Nutritional Strategies to Enhance Performance

Exercise • Nutrition • Health • Performance

ESNL

Exercise & Sport Nutrition Lab

Richard B. Kreider, PhD, FACSM, FISSN

Professor & Head, Department of Health & Kinesiology

Thomas A. & Joan Read Endowed Chair for Disadvantaged Youth

Director, Exercise & Sport Nutrition Lab

Texas A&M University

rkreider@hlkn.tamu.edu

ExerciseAndSportNutritionLab.com

hlkn

Texas A&M Department of Health & Kinesiology

VISION 2020

TEXAS A&M UNIVERSITY

hlknweb.tamu.edu

TEXAS A&M UNIVERSITY

Exercise • Nutrition • Health • Performance

ESNL

Exercise & Sport Nutrition Lab

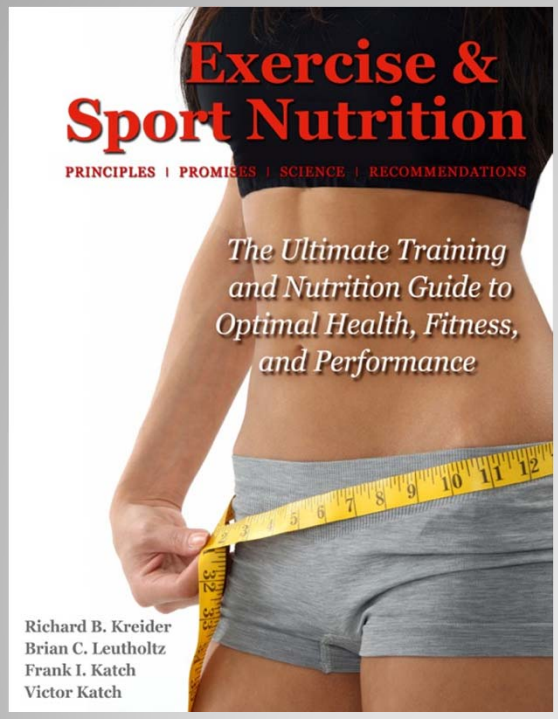
Dedicated to evaluating the interaction between exercise and nutrition on health, disease, and human performance

www.ExerciseAndSportNutritionLab.com

ESNL Research

- Endurance / Ultraendurance
- Overtraining
- Nutritional Interventions
  - Carbohydrate
  - Inosine
  - Phosphate
  - BCAA/glutamine
  - Creatine
  - HMB
  - Calcium Pyruvate
  - CLA
  - Protein/EAA
  - CHO Gels (Honey)
  - Ribose
  - Green Tea / Caffeine
  - Meal Timing
  - Colostrums
  - D-Pinitol
  - Coleus Forskohlii
  - ZMA
  - Methoxyisoflavones
  - Ecdysterones
  - Sulfo-Polysaccharides "Myostatin Inhbitor"
  - Calcium
  - Glucosamine and Chondoitin
  - Aromatase Inhibitors
  - BCAA, CHO, Leucine
  - Melatonin
  - Arachidonic Acid
  - Milk protein subfractions
  - CoQ10
  - Beta Alanine
  - Russian Tarragon
- Exercise & Diet Interventions to Optimize Health & Training Adaptations
- Weight Loss & Maintenance

Exercise & Sport Nutrition



jissn journal of the international society of sports nutrition

TRACKED FOR IMPACT FACTOR

Welcome Texas A&M University (Log on / register)

BioMed Central home | Journals A-Z | Feedback | Support | My details

Home | Browse articles | Supplements | Search | Submit article | My JISSN | About JISSN

Review

Highly accessed | Open Access

ISSN exercise & sports nutrition review: research & recommendations

Richard B Kreider, Colin D Wilborn, Lem Taylor, Bill Campbell, Anthony L Almada, Rick Collins, Mathew Cooke, Conrad P Earnest, Mike Greenwood, Douglas S Kalman, Chad M Kerksick, Susan M Kleiner, Brian Leutholtz, Hector Lopez, Lonnie M Lowery, Ron Mendel, Abbie Smith, Marie Spano, Robert Wildman, Darryn S Willoughby, Tim N Ziegenfuss and Jose Antonio

Journal of the International Society of Sports Nutrition 2010, **7**:7 doi:10.1186/1550-2783-7-7

Published: 2 February 2010

Abstract (provisional)

Sports nutrition is a constantly evolving field with hundreds of research papers published annually. For this reason, keeping up to date with the literature is often difficult. This paper is a five year update of the sports nutrition review article published as the lead paper to launch the JISSN in 2004 and presents a well-referenced overview of the current state of the science related to how to optimize training and athletic performance through nutrition. More specifically, this paper provides an overview of: 1.) The definitional category of ergogenic aids and dietary supplements; 2.) How dietary supplements are legally regulated; 3.) How to evaluate the scientific merit of nutritional supplements; 4.) General nutritional strategies to optimize performance and enhance recovery; and, 5.) An overview of our current understanding of the ergogenic value of nutrition and dietary supplementation in regards to weight gain, weight loss, and performance enhancement. Our hope is that ISSN members and individuals interested in sports nutrition find this review useful in their daily practice and consultation with their clients.

The complete article is available as a provisional PDF. The fully formatted PDF and HTML versions are in production.

Journal of the International Society of Sports Nutrition Volume 7

Viewing options: Abstract, PDF (534KB)

Associated material: Readers' comments, PubMed record

Related literature: Articles citing this article on Google Scholar, on PubMed Central; Other articles by authors on Google Scholar, on PubMed; Related articles/pages on Google, on Google Scholar, on PubMed

Tools: Download citation(s), Email to a friend, Order reprints, Post a comment

Post to: Citeulike, Connotea, Del.icio.us, Facebook, Mendeley, Twitter

www.ExerciseAndSportNutrition.com

www.jissn.com/content/7/1/7

Ergogenic Aid

Any training technique, mechanical device, nutritional practice, pharmacological method, or psychological technique that can improve exercise performance capacity and/or enhance training adaptations.

www.jissn.com/content/7/1/7

ESNL

Ergogenic Aid
Analysis

- Does the theory make sense?
- Is there any scientific evidence supporting the ergogenic value?
- Is it legal and/or safe?

www.jissn.com/content/7/1/7

ESNL

Ergogenic Aids

Scientific Evidence?

- Studies on athletes or trained subjects?
- Employed a double blind, repeated measures, placebo controlled, randomized clinical design?
- Appropriate statistical interpretation?
- Do claims match results?
- Data presented at reputable scientific meeting and/or published in peer-reviewed journal?
- Results replicated by others?
- Disclosures and competing interest declared?

www.jissn.com/content/7/1/7

ESNL

Ergogenic Aids

Categories

I. ***Apparently Effective***. Supplements that help meet general caloric needs and/or the majority of research studies show is effective and safe.

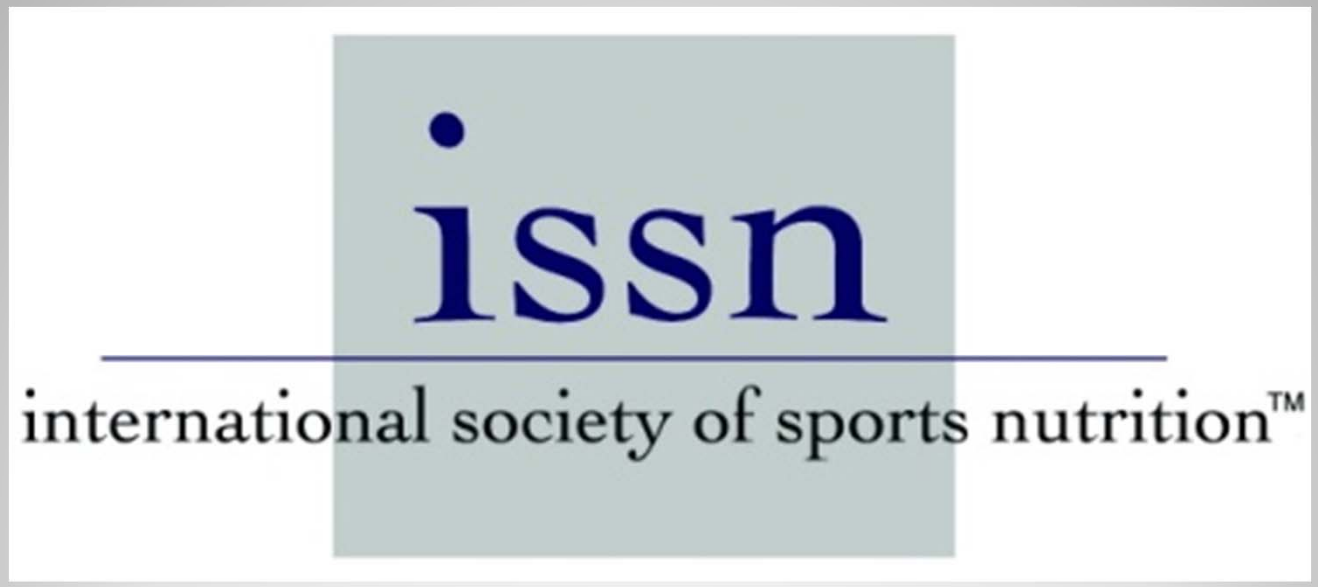
II. ***Possibly Effective***. Supplements with initial studies supporting the theoretical rationale but requiring more research.

III. ***Too Early To Tell***. Supplements with sensible theory but lacking sufficient research to support its current use.

IV. ***Apparently Ineffective***. Supplements that lack a sound scientific rationale and/or research has clearly shown to be ineffective.

www.jissn.com/content/7/1/7

ESNL



What are nutritional needs of active individuals and athletes?

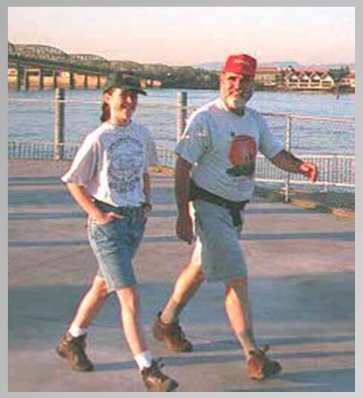
Energy Needs

- ***General Fitness Training*** (e.g., 30 - 40 min/d; 3 d/wk)
  - Exercise energy expenditure generally 200 – 400 kcals/workout
  - Energy needs can be met on normal diet (e.g., 1,800 – 2,400 kcals/day or about 25 - 35 kcals/kg/day for a 50 – 80 kg individual)
- ***Moderate Training*** (e.g., 2-3 hrs/d; 5-6 d/wk)
  - Exercise energy expenditure generally 600 – 1,200 kcals/hour
  - Caloric needs may approach 50 – 80 kcals/kg/day (2,500 – 8,000 kcals/day for a 50 – 100 kg athlete)
- ***Elite Athletes*** (e.g., 3-6 hrs/d; 5-6 d/wk)
  - Energy expenditure in Tour de France reported as high as 12,000 kcals/day (150 - 200 kcals/kg/d for a 60 – 80 kg athlete)
  - Caloric needs for large athletes (i.e., 100 – 150 kg) may range between 6,000 – 12,000 kcals/day depending on the volume/intensity of training
  - Often difficult for athletes to eat enough food in order to meet caloric needs

www.jissn.com/content/7/1/7

Nutritional Guidelines

General Fitness / Active Populations



- Diet focused on goals (maintenance, weight gain, weight loss)
- **Carbohydrate** (45%-55% of calories)
  - 3 – 5 g/kg/d
- **Protein** (10-15% of calories)
  - 0.8 – 1.0 g/kg/d (younger)
  - 1.0 – 1.2 g/kg/d (older)
- **Fat** (25-35% of calories)
  - 0.5 – 1.5 g/kg/d
- Make Good Food Choices
- Meal timing can optimize training response

www.jissn.com/content/7/1/7

ESNL

Nutritional Guidelines

Athletes

- Diet focused on goals (maintenance, weight gain, weight loss)
- **Carbohydrate** (55%-65% of calories)
  - 5 – 8 g/kg/d – moderate training
  - 8 – 10 g/kg/d – heavy training
- **Protein** (15-20% of calories)
  - 1.0 – 1.5 g/kg/d moderate training
  - 1.5 - 2.0 g/kg/d during heavy training
- **Fat** (25-30% of calories)
  - 0.5 – 1.5 g/kg/d
- Meal Timing Important
- Use of energy supplements helpful

www.jissn.com/content/7/1/7

ESNL

Nutritional Guidelines

Meal Timing

- Pre-exercise meals (4-6 h)
- Pre-exercise snack (30-60 min)
  - 40-50 g CHO, 10 g PRO
- Sports drinks during exercise (> 60 min)
  - 6%-8% glucose-electrolyte solution
  - Sports gels/bars at half-time
- Post-exercise snack (within 30 min)
  - 1 g/kg CHO, 0.5 g/kg PRO
- Post-exercise meal (within 2 hrs)
- Carbohydrate loading (2-3 days prior to competition)
  - Taper training by 30%-50%
  - Ingest 200-300 extra grams of CHO

www.jissn.com/content/7/1/7

ESNL

Vitamins & Minerals

- No clear ergogenic value of vitamin supplementation for athletes who consume a normal, nutrient dense diet.
- Some vitamins may help athletes tolerate training to a greater degree by reducing oxidative damage (Vitamin E, C) and/or help to maintain a healthy immune system during heavy training (Vitamin C).
- Some athletes susceptible to mineral deficiencies in response to training and/or prolonged exercise.
- Supplementation of minerals in deficient athletes has generally been found to improve exercise capacity.
- Some potential benefits reported from iron, sodium phosphate, sodium chloride, and zinc supplementation
- Use of a low-dose daily multivitamin and/or a vitamin enriched post-workout carbohydrate/protein supplement is advisable

www.jissn.com/content/7/1/7

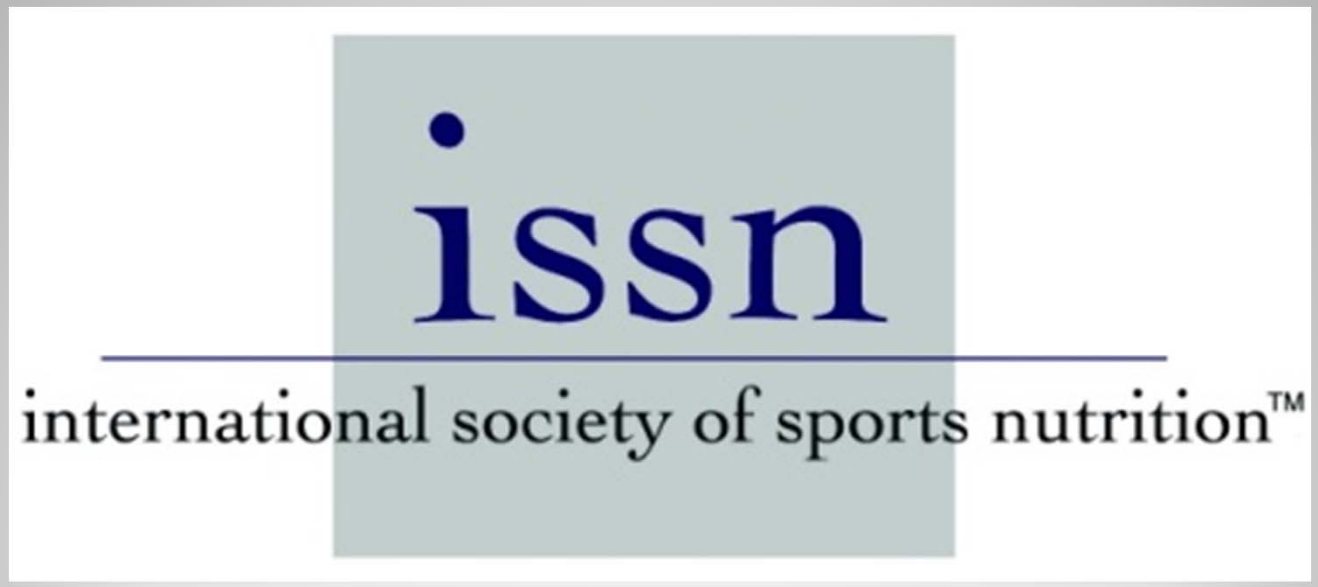
ESNL

Water

- Most important nutritional ergogenic aid
- Performance can be impaired when ≥ 2% of body weight is lost through sweat.
- Fluid loss of > 4% of body weight during exercise may lead to heat illness, heat exhaustion, heat stroke, and death
- Athletes should ingest 0.5 to 2 L/h (e.g., 6-8 oz of cold water or a GES every 5 to 15-min) to maintain hydration
- Addition of 1 g/L of salt can help maintain hydration in hot & humid environments

www.jissn.com/content/7/1/7

ESNL



What are the ergogenic value of various nutritional supplements?

Exercise & Sports Nutrition Review

Apparently Effective

Muscle Building Supplements	Weight Loss Supplements	Performance Enhancement
• Weight gain powders • Creatine • Protein/ EAA	• Low-calorie foods, MRPs, and RTDs • Some thermogenic supplements	• Water and sports drinks • Carbohydrate • Creatine • Sodium phosphate • Sodium bicarbonate • Caffeine • β-alanine

www.jissn.com/content/7/1/7

ESNL

issn international society of sports nutrition

Exercise & Sports Nutrition Review

Possibly Effective

Muscle Building Supplements	Weight Loss Supplements	Performance Enhancement
• HMB • BCAA	• High-fiber diets • Calcium • Green tea & caffeine • Conjugated Linoleic Acids	• Post-exercise carbohydrate & protein • EAA • BCAA • HMB • Glycerol

www.jissn.com/content/7/1/7

ESNL

issn international society of sports nutrition

Exercise & Sports Nutrition Review

Too Early to Tell

jissn
journal of the international society of sports nutrition™

Muscle Building Supplements	Weight Loss Supplements	Performance Enhancement
• α-Ketoglutarate	• Gymnema sylvestre	• Medium chain triglycerides
• α-Ketoisocaproate	• Chitosan	• *Arginine / NO2*
• Ecdysterones	• Phosphatidl Choline	• *GAKIC*
• Growth hormone releasing peptides and secretogues	• Betaine	
• Ornithine α-Ketoglutarate	• Coleus Forskolin	
• Zinc/magnesium aspartate	• DHEA	
	• Psychotropic Nutrients/Herbs	

www.jissn.com/content/7/1/7

ESNL

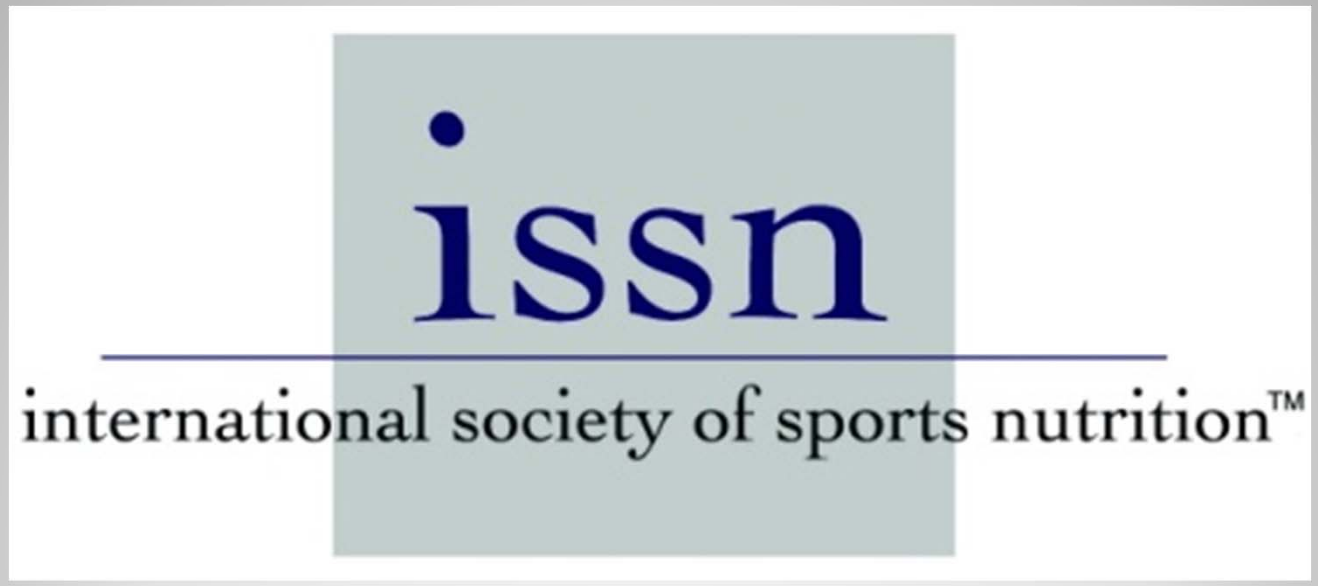
issn
international society of sports nutrition™

Exercise & Sports Nutrition Review

Apparently Ineffective

Muscle Building Supplements	Weight Loss Supplements	Performance Enhancement
• Glutamine	• Calcium Pyruvate	• Glutamine
• Smilax	• Chitosan	• Ribose
• Isoflavones	• Chromium (non-diabetics)	• Inosine
• Sulfo-polysaccharides (myostatin inhibitors)	• HCA	
• Boron	• L-Carnitine	
• Chromium	• Phosphates	
• Conjugated linoleic acids	• Herbal diuretics	
• Gamma oryzanol		
• Prohormones		
• Tribulus terrestris		
• Vanadyl sulfate (vanadium)		

www.jissn.com/content/7/1/7



Performance Enhancement Nutrition Strategies

Strength / Power Athletes

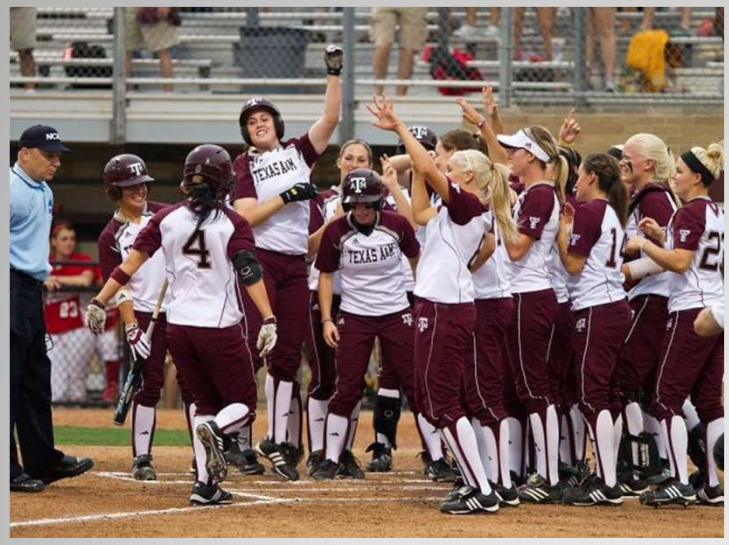
Nutrition Strategies

Strength/Power Athletes

- Nutritional Goals
  - Provide CHO & PRO
  - Maintain Hydration
  - Increase power and recovery from high intensity exercise
  - Improve high intensity exercise performance
  - Increase muscle mass

ESNL

Nutrition Strategies
Strength/Power Athletes



- Nutritional Strategies
  - Moderate to High CHO and PRO diet
  - Water/GES
  - Post-Exercise PRO/EAA
- Ergogenic Aids
  - Creatine
  - β-alanine
  - Sodium Bicarbonate

Nutritional Guidelines

Strength / Power Athletes

- Diet focused on goals (maintenance, weight gain, weight loss)
- **Carbohydrate** (40-55% of calories)
  - 3 – 5 grams/kg/day typically sufficient
- **Protein** (15-30% of calories)
  - 1.5 – 2.0 grams/kg/day general
  - 2.0 – 2.25 grams/kg/day during heavy training and/or at altitude
- **Fat** (20-30% of calories)
  - 1 – 1.5 grams/kg/day
- Greater emphasis on meal timing
- May need more education about nutritional ergogenic aids

www.jissn.com/content/7/1/7

ESNL

Essential Amino Acids

- EAA are amino acids the body is not able to synthesize and must be obtained in the diet.
- Some of these AA have ergogenic potential
- Timing EAA intake can influence muscle protein synthesis (MPS)

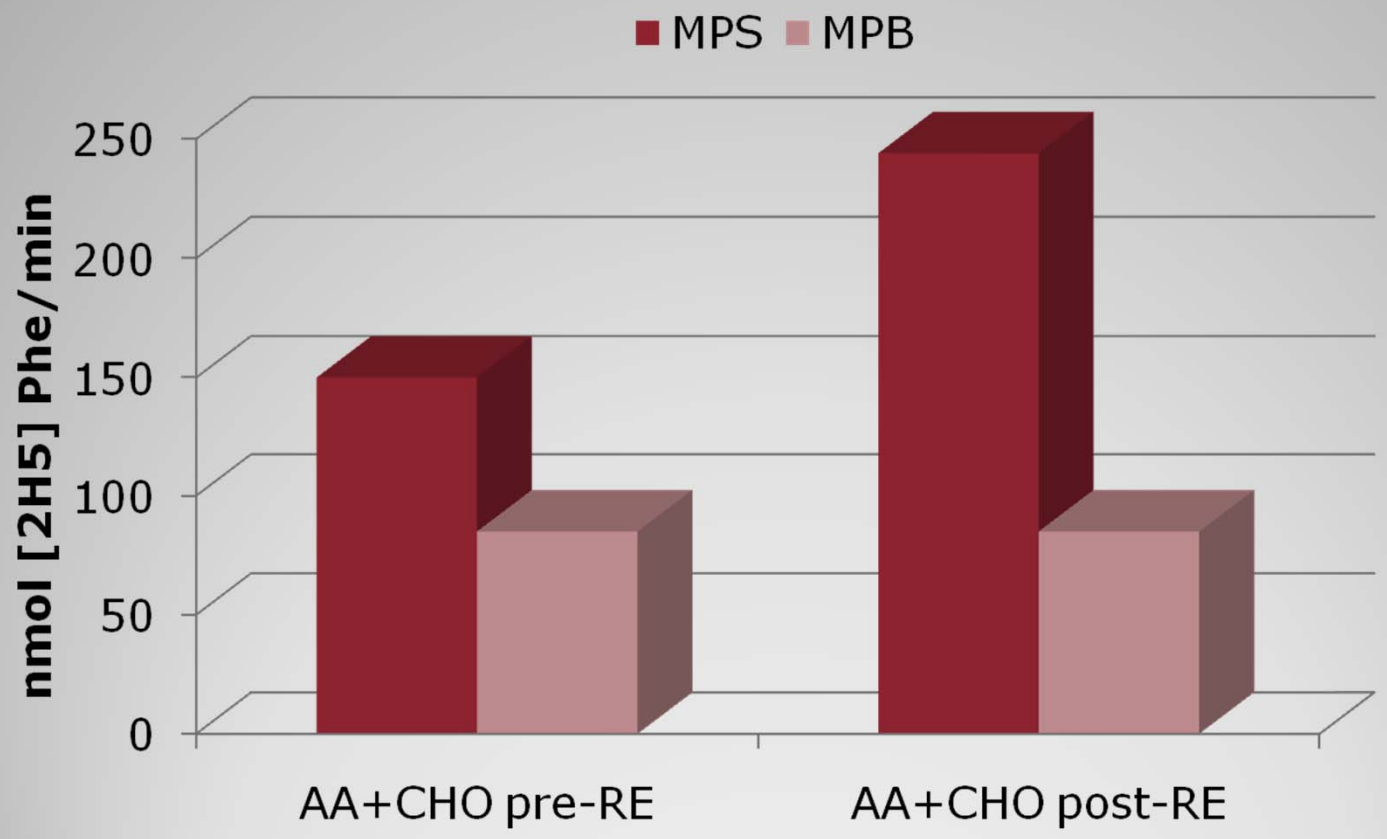
*Isoleucine	Phenylalanine
*Leucine	Threonine
Lysine	Tryptophan
Methionine	*Valine
*BCAA	

ESNL

issn
international society of sports nutrition™

Effect of Mixed AA & CHO on Protein Turnover

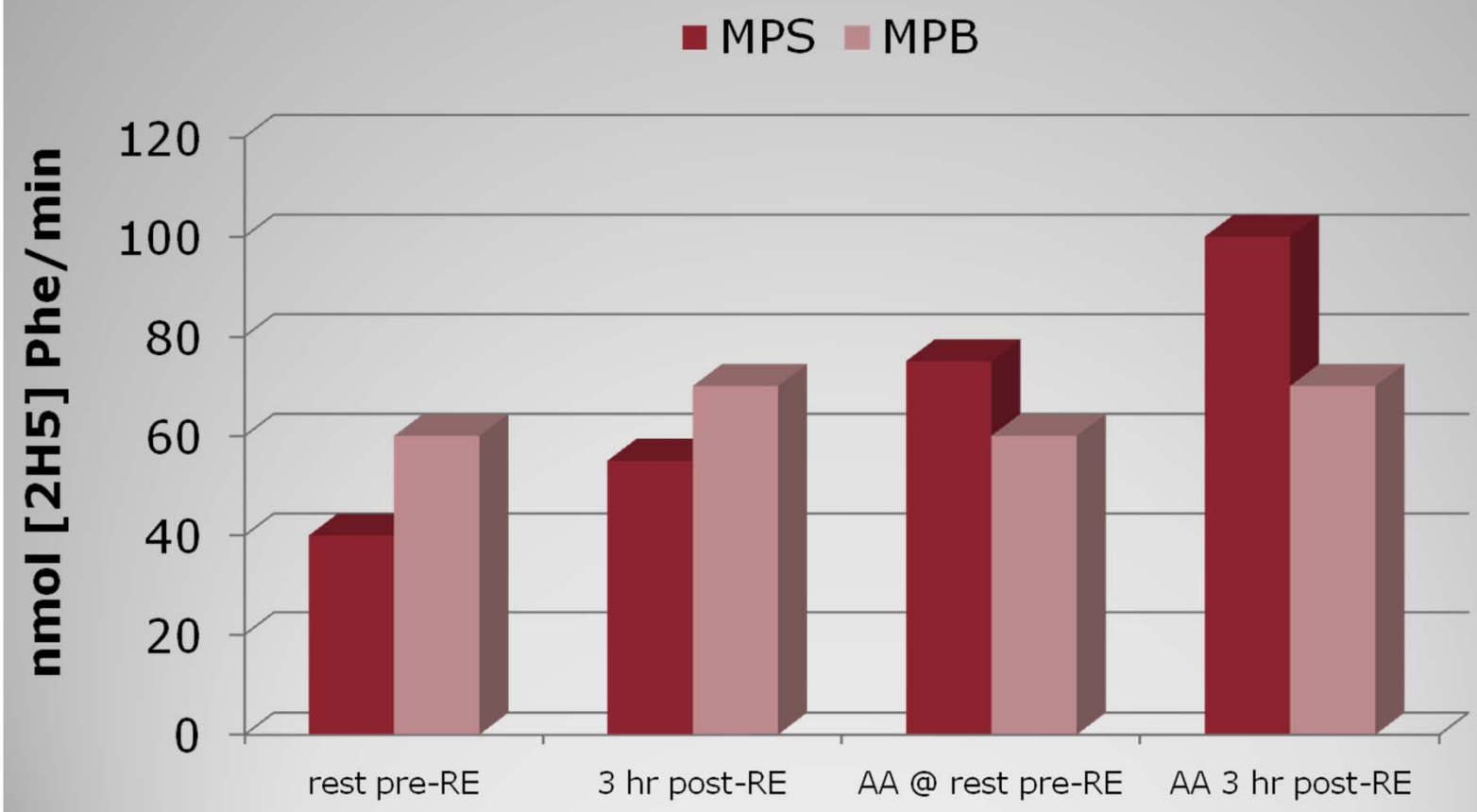
Rasmussen & Phillips. Ex Sport Sci Rev. 31(3): 127-31, 2003



40 grams infused mixed AA + 40 grams infused CHO

Effect of EAA on Protein Turnover

Rasmussen & Phillips. Ex Sport Sci Rev. 31(3): 127-31, 2003



6 grams oral EAA + 35 grams oral CHO

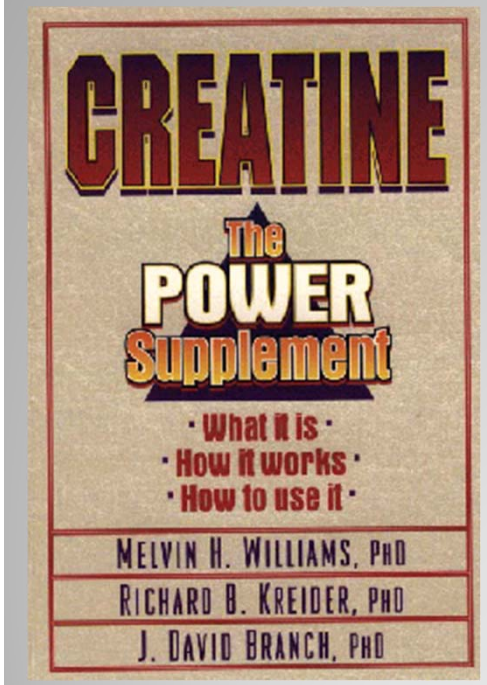
How much EAA is needed to enhance muscle protein synthesis?

- As little at 3 grams of EAA's is enough to significantly increase protein synthesis (*Miller et al. 2003*)
- 6 grams of EAA's appears to be an optimal dose (*Borsheim et al. Am J Physiol. 283:E648-57, 2002*).
- 100 grams of CHO can increase protein synthesis by 35% while 6 grams of EAA's increases protein synthesis by 250% (*Biolo et al. 1997, Borsheim et al. 2003*)
- ***20 g of whey protein contains about 9 g of EAA's***

ESNL

issn
international society of sports nutrition

Creatine

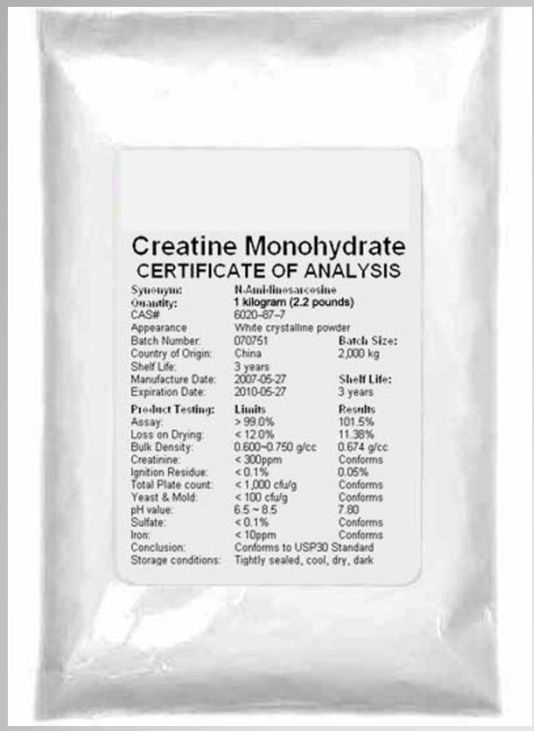


- Creatine is a naturally occurring non-essential AA discovered in 1832.
- Creatine studies began in early 1900's with interest rekindled by Ingwall and Hultman in 1970's.
- Athletes reported to be using creatine as a ergogenic aid since 1960's.
- Potential therapeutic role investigated since 1970's.
- Emphasis on ergogenic value in athletes since early 1990's as synthetic creatine became available.
- Current research focus on medical uses

ESNL

issn
international society of sports nutrition™

Background



- Naturally occurring amino acid-like compound found primarily in muscle (95%)
- 2/3 stored as PCr
- 1/3 stored as free creatine
- Total creatine content is about 120g for a 70 kg person
- Body breaks down about 1-2% of creatine pool per day into creatine
- 1/2 of creatine obtained by diet
- 1/2 synthesized from AA from glycine, arginine, and methionine

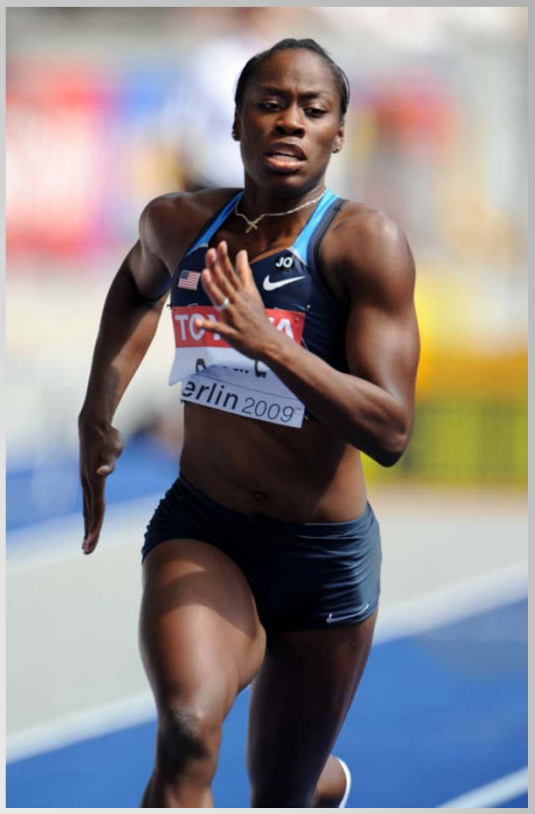
ESNL

issn
international society of sports nutrition™

Creatine

Reported Benefits

- Increase muscle PCr
- Increased single and repetitive sprint performance
- Increased muscle mass & strength
- Enhanced glycogen synthesis
- Possible enhancement of aerobic capacity via greater shuttling of ATP from mitochondria and buffering of acidity
- Increased work capacity
- Enhanced recovery
- Greater training tolerance



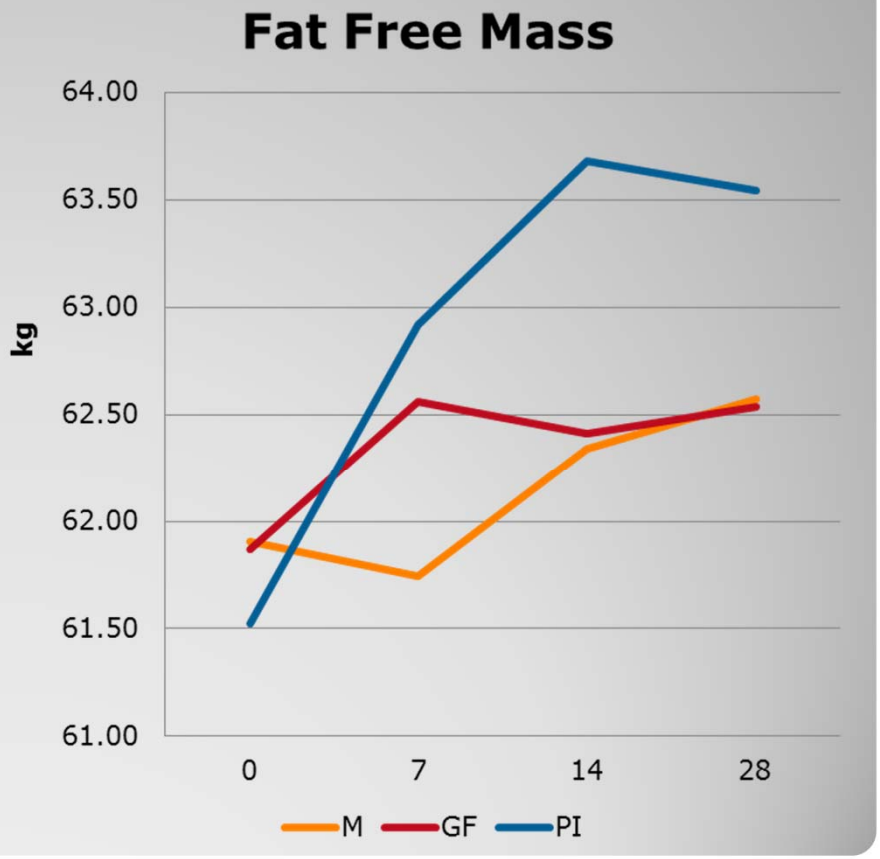
ESNL

issn
international society of sports nutrition™

Effects of ingesting Effects of Ingesting Supplements Designed to Promote Lean Tissue Accretion on Body Composition During Resistance-Training

Kreider et al. IJSN 6:234-46, 1996

- 28 resistance trained males
- In a DB-R-P manner, assigned to supplement diet with:
  - Maltodextrin (190 g/d)
  - Gainers Fuel 1000 (290 g/d)
  - Phosphagain (64 g/d CHO, 67 g/d PRO, 20 g/d CM)
- Greater gain in FFM and body mass in CM group
- Improved strength & muscle endurance in CM group



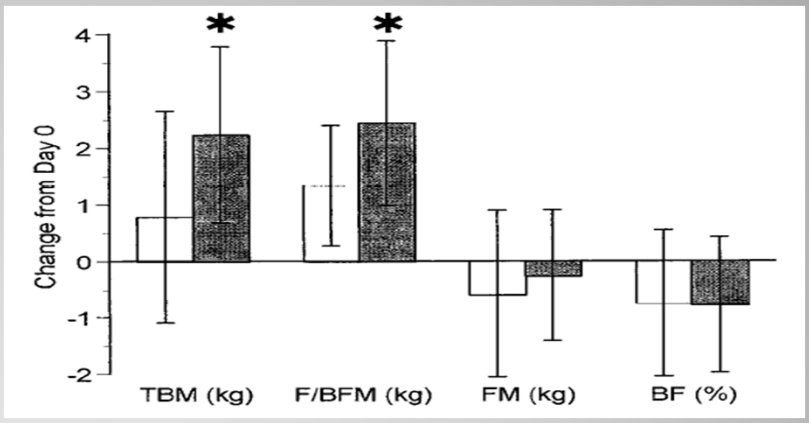
ESNL

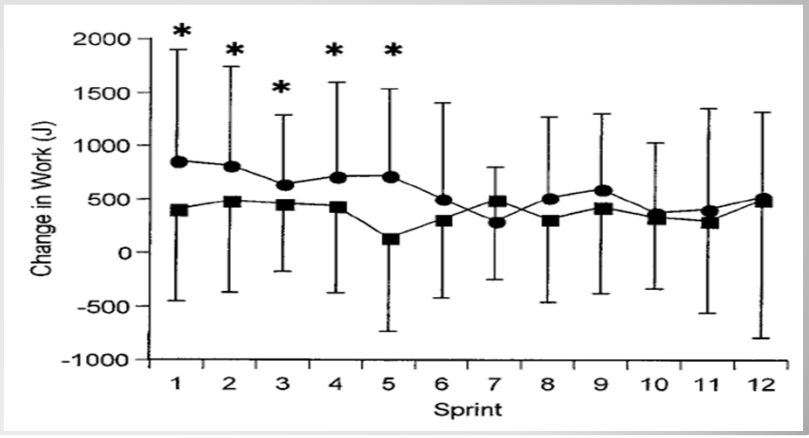
issn
international society of sports nutrition

Effects of Creatine Supplementation on Body Composition, Strength, and Sprint Performance

Kreider et al. MSSE 30:73-82, 1998

- 28 DI football players
- In a DB-R-P controlled manner, assigned to supplement diet with:
  - CHO containing placebo
  - CHO plus 15.75 g/d CM
- Greater gains in FFM, strength, and sprint performance
- Comprehensive safety analysis revealed no adverse effects during intense training





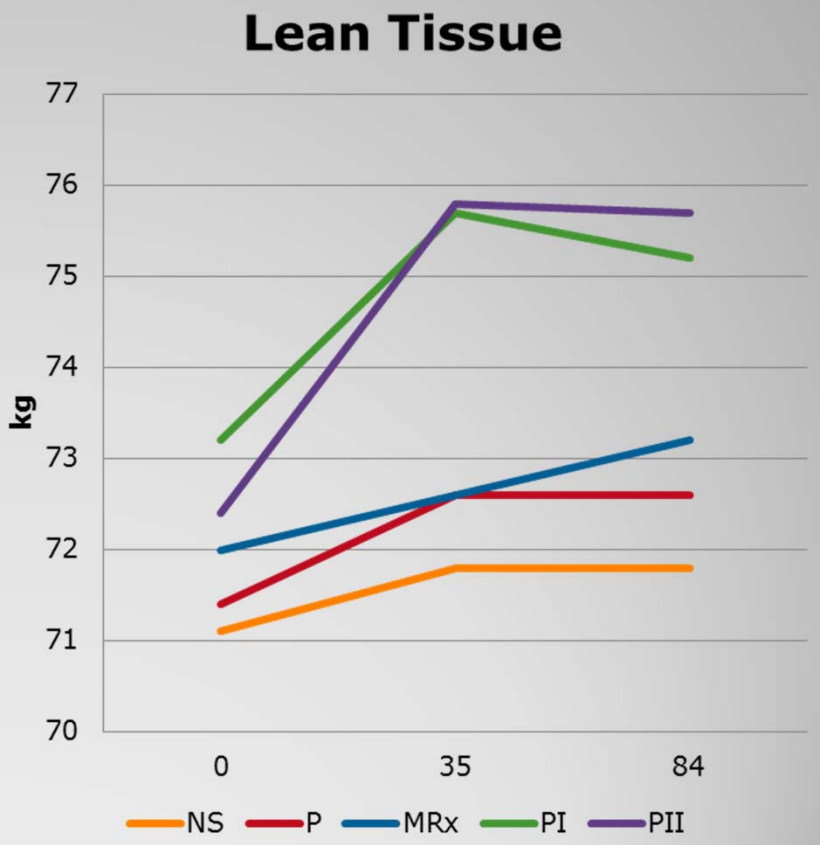
ESNL

issn
international society of sports nutrition™

Effects of Nutritional Supplementation During Off-Season College Football Training on Body Composition & Strength

Kreider et al. JEP 2(2):24-39, 1999

- 62 DI football players
- In a DB-R-P manner, assigned to supplement diet with:
  - Non-Supplemented Control
  - Maltodextrin Placebo
  - MetRx
  - Phosphagain I (20 g/d CM)
  - Phosphagain II (25 g/d CM)
- Greater gains in FFM & strength in CM groups



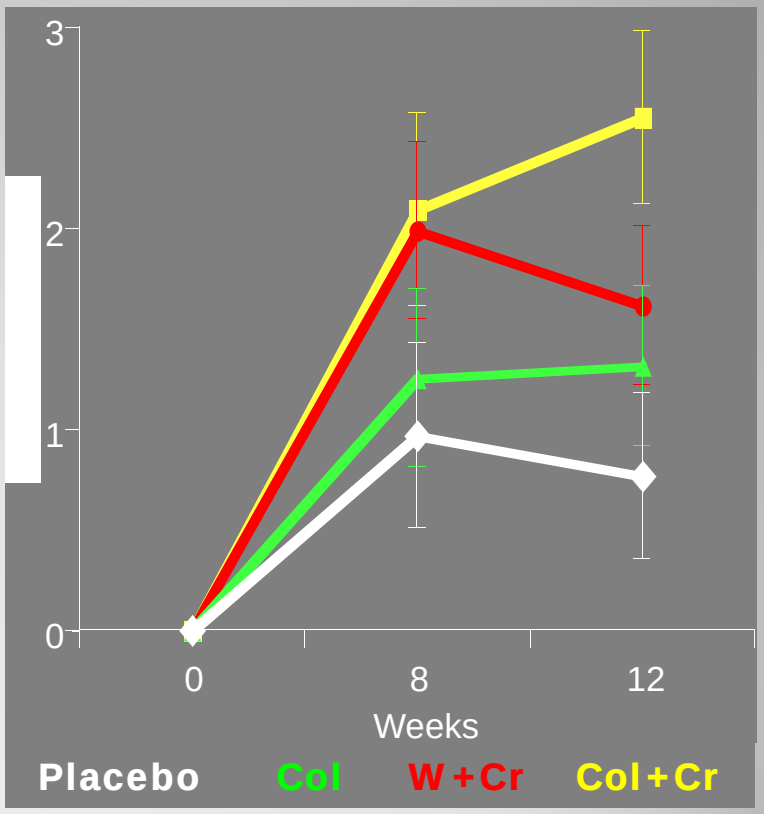
ESNL

issn
international society of sports nutrition

Impact of differing protein sources and a creatine containing nutritional formula after 12 weeks of resistance training

Kerksick et al. Nutrition. 23:647-656, 2007

- 49 resistance trained males
- In a DB-R manner, assigned to supplement diet during resistance-training with:
  - 60 g/d of casein/whey or colostrum
  - With or without 3 g of CM
- Adding CM to whey and colostrum increased weight & FFM gain during training
- Colostrum > gain than whey
- Significant training adaptations with no differences among groups



ESNL

issn
international society of sports nutrition

Long-term Safety of Creatine Supplementation Among Athletes

21 Month Open Label Safety Study

- 100 NCAA division IA football players volunteered to participate
- Subjects elect to ingest creatine containing supplements or non-creatine supplements.
- Creatine supplementation:
  - 15.75 g/d for 5-d
  - Average of 5 g/d for 21 months
- Supplements administered following workouts/practices and documented
- Blood/urine samples collected at 0, 1.5, 2, 4, 6, 9, 12, 15, & 21 months.

ESNL

issn
international society of sports nutrition™

Long-term Safety of Creatine Supplementation Among Athletes

Kreider et al. J Mol Cellular Biochem. 244:95–104, 2003

- MANOVA revealed *no significant differences* (p=0.51) in a 55-item panel of blood and urine markers.
- RM ANOVA revealed *no clinically significant differences* among creatine users and controls in markers of renal function, muscle & liver enzymes, markers of catabolism, electrolytes, blood lipids, red cell status, lymphocytes, urine volume, clinical urinalysis, or urine specific gravity.
- No perception of greater incidence of side effects
- Some evidence of greater training tolerance

ESNL

issn
international society of sports nutrition™

Long-term Safety of Creatine Supplementation Among Athletes

Greenwood et al. J Mol Cellular Biochem. 244:83–88, 2003

- Creatine users (45-54% use rate) experienced:
  - Cramping (37/96, 39%)
  - Heat/dehydration (8/28, 36%)
  - Muscle tightness (18/42, 43%)
  - Muscle strains/pulls (25/51, 49%)
  - Non-contact joint injuries (44/132, 33%)
  - Contact injuries (39/104, 44%)
  - Illness (12/27, 44%)
  - Missed practices due to injury (19/41, 46%)
  - Players lost for season (3/8, 38%)
  - Total injuries/missed practices (205/529, 39%)

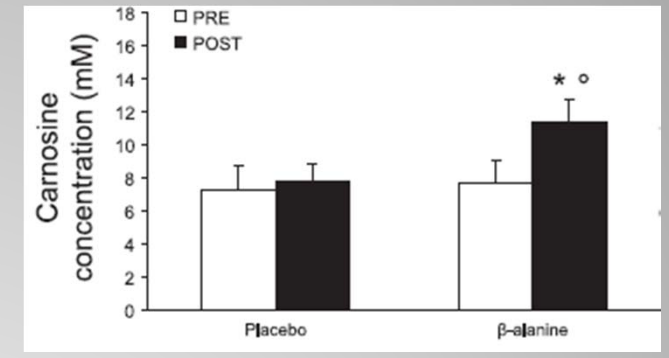
ESNL

issn
international society of sports nutrition™

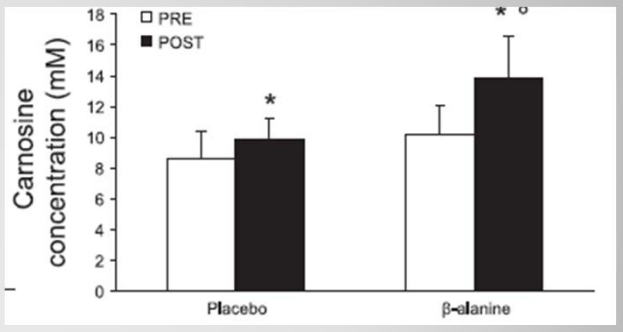
Beta-Alanine

- Muscle carnosine has been reported to serve as a physiological buffer, possess antioxidant properties, influence enzyme regulation, and affect sarcoplasmic reticulum calcium regulation.
- Beta-alanine (β-ALA) is a non-essential amino acid. β-ALA supplementation (e.g., 2–6 grams/day) has been shown to increase carnosine concentrations in skeletal muscle by 20–80% (*Culbertson et al, Nutrients, 2010*).

Dareve et al. JAP, 2007



Soleus



Gastrocnemius

ESNL

issn
international society of sports nutrition™

Beta-Alanine

- Stout et al. (*JISSN, 2008*) reported that 28-d of β-ALA supplementation (3-6 g/d) delayed the onset of neuromuscular fatigue.
- Hoffman et al. (*IJSNEM, 2008*) reported that creatine / β-ALA supplementation (10/3 g/d) increased FFM in college football players participating in a 10-wk resistance training program.
- Kendrick et al. (*AA, 2008*) reported that 3.6 g/d of β-ALA for 4-wks increased training adaptations

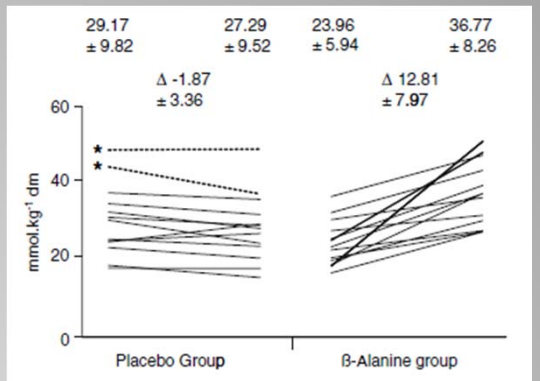


Fig. 2 Changes in M-[Carn] in each individual following training, with or without β-alanine supplementation. Values marked by *asterisks* are discussed in the text

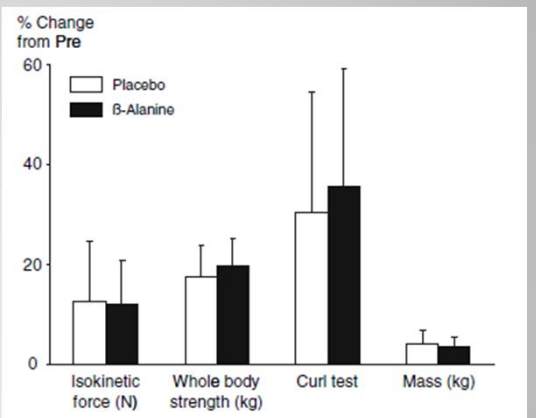


Fig. 1 The percentage change in exercise performance measures and mass. All values were significantly increased pre to post but there was no significant difference between treatment groups

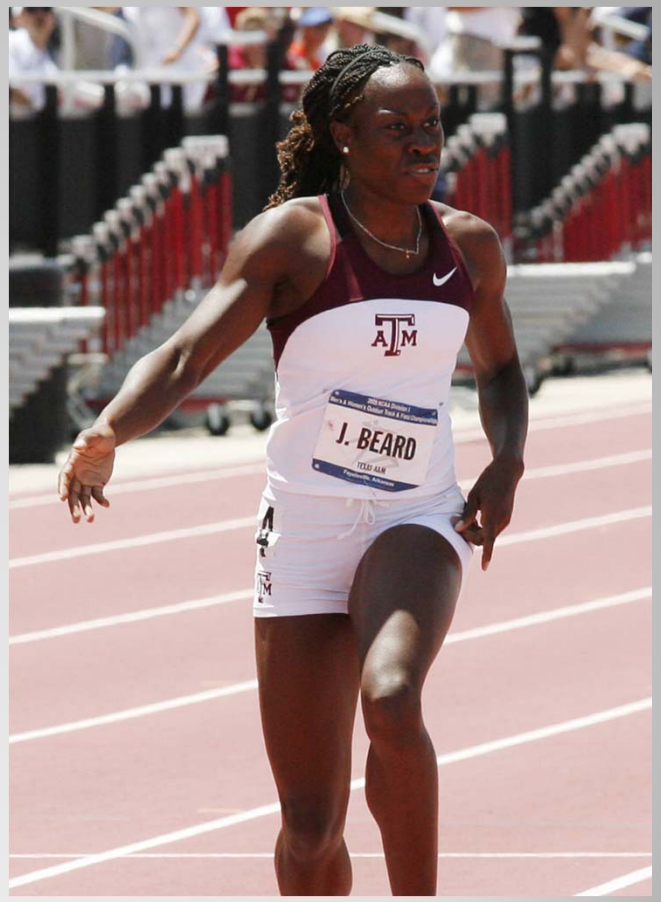
ESNL

issn
international society of sports nutrition™

Sodium Bicarbonate

Apparently Effective

- Supplementation Protocols:
  - 0.3 g/kg of baking soda 1 to 2 hours before competition
  - 10 g/d for 5-d
- Reported to buffer acidity and improve high intensity exercise performance (1 - 3 min)
- Possible GI distress
- Start out with a small amount during training to build up tolerance



ESNL

issn
international society of sports nutrition™

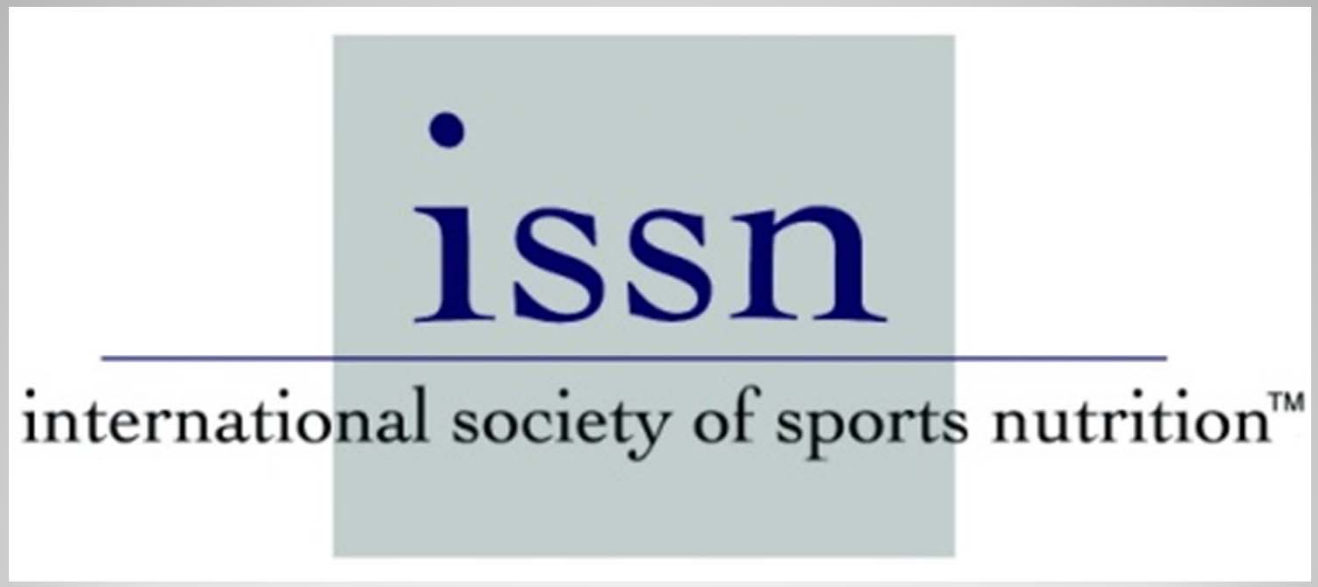
Effects of chronic bicarbonate ingestion on performance of high intensity work

McNaughton et al. EJAP, 80:333-6. 1999

- 8 subjects performed a 60-s sprint on a CE prior to and following 5-d of supplementation of SB (0.5 g/kg/d) and following 1 month cessation
- SB significantly increased blood bicarbonate levels and pH levels
- SB increased work by 14% and peak power

ESNL

issn
international society of sports nutrition™



Performance Enhancement Nutrition Strategies

Endurance Athletes

Nutrition Strategies

Endurance Athletes

- Goals
  - Provide necessary dietary carbohydrate
  - Maintain hydration and blood glucose levels during exercise
  - Spare muscle glycogen utilization during exercise
  - Promote glycogen resynthesis
  - Increase endurance capacity
  - Increase anaerobic threshold
  - Maintain muscle mass

ESNL

Nutrition Strategies
Endurance Athletes

- Nutritional Strategies
  - High CHO diet
  - CHO Loading
  - Post-Exercise CHO/PRO
- Ergogenic Aids
  - Water/GES during exercise
  - Caffeine
  - Sodium Phosphate
  - Creatine

ESNL

issn
international society of sports nutrition™

Carbohydrate / Glucose Electrolyte Drinks

Apparently Effective

- The general consensus in the scientific literature is the body can oxidize 1 – 1.1 gram of CHO per minute of carbohydrate or about 60 grams per hour.
- The ACSM recommends ingesting 0.7 g/kg/hr during exercise in a 6-8% solution (i.e., 6-8 grams per 100 ml of fluid).
- Harger-Domitrovich et al (*MSSE, 2007*) reported that 0.6 g/kg/h of maltodextrin optimized carbohydrate utilization (30 - 70 grams of carbohydrate per hour for a 50 – 100 kg individual).
- Jeukendrup et al (*Scan J Med Sci Sports, 2008*), reported that ingesting a glucose and fructose beverage in a 2:1 ratio during exercise enhanced carbohydrate oxidation (1.8 g/min) better than glucose alone as well as helped promote greater fluid retention.

Carbohydrate / Glucose Electrolyte Drinks

Apparently Effective

Type of Carbohydrate	Glycemic Index
Sugar Alcohols (e.g., mannitol, erythritol, lactitol, sorbitol, isomalt, xylitol)	0-15
Fructose	19
Galactose	20
Isomaltulose	32
Lactose	46
Honey	55
Trehalose	67
Sucrose	68
Dextrose	93
Glucose	99
Maltose	105
Maltodextrin	137

- Oxidation rates of sucrose, maltose, and maltodextrins are high while fructose, galactose, trehalose, and isomaltulose are lower.
- Combinations of glucose-sucrose or maltodextrin-fructose have been shown to maximize exogenous carbohydrate utilization during exercise but have short lived effects on blood glucose.
- Adding lower GI carbohydrates like fructose, trehalose, or galactose to a mixture of carbohydrate given prior or during exercise can spare glycogen depletion and have less of an effect on insulin.

ISSN Position Stand - Caffeine

- Caffeine is effective for enhancing sport performance in trained athletes when consumed in low-to-moderate dosages (~3-6 mg/kg) and overall does not result in further enhancement in performance when consumed in higher dosages (≥ 9 mg/kg).
- Caffeine exerts a greater ergogenic effect when consumed in an anhydrous state as compared to coffee.
- Caffeine can enhance vigilance during bouts of extended exhaustive exercise, as well as periods of sustained sleep deprivation.
- Caffeine is ergogenic for sustained maximal endurance exercise, and has been shown to be highly effective for time-trial performance.

Goldstein et al. JISSN. 7:5, 2010

ISSN Position Stand - Caffeine

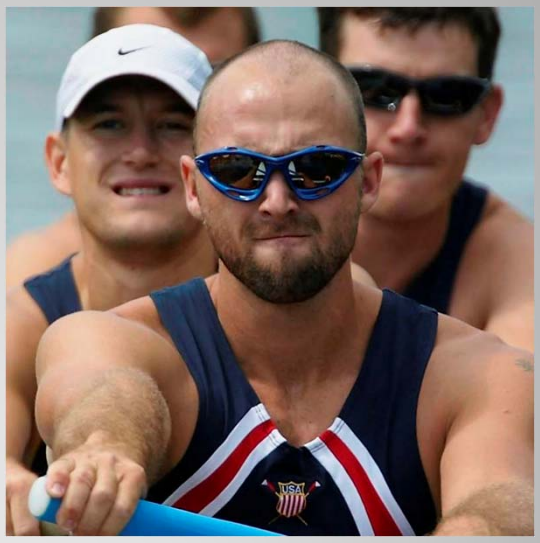
- Caffeine supplementation is beneficial for high-intensity exercise, including team sports such as soccer and rugby, both of which are categorized by intermittent activity within a period of prolonged duration.
- The literature is equivocal when considering the effects of caffeine supplementation on strength-power performance, and additional research in this area is warranted.
- The scientific literature does not support caffeine-induced diuresis during exercise, or any harmful change in fluid balance that would negatively affect performance.

Goldstein et al. JISSN. 7:5, 2010

Sodium Phosphate

Apparently Effective

- Involved in acid-base balance, energy metabolism, and heart function.
- 4 gm/d x 3 to 6-d of sodium phosphate
- Increases VO_2 max & AT by 5 -10%.
- Effective aid primarily for endurance athletes but may also be helpful for short-duration and/or intermittent high intensity exercise.
- May cause stomach upset and stool softening.



ESNL

issn
international society of sports nutrition™

Sodium Phosphate

Apparently Effective

Study	Findings
Cade et al., MSSE, 1984	Trained runners; 9% ↑ in VO_2max; ↓ submaximal lactate levels
Kreider, et al., MSSE, 1990	Trained runners; 9% ↑ in VO_2max; 12% ↑ in VANT; NS but 14-s faster 5-mile run time
Stewart, et al., Res. Q., 1990	Trained cyclists; 11% ↑ in VO_2max; 20% ↑ in time to exhaustion
Kreider et al., IJSN, 1992	Trained cyclists & triathletes; 9% ↑ in VO_2max; 10% ↑ in VANT; 17% ↑ in power during 40 km race; 13% ↑ in EJ and 24% ↑ MFS

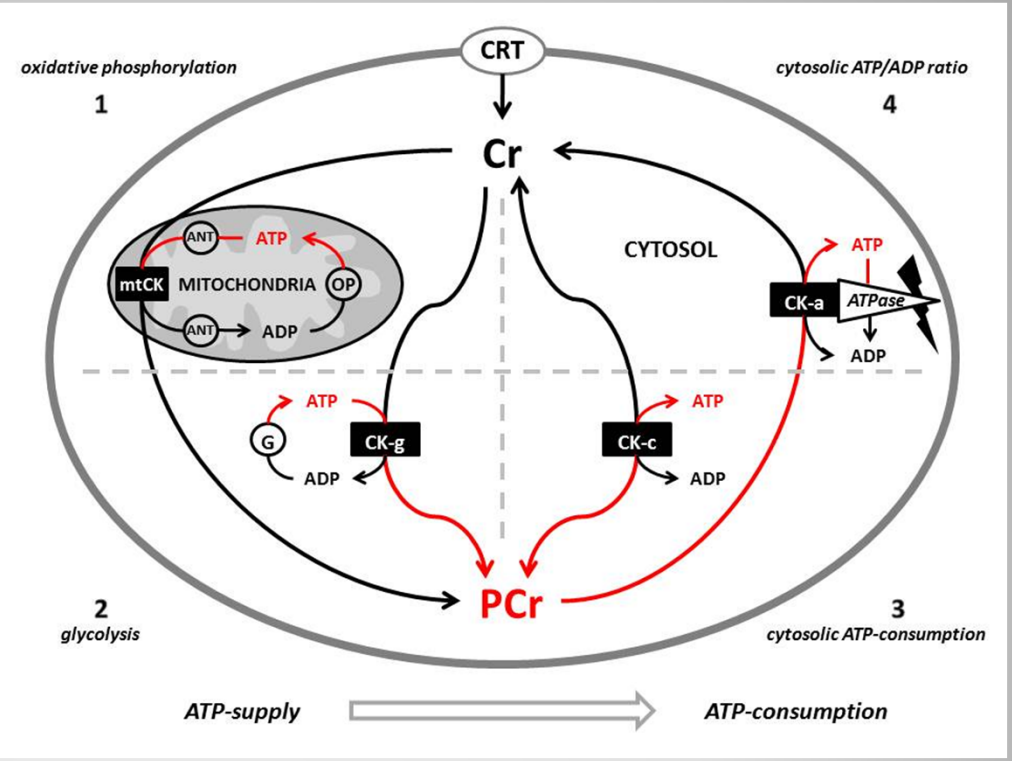
ESNL

issn
international society of sports nutrition™

Creatine for Endurance Athletes

Kreider & Jung, JENB . 15(2):53-69, 2011

- Enhanced glycogen synthesis
- Possible enhancement of aerobic capacity via greater shuttling of ATP from mitochondria and buffering of acidity



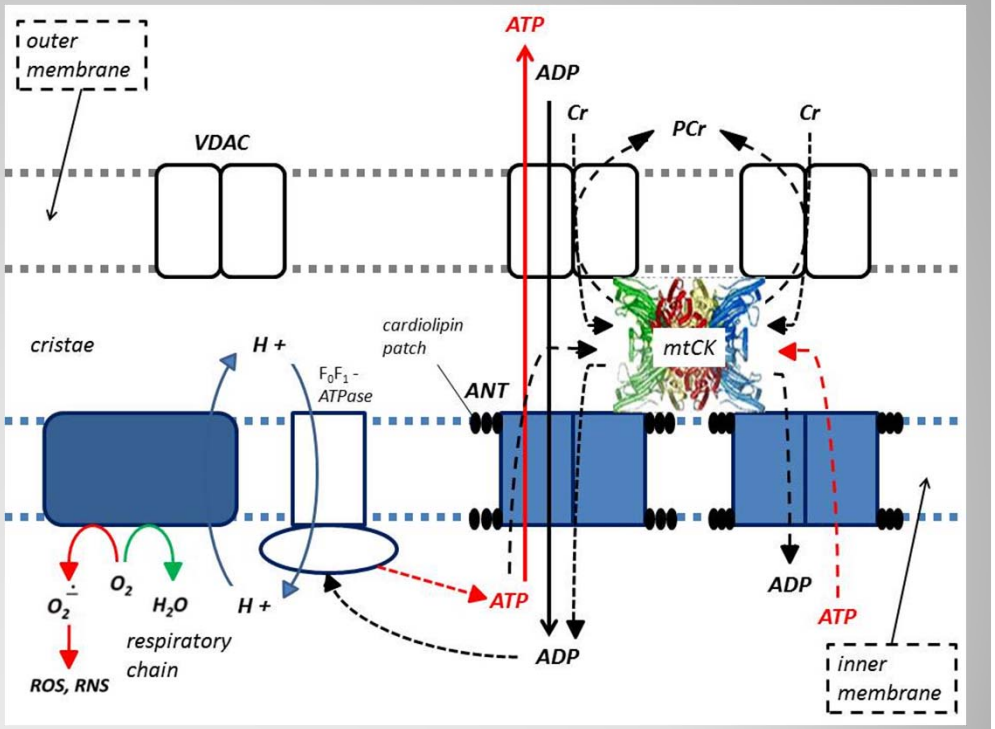
ESNL

issn
international society of sports nutrition™

Creatine for Endurance Athletes

Kreider & Jung, JENB . 15(2):53-69, 2011

- Enhanced glycogen synthesis
- Possible enhancement of aerobic capacity via greater shuttling of ATP from mitochondria and buffering of acidity



ESNL

issn international society of sports nutrition

Performance Enhancement Program

- Stress high CHO, nutrient dense, isoenergetic diet
- Daily multi-vitamin (with iron for women)
- Taper & CHO load before competition
- Pre-practice snack with compliant energy bars/drinks/shake
- Water and GES during exercise
- Post-practice snack with compliant energy bars/drinks/shake
- Evening snacks or compliant energy bar/shake
- Sport specific use of effective and non-banned ergogenic aids

ESNL

issn
international society of sports nutrition™

Performance Enhancement Program

- Strength/Power/Sprint Athletes
  - Moderate to High CHO/PRO diet
  - Water/GES
  - Post-Exercise PRO
  - Creatine
  - β-alanine
  - Sodium Bicarbonate
- Endurance Athletes
  - High CHO diet/CHO loading
  - Water/GES
  - Caffeine
  - Sodium Phosphate
  - Creatine

ESNL

issn
international society of sports nutrition™

Exercise & Sport Nutrition Lab

Exercise • Nutrition • Health • Performance

ESNL

Exercise & Sport Nutrition Lab

Richard B. Kreider, PhD, FACSM, FISSN

Professor & Head, Department of Health & Kinesiology

Thomas A. & Joan Read Endowed Chair for Disadvantaged Youth

Director, Exercise & Sport Nutrition Lab

Texas A&M University

rkreider@hlkn.tamu.edu

ExerciseAndSportNutritionLab.com

hlkn

Texas A&M Department of Health & Kinesiology

VISION 2020