



Performance Enhancing Substances: Selected Nutritional Ergogenic Aids

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Learning Outcomes



1. Share information on ergogenic aids/dietary supplements in general
2. Share information on the mechanisms where ergogenic aids may work
3. Share information on Caffeine
4. Share information on Branch Chain Amino Acids
5. Share information on Creatine
6. Share information on efficacy of and possible adverse effects of ergogenic aids/dietary supplements

COUNTERTHINK



ART - DAN BERGER - CONCEPT - MIKE ADAMS

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Definitions

Ergogenic Aid – any substance that can increase the capacity for bodily or mental labor, especially by eliminating fatigue symptoms.
(Benardot)

Types – Nutritional, Pharmacologic, Mechanical, Physiological, Psychological

Nutritional – Any substance that enhances performance and are either nutrients, metabolic by-products of nutrients, food (plant) extracts, or substances commonly found in foods (caffeine or creatine) that are provided in amounts more concentrated than commonly found in the natural food supply (Benardot)



Definitions

Dietary Supplements – a product (other than tobacco) intended to supplement the diet that contains one or more of the following dietary ingredients:

Vitamin, Mineral, Herb or other Botanicals, Amino Acids, Concentrate, Metabolite, Constituent, Extract or a combination of any of the above. (Haff & Triplett)



Brief History of Ergogenic Aid Use

- Early “Sports medicine” physicians encouraged Greeks and Romans to eat raw meat to increase their “animal competitiveness”
- Some early greeks/romans ate hallucinogenic mushrooms and sesame seeds to enhance performance
- 1889 Charles Edward-Sequard (French physiologist), claimed to have reversed aging by self-injecting testicular extracts
- 1904 Olympics, Thomas John Hicks; a Brit running for the U.S. consumed a small amount of Brandy and a small quan. of Strychnine sulfate (rat poison)
- 1935 testosterone synthesized
- 1940's – 1960's+ steroids used
- Today – What isn't used



Mechanisms for Ergogenic Aids to Work

1. Act as a central or peripheral nervous system stimulant (caffeine)
2. Increase storage and/or availability of a limiting substrate (carbs, creatine)
3. Act as a supplemental fuel source (glucose)
4. Reduce or neutralize performance-inhibiting metabolic byproducts (sodium bicarb)
5. Facilitate recovery (high glycemic carbs)
6. Enhance resistance-training responsiveness (anabolic steroids, HGH etc)
(McArdle, Katch, & Katch)

Why Use Ergogenic Aids?

The reasons seem to be endless and population dependent; ranging from performance enhancement to beach body





Determination of Effectiveness

How do we know it works

Depends on:

- Appropriate methodology - validity, safety
- Substance Amount – not enough or excess may demonstrate no effect or adverse effect
- Subjects – trained vs untrained, animal vs human, men vs women, diseased vs healthy, young vs elderly
- Task – anaerobic vs aerobic, multi-muscular maneuvers vs fine motor coordination, lab tests vs field tests, clinical outcome vs athletic outcome
- Use and Delivery – acute vs chronic, powdered vs encapsulated, parenteral vs enteral (oral), therapeutic dose vs superpharmacological dose
- Placebo effect???
- Peer reviewed material vs magazine/infomercial



Nutritional Ergogenic Aids

Nutritional Ergogenic Aids to be discussed:

1. Caffeine
2. Branch Chain Amino Acids
3. Creatine



Caffeine – General Facts

Chemical name – 1,3,7-trimethylxanthine, belongs to a group of lipid soluble purines. Found naturally in coffee beans, tea leaves, chocolate, cocoa beans, cola nuts, carbonated beverages.

- Quite ubiquitous in that it is found in sodas, coffee, alcoholic and nonalcoholic drinks, energy drinks, candy bars, OTC meds, and supplements
- >50% of U.S. adults consume 300 mg daily (8 oz coffee = 100 mg)
- Intestinal absorption is rapid, reaching peak plasma conc in about 1 hr
- Half Life varies between 3-6 hours, most people closer to 6 hours



Caffeine – General Effects



- Most people think of caffeine as a “Wake me Up” substance

This is somewhat true and somewhat misleading

Caffeine competes with adenosine receptors in the brain preventing drowsiness/sleep, which means that you can be a somewhat more awake tired person. (zoned)

The brain recognizes this as an emergency and releases epinephrine/adrenaline which:

Increases HR

Increased Respiration

BP increases

Liver releases glycogen

Increased Muscle Contractility Strength

Increased Bronchodilation

Increased Cardiac Output

Increased VO₂



Caffeine – Ergogenic Effects

- Metabolic theory suggests that caffeine promotes muscle lipolysis sparing muscle glycogen.

By competing with muscle adenosine an increase of cyclic adenosine monophosphate (AMP), causing increased Lipolysis and increased release of FFA

- Indirectly, by stimulating epinephrine release from the adrenal medulla, related to the adenosine competition in the brain which registers as an emergency
- Enhances motorneuronal excitability to facilitate motor unit recruitment by:
 - Lowering the threshold for motor unit recruitment
 - Alter excitation-contraction coupling
 - Facilitates nerve transmission
 - Mobilization of intracellular calcium ion from the Sarcoplasmic Reticulum
 - Enhances alertness & Concentration

Caffeine

These all sound good RIGHT??

Please remember that as these interactions effect skeletal muscle so also do they effect Cardiac muscle!





Caffeine – Adverse Effects

- Anxiety
 - Restlessness
 - Tremors
 - Palpitations
 - Physical Addiction with withdraw S+S such as:
Headache (vasodilation), fatigue, flulike symptoms, difficulty concentrating
Intake of >9mg/kg (150 lb person = 68kg = 612 mg) increase the possibility
- Gastrointestinal Disturbances
 - Insomnia
 - Cardiac Arrhythmias
 - Dehydration

Caffeinated Products

Product	Mgs	Picture
Dunkin Doughnuts Coffee w/Turbo shot 20 oz	436 mg	
Starbucks Venti 20 oz	415 mg	
Bang Energy Drink 16 oz	357 mg	
Zantrex 3 Weight Loss OTC 2 capsules	300 mg	



Caffeine and Exercise Effect

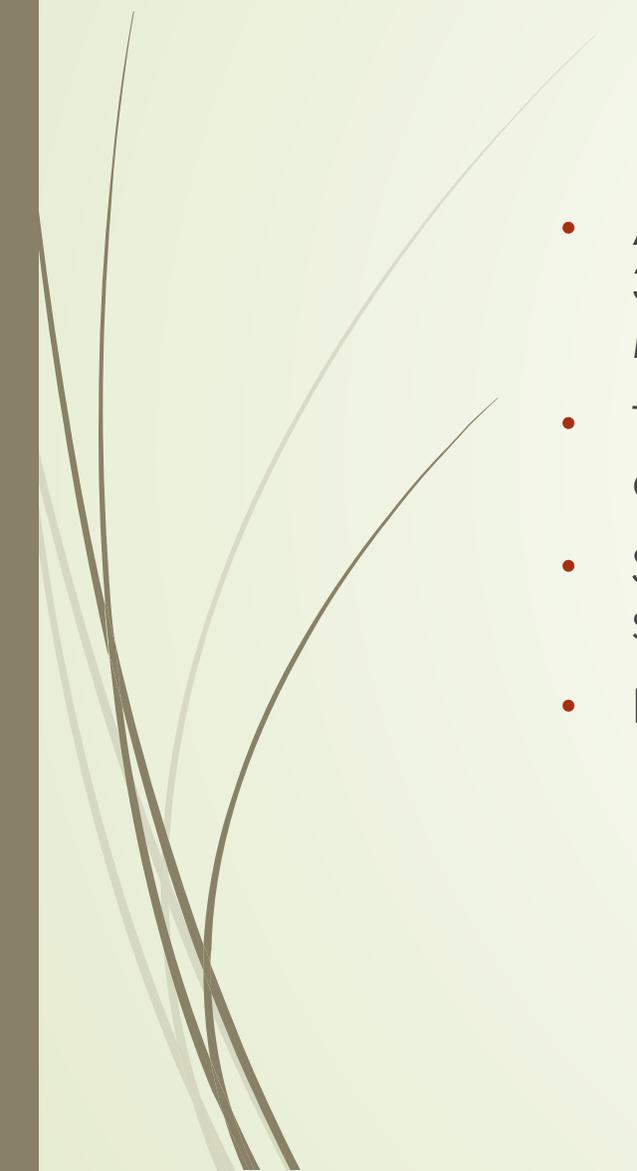
- Many studies have been done to date investigating the ergogenic effect of caffeine.
- These studies cover multiple sport settings and populations.
- In general, studies demonstrate some increase in performance in submax exercise with ingestion of 3-6 mg/kg (200-400mg for a 68kg/150lb), all state that results are **HIGHLY Individualized**.

Desbrow et.al, Goldstein et.al, Graham

- Another possible reason for increased performance is the effect on RPE (rate of perceived exertion). Caffeine seems to decrease RPE in exercise. This has been noted in multiple studies; Cureton et.al, Stadheim et.al, Astorino et.al, Ganio et.al, Jenkins et.al, Motl et.al, O'Conner et.al



Caffeine and Exercise Effect

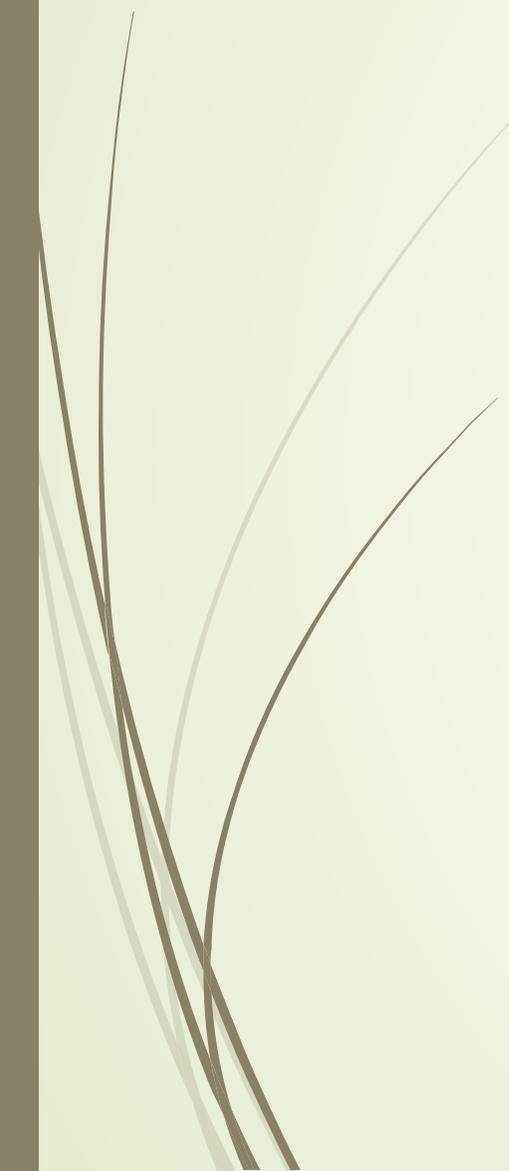
- A meta analysis conducted by Warren et.al (Med Sci Sport 2010) looked at 34 studies on Maximal Voluntary Contraction (strength) and 27 studies for MVC (strength endurance)
 - This analysis showed a large (14%) increase in MVC strength endurance and a small (4%) increase on MVC strength, overall
 - Sub group meta-analysis found that muscle group size and location were significant factors within MVC strength but not in MVC strength endurance
 - Lower body showed greater increases than upper body
- 



Caffeine and Exercise Effects

What do we take from this?

Much more research needs to be done by independent peer reviewed researchers to determine exactly how/why caffeine interact within the body to produce ergogenic effect





Caffeine: NSCA Statement Ban Status

NSCA Statement: “Despite the great deal of data on the active ingredients in energy drinks (caffeine & carbs), there is limited data to show that they enhance aerobic or anaerobic exercise performance.

Ban Status – NCAA Currently Banned at 15 ug/ml

IOC Currently Banned at 12 ug/ml

WADA Not Banned since 2004, but monitoring

70 kg ath. Would be able to consume 5-6 8 oz cups 1 hr prior to exercise, exercise 1-1.5 hrs, and provide a urine sample ~12 ug/ml



Creatine – General Facts

- Classified as a Physiological ergogenic aide, however, many consider it a nutritional aide
- Also known as Pcr (Phosphocreatine) or CP (Creatine Phosphate)
- An amine present in small amounts in animal foods
- Synthesized in Liver/Kidneys/Pancreas by combining Arginine, Glycine, Methionine
- Called a “Metabolic Buffer” because of it’s ability to assist in ATP regeneration.
- 98% stored in skeletal, muscle
- Endogenous production/utilization is ~2 gm/day. 70kg (154lbs) male needs ~16 oz of fresh meat (beef/pork) or fish (tuna/salmon/cod)



Creatine Importance to Exercise

- Has an essential role in energy metabolism as a substrate for the formation of adenosine triphosphate (ATP) by rephosphorylating adenosine diphosphate (ADP) especially during short duration, high intensity exercise.
(McArdle, Katch, & Katch)
- The ability to rapidly rephosphorylate ADP is dependent on the enzyme creatine kinase and the availability of CP within the muscle.
(McArdle, Katch, & Katch)
- High intensity exercise depletes CP quickly, roughly 35-57% reduction in 6 seconds from resting levels, more so as H.I. exercise continues
- As CP levels deplete the ability to perform max exercise decreases

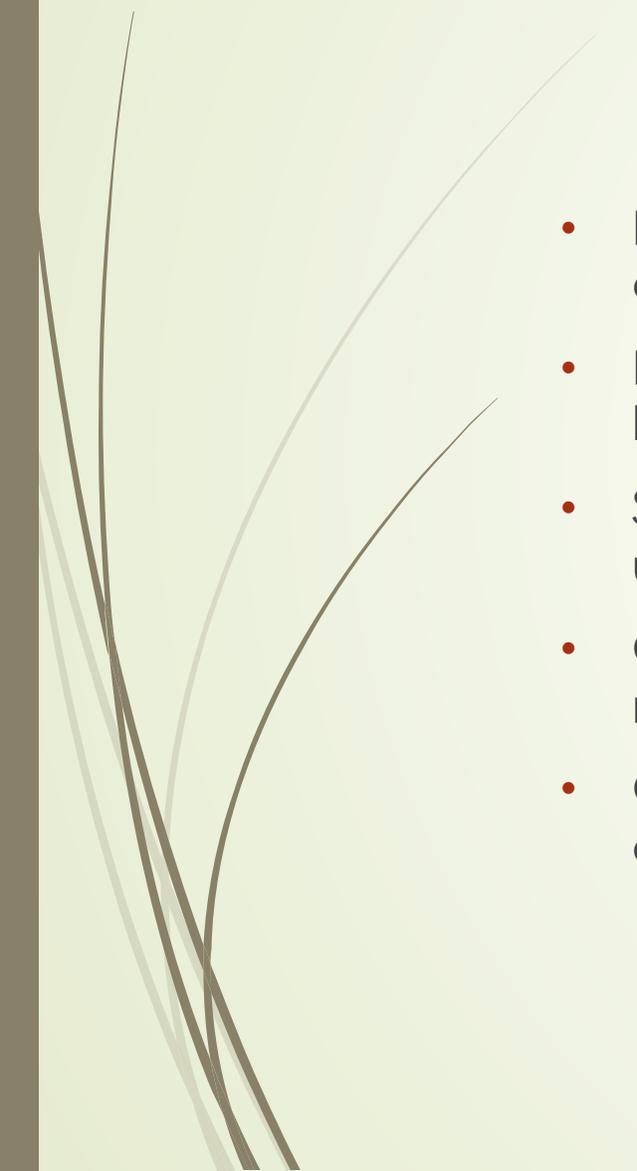


Creatine - Importance to Exercise

- Appears most effective in improving short term, maximal intensity exercise types (lab not field)
 - No reported ergogenic effects in endurance activities
 - There does not seem to be a direct effect on heart rate, O₂ consumption, or lactate concentrations post exercise
 - There is no conclusive evidence to date for an anabolic effect
 - Creatine has been shown to have water retention effects, which contribute to the “Swollen” look during lifting
- 



Creatine Supplementation



- Froiland et.al (2004) reported 37% of college athletes use or have used creatine in competition preparation
- Labotz et.al (1999) reported that 80%+ of strength/power athletes use or have used creatine
- Swirzinski et.al reported that 90% of high school athletes who supplement used creatine (2000)
- Creatine supplementation is reported to increase the creatine content of muscle by ~ 20% (Buford et.al, Febbraio et.al, Hultman et.al)
- Once dry weight creatine concentration reaches 150-160 mmol/kg, additional supplementation offers no additional help (Haff & Triplett)



Creatine Supplementation Regimen

This “ceiling” effect should modify the “More is better” attitude

Supplemental form is Creatine Monohydrate, sold in powder, tablet, capsule, and liquid forms

Sold OTC or mail order

- Typically creatine supplementation involves using a loading dose of 20-25 gms daily for 5 days, or 0.3 g/kg if you wish to dose relative to personal mass
- [there is no evidence as yet whether 5gm QID is better than a single dose of 20-25 gm/day]
- A maintenance dose of 2 gm/day
- Once supplementation ends endogenous levels will return (2 gm/day)



Creatine Efficacy

- It appears that creatine supplementation is more productive for training rather than as a direct performance enhancer. (Haff & Triplett)
- Used in training, there has been an increase in FFM, partly due to increased muscle contractile proteins as well as increased water retention in the muscle
- There is some evidence to suggest that supplementation may be helpful during injury rehabilitation to help rebuild atrophied muscle



Creatine – Adverse Effects

Adverse effects usually means that there is some debilitating effect.

- Strength to Mass ratio can be negatively affected with overall mass increase.
- All additional reported negative effects to date have been shown as anecdotal:

GI disturbances, Cardiac and muscular problems, muscle cramping have not been found in peer reviewed research as yet

- Long term concerns revolve around possible Hepatic and Renal toxicity due to the high nitrogen content; to date no reported data



Branch Chain Amino Acids

Amino Acids as we know are the building blocks of not just protein but of every structure in the body.

There are 9 indispensable/essential AA's:

Leucine	Phenylalanine
Isoleucine	Threonine
Valine	Tryptophan
Methionine	Histidine
Lysine	

Indispensable/Essential means that we must ingest them, they cannot be made from the other 11 amino acids



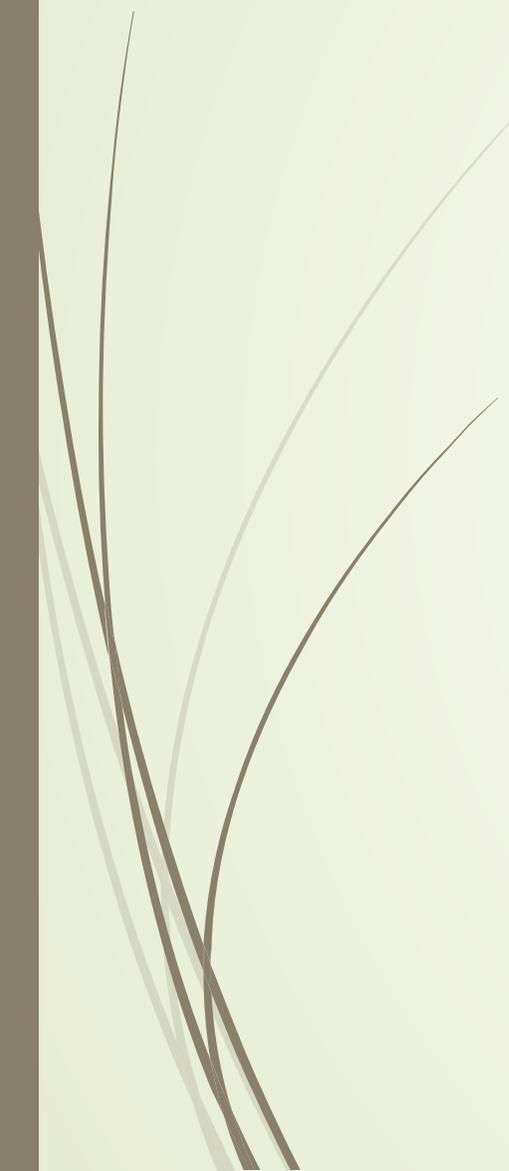
Branch Chain Amino Acids

Valine, Leucine, & Isoleucine are the BCAA's

Why are they singled out?

What are/were the early claims

BCAA's perform the following functions:

1. BCAA's contribute as local muscle fuel for endurance activity
 2. BCAA's decrease fatigue during endurance activity
 3. BCAA's in addition to other AA's boost the bodies natural production of testosterone, GH, Insulin or Insulin like growth hormone (IGF-1)
 4. BCAA's boost protein synthesis and retard protein catabolism
- 



Branch Chain Amino Acids

Current Research

Let's look at each claim

1. BCAA's contribute as local muscle fuel for endurance activity
 - **Through gluconeogenesis a small amount of glucose can be generated as fuel, but in the presence of carbs this influx would be minimal**
2. BCAA's decrease fatigue during endurance activity
 - * **“Central Fatigue Theory” suggests that concentrations of serotonin can impair CNS function in endurance activity = decrease performance. Serotonin increases as a result of elevated bloodborne tryptophan (precursor to serotonin). BCAA's compete with the albumin receptors the same as Tryptophan. However, as exercise continues plasma BCAA levels fall off for a variety of reasons. Current research is ambiguous at this time (Bahrke & Yesalis)**



Branch Chain Amino Acids

Current Research

3. BCAA's in addition to other AA's boost natural testosterone, GH, Insulin or Insulin like Growth Hormone (IGF-1)
 - **Current research on Arginine, Lysine, Tyrosine and other AA's have produced no positive effect on GH levels, insulin secretion, diverse measures of anaerobic power or VO2 max to date (McArdle, Katch, & Katch)**
4. BCAA's boost protein synthesis and retard protein catabolism
 - **It appears that Leucine alone is the BCAA key for stimulating protein synthesis. (Campbell, Katsanos et.al, & Rieu et.al)**
 - **In support of this theory (Pasiakos et.al) conducted a study where leucine enriched EAA beverage was given to trained males during a cycling exercise. 3 hr post exercise, muscle protein synthesis was 33% higher**

Ergogenic Aids & Dietary Supplements Risky Business

Utilizing any Ergogenic Aid or Dietary Supplement has potential risk for the following reasons:

1. Unknown or not enough data on adverse effects
2. Unknown or unlabeled compounds or substances finding their way into the supplement





Ergogenic Aids & Dietary Supplements Risky Business

1. Unknown Adverse Effects
 - The lion share of products on the market today have not been studied adequately to prove the stated benefit and to discover potential adverse effects, short term or long term
 - Athletes are quite willing to believe “Hype” or “Testimonials” about product statements without investigation, simply because they are looking for “An Edge”
 - Many athletes are even willing to overlook potential adverse effects in lieu of the stated short term performance benefit. “It’s my Body”



Ergogenic Aids & Dietary Supplements Risky Business

2. Unknown compounds, substances, or additives
 - Quite a few manufacturers are deceitful about what goes into their products
 - Hidden caffeine, hidden anabolic compounds, hidden sugars, etc...
 - There are literally hundreds of substances that are deemed illegal, prohibited, or banned by WADA, NCAA, IOC, USOC, etc...
 - The universal reality is that regardless of lack of knowledge, athletes are responsible for what goes into their bodies.



Position Statements on Ergogenic Aids

NSCA – Strength and Conditioning Professional Standards & Guidelines

Standard 9.1

Strength & Conditioning Professionals must not prescribe, recommend, or provide drugs, controlled substances or supplements that are illegal, prohibited, or harmful to participants for any purpose including enhancing athletic performance, conditioning, or physique. Only those substances that are lawful and have been scientifically proven to be beneficial, or at least not harmful, may be recommended or provided to participants by Strength & Conditioning Professionals, and only to individuals age 18 or above.

NATA-BOC & ACSM

Both organizations take a food first stance

Ergogenic Aids & Dietary Supplements Help in Determining Safety

There are several agencies that independently test products for illegal substances, strength & purity

1. USP (United States Pharmacopeia)



2. Aegis Shield



Ergogenic Aids & Dietary Supplements Help in Determining Safety

3. BSCG (Banned Substance Control Group)



4. Informed Choice





Thank you

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