14° CONGRESSO NAZIONALE SINut

SINut Società Italiana di Nutraceutica

12-14 settembre 2024

Bologna

Nutraceutica e supplementazione nello sport tra evidenze scientifiche e fake news

Luca Belli

Società Italiana Nutrizione Sport e Benessere

SINSeB NUTRIZIONE SPORT BENESSERE

Il sottoscritto Luca Belli
ai sensi dell'art. 3.3 sul Conflitto di Interessi, pag. 17 del Reg. Applicativo dell'Accordo Stato-Regione del 5 novembre 2009,

dichiara

che negli ultimi due anni NON ha avuto rapporti diretti di finanziamento con soggetti portatori di interessi commerciali in campo sanitario

SINSeB
NUTRIZIONE SPORT BENESSERE

www.sinseb.it

TOPICS

- Composizione Corporea
- Nutrizione sportiva nell'Atleta Master nei vari sport
- Nutraceutica per la prevenzione e a supporto della prestazione sportiva
- Rischio cardiovascolare nell'Atleta Master
- Medicina sportiva e prevenzione degli infortuni
- Sarcopenia: Esercizio fisico e Nutrizione

Marketing of Nutraceuticals in Sports

"The market for nutraceuticals is booming."

Market Trends

1.Market Size: The global nutraceutical market is estimated to be worth $488.41 billion in 2024 and is expected to reach $626.02 billion by 2029, with a compound annual growth rate (CAGR) of 5.09%.

2.Growth in Italy: In Italy, the dietary supplements sector, which includes nutraceuticals, is worth about €3.8 billion and is expected to grow further.

Growth Factors

•**Interest in Health and Wellness**: The growing interest in maintaining overall health and wellness is one of the main factors driving market growth.

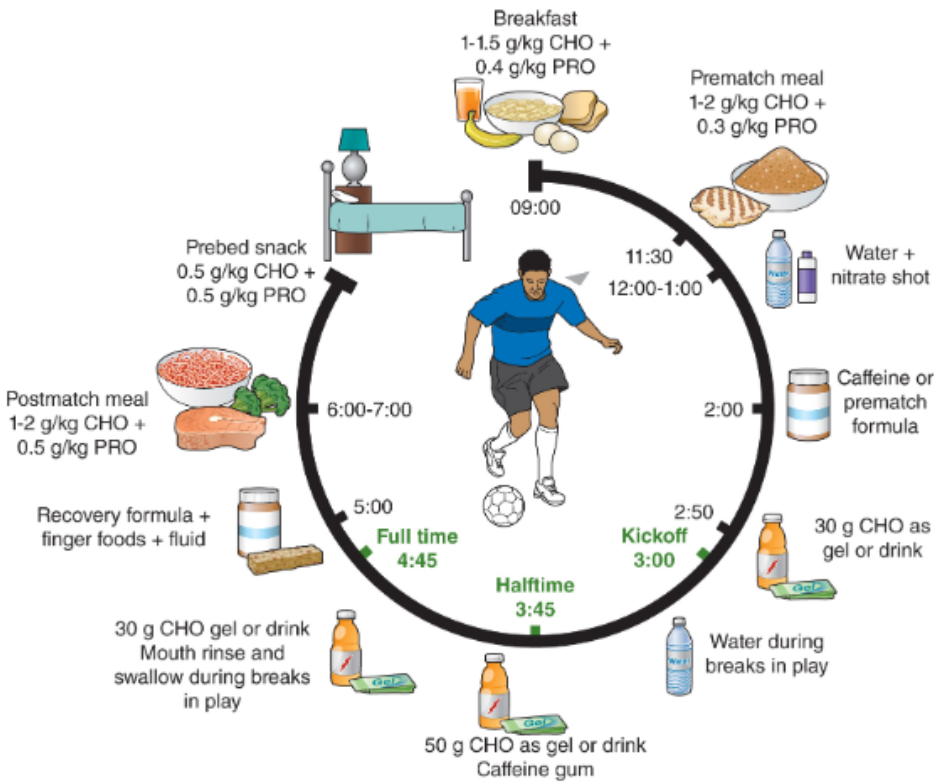
•**Regulation and Quality**: Companies must adhere to strict quality standards and regulations to ensure the safety and efficacy of their products, which is crucial for maintaining consumer trust.

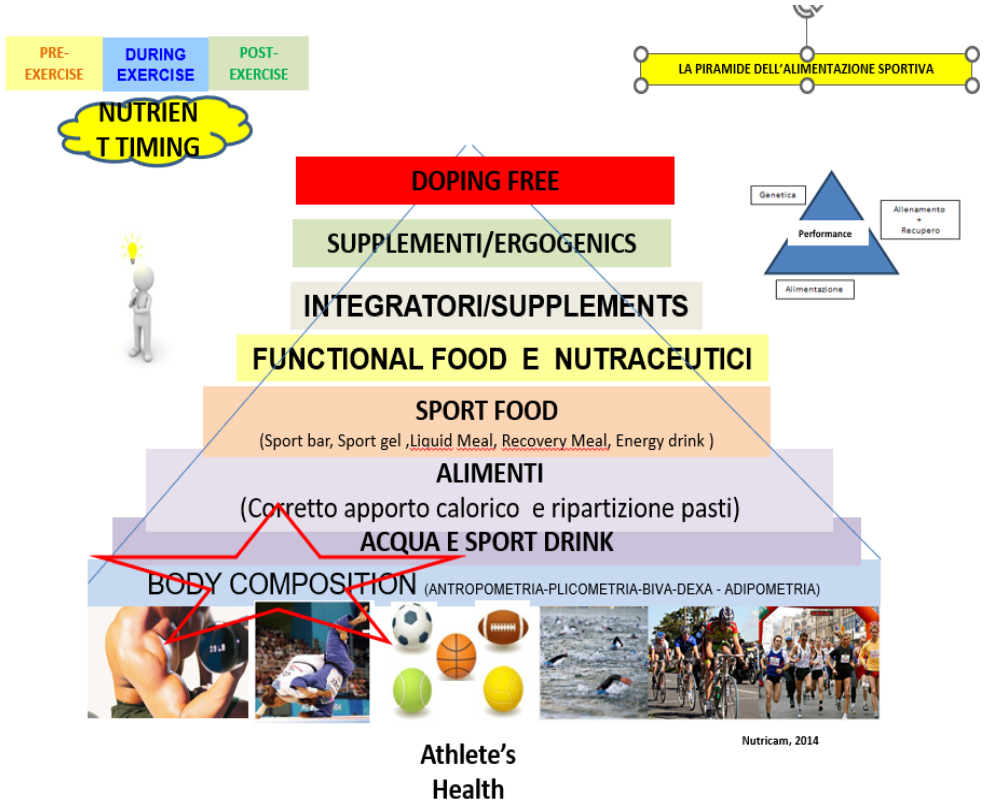
Future Prospects

The nutraceutical market in sports is expected to grow further due to the increasing demand for products that enhance sports performance and recovery, as well as ongoing innovation in the sector.

The complexity of sports nutrition

The complexity of sports nutrition





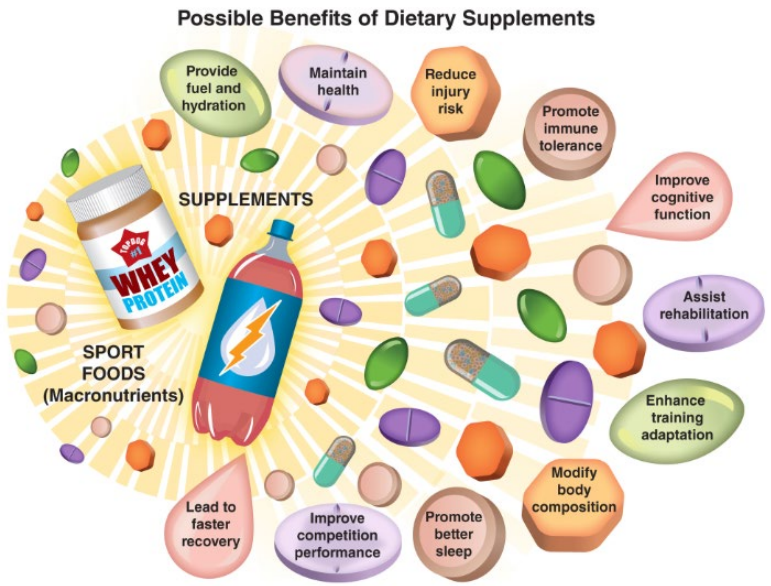
Athlete's Health

Athletes and Possibile Benefits of Nutraceuticals

Consensus statement

IOC consensus statement: dietary supplements and the high-performance athlete

To cite: Maughan RJ, Burke LM, Dvorak J, *et al*. *Br J Sports Med* 2018;**52**:439–455.



ATHLETES USE SUPPLEMENTS

1. ***to correct or prevent nutrient deficiencies that may impair health or performance***

2. *for convenient provision of energy and nutrients around an exercise session*

3. ***to achieve a specific and direct performance benefit in competition***

4. *to gain a performance improvement indirectly accrued from outcomes such as allowing more effective training (ie, higher intensity, greater volume), better recovery from training sessions, optimising mass and body composition, or reducing risks of injury and illness*

5. ***for financial gain (sponsorship) or because products are provided free of charge***

6. *as a 'just in case' insurance policy*

7. ***because they know or believe that other athletes/competitors are using the supplement(s).***

Nutraceuticals in Sports

The complexity of sports performance

It is difficult to quantify in percentage terms how much proper nutrition and/or supplementation influences sports performance, as there are multiple factors that contribute to optimizing good performance, from genetics to training, from environmental factors such as hot or cold climate, to humidity levels or the athlete's psychology.

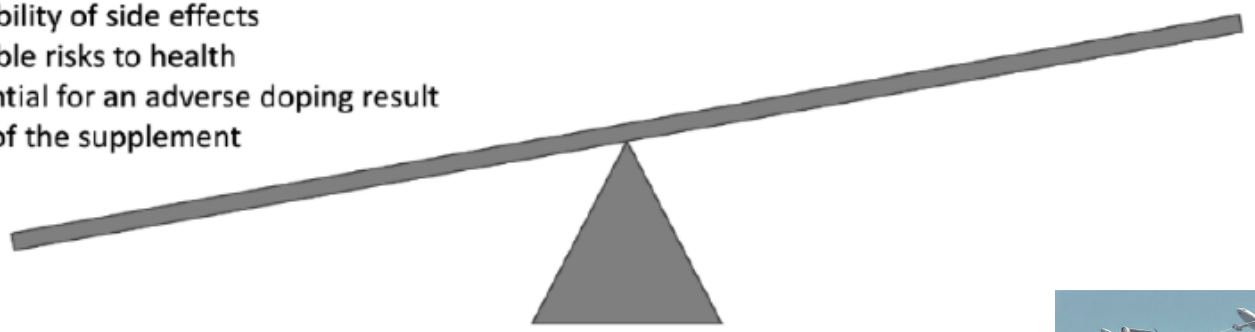
Potential Risks Vs Benefits of Nutraceuticals

Risks or the costs

- the possibility that the supplement is ineffective
- the possibility that the supplement may actually decrease performance
- the possibility that the supplement does not contain the active substance
- the possibility that the supplement contains unwanted substances
- the possibility of side effects
- the possible risks to health
- the potential for an adverse doping result
- the cost of the supplement

Potential benefits

- correction of nutrient deficiencies
- achievement of nutritional goals
- enhancement of a physiological/biochemical function to directly or indirectly improve performance



Source: adapted from Maughan, Burke et al., 2018, https://goo.gl/vF6Tji

Risk of contamination

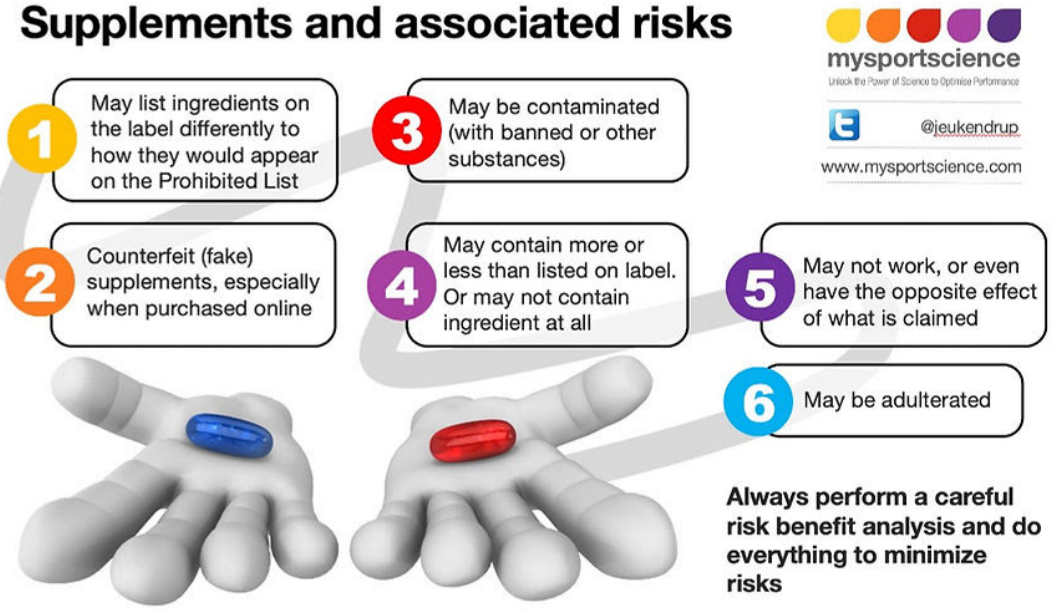
nutrients

MDPI

Review

Intended or Unintended Doping? A Review of the Presence of Doping Substances in Dietary Supplements Used in Sports

José Miguel Martínez-Sanz [1,2,*], Isabel Sospedra [1,2], Christian Mañas Ortiz [3], Eduard Baladía [2,4], Angel Gil-Izquierdo [2,5] and Rocio Ortiz-Moncada [2,6]



With rates of contamination between 12 and 58%, non-intentional doping is a point to take into account before establishing a supplementation program.

A Big Problem

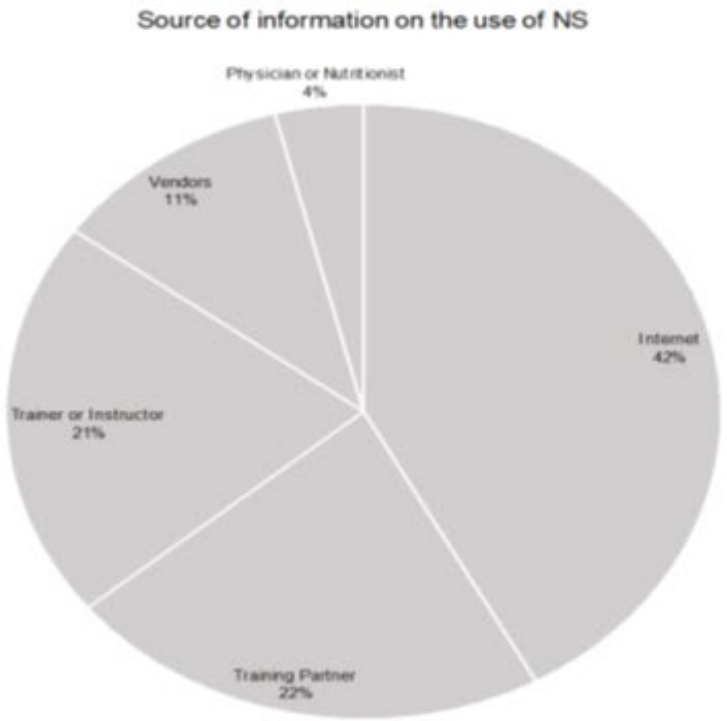
N. 3148

- **M 92,2% F 7,8%**

International Journal of Medical Science and Health Research
Vol. 3, No. 02; 2019
ISSN: 2581-3366

Nutritional Supplements Use in Physically Active Italian Adults: What Do They Use and How Are They Influenced?

Roberto Cannataro[1]*, Virginia Lemon[2], Maria Cristina Caroleo[1], Erika Cione[1] and Stella Lucia Volpe[2].



ATTENTION
Supplements whithout Evidence

Table 3 Summary of categorization of dietary supplements based on available literature

Category	Muscle building supplements	Performance enhancement
I. Strong Evidence to Support Efficacy and Apparently Safe	• HMB • Creatine monohydrate • Essential amino acids (EAA) • Protein	• β-alanine • Caffeine • Carbohydrate • Creatine Monohydrate • Sodium Bicarbonate • Sodium Phosphate • Water and Sports Drinks
II. Limited or Mixed Evidence to Support Efficacy	• Adenosine-5'-tri… • Branched-ch… (BCAA) • Phosph…	• L-Alanyl-L-Glutamate • Arachidonic acid • Branched-chain amino acids (BCAA) • Citrulline • Essential amino acids (EAA) • Glycerol • HMB • Nitrates • Post-exercise carbohydrate and protein • Quercetin • Taurine
III. Little to No Evidence to Support Efficacy and/or Safety	• Agmatine sulfate • Alpha-ketoglutarate • Arginine • Boron • Chromium • Conjugated linoleic acids (CLA) • D-Aspartic acid • Ecdysterones • Fenugreek extract • Gamma oryzanol (Ferulic acid) • Glutamine • Growth-hormone releasing peptides and Secretogogues • Isoflavones • Ornithine-alpha-ketoglutarate • Prohomones • Sulfo-polysaccharides • *Tribulus terrestris* • Vanadyl sulfate • Zinc-magnesium aspartate	• Arginine • Carnitine • Glutamine • Inosine • Medium-chain triglycerides (MCT) • Ribose

SUPPLEMENTS WITH STRONG EVIDENCE

Kerksick *et al. Journal of the International Society of Sports Nutrition* (2018) 15:38
https://doi.org/10.1186/s12970-018-0242-y

Journal of the International Society of Sports Nutrition

REVIEW Open Access

ISSN exercise & sports nutrition review update: research & recommendations

Tabella 11.2 – Integratori e prodotti per lo sport suddivisi in base all'efficacia d'azione, alla sicurezza d'uso e ai vigenti regolamenti antidoping internazionali.

Gruppo A	Integratore
Prodotti dall'efficacia comprovata in alcuni sport e per specifiche situazioni (il cui uso prevede protocolli basati sull'evidenza)	
Prodotti per lo sport: *sono prodotti specifici utili per fornire una fonte pratica di nutrienti* ***quando è impraticabile consumare alimenti d'uso comune***	**Prodotti per lo sport:** Bevande per lo sport Gel per lo sport Gelatine e caramelle per lo sport Pasti liquidi Proteine del siero di latte Barrette energetiche Elettroliti
Integratori o farmaci: *vengono usati per trattare problemi clinici, incluse carenze nutritive diagnosticate. Richiedono, pertanto, prescrizione o consiglio e supervisione da parte di un medico qualificato*	**Integratori o farmaci:** Integratori di calcio Integratori di ferro Probiotici Multivitaminici/minerali Vitamina D
Aiuti ergogenici: *utili per contribuire al miglioramento della prestazione sportiva se adoperati con protocolli individuali sotto la direzione di un medico sportivo o altro professionista qualificato. Sebbene sussista un'evidenza di base per l'uso di questi prodotti, spesso è necessaria una ricerca supplementare per ottimizzare i protocolli per l'uso specifico e individuale.*	**Aiuti Ergogenici:** Caffeina Beta alanina Bicarbonato Succo di barbabietola/nitrati Creatina

Nutraceuticals and Sport

Nutrition supplement	Description	Claim	Scientific evidence
Androstenedione	Synthetic product to stimulate testosterone synthesis	Increases testosterone, increases muscle mass, and improves recovery	Does not increase testosterone and has no effect on strength
Ashwagandha	Herb	Adaptogen that reduces stress, increases muscle mass, and improves performance	No effect on performance
Bee pollen	Mixture of bee saliva, plant nectar, and pollen	Increases energy levels, enhances physical fitness, improves endurance, and boosts immune function	No supporting evidence
Beetroot juice	A good source of dietary nitrate (NO_3^-)	Decreases the oxygen cost of exercise and improves endurance exercise performance	Decreases the oxygen cost of exercise and improves endurance exercise performance
β-alanine	Amino acid that in combination with histidine forms the dipeptide carnosine, which is an important intracellular buffer	Buffers hydrogen ions in muscle and improves high-intensity exercise performance	Positive effects in high-intensity exercise capacity tests, but evidence for improvements in performance tests is lacking
β-hydroxy β-methylbutyrate (HMB)	Metabolite of the essential amino acid leucine	Decreases protein breakdown, improves muscle mass, and increases strength	Possible small effects on lean body mass and strength

Nutrition supplement	Description	Claim	Scientific evidence
Caffeine	Substance in coffee and chocolate	Increases performance and alertness	Improves performance in most events except short high-intensity exercise and increases cognitive functioning during exercise
Cannabidiol	Nonpsychoactive substance from the cannabis plant	Has anxiolytic properties, reducing emotional responses to stress, fearful memories, and pain; also has anti-inflammatory actions	Some evidence that it could assist recovery from exercise but no supporting evidence for improving performance
Carnitine	Vitamin-like substance important for FA transport	Improves fat oxidation and endurance exercise performance, helps weight loss, and improves $\dot{V}O_2$max	Taken up by muscle; if coingested with carbohydrate, improves performance in endurance exercise
Choline	Precursor of the neurotransmitter acetylcholine	Improves performance and decreases fatigue	No supporting evidence
Chromium	Trace element that potentiates insulin action	Builds muscle and helps weight loss	No supporting evidence
Coenzyme Q10	Part of the electron-transport chain in the mitochondria	Improves $\dot{V}O_2$max, improves performance, and reduces fatigue	No supporting evidence
Cordyceps	Mushroom	Improves cognitive function and exercise performance	Limited supporting evidence

Nutrition supplement	Description	Claim	Scientific evidence
Creatine	High-energy phosphate carrier important for direct energy	Improves strength, reduces fatigue, and increases protein synthesis	Improves performance in single and repeated sprint bouts and improves recovery between bouts; anabolic properties unclear
Dehydroepiandrosterone (DHEA)	A precursor of testosterone and estradiol	Improves immune function, increases life span, protects against cardiovascular diseases, increases lean body mass, and increases well-being	Some evidence in humans for improved well-being
Dihydroxyacetone (DHA) and pyruvate	Intermediates of carbohydrate metabolism usually used in combination	Facilitate carbohydrate and fat metabolism and improve endurance performance, insulin sensitivity, and recovery and increase glycogen storage	Limited supporting evidence
Fish oil and omega-3 fatty acids	Polyunsaturated fatty acids	Increase $\dot{V}O_2$max and muscle protein synthesis, enhance recovery from damaging exercise, and improve cognitive function	No supporting evidence for increased $\dot{V}O_2$max, but some evidence for the other effects with combinations of DHE and EHA
Ginseng	Root of the Araliaceae plant	Improves strength, performance, stamina, and cognitive functioning and reduces fatigue	No supporting evidence, but studies were poorly designed
Glandulars	Extracts of animal glands	Improve strength, performance, and stamina	No supporting evidence
Green tea	Plant leaf extract containing polyphenol catechins and caffeine	Increases fat oxidation at rest and during exercise	Limited supporting evidence
Glycerol	Backbone of a triacylglycerol molecule	Induces hyperhydration, decreases heat stress, and improves performance	Induces hyperhydration and decreases heat stress during exercise; effects on performance unclear
Inosine	Nucleoside	Increases ATP stores and improves strength, training quality, and performance	No supporting evidence
Ketone salts	Sodium or potassium salts of ketone bodies (β-hydroxy butyrate or acetoacetate)	Alternative fuel for muscle, is glycogen sparing, and increases endurance performance	No supporting evidence
Lecithin	Phosphatidylcholine	Increases $\dot{V}O_2$max and performance	No supporting evidence
Medium-chain triacylglycerol (MCT)	Synthesized from coconut oil	Supplies energy, reduces muscle glycogen breakdown, and improves performance	No supporting evidence
Pangamic acid	Varied composition depending on supplier	Increases oxygen delivery	No supporting evidence
Phosphate salts	Mineral	Increases ATP, provides energy, and buffers lactic acid	Possible ergogenic effects; improves performance in events 1 hour or shorter
Phosphatidylserine	Structural component of cell membranes	Reduces stress responses and improves recovery	Little supporting evidence
Polylactate and lactate salts	Polymers of lactate	Provide energy	No effect on performance
Pyruvate	Intermediate of carbohydrate metabolism	Facilitates carbohydrate metabolism and improves endurance performance and recovery	Limited supporting evidence
Polyphenols	Plant phytonutrient such as flavonoids that contain multiple phenolic groups (e.g., quercetin)	Improves endurance performance	Limited evidence of improved performance in sufficient doses
Sodium bicarbonate	Buffer present in blood	Buffers lactic acid and improves high-intensity exercise performance	Improves high-intensity exercise performance

Nutrition supplement	Description	Claim	Scientific evidence
Sodium citrate	Buffer	Buffers lactic acid and improves high-intensity exercise performance	Can improve performance with larger doses
Sodium nitrate	Mineral source of nitrate	Decreases the oxygen cost of exercise and improves endurance exercise performance	Decreases the oxygen cost of exercise and improves endurance exercise performance
Vanadium	Trace element	Helps weight loss and improves insulin sensitivity and recovery	Increases insulin sensitivity in patients with insulin resistance; studies in healthy individuals lacking
Wheat germ oil	Extracted from embryo of wheat	Improves endurance	No supporting evidence

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HYDRATION IN SPORT
WATER COCONUT SUPER DRINK
Myth or reality?

Pros:

1.Natural Electrolytes: Coconut water contains naturally occurring electrolytes like potassium, sodium, magnesium, and calcium, which are essential for hydration.

2.Low in Calories: It's generally lower in calories compared to many sports drinks, making it a lighte hydration option.

3.No Added Sugars: Pure coconut water doesn't contain added sugars, artificial colors, or preservatives.

4.Antioxidant Properties: Coconut water has antioxidants which can help neutralize oxidative stress and free radicals.

5.Digestive Health: It can aid in digestion due to its fiber content and bioactive enzymes.

Cons:

1.Taste: Some people find the taste of coconut water to be an acquired one and may not prefer its natural, nutty flavor.

2.Cost: It can be more expensive than most sports drinks, especially if it's organic or from premium brands.

3.Lower Sodium: While it's rich in potassium, it's lower in sodium, which is a crucial electrolyte lost in sweat.


Kalman et al. Journal of the International Society of Sports Nutrition 2012, 9:1
http://www.jissn.com/content/9/1/1

jissn

RESEARCH ARTICLE Open Access

Comparison of coconut water and a carbohydrate-electrolyte sport drink on measures of hydration and physical performance in exercise-trained men

Douglas S Kalman[1], Samantha Feldman[1], Diane R Krieger[1] and Richard J Bloomer[2*]

sports MDPI

Brief Report

Coconut Water: A Sports Drink Alternative?

Brendan J. O'Brien [1,*], Leo R. Bell [1], Declan Hennessy [2], Joshua Denham [3,4] and Carl D. Paton [5]

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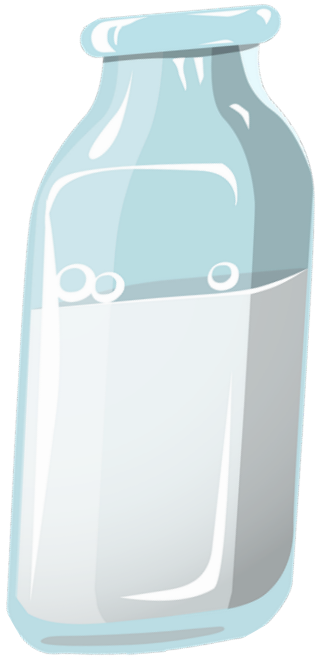
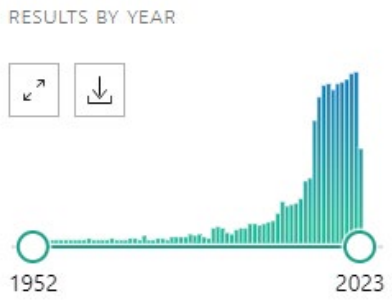
HYDRATION IN SPORT
Milk the new sport drink
Myth or reality?





Journal of the International Society of Sports Nutrition

BioMed Central

Review

Open Access

Milk: the new sports drink? A Review

Brian D Roy

Address: Centre for Muscle Metabolism and Biophysics, Faculty of Applied Health Sciences, Brock University, St. Catharines, Ontario, Canada
Email: Brian D Roy - Brian.Roy@brocku.ca

Published: 2 October 2008
Journal of the International Society of Sports Nutrition 2008, 5:15 doi:10.1186/1550-2783-5-15

Received: 18 June 2008
Accepted: 2 October 2008

British Journal of Nutrition (2007), **98**, 173–180
© The Authors 2007

Milk as an effective post-exercise rehydration drink

Susan M. Shirreffs*, Phillip Watson and Ronald J. Maughan
School of Sport and Exercise Sciences, Loughborough University, Loughborough LE11 3TU, UK

(Received 14 July 2006 – Revised 19 January 2007 – Accepted 24 January 2007)

Randomized Controlled Trial > Am J Clin Nutr. 2016 Mar;103(3):717-23.
doi: 10.3945/ajcn.115.114769. Epub 2015 Dec 23.

A randomized trial to assess the potential of different beverages to affect hydration status: development of a beverage hydration index

Ronald J Maughan [1], Phillip Watson [2], Philip Aa Cordery [2], Neil P Walsh [3], Samuel J Oliver [3], Alberto Dolci [3], Nidia Rodriguez-Sanchez [4], Stuart Dr Galloway [4]

Affiliations + expand
PMID: 26702122 DOI: 10.3945/ajcn.115.114769

Randomized Controlled Trial > Br J Nutr. 2013 Oct;110(7):1285-91.
doi: 10.1017/S0007114513000536. Epub 2013 May 31.

Effect of varying the concentrations of carbohydrate and milk protein in rehydration solutions ingested after exercise in the heat

Lewis J James [1], Gethin H Evans, Joshua Madin, Darren Scott, Michael Stepney, Russell Harris, Robert Stone, David J Clayton

Eur J Appl Physiol (2008) 104:633–642
DOI 10.1007/s00421-008-0809-4

ORIGINAL ARTICLE

A comparison of the effects of milk and a carbohydrate-electrolyte drink on the restoration of fluid balance and exercise capacity in a hot, humid environment

Phillip Watson · Thomas D. Love · Ronald J. Maughan · Susan M. Shirreffs

Randomized Controlled Trial > Appl Physiol Nutr Metab. 2014 Dec;39(12):1366-72.
doi: 10.1139/apnm-2014-0174. Epub 2014 Aug 14.

Comparing the rehydration potential of different milk-based drinks to a carbohydrate-electrolyte beverage

Ben Desbrow [1], Sarah Jansen, Abby Barrett, Michael D Leveritt, Christopher Irwin

Review > J Appl Physiol (1985). 2017 Apr 1;122(4):945-951. doi: 10.1152/japplphysiol.00745.2016.
Epub 2017 Jan 26.

Optimizing the restoration and maintenance of fluid balance after exercise-induced dehydration

Gethin H Evans [1], Lewis J James [2], Susan M Shirreffs [3], Ronald J Maughan [2]

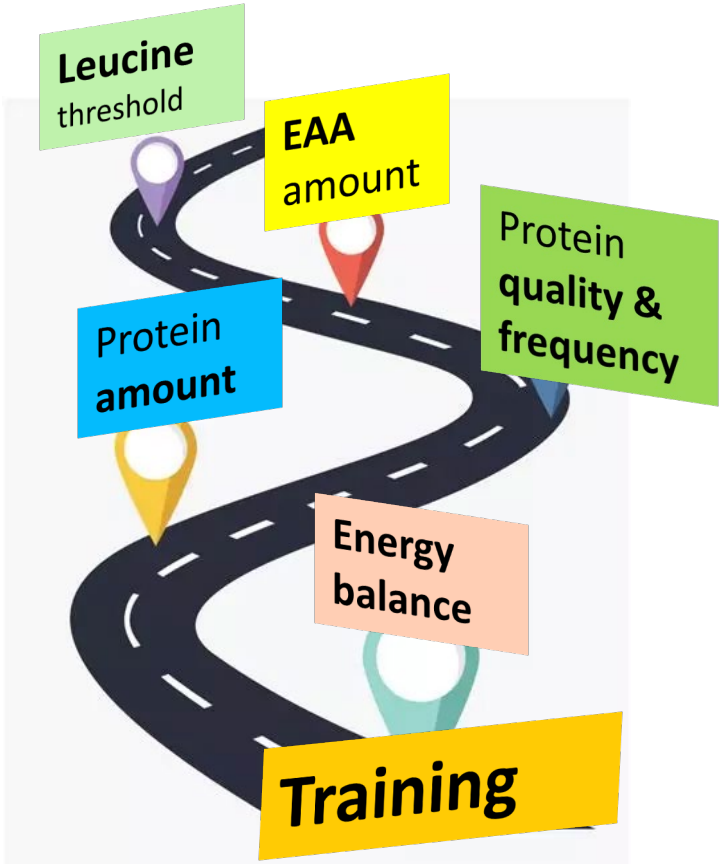
Affiliations + expand
PMID: 28126906 DOI: 10.1152/japplphysiol.00745.2016

HYDRATION IN SPORT
Milk the new sport drink
Myth or reality?

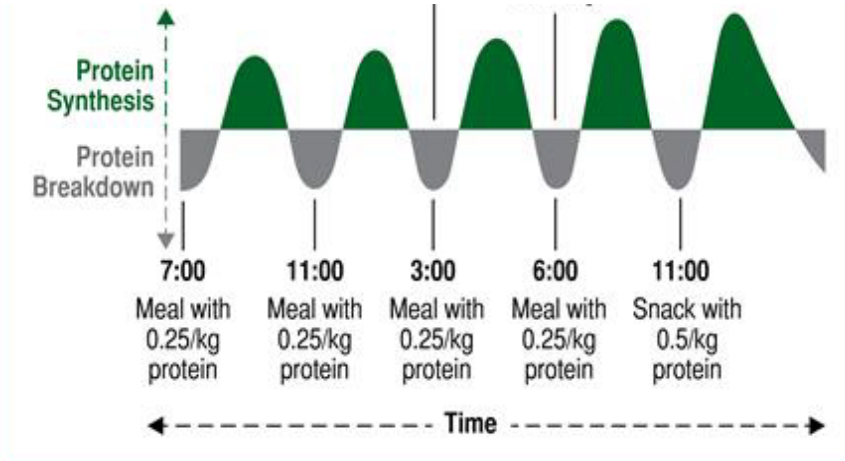
"Milk is a complex drink containing sodium, potassium, carbohydrate, and protein, constituents that may all independently and positively influence rehydration either by affecting the composition of the extracellular fluid or by reducing the overall rate of fluid absorption."

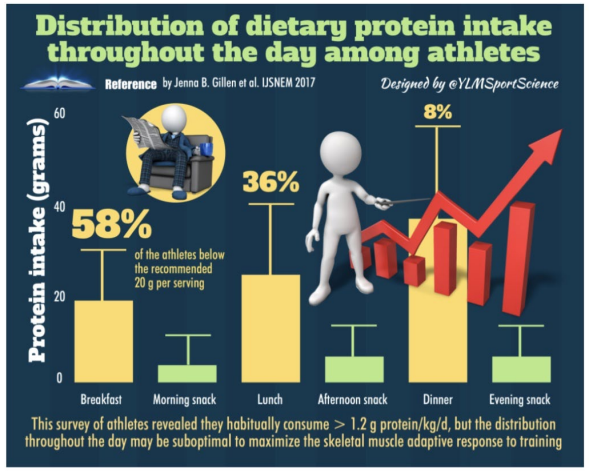
Evans, G. H., James, L. J., Shirreffs, S. M., & Maughan, R. J. (2017). Optimizing the restoration and maintenance of fluid balance after exercise-induced dehydration. *Journal of applied physiology(Bethesda,Md.:1985)*,*122*(4),945–951. https://doi.org/10.1152/japplphysiol.00745.2016

DIETARY PROTEIN IN SPORT



- Protein quality and Protein intake
- Protein Source
- Protein Safety
- Protein Supplement and performance
- Timing
- EAA





Importance of Quality Supplements

molecules

MDPI

Article

Focus on the Protein Fraction of Sports Nutrition Supplements

Luisa Pellegrino, Johannes A. Hogenboom, Veronica Rosi, Marta Sindaco, Stefano Gerna and Paolo D'Incecco *

Abstract: Increasing awareness of balanced diet benefits is boosting the demand for high-protein food and beverages. Sports supplements are often preferred over traditional protein sources to meet the appropriate dietary intake since they are widely available on the market as stable ready-to-eat products. However, the protein components may vary depending on both sources and processing conditions. The protein fraction of five commercial sports supplements was characterized and compared with that of typical industrial ingredients, i.e., whey protein concentrates and isolates and whey powder. The capillary electrophoresis profiles and the amino acid patterns indicated that, in some cases, the protein was extensively glycosylated and the supplemented amino acids did not correspond to those declared on the label by manufacturers. The evaluation by confocal laser scanning microscopy evidenced the presence of large aggregates mainly enforced by covalent crosslinks. The obtained findings suggest that, beside composition figures, provisions regarding sports supplements should also consider quality aspects, and mandatory batch testing of these products would provide more reliable information to sport dieticians.

Citation: Pellegrino, L.; Hogenboom, J.A.; Rosi, V.; Sindaco, M.; Gerna, S.; D'Incecco, P. Focus on the Protein Fraction of Sports Nutrition Supplements. *Molecules* **2022**, *27*, 3487. https://doi.org/10.3390/molecules27113487

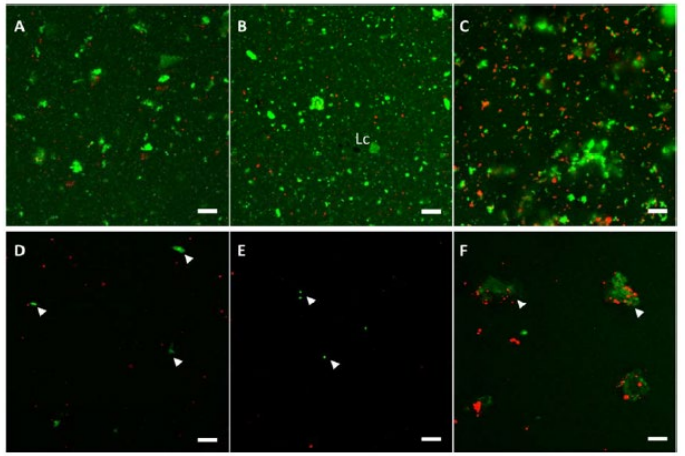
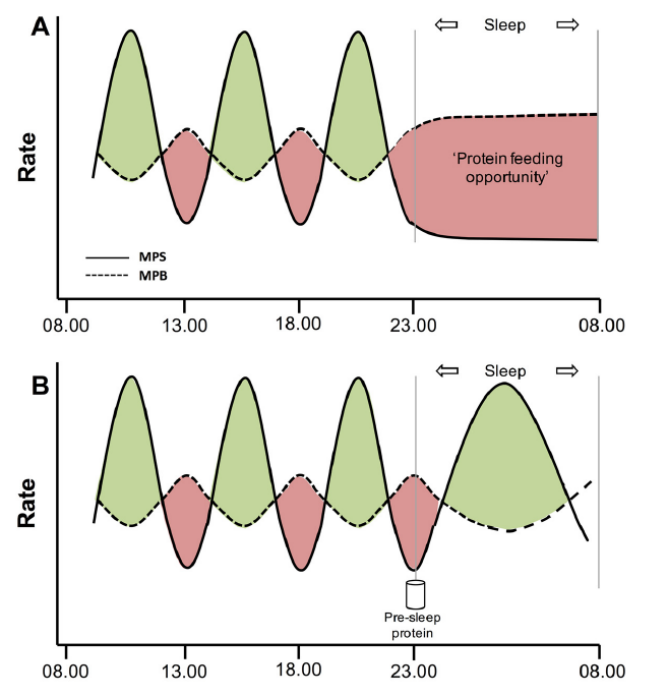


Figure 2. CLSM of whey powder (WP) (**A**), whey protein concentrate (WPC) (**B**) and Y08 (**C**) samples rehydrated with water (upper row) and subsequently solubilized with urea/DDT buffer (lower row).

- **Aggregates and Protein glycosilated**
- **Nutrition Facts Label**

Protein and Sleep

Recent studies investigating the impact of pre-sleep protein ingestion suggest that at least 40 g of protein is required to display a robust increase in muscle protein synthesis rates throughout overnight sleep



nutrients
MDPI

Review

Pre-Sleep Protein Ingestion to Improve the Skeletal Muscle Adaptive Response to Exercise Training

Jorn Trommelen and Luc J. C. van Loon *

NUTRIM School of Nutrition and Translational Research in Metabolism, Maastricht University Medical Centre+, P.O. Box 616, Maastricht 6200 MD, The Netherlands; jorn.trommelen@maastrichtuniversity.nl
* Correspondence: l.vanloon@maastrichtuniversity.nl; Tel.: +31-43-388-1397

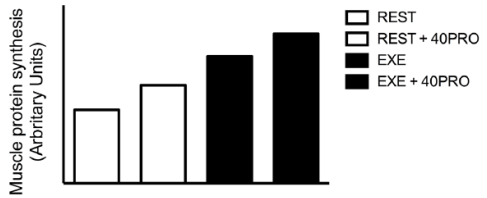
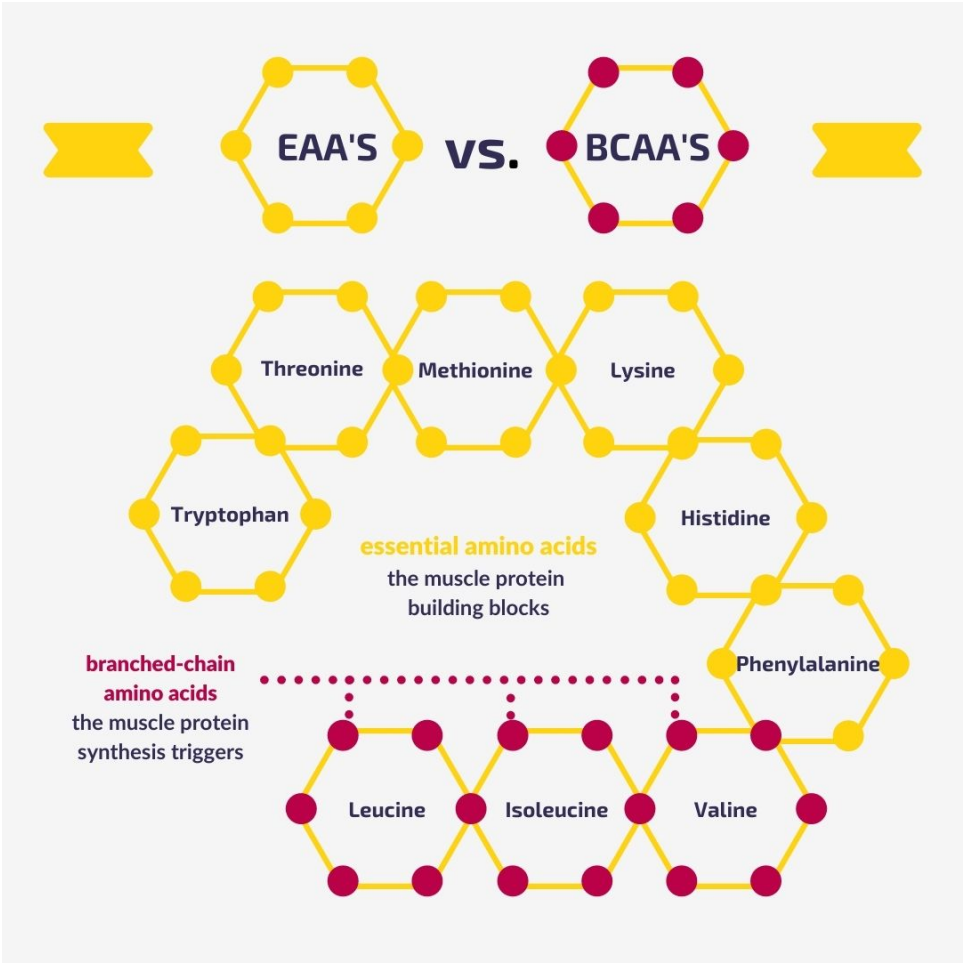


Figure 2. Conceptual framework of the overnight muscle protein synthetic response to 40 g of pre-sleep protein feeding at rest or following prior exercise.

Figure 1. Schematic representation of the process of muscle protein synthesis (MPS) and muscle protein breakdown (MPB) throughout the day. Protein ingestion stimulates MPS rates and allows for net muscle protein accretion (green areas). During post-absorptive conditions, MPB rates exceed MPS rates, resulting in a net loss of muscle protein (red areas). Overnight sleep is the longest post-absorptive period of the day (**A**). Pre-sleep protein ingestion stimulates overnight muscle protein synthesis rates (**B**), thereby improving muscle reconditioning during overnight sleep.


EAAs vs BCAAs


EAA'S
vs.
BCAA'S
Threonine
Methionine
Lysine
Tryptophan
Histidine
essential amino acids
the muscle protein
building blocks
branched-chain
amino acids
the muscle protein
synthesis triggers
Phenylalanine
Leucine
Isoleucine
Valine

BCAA vs EAA

Wolfe *Journal of the International Society of Sports Nutrition* (2017) 14:30
DOI 10.1186/s12970-017-0184-9

Journal of the International Society of Sports Nutrition

REVIEW Open Access

Branched-chain amino acids and muscle protein synthesis in humans: myth or reality?

Robert R. Wolfe

At present, we do not believe there is sufficient evidence to recommend BCAA supplements for enhancing muscle anabolism or alleviating muscle damage or, for that matter, for any other reason.

Sufficient high-quality protein or EAA (that naturally includes BCAA)

Education

Supplements used to prevent or treat nutrient deficiencies

Consensus statement

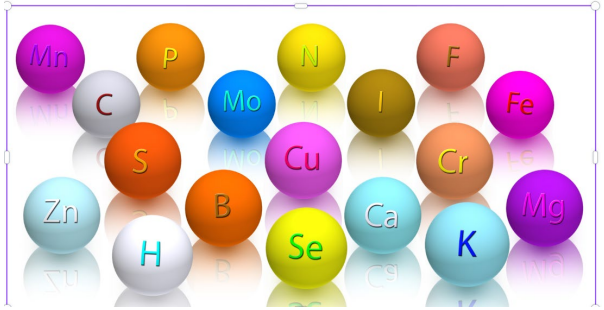
IOC consensus statement: dietary supplements and the high-performance athlete

To cite: Maughan RJ, Burke LM, Dvorak J, *et al*. *Br J Sports Med* 2018;**52**:439–455.

Table 1 Examples of micronutrients often requiring supplementation in athletes (see Larson-Meyer *et al*[18] for additional information)

Micronutrient	Overview	Diagnosis and outcomes of insufficiency	Protocols and outcomes of supplementation
Vitamin D	It is important in the regulation of gene transcription in most tissues, so insufficiency/deficiency affects many body systems.[42] Many athletes are at risk of insufficiency at various times throughout the year.[43]	No consensus over the serum 25-hydroxyvitamin D concentration (the marker of vitamin D status) that defines deficiency, insufficiency, sufficiency and a tolerable upper limit. The need to supplement depends on UVB exposure and skin type.	Supplementation of between 800 IU and 1000–2000 IU/day is recommended to maintain status for the general population. Supplementation guidelines are not yet established in athletes. Short-term, high-dose supplementation which includes 50 000 IU/week for 8–16 weeks or 10 000 IU/day for several weeks may be appropriate for restoring status in deficient athletes. Careful monitoring is necessary to avoid toxicity.[44]
Iron	Suboptimal iron status may result from limited iron intake, poor bioavailability and/or inadequate energy intake, or excess iron need due to rapid growth, high-altitude training, menstrual blood loss, foot-strike haemolysis, or excess losses in sweat, urine or faeces.[45]	Several measures performed simultaneously provide the best assessment and determine the stage of deficiency. Recommended measures: serum ferritin, transferrin saturation, serum iron, transferrin receptor, zinc protoporphyrin, haemoglobin, haematocrit and mean corpuscular volume.[46]	Athletes who do not maintain adequate iron status may need supplemental iron at doses greater than their RDA (ie, >18 mg/day for women and >8 mg/day for men). Athletes with iron deficiency require clinical follow-up, which may include supplementation with larger doses of oral iron supplementation along with improved dietary iron intake.[45] Numerous oral iron preparations are available and most are equally effective as long as they are taken.[47] High-dose iron supplements, however, should not be taken unless iron deficiency is present.
Calcium	Avoidance of dairy products and other calcium-rich foods, restricted energy intake and/or disordered eating increases risk of suboptimal calcium status.[45]	There is no appropriate indicator of calcium status. Bone mineral density scan may be indicative of chronic low calcium intake, but other factors including suboptimal vitamin D status and disordered eating are also important.	Calcium intakes of 1500 mg/day and 1500–2000 IU vitamin D are recommended to optimise bone health in athletes with low energy availability or menstrual dysfunction.[45]

Note: Indiscriminate supplementation with any of the above nutrients is not recommended. Deficiencies should first be identified through nutritional assessment, which includes dietary intake and the appropriate blood or urinary marker, if available.[17]



A frank deficiency of one or more of these nutrients
may lead to a measurable impairment of sports performance—
either directly or by reducing the athlete's ability to
train effectively (eg, iron deficiency anaemia) or to stay free
from illness or injury (eg, impact of vitamin D deficiency on
bone health).

Supplements used to prevent or treat nutrient deficiencies

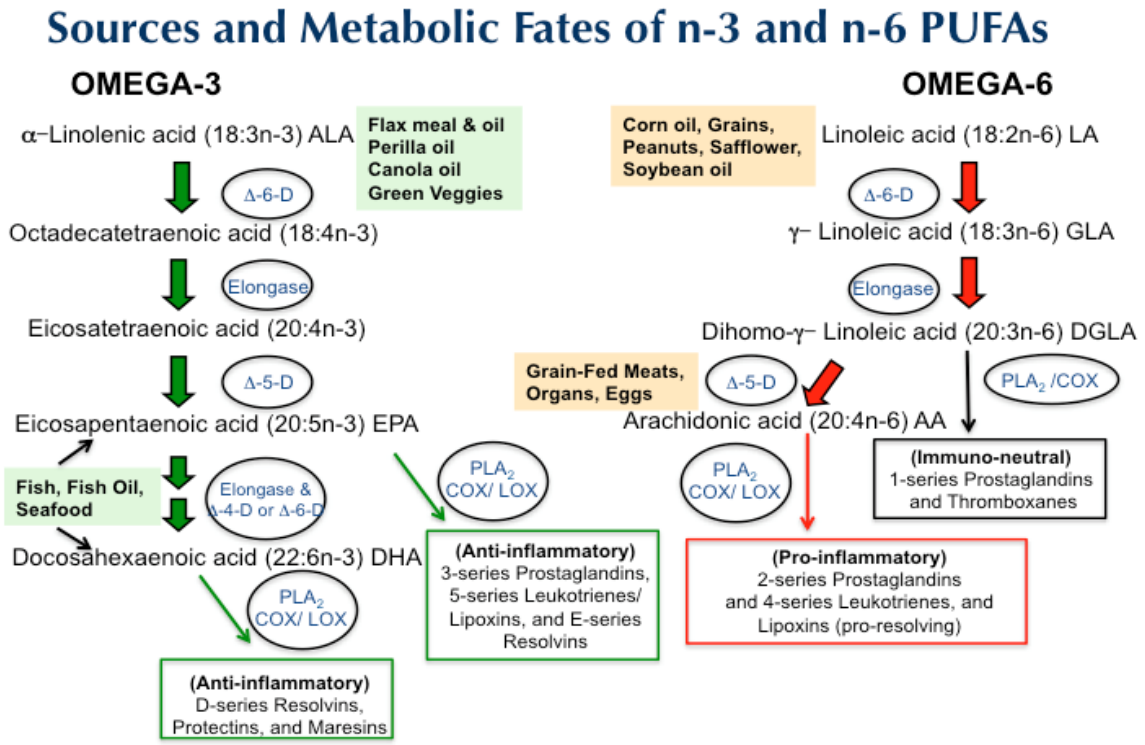
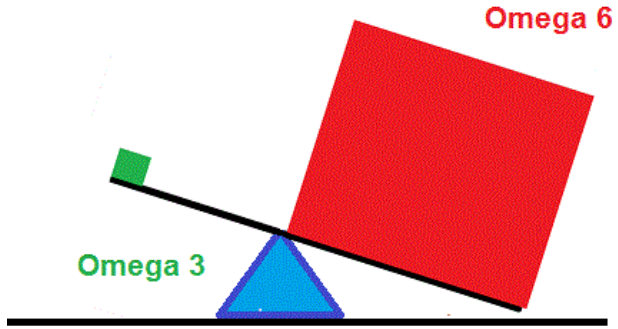


Figure 3: Sources of Essential Fatty Acids and Omega-3 / Omega-6 PUFA Metabolism. Lopez



Rapporto Omega6/Omega 3 nella popolazione italiana è tra 10 e 13 : 1

IOC consensus statement: dietary supplements and the high-performance athlete

Maughan RJ, et al. Br J Sports Med 2018;52:439–455.

Table 5 Supplements that may assist with training capacity, recovery, muscle soreness and injury management

Supplement	Proposed mechanism of action	Evidence for efficacy[41]
Omega-3 fatty acids About 2 g/day	Improved cognitive processing Decreased risk/enhanced recovery from mTBI Increased muscle protein synthesis Reduced symptoms of, or enhanced recovery from, muscle damaging exercise (eg, DOMS)	Improved cognitive processing following omega-3 fatty acid supplementation shown in healthy older adult with mild or severe cognitive impairment (reviewed in ref [138]). It is not known if these benefits would occur in young, healthy athletes, or how this would translate to athletic performance. Animal data show that the structural damage and cognitive decline associated with mTBI are reduced/attenuated with omega-3 fatty acid supplementation when ingested either before or after the injury (reviewed in refs [138–140]). Two case studies support these findings,[141 142] and large, double-blind, placebo-controlled trials are currently under way (ClinicalTrials.gov NCT101903525 and NCT01814527). In muscle, omega-3 fatty acid supplementation can increase muscle protein synthesis,[143 144] but this may not occur when protein is ingested after exercise in recommended amounts.[143 144] Anti-inflammatory effects of omega-3 fatty acid intake may reduce muscle damage or enhance recovery from intense, eccentric exercise (eg, decrease DOMS), but this is not a consistent finding.[145 146] No indication that decreased omega-3 fatty acids in the body impair performance, and high-dose supplements can cause some adverse effects (reviewed in refs [114 139]), so the best recommendation may be to include rich sources of omega-3 fatty acids, such as fatty fish, in the diet instead of supplements. Low risk but unclear if supplementation should be pursued by athletes, in lieu of including fatty fish in the diet as a source of omega-3 fatty acids. Fish oil or omega-3 fatty acid supplement consumption could include heavy metal contaminants, or cause bleeding, digestive problems and/or increased LDL.

Fat profile and precision nutraceutilcals supplements

FAT PROFILE SU ERITROCITI DI MEMBRANA RBCs e PLASMA

ACIDO GRASSO	NOME ACIDO GRASSO	% Acidi Grassi RBCs	Riferimento RBCs (%)	% Acidi Grassi plasma
ACIDI GRASSI SATURI (SFA)	Palmitico C16:0	23,3	17-27	28,4
	Stearico C18:0	20,9	13-20	14,1
ACIDI GRASSI MONO INSATURI (MUFA)	Palmitoleico C16:1 n-7	0,28	0,2-0,5	0,58
	Oleico C18:1 n-9	16,8	9-18	13,1
	Vaccenico C18:1 n-7	1,2	0,7-1,3	1,8
ACIDI GRASSI POLIINSATURI (PUFA)-Omega-6	Cis-Linoleico C18:2 n-6	8,9	9-16	13,9
	Diomo-gamma-Linolenico C20:3 n-6 DGLA	2,5	1,3-2,4	3,8
	Arachidonico C20:4 n-6 AA	16,0	13-17	13,3
ACIDI GRASSI POLIINSATURI (PUFA)-Omega-3	Eicosapentaenoico C20:5 n-3 EPA	0,32	0,5-0,9	0,37
	Docosaesaenoico C22:6 n-3 DHA	4,2	5-7	2,6

SFA	44	30-45
MUFA	18	13-23
PUFA	32	28-39
SFA/MUFA	2,4	1,7-2
OMEGA-6/OMEGA-3	6,1	3,5-5,5
OMEGA-3 INDEX	4,5	< 4 molto basso (rischio cardiovascolare) 4 - 6 basso 6 - 8 buono > 8 ottimale

AA/EPA	35,9	**Valore di riferimento** < 5 valore ottimale 5-15 valori popolazione > 15 valore patologico
EPA + DHA	3,0	< 2,9 molto basso 2,9 - 4,0 basso 4,0 -5,2 buono > 5,2 ottimale
AA/(EPA + DHA)	4,5	< 1 valore ottimale 1-3 popolazione media > 3 valore patologico

Indice Δ9- desaturasi 18:0/18:1	1,2	<0,7 iperattività 0,7-1,3 normale attività >1,3 ipoattività
Indice Δ6- desaturasi + elungasi 18:2/20:3	4	<5 iperattività 5-8 normale attività >8 ipoattività
Indice Δ5- desaturasi 20:4/20:3	6	<6 ipoattività 6-9 normale attività >9 iperattività
Indice Δ9- desaturasi 16:0/16:1	83	<45 iperattività 45-132 normale attività >132 ipoattività

- fuori limite
- poco sopra limite
- valori buoni
- valori ottimali

Relationship Between Distance Run Per Week, Omega-3 Index, and AA/EPA

Front Physiol. 2019 Apr 26;10:487. doi: 10.3389/fphys.2019.00487. eCollection 2019.
Davinelli S[1,2], Corbi G[1], Righetti S[3], Casiraghi E[4], Chiappero F[4], Martegani S[5], Pina R[4], De Vivo I[2,6], Simopoulos AP[7], Scapagnini G[1].

These findings suggest that distance running training and its weekly volume may negatively contribute to changes of the ω-3 index and AA/EPA ratio.

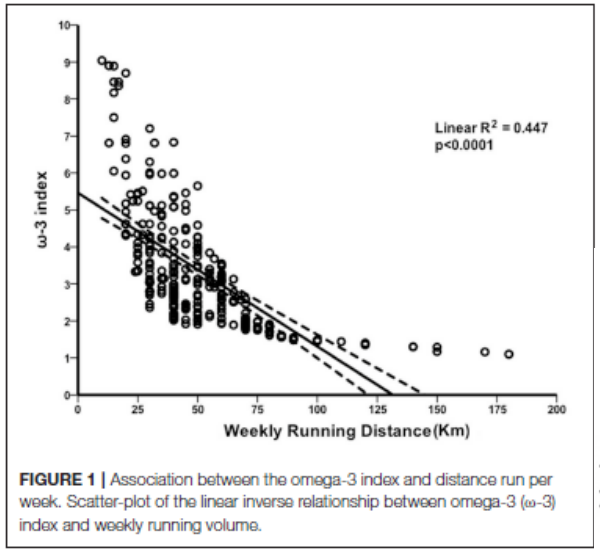
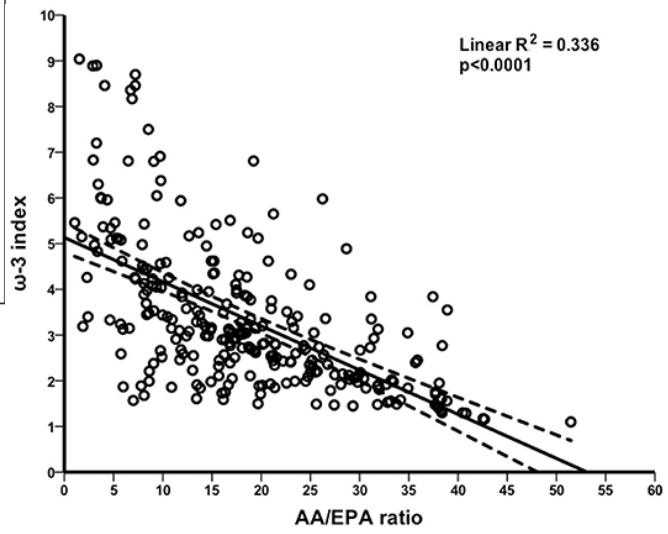


FIGURE 1 | Association between the omega-3 index and distance run per week. Scatter-plot of the linear inverse relationship between omega-3 (ω-3) index and weekly running volume.



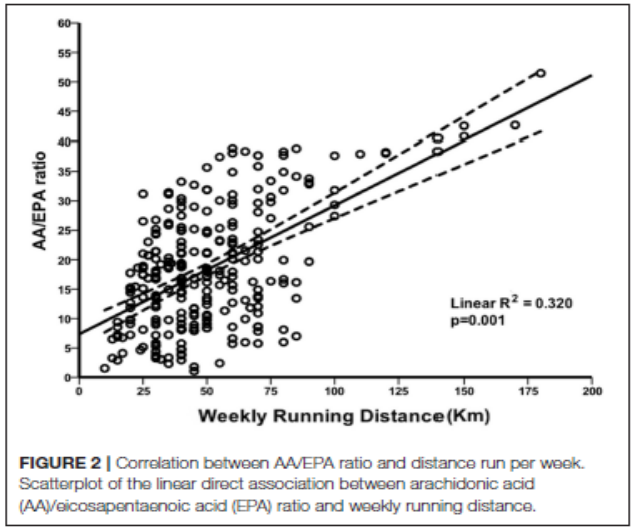


FIGURE 2 | Correlation between AA/EPA ratio and distance run per week. Scatterplot of the linear direct association between arachidonic acid (AA)/eicosapentaenoic acid (EPA) ratio and weekly running distance.

Original Research Communications ASN

Predicting the effects of supplemental EPA and DHA on the omega-3 index

Rachel E Walker,[1] Kristina Harris Jackson,[2] Nathan L Tintle,[3] Gregory C Shearer,[1,4] Aldo Bernasconi,[5] Serge Masson,[6] Roberto Latini,[6] Bobak Heydari,[7] Raymond Y Kwong,[8] Michael Flock,[9] Penny M Kris-Etherton,[1] Anne Hedengran,[10] Robert M Carney,[11] Ann Skulas-Ray,[12] Samuel S Gidding,[13] Antonella Dewell,[14] Christopher D Gardner,[14] S Marlene Grenon,[15] Barbara Sarter,[16] John W Newman,[17] Theresa L Pedersen,[18] Mark K Larson,[19] and William S Harris[2,4]

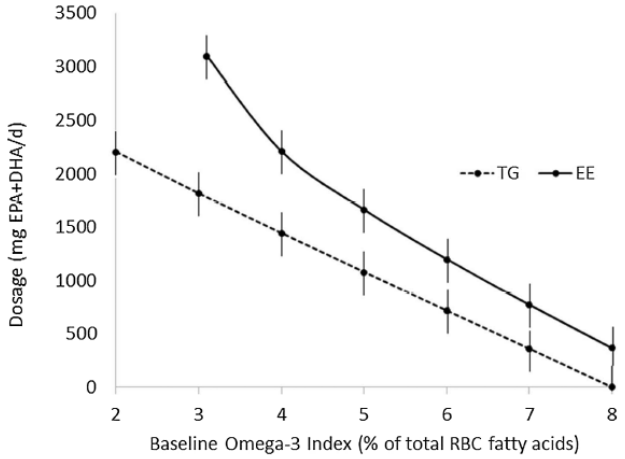
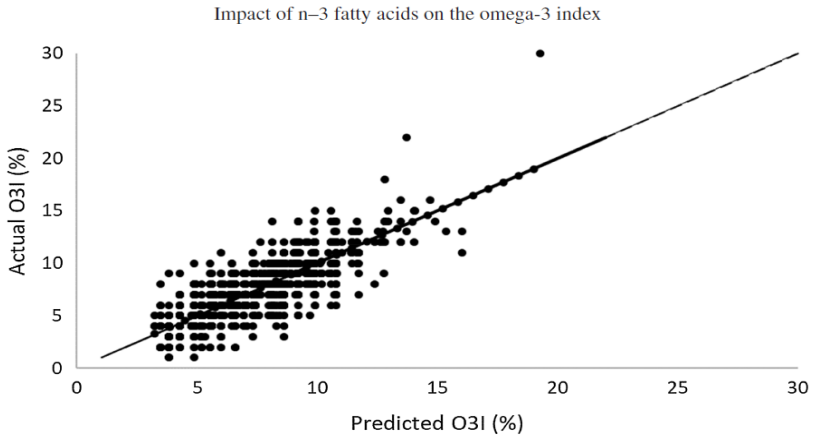


FIGURE 1 LC n-3 fatty acid doses needed to attain an RBC EPA + DHA concentration (omega-3 index, or O3I in the equations) of 8% in ~13 wk, as a function of the baseline O3I. The model equations as estimated using the 10-fold cross-validation approach described in the article with an *n* of 1422 were rearranged to solve for the necessary dosage to attain a postsupplementation O3I of 8%. The results are shown with separate lines for ethyl ester (EE) and triglyceride (TG) supplements. The error bars reflect the 95% CIs.
The equation for TG is: $Dose = 3292.68293 - \frac{\sqrt{7.29 \times 10^{-6} + 1.64 \times 10^{-6}(-4.479 + 0.158 BaselineO3I + 0.05 Baseline\ O3I^2)}}{8.2 \times 10^{-7}}$.
The equation for EE is: $Dose = 3292.68293 - \frac{\sqrt{7.29 \times 10^{-6} + 1.64 \times 10^{-6}(-5.4 + 0.158 BaselineO3I + 0.05 Baseline\ O3I^2)}}{8.2 \times 10^{-7}}$.

Baseline O3I, dose, and chemical formulation were significant predictors of O3I response to supplementation. The model developed here can be used by researchers to help estimate the O3I response to a given EPA + DHA dose and chemical form.



Nutritional supplements for immune Health in athletes

Table 4 Nutritional supplements for immune health in athletes: proposed mechanism of action and evidence for efficacy

Supplement	Proposed mechanism of action	Evidence for efficacy
Vitamin D	This is an essential fat-soluble vitamin known to influence several aspects of immunity, particularly innate immunity (eg, expression of antimicrobial proteins). Skin exposure to sunlight accounts for 90% of the source of vitamin D.	Moderate support Evidence for deficiency in some athletes and soldiers, particularly in the winter (decreased skin sunlight exposure) Deficiency has been associated with increased URS. Recommend 1000 IU/day D_3 autumn-spring to maintain sufficiency Further support required[98]
Probiotics	Probiotics are live micro-organisms that when administered orally for several weeks can increase the numbers of beneficial bacteria in the gut. These have been associated with a range of potential benefits to gut health, as well as modulation of immune function.	Moderate support in athletes with daily dose of ~10^{10} live bacteria Cochrane review of 12 studies (n=3720) shows ~50% decrease in URS incidence and ~2 day shortening of URS; minor side effects. More evidence is required supporting efficacy to reduce gastrointestinal distress and infection, for example, in a travelling athlete.[23 99]
Vitamin C	This is an essential water-soluble antioxidant vitamin that quenches ROS and augments immunity. It reduces interleukin-6 and cortisol responses to exercise in humans.	Moderate support for 'preventing URS' Cochrane review of 5 studies in heavy exercisers (n=598) shows ~50% decrease in URS taking vitamin C (0.25–1.0 g/day). Further support required Unclear if antioxidants blunt adaptation in well-trained Relatively small effects on cortisol compared with carbohydrate; immune measures no different from placebo No support for 'treating URS' Cochrane reviews show no benefit of initiating vitamin C supplementation (>200 mg/day) after onset of URS.[100 101]
Glutamine	This is a non-essential amino acid that is an important energy substrate for immune cells, particularly lymphocytes. Circulating glutamine is lowered after prolonged exercise and very heavy training.	Limited support Supplementation before and after exercise does not alter immune perturbations. Some evidence of a reduction in URS after endurance events in competitors receiving glutamine supplementation (2×5 g) Mechanism for therapeutic effect requires investigation.[107 108]
Caffeine	This is a stimulant found in a variety of foods and drinks (eg, coffee and sports drinks). Caffeine is an adenosine receptor antagonist and immune cells express adenosine receptors.	Limited support Evidence that caffeine supplementation activates lymphocytes and attenuates the fall in neutrophil function after exercise Efficacy for altering URS in athletes remains unknown.[109 110]
Echinacea	This is a herbal extract claimed to enhance immunity via stimulatory effects on macrophages. There is some in vitro evidence for this.	Limited support Early human studies indicated possible beneficial effects, but more recent, larger scale and better controlled studies indicate no effect of Echinacea on infection incidence or cold symptom severity.[111 112]
Omega-3 PUFAs	Found in fish oil May influence immune function by acting as a fuel, in their role as membrane constituents or by regulating eicosanoid formation, for example, prostaglandin Prostaglandin is immunosuppressive. Claimed to exert anti-inflammatory effects postexercise	Limited support for blunting inflammation and functional changes after muscle-damaging eccentric exercise in humans and no evidence of reducing URS in athletes[113 114]
Vitamin E	An essential fat-soluble antioxidant vitamin that quenches exercise-induced ROS and augments immunity	No support Immune-enhancing effects in the frail elderly but no benefit in young, healthy humans One study actually showed that vitamin E supplementation increased URS in those under heavy exertion. High doses may be pro-oxidative.[115 116]
Carbohydrate (drinks, gels)	It maintains blood glucose during exercise, lowers stress hormones, and thus counters immune dysfunction.	Low-moderate support Ingestion of carbohydrate (30–60 g/hour) attenuates stress hormone and some, but not all, immune perturbations during exercise. Very limited evidence that this modifies infection risk in athletes[19 102]
Bovine colostrum	First milk of the cow that contains antibodies, growth factors and cytokines Claimed to improve mucosal immunity and increase resistance to infection	Low-moderate support that bovine colostrum blunts the decrease in saliva antimicrobial proteins after heavy exercise Some evidence in small numbers of participants that bovine colostrum decreases URS Further support required[103 104]
Polyphenols, for example, Quercetin	These are plant flavonoids. In vitro studies show strong anti-inflammatory, antioxidant and antipathogenic effects. Animal data indicate an increase in mitochondrial biogenesis and endurance performance.	Low-moderate support Human studies show some reduction in URS during short periods of intensified training and mild stimulation of mitochondrial biogenesis and endurance performance, although in small numbers of untrained subjects. Limited influence on markers of immunity Putative antiviral effect for Quercetin Further support required[105 106]

Cochrane reviews have noted the low quality of many studies on nutritional supplements that are claimed to support immunity; specifically, small samples, poor controls and unclear procedures for randomization and blinding were commonplace.

Ergogenic Supplements Supported by Good Evidence of Efficacy

	Mode of action	Ergogenic effects	Effective dosing regimen	Concerns and side effects
Caffeine	Central nervous stimulant, adenosine receptor antagonist	Reduces perception of fatigue; enhances endurance, repeated sprint performance, skill, and fine motor control; improves cognitive function	3-6 mg/kg b.w. as pill or powder consumed ~60 min prior to exercise or lower doses (1-3 mg/kg b.w.) provided both before and during exercise, consumed with some carbohydrate	Highly individual response (both positive and negative) and side effects with high doses include anxiety, nausea, tremors, reduced sleep quality, tachycardia, and arrhythmias
Creatine	Increases muscle creatine stores, increasing the rate of resynthesis of phosphocreatine	Improves high-intensity repeated sprint performance, enhances training capacity and chronic training adaptations (muscle strength and power), and may also support brain function	Loading phase: ~20 g/day for 5-7 days followed by maintenance phase of 3-5 g/day for the duration of the supplementation period	Potential for 1-2 kg b.w. increase after creatine loading but lower doses (2-5 g/day) for 28 days may avoid the associated increase in body weight
β-alanine	Increases muscle carnosine, an important intracellular H^+ buffer	May improve high-intensity exercise and repeated sprint performance and may enhance training capacity	Daily consumption of ~6 g/day ingested via a split-dose regimen of ~1.5 g every 3-4 hours over an extended supplement time frame of 4-12 weeks	Sprint training may be more effective to increase muscle buffering capacity. Possible skin rashes or transient paraesthesia (skin tingling)
Nitrate	Increases tissue nitrite and nitric oxide, which reduces the oxygen cost of exercise via enhanced muscle contraction efficiency and reduced ATP cost of force production	Improves economy, endurance, and intermittent high-intensity exercise performance in sub-elite athletes; less effective for the highly trained	Bolus nitrate dose of 5-9 mmol (310-560 mg) ingested (usually as beetroot juice concentrate) 2-3 hours before exercise; prolonged periods of nitrate intake (>3 days) may enhance effect	Beetroot juice may discolor urine

Creatine
Myth or reality?

Kreider et al. Journal of the International Society of Sports Nutrition (2017) 14:18
DOI 10.1186/s12970-017-0173-z

Journal of the International Society of Sports Nutrition

REVIEW Open Access

International Society of Sports Nutrition position stand: safety and efficacy of creatine supplementation in exercise, sport, and medicine

Richard B. Kreider[1*], Douglas S. Kalman[2], Jose Antonio[3], Tim N. Ziegenfuss[4], Robert Wildman[5], Rick Collins[6], Darren G. Candow[7], Susan M. Kleiner[8], Anthony L. Almada[9] and Hector L. Lopez[4,10]

Ergogenic Supplements Supported by Good Evidence of Efficacy

	Mode of action	Ergogenic effects	Effective dosing regimen	Concerns and side effects
Creatine	Increases muscle creatine stores, increasing the rate of resynthesis of phosphocreatine	Improves high-intensity repeated sprint performance, enhances training capacity and chronic training adaptations (muscle strength and power), and may also support brain function	Loading phase: ~20 g/day for 5-7 days followed by maintenance phase of 3-5 g/day for the duration of the supplementation period	Potential for 1-2 kg b.w. increase after creatine loading but lower doses (2-5 g/day) for 28 days may avoid the associated increase in body weight

Creatine is one of the most popular supplements among athletes, and unlike many of the supplements on the market, it has an excellent evidence base for its positive effects on sports performance and metabolism.

Supplementing with creatine increases the amount of creatine in the body by up to 30%. There are many different types of creatine available on the market, but the simplest and most researched form is creatine monohydrate.

The standard dosing of creatine is 3-5g per day or 0.1 g/kg of body mass. Although many of the earliest studies used 'loading phases' of creatine of 20-30g per day to saturate stores quickly, smaller doses are equally effective, but simply take a little longer to build up in the body and have an effect.

Creatine Endurance Sport

The effects on endurance performance are less known. In terms of time trial performances, results are mixed.

Creatine supplementation elevates skeletal muscle phosphocreatine (PCr) stores facilitating a greater capacity to rapidly resynthesize ATP and buffer hydrogen ion accumulation. When co-ingested with carbohydrates, creatine enhances glycogen resynthesis and content, an important fuel to support high-intensity aerobic exercise. In addition, creatine has the potential to increase mitochondrial biogenesis.
However, creatine supplementation appears to be more effective at improving performances that require multiple surges in intensity an Creatine supplementation may be beneficial for sports, such as cross-country skiing, mountain biking, cycling, triathlon, and for short-duration events where end-spurts are critical for performance d/or during end spurts, which are often key racedefining moments.

In contrast, creatine supplementation increases body mass, which may offset the potential positive effects, particularly in weight-bearing activities and other Meta-analysis have shown that CM supplementation is ineffective on endurance performance in a trained population.

Forbes et. al .Creatine supplementation and endurance performance: surges and sprints to win the race JOURNAL OF THE INTERNATIONAL SOCIETY OF SPORTS NUTRITION 2023, VOL. 20, NO. 1, 2204071

J. Fernandez-Landa et al. Effects of Creatine Monohydrate on Endurance Performance in a Trained Population: A Systematic Review and Meta-analysis

Van Loon LJ, Oosterlaar A, Hartgens F, Hesselink M, Snow R, Wagenmakers AJM. Effects of creatine loading and prolonged creatine supplementation on body composition, fuel selection, sprint and endurance performance in humans. Clin Sci. 104(2):153-62. 2003

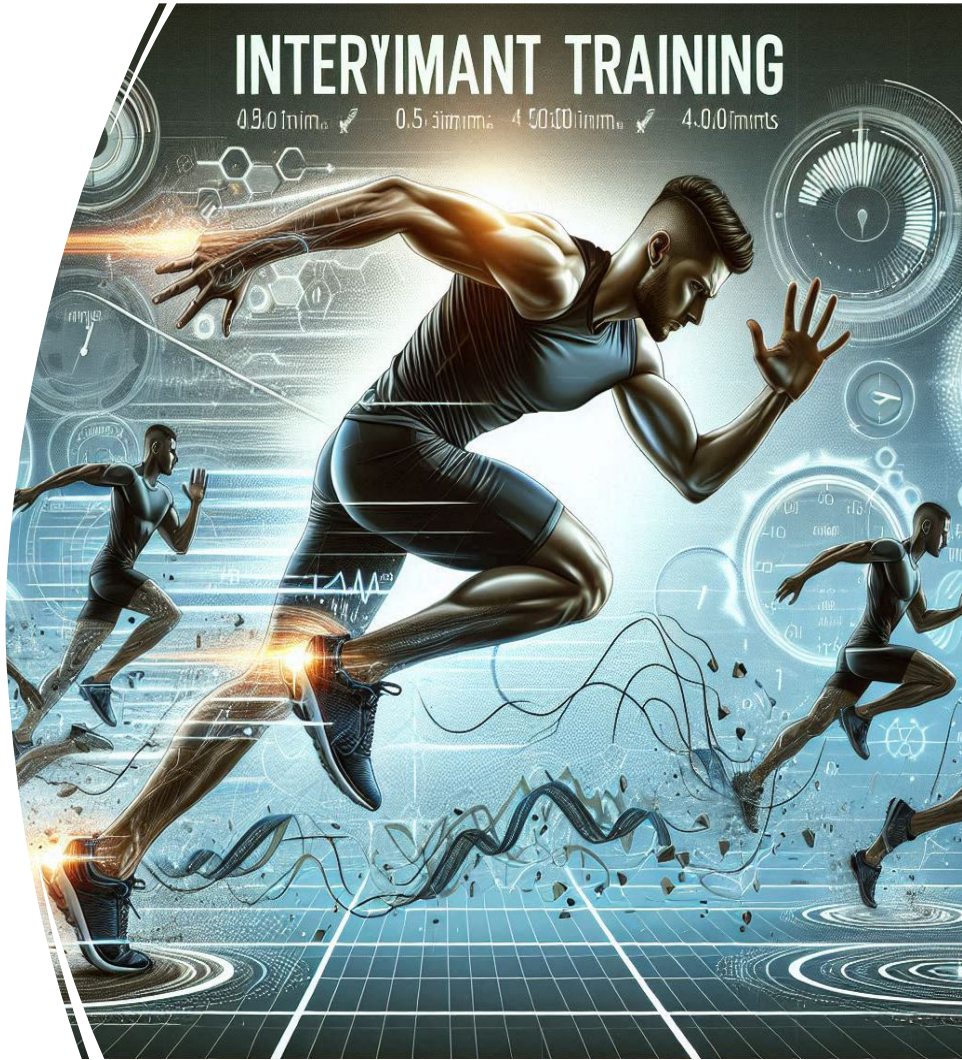
Van Schuylenbergh R, Van Leemputte M, Hespel P. Effects of oral creatine-pyruvate supplementation in cycling performance. Int J Sports Med. 24(2):144-50, 2003

Reardon T, Ruell P, Fiatarone Singh M, Thompson C, Rooney K. Creatine supplementation does not enhance submaximal aerobic training adaptations in healthy young men and women. Eur J Appl Physiol. 98(3):234-41, 2006

Creatine Intermittent Sport

Creatine supplementation is beneficial in sports involving intermittent high intensity exercise and has been shown to improve performance of measures like repeated sprint speed and jump height . These benefits are potentially helpful in common team sports like soccer, football or basketball. In these sports, the positive effects of creatine with resistance training on muscle mass and strength may also be beneficial.

Creatine is beneficial for intermittent high intensity sports as supplementation has been shown to improve performance of measures like repeated sprint speed and jump height.



Ramírez-Campillo R, González-Jurado JA, Martínez C, Nakamura FY, Peñailillo L, Meylan CMP, Caniuqueo A, Cañas-Jamet R, Moran J, Alonso-Martínez AM, Izquierdo M. Effects of plyometric training and creatine supplementation on maximal-intensity exercise and endurance in female soccer players. J Sci Med Sport. 19(8):682-7, 2016

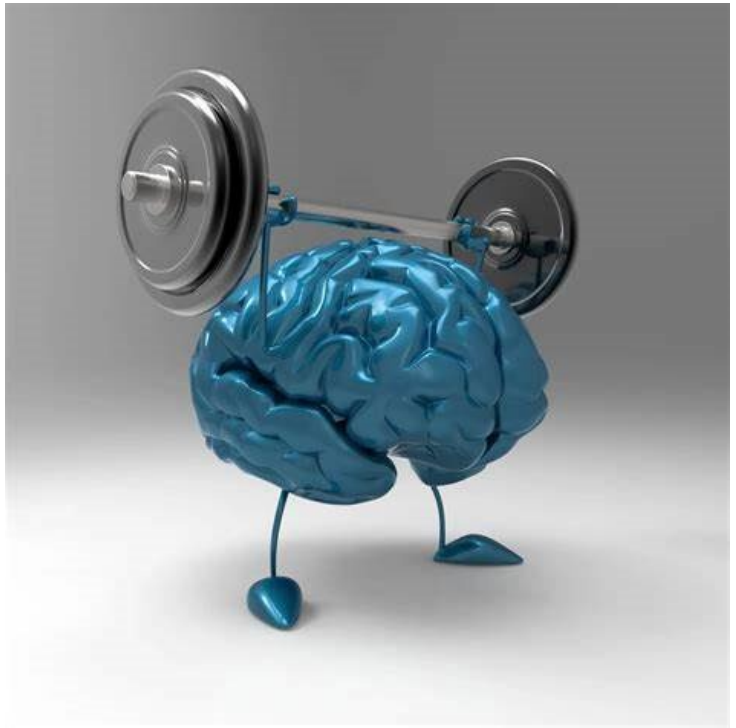
Williams J, Abt G, Kilding A. Effects of Creatine Monohydrate Supplementation on Simulated Soccer Performance. Int J Sports Physiol Perform. 9(3):503-10, 2014

Creatine
Power and Strenght Sport

Creatine is a very popular supplement for strength and power athletes, where events generally last <30s. It can augment increases in muscle mass and strength during resistance training, as well as improve performance in competition. In such sports, the increase in body weight is generally not problematic, as the increase in performance more than compensates for the increased body mass. Such sports that benefit from creatine supplementation include 100m and 200m sprints, weightlifting and powerlifting and sprint swimming.

1.Butts J, Jacobs B, Silvis M. Creatine Use in Sports. Sports Health: A Multidisciplinary Approach. 10(1):31-4, 2018

Creatine and Brain



1. Aspects of **cognitive performance** improved in most studies
2. Reduction of impact of **concussion** or improved recovery from concussion

Creatine supplementation 'can' increase brain creatine levels ~ 5-10% across all populations and could also have a major impact on brain function, including improved cognitive processing and better recovery from brain injury and induces changes in cerebral high energy phosphates during sleep deprivation

The optimal dosing protocol is unknown.

Roschel, H., Gualano, B., Ostojic, S. M., Rawson, E. S. Creatine supplementation and brain health. Nutrients2021;13(2), 586.

Dolan, E. Gualano, B., Rawson, E. S.Beyond muscle: the effects of creatine supplementation on brain creatine, cognitive processing, and traumatic brain injury.Eur J Sport Sci, 2019;19(1):1-14.

REVIEW Open Access

Common questions and misconceptions about creatine supplementation: what does the scientific evidence really show?

Antonio et al. Journal of the International Society of Sports Nutrition (2021) 18:13

(1)Creatine supplementation does not always lead to water retention.
(2). Creatine is not an anabolic steroid.
(3). Creatine supplementation, when ingested at recommended dosages, does not result in kidney damage and/or renal dysfunction in healthy individuals.
(4). The majority of available evidence does not support a link between creatine supplementation and hair loss / baldness.
(5). Creatine supplementation does not cause dehydration or muscle cramping.
(6). Creatine supplementation appears to be generally safe and potentially beneficial for children and adolescents.
(7). Creatine supplementation does not increase fat mass.
(8). Smaller, daily dosages of creatine supplementation (3-5 g or 0.1 g/kg of body mass) are effective. Therefore, a creatine 'loading' phase is not required.
(9). Creatine supplementation and resistance training produces the vast majority of musculoskeletal and performance benefits in older adults. Creatine supplementation alone can provide some muscle and performance benefits for older adults.
(10).Creatine supplementation can be beneficial for a variety of athletic and sporting activities.
(11).Creatine supplementation provides a variety of benefits for females across their lifespan.
(12).Other forms of creatine are not superior to creatine monohydrate

Beta-alanine: the new creatine?

Ergogenic Supplements Supported by Good Evidence of Efficacy

	Mode of action	Ergogenic effects	Effective dosing regimen	Concerns and side effects
β-alanine	Increases muscle carnosine, an important intracellular H^+ buffer	May improve high-intensity exercise and repeated sprint performance and may enhance training capacity	Daily consumption of ~6 g/day ingested via a split-dose regimen of ~1.5 g every 3-4 hours over an extended supplement time frame of 4-12 weeks	Sprint training may be more effective to increase muscle buffering capacity. Possible skin rashes or transient paraesthesia (skin tingling)

Effects of beta-alanine on exercise performance?

Follow-up studies showed improvements in high intensity exercise performance. These improvements are generally seen during all-out exercise between 1 and 4 min of duration.

If the exercise is shorter, there does not seems to be a benefit and if the exercise is longer, the results seem a little more varied. Some studies (5-15 min) show benefits, others don't. If the exercise is much longer (1h or so) there don't seem to be benefits.

Beta-alanine does not seem to help in team sports where the nature of the activity is more intermittent either.

Beta-alanine works by **elevating levels of carnosine in the body**. When beta-alanine is ingested, it combines with another amino acid L-histidine, forming carnosine. Carnosine acts as an intracellular proton buffer — it protects against drops in pH (increases in acidity).

Beta-alanine
Myth or reality?

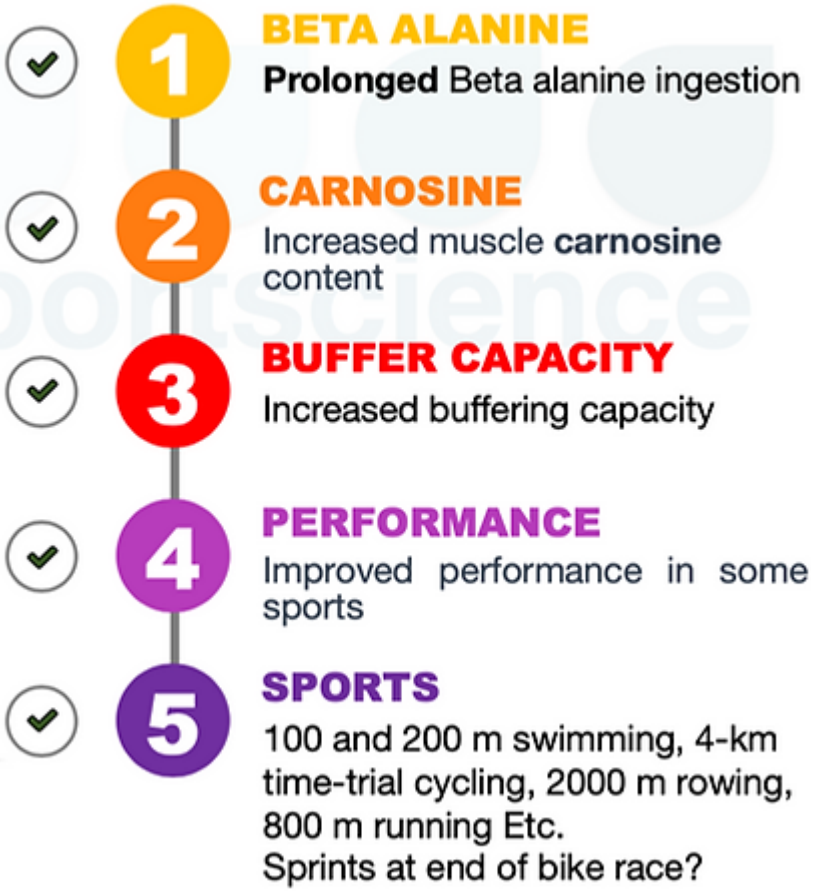
How should you use beta-alanine?

Typically, studies have used supplementing strategies of multiple doses of 400 mg or 800 mg, administered at regular intervals for up to eight hours (4-8 times a day), over periods ranging from 4 to 10 weeks. After a 10-week supplementing strategy, the reported increase in intramuscular carnosine content is on average about 80% (but the range is quite large: around 20 to 200%). Some athletes may therefore benefit more than others.

Is beta alanine safe?

It appears to be safe. It is a naturally occurring compound and there is only one side effect that is frequently reported. This side effect is paraesthesia, is a pricking, burning, tingling or numbing sensation that is usually felt in the arms, legs, hands, feet and nose. The exact reason why this happens is not clear but the effects wear off and there are no long term negative effects. Beta-alanine usually comes in a slow release form, which means it is absorbed slower and over a longer period of time and this takes care of most of the symptoms. So if you use slow-release beta-alanine you may not get any symptoms at all or at least they will be very much reduced.

Beta-alanine
Myth or reality?



In conclusion...

Whether or not beta-alanine can help the athletes performance, therefore depends very much on what the performance is. If your event is between 1-4 min in duration it seems to be worth a try. There are not many supplements that can be backed up by

1. Evidence of efficacy
2. Multiple studies reproducing the effect
3. A clearly described and plausible physiological mechanism

Beta-alanine has all of the above, although it may apply primarily to the window of 1-4 min as discussed.

No positive effects on body composition in terms of a decrease in FM (Fat Mass) and an increase in FFM (Fat Free Mass) have been documented.

No effective if used acutely (as pre work-out)

Caffeine
Myth or reality?

- **It has been demonstrated that caffeine supplementation significantly improves various aspects of physical performance. The small to moderate benefits from caffeine use include muscle endurance, movement speed, muscle strength, sprint performance, jumps, throws, and a wide range of sport-specific aerobic and anaerobic actions**

- **Aerobic capacity seems to be the form of exercise with the most consistent benefits, ranging from moderate to large, derived from caffeine use, although the extent of its effects differs from individual to individual.**

- **It has been consistently shown that caffeine improves physical performance if consumed in doses of 3-6 mg/kg of body mass. The minimum effective doses of caffeine are currently unclear but could be as low as 2 mg/kg of body mass. Very high doses of caffeine (e.g., 9 mg/kg) are associated with a high incidence of side effects and do not seem necessary to elicit an ergogenic effect.**

- **The most commonly used timing for caffeine supplementation is 60 minutes before exercise. The optimal timing for caffeine intake probably depends on the source of the caffeine. For example, compared with caffeine capsules, caffeine chewing gums may require a shorter waiting time from consumption until the beginning of the training session.**

- **Caffeine seems to improve physical performance in both trained and untrained individuals.**

Ergogenic Supplements Supported by Good Evidence of Efficacy

	Mode of action	Ergogenic effects	Effective dosing regimen	Concerns and side effects
Caffeine	Central nervous stimulant, adenosine receptor antagonist	Reduces perception of fatigue; enhances endurance, repeated sprint performance, skill, and fine motor control; improves cognitive function	3-6 mg/kg b.w. as pill or powder consumed ~60 min prior to exercise or lower doses (1-3 mg/kg b.w.) provided both before and during exercise, consumed with some carbohydrate	Highly individual response (both positive and negative) and side effects with high doses include anxiety, nausea, tremors, reduced sleep quality, tachycardia, and arrhythmias

Caffeine
Myth or reality?

Interindividual differences in sport and physical performance, as well as adverse effects on sleep or feelings of anxiety following caffeine ingestion, can be attributed to genetic variation associated with caffeine metabolism and physical and psychological response. Other factors, such as habitual caffeine intake, may also play a role in individual response variation.

It has been demonstrated that caffeine is ergogenic for cognitive functions, including attention and vigilance, in most individuals.

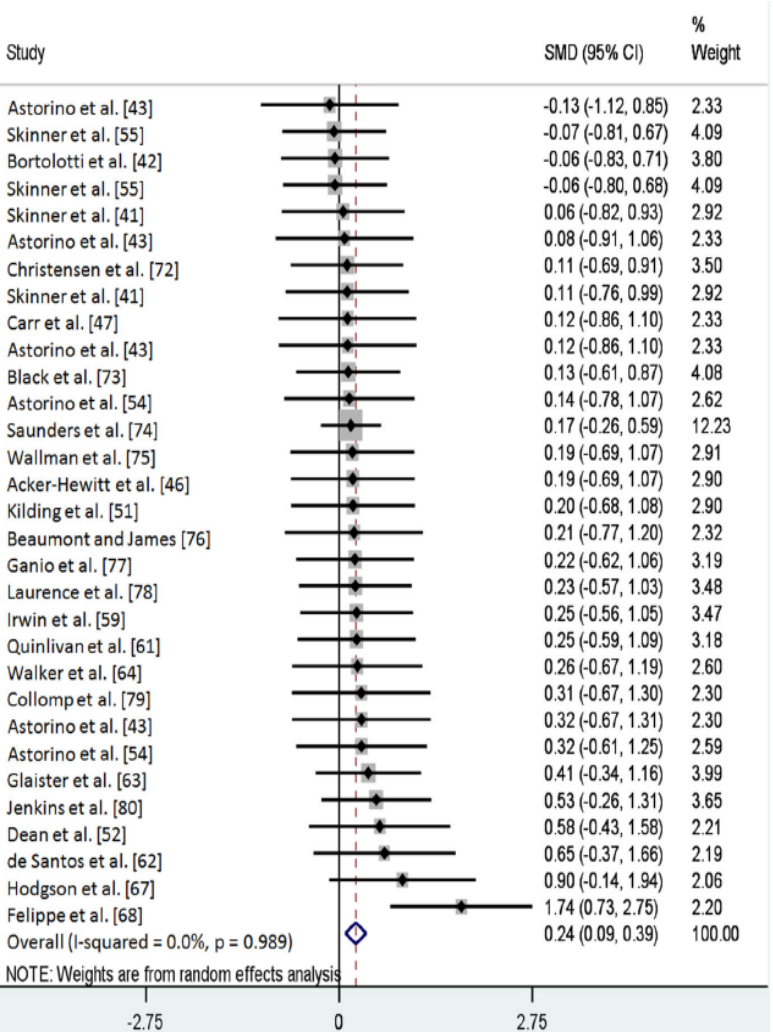
Caffeine may improve cognitive and physical performance in some individuals under conditions of sleep deprivation.

The use of caffeine together with endurance exercises in heat and at altitude is well supported when dosages vary respectively from 3 to 6 mg/kg and 4-6 mg/kg.

It has been demonstrated that alternative sources of caffeine, such as caffeine-containing chewing gums, mouth rinses, energy gels, and chewing gums, improve performance, mainly in aerobic exercise.

It has been demonstrated that energy drinks and pre-workout supplements containing caffeine improve both anaerobic and aerobic performance.

Caffeine
Myth or reality?



Sports Med
https://doi.org/10.1007/s40279-018-0939-8

SYSTEMATIC REVIEW

The Effect of Acute Caffeine Ingestion on Endurance Performance: A Systematic Review and Meta–Analysis

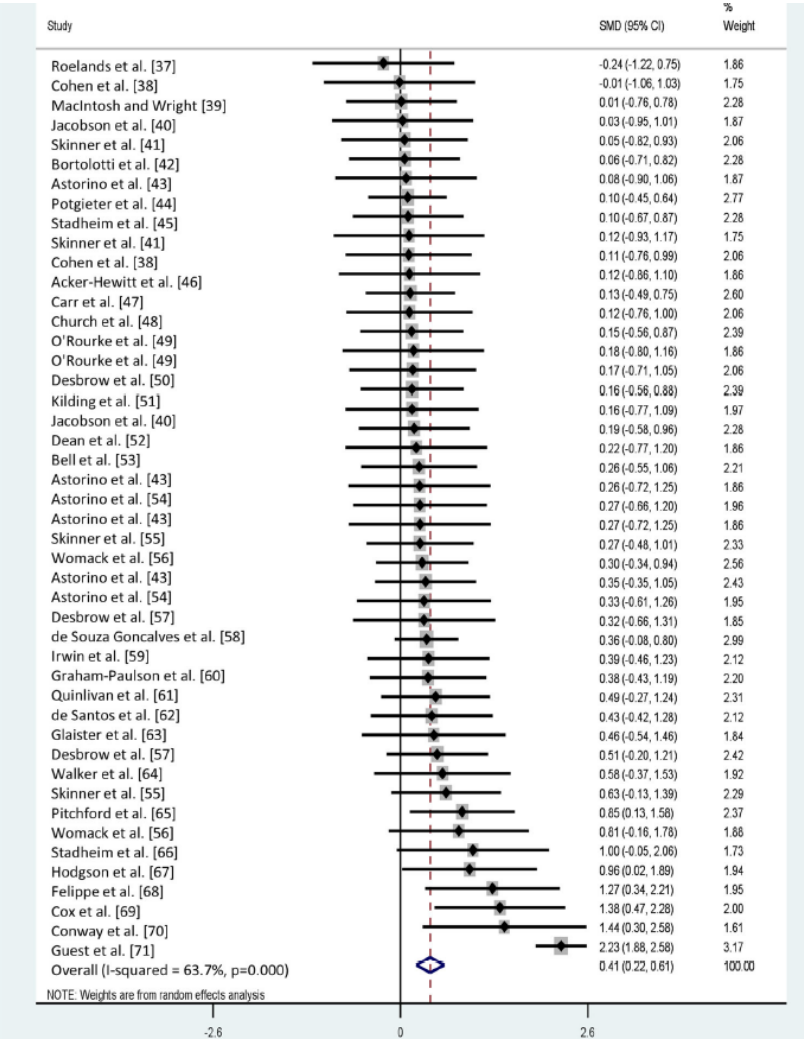
Kyle Southward[1] · Kay J. Rutherfurd-Markwick[2,3] · Ajmol Ali[1,3]

Key Points

This systematic review and meta-analysis investigated the effects of caffeine on endurance performance.

The results showed that caffeine has a small but positive effect on endurance time-trial performance.

However, differences between studies in response to caffeine were evident as some studies reported ergolytic effects following caffeine ingestion.



Caffeine
Myth or reality?

Sports Medicine (2019) 49:17–30
https://doi.org/10.1007/s40279-018-0997-y

REVIEW ARTICLE

The Influence of Caffeine Supplementation on Resistance Exercise: A Review

Jozo Grgic[1] · Pavle Mikulic[2] · Brad J. Schoenfeld[3] · David J. Bishop[1,4] · Zeljko Pedisic[1]

Key Points

Caffeine supplementation may acutely enhance muscular endurance, maximal strength, and power in resistance exercise.

Doses in the range of 3–9 mg·kg^{-1} seem to be adequate for eliciting ergogenic effects. Caffeine seems to be generally safe when taken in these doses; however, at doses as high as 9 mg·kg^{-1} or higher, side effects might be more pronounced.

Blood pressure may be increased following caffeine ingestion, and therefore caution is needed regarding caffeine supplementation among individuals with high blood pressure.

The mechanism by which caffeine intake affects resistance exercise performance is likely multifactorial.

López-González et al. Journal of the International Society of Sports Nutrition (2018) 15:60
https://doi.org/10.1186/s12970-018-0267-2

Journal of the International Society of Sports Nutrition

REVIEW Open Access

Acute caffeine supplementation in combat sports: a systematic review

Luis M. López-González[1], Antonio J. Sánchez-Oliver[2,3*], Fernando Mata[1], Pablo Jodra[4], Jose Antonio[5] and Raúl Domínguez[6]

Conclusions and practical applications
Caffeine doses of 3–6 mg/kg have been associated with increased glycolytic activity during real or simulated combats. This effect is accompanied by increased blood lactate concentrations and improved performance, as measured through the engagement time or number of throws performed in a contest. In addition, the higher rate of glycolysis takes place in the absence of a concomitant increase in the level of exertion perceived by the athlete. By way of conclusion, caffeine supplementation could have an ergogenic effect in combat sport practitioners and thus improve performance indicators such as hand grip strength and the strength, power and muscular endurance of the arms.

Journal of Science and Medicine in Sport 22 (2019) 353–360

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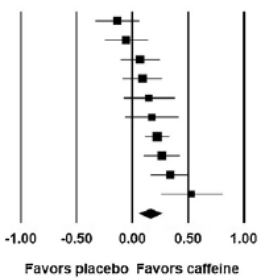
Review

The effects of caffeine ingestion on isokinetic muscular strength: A meta-analysis

Jozo Grgic[a,*], Craig Pickering[b,c]

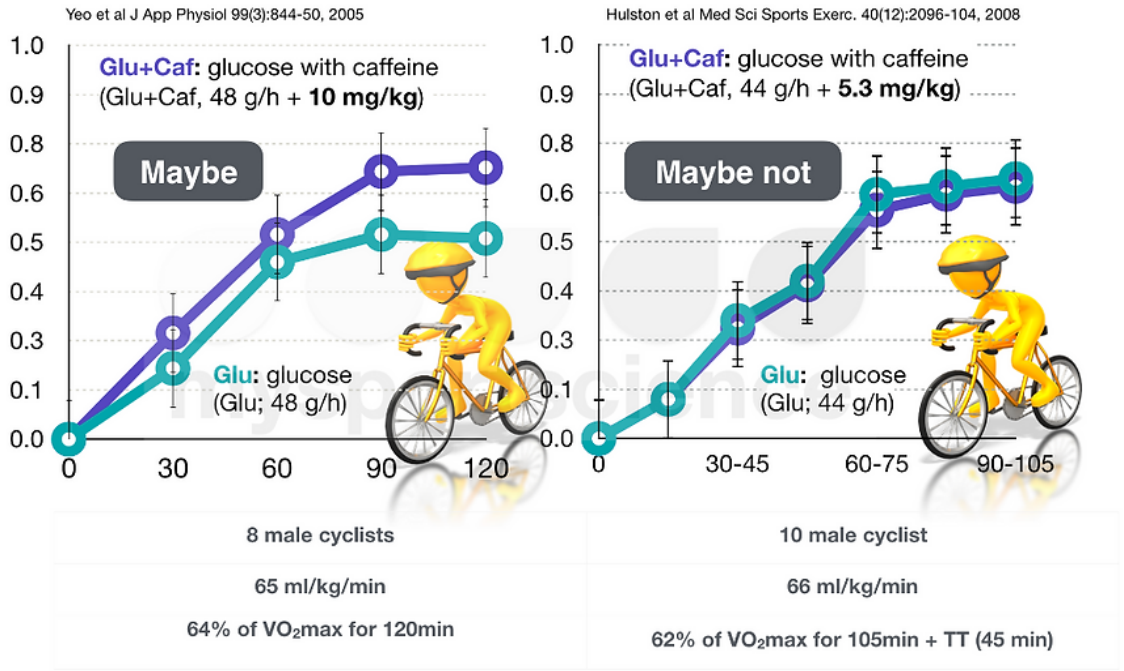
5. Conclusion

In conclusion, this meta-analysis demonstrates that acute caffeine ingestion may lead to significant increases in isokinetic strength performance. Additionally, this meta-analysis reports that the effects of caffeine on isokinetic muscular strength are predominantly manifested in knee extensor muscles and at higher angular velocities. Finally, these conclusions are based on studies with excellent to good methodological quality, and on analyses with low levels of heterogeneity.



Additive Effect of Combining Different Substances

Combing Caffeine + Taurine has been reported to increase alertness, aerobic and anaerobic performance , reaction time and upper body strenght in several studies



Caffeine + Carbohydrate during exercise has been shown to be more effective in improving endurance exercise performance than either caffeine or carbohydrate alone.

It seems that in order to see the effects of caffeine on carbohydrate absorption, a large dose of caffeine is needed. Such high intakes are not recommended because of increased side effects. The lower dose is effective in improving performance but it does not seem to do so by enhancing carbohydrate use. With highly individual responses to caffeine, the recommendation is that athletes experiment with lower doses and work out what works best for them.

Beetroot Juice
Myth or reality?

Review | Open Access | Published: 09 October 2021

Effect of dietary nitrate on human muscle power: a systematic review and individual participant data meta-analysis

Andrew R. Coggan, Marissa N. Baranauskas, Rachel J. Hinrichs, Ziyue Liu & Stephen J. Carter

Journal of the International Society of Sports Nutrition **18**, Article number: 66 (2021) | Cite this article

Ergogenic Supplements Supported by Good Evidence of Efficacy

	Mode of action	Ergogenic effects	Effective dosing regimen	Concerns and side effects
Nitrate	Increases tissue nitrite and nitric oxide, which reduces the oxygen cost of exercise via enhanced muscle contraction efficiency and reduced ATP cost of force production	Improves economy, endurance, and intermittent high-intensity exercise performance in sub-elite athletes; less effective for the highly trained	Bolus nitrate dose of 5-9 mmol (310-560 mg) ingested (usually as beetroot juice concentrate) 2-3 hours before exercise; prolonged periods of nitrate intake (>3 days) may enhance effect	Beetroot juice may discolor urine

High-intensity intermittent exercise performance might be positively impacted by nitrate

Dietary nitrate enhances repeated sprint performance and may attenuate the decline in cognitive function (and specifically reaction time) that may occur during prolonged intermittent exercise.

The effects are likely to be greater if beetroot juice is consumed for several days prior to a competition but there are acute effects too and I would recommend taking nitrate 2-3 hours prior to competition.

The performance benefits are particularly seen during all-out exercise lasting 5-30 min.

Take Home Message

Any use of performance supplements should be thoroughly trialed in training before implementation into a competition environment, since, in some scenarios, outcomes ranging from a lack of efficacy to deleterious responses may outweigh any expected performance enhancement.

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