Supplements & Ergogenic Aids in Sports

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Introduction

• *Ergogenic aid*: any substance or strategy that improves athletic performance by improving the production of energy

• *Dietary supplement*: a vitamin, mineral, herb, botanical, amino acid, metabolite, constituent, extract, or a combination of any of these ingredients
Introduction

• Why athletes use ergogenic aids?
  ▫ Improve performance
  ▫ Delay fatigue
  ▫ Change body composition
  ▫ Improve health
  ▫ Increase strength
  ▫ Psychological Reasons

Supplement Use among Athletes

▫ All elite athletes: 60%
▫ Colligate athletes: 45%
  • Multivitamin/mineral supplements and creatine
▫ Adolescent athlete: 30%
Safety and Effectiveness

- Some supplements may be beneficial
- Some impair performance and health
- Two crucial question:
  - Is it safe?
  - Is it effective?
- Not easily answered “yes” or “no”
  - Need more detailed information, research
  - Need to consider the risk-benefit ratio

Caffeine

- Use as an ergogenic aid
- Improve endurance performance
- Delay fatigue
- Enhance fat loss
  - There is no evidence to support this effect
  - Increase FFA mobilization, but no effect on fat oxidation
Caffeine

• Amount for desired effect:
  ▫ 5-6mg/kg

• Consumed in a variety of ways:
  ▫ Strongly brewed coffee (8oz = 85mg)
  ▫ Caffeine-containing soft drink (12 oz = 36 mg)
  ▫ Caffeine-containing pills (1 tablet = 100 mg)

Caffeine

• Certain levels is legal

• NCAA:
  ▫ Urinary caffeine levels exceeding 15μg/mL → disqualification
  ▫ Difficult to reach by food intake (17 Caffeine containing soft drink )
Caffeine

• Adverse effects:
  ▫ Blood pressure (rest & during exercise)
  ▫ Increased heart rate
  ▫ Gastrointestinal distress
  ▫ Insomnia
  ▫ Addictive for routine users
    • Severe headache due to sudden withdrawal

The acute effects of a caffeine-containing supplement on strength, muscular endurance, and anaerobic capabilities

Purpose

- To examine the acute effects of a caffeine-containing supplement on upper and lower body strength and muscular endurance as well as anaerobic capabilities

Methods

- **Subjects:**
  - Thirty-seven resistance-trained men
  - Healthy
  - No medication
  - No nutritional supplements in the 6 weeks prior to the study
- **Study design:**
  - Randomized double-blind placebo, controlled
Methods

• First laboratory visit:
  ▫ Subjects performed 2 Wingate Anaerobic Tests
    • Peak power & mean power
  ▫ *After 25 hours*
    ▫ 1 repetition maximum (1RM) & Muscular endurance (TOTV) on:
      • Leg extension (LE)
      • Bench press (BP) exercises

Methods

• Second laboratory visit:
  ▫ Subjects were randomly assigned to 1 of 2 groups:
    ▫ Caffeine-containing supplement group (n = 17)
    ▫ Cellulose placebo group (n = 20)
  • *1 hour after ingestion*:
    ▫ 2 Wingate Anaerobic Tests (Peak power & mean power)
  • *After 24 hours*:
    ▫ Ingestion another dose of caffeine & placebo
    ▫ 1RM strength and muscular endurance on the LE and BP exercises
Results

• A significant increase in BP 1RM for the SUPP group
• The caffeine-containing supplement had no effect, on LE 1RM, LE TOTV, BP TOTV, PP, and MP.

Discussion & Conclusion

• The caffeine-containing supplement may be an effective supplement for increasing upper-body strength
• Future studies needed to determine the effective dosage of caffeine for muscular endurance and anaerobic capabilities
Implication

• For high intensity anaerobic activities, ingesting a supplement that contain a moderate dose of caffeine about 1 hour before the activity may be beneficial for increasing upper body strength

Evaluation

• (+)
  ▫ Explained and compared the past studies
  ▫ 25 references (1978-2005)

• (-)
  ▫ Male only
  ▫ No dietary record
  ▫ Ambiguous terminology
Creatine

- Nitrogen-containing compound found in meat and fish
- Source of muscle energy in form of phosphocreatine
- The most used nutritional supplement among athletes
- Forms: powder, pills, liquids, and protein bars

Creatine

- Effects:
  - Increases storage of phosphocreatine
  - Increases ATP production
  - Increased strength, endurance, and muscle gains
- Increases intracellular water in the muscle
- Stimulate muscle glycogen
- Enhancing glycogen storage
- More studies needed
Creatine

- Consumed as creatine monohydrate
- Usual dose: 3 to 5 g/day

- Loading period:
  - 20g/day for the first 5 days
  - 5 to 10g/day thereafter

Creatine

- Some evidence supports the positive effect of creatine on performance in some sports such as high-intensity and short duration
- Some evidence does not support the positive effect of creatine on some sports such as running or swimming
- Safety and effectiveness of creatine supplementation has been debated
Creatine

- Possible side effects:
  - Gastrointestinal disturbances
  - Cramps

The effects of creatine supplementation on selected factors of tennis specific training

Purpose

• To determine the effects of both short term (six days) and medium term (five weeks) use of creatine on tennis players’ performance

Method

• Subjects:
  ▫ 36 healthy, non-vegetarian, male tennis players
  ▫ None had used any creatine supplements in the two months prior the study period

• Experimental design:
  ▫ Double blind, placebo controlled design
  ▫ Players were assigned randomly to:
    • Creatine group (n=24)
    • The placebo group (n=12)
Method (cont.)

- **Performance tests:**
  - Test 1: at the start of the study
  - Test 2: after six days of creatine loading
  - Test 3: after a four week maintenance phase
- Tests were on:
  - Tennis specific running (repetitive short sprints)
  - Velocity of repeated ground strokes
  - Serving velocity

Method (cont.)

- **Strength measurement:**
- After an individual warm up
  - Strength of the leg muscles
  - Strength of the chest and arm muscles
Results

• **Test 1: Baseline levels**
  • No differences between the creatine group and the placebo group in:
    ▫ Serving velocity
    ▫ Forehand and backhand velocity
    ▫ Sprinting velocity
    ▫ Strength measurements

Results (cont.)

• **Test 2: Six day loading phase**
  • No differences in:
    ▫ Body weight
    ▫ Sprinting time
    ▫ Serving velocity
    ▫ Ground stroke velocity
    ▫ Strength measurements
Results (cont.)

- **Test 3: Four week maintenance phase**
  - The size of the groups was reduced (creatine n=14, placebo n=10)
  - A significant increase in total body weight in the creatine group
  - No differences in performance for
    - Sprinting time
    - Serving velocity
    - Ground stroke velocity
    - Strength measurements

Discussion & Conclusion

- The results did not support some previous studies that have shown *creatine supplementation may be ergogenic for a high stroke velocity*

- Creatine supplementation in tennis players, whether short term or medium term, has not been shown to enhance tennis specific performance.
Implication

• Creatine supplementation cannot be recommended for tennis players for performance enhancement

Evaluation

• (+)
  ▫ Clear explanations of methods
  ▫ Good visuals

• (-)
  ▫ Male only
  ▫ Dropouts after the second test
Anabolic Steroids and Athletes

- What are AAS?
- How does it work?
- Are there any negative effects on the human body?
- Is it safe?
- Research

Anabolic Steroids

- What are AAS?

  - Testosterone derivatives that cause an androgenic and anabolic effect on both reproductive and non-reproductive target tissues in the body.

  - The goal of these derivatives is to prolong the active biological form of testosterone in the body.
Anabolic Steroids

Mechanism of Action

- How does it work?
  - There are three main effects:
    1. Increase in protein synthesis by causing a positive nitrogen balance/retention in skeletal muscle.
    2. Blocks glucocortocosteroid receptors causing an anti-catabolic effect on skeletal muscle.
    3. Psychological- sense of euphoria, increased aggression, decreased fatigue, decreased recovery time, intense training bouts, extreme strength.

Anabolic Steroids

Positive Effects

- Increased muscle mass
- Increased strength
- Decreased recovery time
- Increased aggression
- Promote healing of injuries
- Maintain same “advantage” as one’s opponent
- Obtaining a winning edge
Anabolic Steroids
Negative Effects

<table>
<thead>
<tr>
<th>Reproductive - Male</th>
<th>Reproductive - Female</th>
<th>Psychological</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Decreased reproductive hormones</td>
<td>• Menstrual irregularities</td>
<td>• Mood swings</td>
</tr>
<tr>
<td>• Testicular atrophy</td>
<td>• Clitoral hypertrophy</td>
<td>• Aggressive behavior</td>
</tr>
<tr>
<td>• Oligospermia/azoospermia</td>
<td>• Uterine atrophy</td>
<td>• Depression</td>
</tr>
<tr>
<td>• Impotence</td>
<td>• Breast atrophy</td>
<td>• Psychosis</td>
</tr>
<tr>
<td>• Prostatic hypertrophy</td>
<td></td>
<td>• Addiction</td>
</tr>
<tr>
<td>• Prostatic carcinoma</td>
<td></td>
<td>• Withdrawal and Dependency Disorders</td>
</tr>
<tr>
<td>• Gynecomastia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Priapism</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Liver
• Hepatocellular damage
• Cholestasis
• Peliosis hepatis
• Hepatoadenoma
• Hepatocarcinoma

Cardiovascular and hematologic effects
• Increased cholesterol
• Decreased HDL cholesterol
• Hypertension
• Thrombosis
• Ventricular hypertrophy

Musculoskeletal
• Early epiphyseal closure in children
• Increased rate of muscle strains/ruptures
• Increased risk of musculotendinous
• Endocrine (other than reproductive)
• Decreased glucose tolerance
Anabolic Steroids
Brands (generic names)

**Oral**
- Oxymetholone
- Oxandrolone
- Methandrostenolone
- Ethylestrenol
- Stanozolol
- Fluoxymesterone
- Norethandrolone
- Methenolone acetate
- Mesterolone
- Testosterone undecanoate

**Injectable**
- Nandrolone decanoate
- Nandrolone phenpropionate
- Testosterone cypionate
- Testosterone enanthate
- Testosterone propionate
- Methenolone enanthate
- Boldenone undecyclenate
- *Trenbolone acetate*
- *Trenbolone*
- Stanozolol

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Anabolic Steroids
Are they SAFE?

- The effect and damage on the human body is related to the amount, type, and duration of use.
- Research is anecdotal, dependent on past steroid use history and truth in subjective information collection.
- May cause severe adverse effects and death if taken with other ergogenic aids “stacking”
- Although AAS have been used under physician supervision, the adverse effects still apply.
Doping and effects of anabolic androgenic steroids on the heart: histological, ultrastructural, and echocardiographic assessment in strength athletes


Purpose

- To evaluate structural and functional dysfunctions in the heart in athletes using anabolic androgenic steroids.
- To evaluate histological and ultrastructural changes in cardiac muscle in adult albino rats injected with AAS.
Methods

<table>
<thead>
<tr>
<th>Humans</th>
<th>Rats</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group I (15 males)</strong></td>
<td><strong>Group I- control group (10 rats)</strong></td>
</tr>
<tr>
<td>Bodybuilders- AAS use for</td>
<td>I a- No AAS</td>
</tr>
<tr>
<td>3-5 yrs.</td>
<td>I b- injected with olive oil 0.8mg 1x/wk</td>
</tr>
<tr>
<td>250mg testosterone</td>
<td>for 8 weeks</td>
</tr>
<tr>
<td><strong>Group II (5 males)</strong></td>
<td><strong>Group II- experimental (20 rats)</strong></td>
</tr>
<tr>
<td>Bodybuilders-No AAS use</td>
<td>Injected with 10mg/kg AAS 1x/wk for 8</td>
</tr>
<tr>
<td></td>
<td>weeks</td>
</tr>
<tr>
<td><strong>Group III (5 males)</strong></td>
<td></td>
</tr>
<tr>
<td>Non-athletes- Control group</td>
<td></td>
</tr>
</tbody>
</table>

**Analyses**
- Microsoft Excel
- ANOVA test
- T-test for the two groups (rats)

Methods- Assessments (Humans)

1.) **Echocardiograph** - Left ventricular wall thickness/hypertrophy
2.) **Conventional & Tissue Doppler** - velocity of systolic and diastolic waves
3.) **Strain Rate Imaging (SRI)** - resting ventricular function, cardiac tissue deformation
Methods- Assessments (Rats)

1.) Light Microscopy-
   General histological features of the tissue

2.) Ultrastructural
   (Transmission electron microscope) -
   Assessment of tissue at a microscopic cellular level

Results- Humans

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Group I</th>
<th>Group II</th>
<th>Group III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echo</td>
<td>Systolic &amp; diastolic ventricular dimensions were smaller</td>
<td>2.0 ± 0.11</td>
<td>3.06 ± 0.08</td>
</tr>
<tr>
<td>LV posterior wall thickness</td>
<td>1.07 ± 0.09</td>
<td>0.88 ± 0.08</td>
<td>0.8 ± 0.11</td>
</tr>
<tr>
<td>LV Mass</td>
<td>212 ± 12</td>
<td>165 ± 3</td>
<td>163 ± 2.5</td>
</tr>
</tbody>
</table>
Results- Humans cont.

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Group I</th>
<th>Group II</th>
<th>Group III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tissue Doppler</td>
<td><strong>Impaired ventricular relaxation</strong></td>
<td>Normal</td>
<td>Normal</td>
</tr>
<tr>
<td></td>
<td><strong>Impaired diastolic function</strong></td>
<td><strong>↓ EM velocity 7.3 ± 1.6 cm/s</strong></td>
<td><strong>↓ AM velocity 10.6 ± 1.8 cm/s</strong></td>
</tr>
<tr>
<td></td>
<td><strong>↑ PSSR</strong></td>
<td><strong>-0.7 ± 0.13</strong></td>
<td><strong>-1.29 ± 0.26</strong></td>
</tr>
<tr>
<td>SRI</td>
<td><strong>↑ PSSR</strong></td>
<td><strong>-1.3 ± 0.25</strong></td>
<td><strong>-1.29 ± 0.26</strong></td>
</tr>
</tbody>
</table>

Results- Rats

- **Control Group & Olive Oil Group**
  - Normal tissue pattern, nucleus, sarcoplasm, mitochondria, and muscle fiber striations

- **AAS Injected Group**
  - Loss in myofibril striations
  - Interrupted Z band
  - Destruction of the sarcolemmal membrane
  - Damaged nuclei of myocytes
  - Shrunken chromatin
  - Damaged mitochondria
Discussion/Conclusion

• AAS may cause cardiac tissue damage and may be irreversible.
• Changes and degeneration in mitochondria, myofibrils, striations, and chromatin were observed in rat group.
• LV hypertrophy, increase in dimension and mass were observed in human group.
• Systolic and diastolic velocity was impaired in human group.
• Increased risk of heart failure and cardiomyopathy in bodybuilders using AAS.
• The amount, type, and duration of use are factors in the degree of damage done to the heart.

Evaluation

(+)
• Comparison to rat cardiac tissue
• Good description of methods
• More than one assessment tool
• Looked at a variety of heart functions
• 27 references—many current 1977-2007

(-)
• Small sample size
• Anecdotal history of AAS use
• Not enough information on healthy heart function
• Unfamiliar terms
Androgenic anabolic steroids also impair right ventricular function


Purpose

• To evaluate the effects of anabolic androgenic steroid use among athletes on right ventricular heart function.
Methods

- 26 male bodybuilders (23-33yrs of age)
- **Divided into three groups:**
  - Group I > 12 used AAS
  - Group II > 14 no AAS use
  - Group II > 15 volunteer subjects
- **Inclusion criteria**
  - 6 to 10 hours of training a week
  - at least 6 months of AAS use
  - no history of cardiovascular disease or hypertension

Methods cont.

- Assessment tools:
  - **Echocardiography**
    L & R ventricular dimensions
  - **Tissue Doppler**
    systolic and diastolic blood velocity

Analyses: one-way variance
Results

- Group II and III showed normal cardiovascular function
- **Group I showed:**
  - $\uparrow$ LV mass
  - $\uparrow$ RV diameter
  - $\downarrow$ control of blood flow (E-wave, E/A ratio of mitral annulus)
  - Depressed diastolic function in both ventricles
  - $\downarrow$ end-diastolic volume
  - $\downarrow$ stroke volume

Discussion/Conclusion

- Although RV remodeling takes place during adaptations to strength training, AAS use shows a depressed diastolic function in both ventricles
- Reversibility of RV function is unknown after the cessation of AAS use
- The decrease in end diastolic volume and stroke volume may increase the risk of cardiovascular dysfunction and disease among AAS users.
Evaluation

(+)  
- Focus on RV function  
- Opportunity for future studies of the RV and AAS use

(-)  
- Very small sample size  
- Only 7 references  
- Grammar errors although able to understand  
- No in-depth information of heart function  
- Anecdotal and subjective data collection

Hormones

- What are hormones?
  - Defined as chemical messenger, which they are synthesized and secreted by endocrine tissue (glands).
  - They are transported in the blood to target tissues or organs.

- What are the different kinds of hormones?
  - Growth hormones are hormones that promote growth.
  - Blood sugars are regulated by insulin and glucagon.
  - Thyroxin is a hormone that regulates the body’s metabolic rate.
  - Anti-diuretic hormone regulates fluid and electrolyte balance.
Human growth (GH)

- GH is also called somatotropin,
  - Which is a protein of 191 amino acids.
  - GH promotes body growth by binding to receptors on the surface of liver cells, which stimulates them to release insulin-like growth factor-1 (IGF-1)
  - IGF-1 is used for the regulation of cell growth within the human body.
    - The IGF-1 is also another name for long chain amino acids or polypeptide proteins, which are a hormone that regulates growth and tissue repair.

Use and Abuse of Growth Hormone

- Using growth hormone is becoming a famous doping treatment among the athletic population.
- GH abuse is common among athletes and it is used to improve exercise performance
Research Review

- To further investigate the relationship between GH and exercise, an interesting research study looked at the effect of growth hormone receptor antagonist treatment on exercise performance.

Growth hormone receptor antagonist treatment reduces exercise performance in young males

**Introduction**

- GH increases blood concentration of glycerol and free fatty acids during exercise both in Growth Hormone-deficient (GH) patients and in healthy people.
- There is contradiction mentioned of the effect of GH on exercise.
  - Some research reported that GH replacement increases maximal oxygen uptake (VO2max).
  - And other research reported that GH reduces oxygen uptake.
  - Theoretically, when GH is administered before exercise, it may increase relative fat oxidation during submaximal exercise by increasing free fatty acid (FFA) release.
  - As a result, an increase in time of exhaustion (TTE) will occur causing sparing of glycogen in the muscle and liver.

**Purpose of the study**

1. To examine the influence of blocking GH action on exercise performance in healthy men, focusing on changes in lactate concentrations and TTE after treatment with the GHR antagonist pegvisomant.
2. To examine the hormonal responses and substrate metabolism to find out whether GH is a determinant stimulus for enhancement of fat metabolism during exercise.
Methods

• Subjects:
  ▫ Twenty healthy males age 24 ± 1 year participated
    • Medical history
    • Physical examination
    • Routine blood test

Method Cont’d

• Exclusion criteria:
  • Metabolic, cardiac, and malignant diseases,
  • Anemia,
  • Hormonal replacement therapy; and
  • Medication with α- or β- blockers.

• Study design:
  • Randomized, placebo-controlled, double-blind
Method Cont’d

• Subjects:
  - One treated with GHR antagonist pegvisomant
  - Other group was the placebo
  - The treatment was given by injection in the abdominal skin every second evening.
  - The experiment lasted for 16 days.
  - VO2max test was used and prolonged exercise trail was examined.
  - Performed an incremental exercise test on a cycle ergometer to assess VO2max.
  - The time to exhaustion was measured to test performance during prolonged exercise.

Method Cont’d

• Serum free fatty acid and glycerol concentrations were analyzed using an enzymatic method by collecting blood samples.
• In addition, muscles biopsies were obtained from the vastus lateralis muscle after subjects completed a prolonged exercise.
  - Fluorometric essay was used to analyze muscle lactate
Results

<table>
<thead>
<tr>
<th></th>
<th>Treatment Group</th>
<th>Placebo Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth hormone (GH),</td>
<td>Increased</td>
<td>No change</td>
</tr>
<tr>
<td>insulin-like growth factor-1 (IGF-1)</td>
<td>Decreased</td>
<td>No change</td>
</tr>
<tr>
<td>IGF binding protein-3</td>
<td>Decreased</td>
<td>--------------</td>
</tr>
<tr>
<td>VO2max</td>
<td>No change</td>
<td>No change</td>
</tr>
<tr>
<td>Blood lactate</td>
<td>Increased</td>
<td>Increased</td>
</tr>
<tr>
<td>Lipolysis, and fat oxidation</td>
<td>No change</td>
<td>No change</td>
</tr>
</tbody>
</table>

Discussion & Conclusion

- An important finding was that GHR antagonist reduced prolonged exercise performance, which showed that the essential role of GH in exercise capacity.
- The researchers mentioned that further studies are needed to examine the effect of GHR antagonist among patients who chronically receive such drugs as part of their therapy.
Evaluation

• (+)
  ▫ Physicians were involved in the injection procedure.
  ▫ 37 references (1972-2007)

• (-)
  ▫ Male only
  ▫ Nothing mentioned about the nutritional status of the subjects.

Conclusion of all Articles

• Athletes should be counseled regarding the appropriate use of ergogenic aids
• Evaluation for safety, efficacy, potency, and legality
• Vitamin and mineral supplements are not required if an athlete is consuming a diet with
  ▫ Balance
  ▫ Variety
  ▫ Moderation
How to Convey Information

- Influence of:
  ▫ Coaches
  ▫ Family
  ▫ Friends
  ▫ Product advertisements

- Solution:
  ▫ To educate athletes on:
    ▪ The physiological mechanism
    ▪ The effects on training
    ▪ The possible side effects
    ▪ The conditions of use

References


Any Questions???