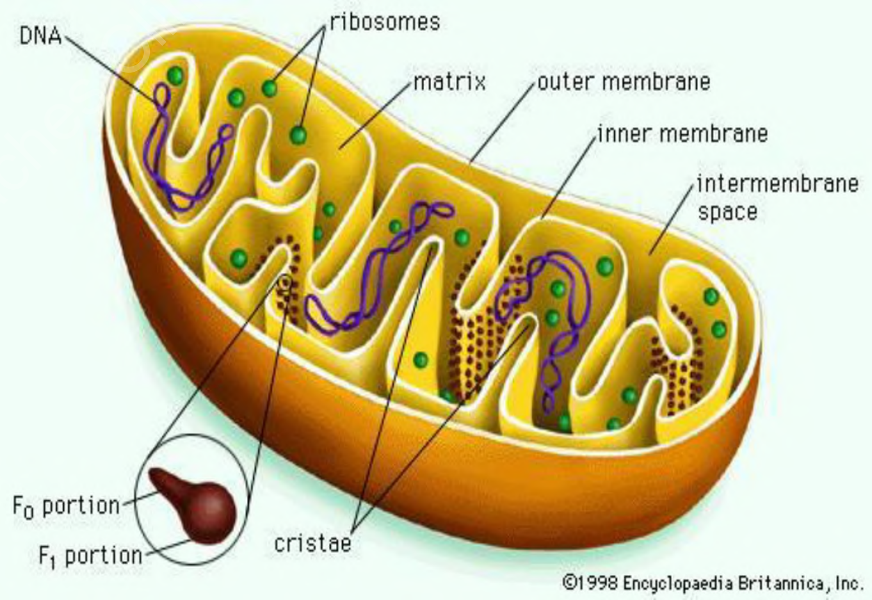
- **60 kg * 1.80 g PRO / kg BM = *108 grams PRO / day***

Part XI

Carbohydrate (*CHO*) Manipulation & Adaptation

Carbohydrate Manipulation & Adaptation

- Hawley, J.A. & Morton, J.P. (*2013*). Ramping up the Signal: Promoting Endurance Training Adaptation in Skeletal Muscle by Nutritional Manipulation, Proceedings of the Australian Physiological Society, 44, 109-115.



Carbohydrate Manipulation & Adaptation

- *"You need to teach your body to operate with low glucose stores because that's what you'll be facing in the later miles of a marathon."*

- *"By not taking in carbs or energy gels during the run, you're giving your body no choice but to go to fat-burning. You will feel fatigued near the end, but that's necessary if you want to get stronger."*

Carbohydrate Manipulation & Adaptation

- The essential premise is that the combination of 1) contractile activity (*i.e. training*) and 2) intentionally compromised muscle glycogen availability combine to amplify the training-induced up-regulation of multiple proteins that underlie mitochondrial biogenesis

Carbohydrate Manipulation & Adaptation

- Prior slide … stated more succinctly …
- Training with diminished carbohydrate availability allows for enhanced skeletal muscle mitochondrial content and, ultimately, greater aerobic capacity

Carbohydrate Manipulation & Adaptation

Has such a hypothesis been strongly, experimentally supported?

NO

Carbohydrate Manipulation & Adaptation

- What does existing scientific literature reveal?
  - Multiple protein precursors (*specifically, mRNA's*) associated with mitochondrial biogenesis can indeed be further up-regulated through the juxtapositioning of compromised carbohydrate status with, for example, endurance training

Carbohydrate Manipulation & Adaptation

- The mRNA → protein synthesis relationship has yet to be compellingly demonstrated
  - Increased mRNA content is necessary albeit not necessarily sufficient for increased protein expression

- Enhanced endurance performance has yet to be quantified

Carbohydrate Manipulation & Adaptation

- <u>Potential</u> application for high school endurance (*student-*)athletes
  - Undertake and complete periodic, two-a-day training sessions with the second session performed with compromised carbohydrate status

Part XII

(*Purportedly*) Ergogenic Nutritional Supplements: A Perspective

Ergogenic Nutritional Supplements: A Perspective

Vitale, K. & Getzin, A., 2019, Nutrition and Supplement Update for the Endurance Athlete: Review and Recommendations, Nutrients, 11(*6*), E1289.

Ergogenic Nutritional Supplements: A Perspective

Burke, L.M., Jeukendrup, A.E., Jones, A.M., & Mooses, M., 2019, Contemporary Nutrition Strategies to Optimize Performance in Distance Runners and Race Walkers, International Journal of Sport Nutrition and Exercise Metabolism, 29, 117 - 129.

Ergogenic Nutritional Supplements: A Perspective

Peeling, P., Castell, L.M., Derave, W., de Hon, O., & Burke, L.M., 2019, Sports Foods and Dietary Supplements for Optimal Function and Performance Enhancement in Track-&-Field Athletes, International Journal of Sport Nutrition and Exercise Metabolism, 29, 198 - 209.

Ergogenic Nutritional Supplements: A Perspective

- (*__AT__* *__LEAST__*) **three fundamental questions …**

- **Are such supplements *safe*?**

- ***Are we (philosophically and / or practically) comfortable* advocating for supplement use among high school student-athletes?**

- **Is there robust, unequivocal *evidence* for efficacy?**

Ergogenic Nutritional Supplements: A Perspective

- (*AT LEAST*) **three questions …**

- **Assume (*hypothetically*) that one could explore and subsequently validate SAFETY**

Ergogenic Nutritional Supplements: A Perspective

- (*__AT LEAST__*) three questions …

- Assume (*hypothetically*) both a philosophical and practical comfort

Ergogenic Nutritional Supplements: A Perspective

What is the quality of supportive evidence for an ergogenic benefit from a specific nutritional supplement?

Ergogenic Nutritional Supplements: A Perspective

- **Four (*4*) classes / compounds for which there is tenable evidence of a performance increment:**
  - **Creatine monohydrate**
  - **Caffeine**
  - **Nitrates (*beetroot juice*)**
  - **Buffering agents (*B-alanine & bicarbonate*)**

Ergogenic Nutritional Supplements: A Perspective

- **Four (*4*) classes / compounds for which there is tenable evidence of a performance increment:**
  - **Creatine monohydrate**
    - **Evidence for enhanced ENDURANCE performance?**
    - **What would be the corresponding physiological mechanism?**

Ergogenic Nutritional Supplements: A Perspective

- Four (*4*) classes / compounds for which there is tenable evidence of a performance increment:
  - Caffeine
    - Peer-reviewed, data-based evidence is EQUIVOCAL
    - What would be the physiological mechanism?

Ergogenic Nutritional Supplements: A Perspective

- **Four (*4*) classes / compounds for which there is tenable evidence of a performance increment:**
  - **Nitrates (*beetroot juice*)**
    - **Multiple physiological mechanisms can be articulated**
    - **Nevertheless, existing peer-reviewed, data-based evidence is EQUIVOCAL**

Ergogenic Nutritional Supplements: A Perspective

- **Four (*4*) classes / compounds for which there is tenable evidence of a performance increment:**
  - **Buffering Agents (*B-alanine & bicarbonate*)**
    - **A well-recognized physiological mechanism exists**
    - **Multiple, practical challenges to utilizing a buffering agent may exist (*gastrointestinal distress, parathesia*)**

Ergogenic Nutritional Supplements: A Perspective

- **Summary perspective:**
  - **Even (*hypothetically*) absent the philosophical / ethical considerations of ergogenic agent use within a high school-aged, student-athlete population, myriad practical challenges such as *equivocality of evidence*, *supplement tolerance*, and *potentially adverse side effects* might catalyze a strong, foundational argument against use**

Ergogenic Nutritional Supplements: A Perspective

- **Summary perspective:**

  - **Understand, emphasize, and teach the incontrovertible value of the ultimate performance enhancing agent: *<u>SLEEP</u>***

  - **Understand, emphasize and teach the (lifelong) incontrovertible value of a nutritional approach / strategy predicated upon macronutrient (*particularly CHO & PRO*) sufficiency and micronutrient (*particularly iron {Fe} and calcium {Ca}*) sufficiency**

Part XIII

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Part XIV

Questions & Discussion

Questions & Discussion