Anabolic steroids are not safe ergogenic aids to increase strength, body size and performance.

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Jessica Ma, Carrie Kwok, Jonathan Ho
Road Map

1. P-CP Hypothesis
2. Clinical & Non-Clinical Use
3. Mechanism
4. Recommended Daily Allowance
5. Safe Level of Consumption
6. Evidence to Support Hypothesis
7. Evidence to Refute Hypothesis
8. Point Hypothesis Critique
9. Conclusion
Hypothesis (P + CP)

The point hypothesis is that anabolic steroids are safe ergogenic aids to increase strength, body size and performance.

The counterpoint hypothesis is that anabolic steroids are not safe ergogenic aids to increase strength, body size and performance.
Use in a Non-clinical or Clinical Setting

Clinical Setting: Anabolic Steroids (AS) promote anabolism to prevent muscle wasting associated with cancer and HIV (D’ Andrea et al, 2006).

Also used for testosterone replacement therapy in hypogonadal men (Brodsky et al, 1996).

Non-clinical Setting: Elite and recreational athletes use above clinical dosages of AS to improve sports performance and/or aesthetics (Bhasin, 1996).

Figure 1. (Brodsky et al, 1996) Muscle protein synthesis rate to whole body protein synthesis rate is greater during testosterone replacement therapy than before therapy.
Mechanism of Action

- Retention of nitrogen and resistance training lead to synthesis of new muscle fibres (Souza et al, 2016).

- Stimulates androgenic receptor molecules to initiate protein synthesis and gene expression (D’Andrea et al, 2006).

- Increase leucine levels biosynthesized leading to increase of skeletal muscle (Brodsky et al, 1996).

- Cause euphoric rush and decrease fatigue so athletes can train longer and at higher intensities (Bonetti et al, 2007).

- Repair mechanism: myocardial collagen may increase to prevent myocardial damage (D’Andrea et al, 2006).

- Genotoxic mechanism: some (trenbolone and nandrolone) can aromatize into estrogen 17 beta-estradiol in adipose, cerebral, and testicular tissues (Souza et al, 2016).
Recommended Daily Allowance (RDA)

- There is no RDA for AS, because it is not a food/nutrient.
- 300mg/week of testosterone enanthate given to normal men as contraceptive did not result in severe toxic effects (Matsumoto, 1988).
  - Significant muscle size and strength were only seen with this dosage amount or more (Souza et al, 2016).
- Normal clinical dosage is 3 times lower (100mg/week) for testosterone replacement therapy in hypogonadal men (Bhasin et al, 1996).
Safe Level of Consumption

**Short Term:**

- Supraphysiologic dosages (600 mg / week of testosterone enanthate) showed greater muscle growth and strength (Bhasin et al, 1996).

- High dosages in the short term can result in:
  - Acne formation and breast tenderness in males (Bhasin et al, 1996).
  - **Reduced sperm production** (Matsumoto, 1988).
Safe Level of Consumption

Long Term:

• **Left ventricular hypertrophy** (D’ Andrea et al, 2006).

• Inhibit lipid metabolism and insulin sensitivity (Bhasin et al, 1996).

• **Decreases HDL** and plasma triglycerides values (Bonetti et al, 2007).

• Significant **testicular hypotrophy** and reduction in sperm count in men (Bonetti et al, 2007).
Evidence in Support of the Counterpoint Hypothesis (AS are not safe)

Study of side effects of AS

- Tested every 6 months
- ↓ Testicular size + sperm count
- 7 Dropped out due to emotional inconsistency, depression, sexual dysfunction, family problems. (Bonetti et al, 2007).

<table>
<thead>
<tr>
<th>Months</th>
<th>0</th>
<th>24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right testicle</td>
<td>20.12 ± 3.03</td>
<td>18.77 ± 2.91</td>
</tr>
<tr>
<td>Left testicle</td>
<td>19.96 ± 2.64</td>
<td>16.92 ± 3.40</td>
</tr>
<tr>
<td># Sperm count</td>
<td>58,625,000± 58,943,969</td>
<td>44,775,000± 44,978,204</td>
</tr>
<tr>
<td>Sperm volume</td>
<td>2.42 ± 1.44</td>
<td>2.75 ± 1.20</td>
</tr>
</tbody>
</table>

Figure 2: (Bonetti et al, 2007) 2 year study. All AS users. All units in CC. N = 20 for 0 months N = 13 for 24 months.
Evidence in Support of the Counterpoint Hypothesis (AS are not safe)

Same study continued:

- Decrease in Follicle Stimulating Hormone (FSH) that is unable to return to baseline level even after 24 months.
- Apo A-1 = component of HDL
- Increase in Lactate Dehydrogenase (LDH) Used to evaluate + indicate diseases (anemia) and conditions (chronic tissue damage).

<table>
<thead>
<tr>
<th></th>
<th>Months</th>
<th>0</th>
<th>12</th>
<th>24</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDL</td>
<td>56.94 ± 13.54</td>
<td>49.11 ± 19.84</td>
<td>43.82 ± 18.67</td>
<td></td>
</tr>
<tr>
<td>FSH Secretions</td>
<td>3.95 ± 2.01</td>
<td>2.45 ± 2.54</td>
<td>3.42 ± 2.64</td>
<td></td>
</tr>
<tr>
<td>APO A-1</td>
<td>116.5 ± 18.01</td>
<td>93.32 ± 29.39</td>
<td>95.23 ± 30.66</td>
<td></td>
</tr>
<tr>
<td>LDH</td>
<td>125.10 ± 26.68</td>
<td><strong>148.63 ± 51.24</strong></td>
<td>129.23 ± 30.46</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3: (Bonetti et al, 2007) ΔMetabolic variables (mg / dl). N = 20 for 0 Months. N = 19 for 12 months. N = 13 for 24 Months.
Evidence in Support of the Counterpoint Hypothesis (AS are not safe)

Compare Micronuclei
- Mean age 23 ± 3.1
- Blind test for Cytogenetic Analysis
- Chromosomal damage is translated by increased number of Micronuclei (MN)
- More severe cellular damage linked to AS Methyldrostanolone users.

Group 1: 15 AS using bodybuilders
Group 2: 20 Non-using bodybuilders
Group 3: 20 Non-using sedentary

<table>
<thead>
<tr>
<th>Groups</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>#Cells</td>
<td>15,35</td>
<td>20,341</td>
<td>20,288</td>
</tr>
<tr>
<td>MN</td>
<td>46</td>
<td>37</td>
<td>39</td>
</tr>
</tbody>
</table>

Figure 4: (Souza et al, 2016) Shows the number of cells + MN in each group. Tested from blood + tissue samples.
Evidence in Support of the Counterpoint Hypothesis (AS are not safe)

- Study on toxicant associated fatty liver disease (TAFLD)
- AST / ALT / GGT are all indicators for healthy liver + bile ducts.
- 20 / 40 / 31 UL for indicators respectively.
- AS users showed higher levels in all three.
- High levels do not indicate liver disease, they indicate an increased risk.

↑ Aspartate aminotransferase (AST)
↑ Alanine aminotransferase (ALT)
↑ Gamma glutamyl transferase (GGT)

<table>
<thead>
<tr>
<th>Variable</th>
<th>G1 (n=95)</th>
<th>G2 (n=85)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>26.4 ± 5.9</td>
<td>28.1 ± 6.6</td>
<td>0.08</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>76.6 ± 11.5</td>
<td>77.0 ± 13.1</td>
<td>0.86</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>176.9 ± 6.4</td>
<td>177.4 ± 7.7</td>
<td>0.58</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>24.5 ± 3.5</td>
<td>24.4 ± 3.3</td>
<td>0.77</td>
</tr>
<tr>
<td>Fat mass (%)</td>
<td>13.7 ± 5.5</td>
<td>14.1 ± 5.8</td>
<td>0.63</td>
</tr>
<tr>
<td>AST (U/L)</td>
<td>55.1 ± 68.3</td>
<td>32.7 ± 13.3</td>
<td>0.002</td>
</tr>
<tr>
<td>ALT (U/L)</td>
<td>43.1 ± 29.2</td>
<td>30.9 ± 12.9</td>
<td>0.000</td>
</tr>
<tr>
<td>GGT (U/L)</td>
<td>30.6 ± 29.2</td>
<td>27.6 ± 11.5</td>
<td>0.38</td>
</tr>
</tbody>
</table>

Figure 5: (Schwingel et al, 2010) Effects of AS on Liver. 180 total subjects. G1 = 95 AS Users. G2 = 85 Non users. Mean AS dosage = 1200 mg / week.
Refuting Evidence in Support of the Point Hypothesis (AS are safe)

- 40 men separated into 4 groups
- Supraphysiological doses of testosterone enanthate = 600 mg/week for 10 weeks
- Compares fat-free mass, muscle size, & muscle strength of arms/legs for all 4 groups
- Only side effects: acne + breast tenderness
- No mood/behavioural difference
Refuting Evidence in Support of the Point Hypothesis (AS are safe)

Limitations (Bhasin et al, 1996):

- Short term study
- Small sample size (40 ‘normal’ men)
- Athletes/body builders often take over 600mg/week and/or stack AS
- Possible that higher dosages of multiple steroids may provoke angry behaviour
- Therefore, results of study cannot be representative to athletes/bodybuilders
Refuting Evidence in Support of the Point Hypothesis (AS are safe)

- Compared cardiac size and function in 23 male weight lifters (12 AS users and 11 non-users)

- **Left ventricular size and dimension** did not significantly differ between AS users and non-users.

- **Left ventricular function** did not differ between the two groups analyzed by **% fractional shortening** and rate of **posterior wall thickening**.

Results: no left ventricular hypertrophy or systolic & diastolic dysfunction in AS users (Thompson et al, 1992).
Refuting Evidence in Support of the Point Hypothesis (AS are safe)

Limitations (Thompson et al, 1992):

● Sample size too small (23 subjects only)
● Lack of evidence in study does not prove that cardiac complications will not or cannot occur in the long term
● Left ventricular % fractional shortening in AS users was slightly reduced, but was not statistically significant
  ○ Significant difference may show with a larger sample
● Reported AS use in animals had negative effects on cardiac structure and function.
Point Hypothesis Critique

- Study on nandrolone decanoate human dosage was performed on rats. Stated that high doses used by athletes associated with detrimental somatic and psychic effects (Georgieva, 2004).
  - Human dosage cited from a secondary source which was also performed on rats. Secondary source reported that AS usage resulted in elevated levels of adrenergic and serotonergic amines in hypothalamus which could contribute to aggressive behaviours (Tamaki, 2003).
- Testosterone study supporting their evidence was stopped by Data & Safety Monitoring Board due to too many adverse effects reported.
  - Eg. Leg edema, hematocrit levels >54%, urinary retention, shortness of breath, and two subjects were diagnosed with prostate cancer (Bhasin, 2005).
Conclusion

Major evidence supports the counterpoint hypothesis that anabolic steroids are not safe ergogenic aids to increase strength, body size and performance.
References


Point Hypothesis References


Questions?