Ergogenic Aids

Ergogenic is defined as “tending to increase work”

An ergogenic aid is defined as “…A physical, mechanical, nutritional, psychological, or pharmacological substance or treatment that either directly improves physiological variables associated with exercise performance or removes subjective restraints which may limit physiological capacity”

Some examples of ergogenic aids are:
- Warm-up
- Caffeine ingestion
- Carbohydrate ingestion
- Liquid ingestion
- Glycerol ingestion
- Phosphate ingestion
- NaHCO₃ ingestion
- Creatine ingestion
- Blood doping
- Erythropoietin
- Growth hormone
- Testosterone

Warm-up

<table>
<thead>
<tr>
<th>BENEFIT</th>
<th>Verified by Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submaximal Exercise</td>
<td></td>
</tr>
<tr>
<td>Muscle temperature</td>
<td>Yes</td>
</tr>
<tr>
<td>Muscle blood flow</td>
<td>Yes</td>
</tr>
<tr>
<td>Oxygen deficit</td>
<td>Yes</td>
</tr>
<tr>
<td>Neuromuscular function</td>
<td>No</td>
</tr>
<tr>
<td>Lipid catabolism</td>
<td>Yes</td>
</tr>
<tr>
<td>Carbohydrate metabolism</td>
<td>Yes</td>
</tr>
<tr>
<td>Muscle glycogen sparing</td>
<td>No</td>
</tr>
<tr>
<td>Risk of musculoskeletal injury</td>
<td>No</td>
</tr>
</tbody>
</table>

Nutritional Ergogenic Aids

- Caffeine
- Glycerol
- Carnitine
- Phosphate
- Sodium Bicarbonate
- Creatine
- Branched chain amino acids

Caffeine

- The most highly consumed drug in North America and Europe
- IOC initially banned caffeine in 1962, then removed from list in 1972
- Today, urinary caffeine > 12 mg/L is an IOC infringement
- This urinary level requires > 13.5 mg/kg caffeine, where 1 cup coffee provides 80 mg
  - Assume 75 kg body mass
    - IOC banned dosage: 1012 mg/80 = 12.7 cups
    - Ergogenic benefit: 330 mg/80 = 4.1 cups
**CAFFEINE**

- Improved exercise endurance
- Stimulant to CNS
- \( \uparrow \) Diuresis
- \( \uparrow \) Lipolysis
- \( \uparrow \) Incidence of cardiac arrhythmias
- \( \downarrow \) Muscle glycogenolysis

**Glycerol**

Ingestion of \( \sim 1.2 \text{ g glycerol/kg body mass} \) with sufficient volumes of water (26 mL/kg) can induce an increase in hydration, termed *hyperhydration*.

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**Carnitine**

Molecule that transports fatty acids into mitochondria. Research indicates that carnitine provides no ergogenic benefit.

**Phosphate**

Some evidence for increased VO\(_2\max\) and VT.

**Sodium Bicarbonate**

Increases blood bicarbonate and buffering potential. Increases performance during intense intermittent exercise.

**Creatine**

- \( \diamond \) Creatine is the main component of creatine phosphate. Creatine is found in meat and fish, but is also able to be synthesized in the body.
- \( \diamond \) Dietary supplementation of creatine of at least 15 g/day for 2-7 days can increase muscle CrP and free Cr.

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**Branched Chain Amino Acids**

The main BCAA’s are leucine, isoleucine and valine. These amino acids decrease the ability for tryptophan to cross the blood brain barrier, impeding the formation of serotonin and the perception of fatigue (central fatigue).
**Other Ergogenic Aids**

**Pure Oxygen Inhalation**
- This procedure can raise blood PaO₂ from 104 mmHg at sea level to ~600 mmHg.
- This raises the blood oxygen content:
  - \(104 \times 0.03 \text{ mL/L/mmHg} = 3.12 \text{ mL/L}\)
  - \(600 \times 0.03 \text{ mL/L/mmHg} = 18 \text{ mL/L}\)
- The raised blood O₂ content can increase VO₂max. However, there is no evidence that breathing pure oxygen aids recovery.

**Erythropoietin (EPO)**
- A hormone that is mainly produced in the kidney in response to hypoxia, anemia, and blood loss.
- EPO stimulates increased red blood cell production (erythropoiesis).
- EPO is widely used by elite endurance athletes, but has caused deaths due to excessive increases in blood viscosity and organ damage.

**Blood Doping**
- The removal of 1-4 units of blood, storage of the blood for 4-8 weeks, and the reinfusion of the red blood cells.
- Reinfusion usually occurs ~1 week prior to competition.
- Blood doping can double the [Hb], but typically this causes too much of an increase in blood viscosity.
  - \(140 \text{ g/L} \times 1.34 \text{ mL/g} \times 0.98 = 148 \text{ mL/L}\)
  - \(200 \text{ g/L} \times 1.34 \text{ mL/L} \times 0.98 = 263 \text{ mL/L}\)
  - \(262 - 148 = 79 \text{ mL/L}\)

**Blood doping can increase VO₂max and improve endurance exercise performance.**

**Growth Hormone (GH)**
- A natural glucoregulatory and anabolic hormone.
- GH use can:
  - ↑ muscle hypertrophy and strength
  - ↓ body fat
  - ↑ growth of flat bones
  - ↑ healing of musculo-skeletal injury

**Anabolic-Androgenic Steroids**
A family of hormones similar to testosterone.
Benefits are similar to GH, but include additional side-effects such as:
- hirsutism
- deepening of the voice
- acne
- aggressive behavior
- decrease in HDL cholesterol
- liver damage
Amphetamines

- Stimulants to the CNS, but far more potent than caffeine.
- Minimal research
- Increase risk for:
  - Over-exertion causing musculoskeletal injury
  - Cardiac arrhythmias
  - Hypertensive responses to exercise
  - Irritability
  - Paranoia