

# Testosterone and Growth Hormone: Use and Misuse in Sports



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## Testosterone

Testosterone was isolated in 1932 and by 1954, the Russian Olympic weightlifting team openly introduced androgens as ergogenic aids. By 1968, essentially 100% of weightlifters used androgens but in 1976, the Olympics reacted and banned them. Despite the World Antidoping Agency (WADA) ban ([www.wada-ama.org](http://www.wada-ama.org)) on a multitude of products designed to artificially boost athletic performance, these agents continue to be used.

Surveys in the 1980s revealed that 80% of power athletes and about 50% of all athletes used androgens. Other surveys in 1989 indicated that 99% of high school male students used androgens for athletic or cosmetic goals. Contemporary cases of abuse by athletes continue to be sports page news.

Two of the most commonly used drugs are testosterone and related androgenic steroids along with growth hormone (GH).

A recent survey of 500 androgen users,<sup>1</sup> 99% male, provides a startling description of the chemically-enhanced athlete (Tables 1 and 2). From this study, a snapshot description emerges of a young adult male taking a combination of five different androgens and accessory medications, using androgens in stacking cycles, with the drugs being obtained from

## John's case

John, a 19-year-old junior football player, has professional aspirations. He is 6'2" and 190 lbs and has been experimenting with multiple health supplements and some gym friends have been urging him to use testosterone and growth hormone (GH) supplements to help him bulk up. He is seeking your advice about prescribing these and your opinion about their side-effects. He has read extensively and is well aware of how to acquire these through Internet ordering.

### Despite your counsel...

Despite your counsel to him about cheating and possible adverse effects, John has obtained and is using both testosterone and GH together, plus several other OTC health products. Not surprisingly, he is achieving greater strength and muscle gains than with his previous weight training, but is having trouble with gynecomastia and fluid retention.

### Five years later...

John returns to your office. He has not succeeded in making a football team and has given this up. He is now married and is planning to have children, but has discovered he has a low testosterone and sperm count. He quit all supplements 8 months ago and is considering taking human chorionic gonadotropin (hCG) to stimulate his pituitary-gonadal axis.

### You explain...

There is no good evidence that hCG will speed up recovery of the pituitary-gonadal axis from chronic suppression. You advise John to wait for recovery, which should eventually occur.

Table 1

Use of androgenic steroids in sports\*

Age	<ul style="list-style-type: none"> <li>• 18-35 years</li> </ul>	<ul style="list-style-type: none"> <li>• 80%</li> </ul>
Starting age of use	<ul style="list-style-type: none"> <li>• 16-19 years</li> <li>• 20-24 years</li> </ul>	<ul style="list-style-type: none"> <li>• 24.4%</li> <li>• 37.6%</li> </ul>
Androgen dose	<ul style="list-style-type: none"> <li>• &lt; 500 mg/week</li> <li>• 500 mg-1,000 mg/week</li> <li>• 1,000 mg-1,500 mg/week</li> </ul>	<ul style="list-style-type: none"> <li>• 4.6%</li> <li>• 35.8%</li> <li>• 33.2%</li> </ul>
Years of use	<ul style="list-style-type: none"> <li>• 1-6 years</li> <li>• &gt; 10 years</li> </ul>	<ul style="list-style-type: none"> <li>• 77%</li> <li>• 12%</li> </ul>
Drug sources	<ul style="list-style-type: none"> <li>• Internet dealer</li> <li>• Internet pharmacy</li> <li>• Gym member</li> <li>• Physician</li> </ul>	<ul style="list-style-type: none"> <li>• 71%</li> <li>• 8.6%</li> <li>• 24%</li> <li>• 12%</li> </ul>

\* Adapted from Parkinson AB, Evans NA: Anabolic Androgenic Steroids: A Survey of 500 Users. Med Sci Sports Exer 2006; 38(4):644-51.

Internet dealers. Interestingly, dietary supplements (used by 84% of athletes) promoted to enhance fat loss and increase muscle size and strength are contaminated (up to 25%) with androgens.<sup>2</sup>

An alarming trend is the increased use of GH, insulin and thyroid hormone.

The only evidence-based accepted legitimate uses of androgens are as replacement of symptomatic androgen deficiency and are a consideration for short-term use, as adjunctive therapy, in HIV-infected men and in glucocorticoid-treated men.<sup>3</sup>

### Androgen deficiency

The diagnosis of androgen deficiency is based on a low serum testosterone, with additional testing of free or bioavailable testosterone, if necessary. Luteinizing hormone and follicle-stimulating hormone should be measured for etiological diagnosis.

### A health professional's perspective

The following demonstrates how a health professional would answer common questions posed by a prospective androgen user:

#### Question 1: Do androgens increase muscle size and strength?

Yes. Studies examining the relationship between muscle size, strength and testosterone demonstrate a clear dose-response correlation for those consuming up to 600 mg of testosterone/week.<sup>4</sup> This effect occurs in young or older males.

#### Question 2: Do androgens cause "roid rage?"

There is little, if any, effect on behaviour shown in randomized, blinded trials. Androgens may

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Table 2

**Accessory medications used\***

Drug	Per cent of users	Dose	Reasons for use
<b>Anabolic agents</b>			
GH	• 25.6%	• 2 IU-32 IU q.d.	• Anabolic/repartitioning agent
Insulin	• 25%	• 2 IU-60 IU q.d.	• Anabolic
IGF-1	• 9.6%	• 20 g-120 g q.d.	• Anabolic
<b>Stimulants/fat loss</b>			
Ephedra/ephedrine	• 68.2%	• 25 mg-250 mg q.d.	• Stimulant/appetite suppressant
Caffeine	• 63.6%	• -	• Stimulant/fat loss
Amphetamine	• -	• -	• Stimulant/appetite suppressant
Clenbuterol	• 58.4%	• 20 mg-200 mg q.d.	• Fat loss
Thyroid (T3/T4)	• 45.6%	• 10 g-300 g q.d.	• Metabolic stimulant
Yohimbine	• 29.2%	• 2.5 mg-10 mg q.d.	• Fat loss
Dinitrophenol	• 13%	• 100 mg-600 mg q.d.	• Metabolic uncoupling agent
<b>Miscellaneous</b>			
Diuretic	• 9.6%	• Variable	• Fluid retention/weight loss
<b>Medications to alleviate side-effects</b>			
Clomiphene	• 59.4%	• 50 mg-150 mg q.d.	• Gynecomastia • Pituitary-gonadal axis suppression/testicular atrophy
Anti-aromastases (anastrozole/letrozole)	• 58.6%	• 0.35 mg-2.5 mg q.d.	• Fluid retention/gynecomastia
Tamoxifen	• 53.4%	• 10 mg-30 mg q.d.	• Gynecomastia
hCG	• 39%	• 100 U-5000 U/dose	• Pituitary-gonadal axis suppression/testicular atrophy
Finasteride	• -	• -	• Alopecia/prostatic hypertrophy

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IGF-1: Insulin-like growth factor 1

T3: Triiodothyronine

T4: Thyroxine

exacerbate personality traits.<sup>4,5</sup> Non-medical androgen use is associated with other high-risk behaviour (e.g., street drug use, a history of STD and multiple sexual partners and not wearing helmets or seatbelts).

*Question 3: Can androgens cause hepatic or cardiac side-effects or adverse lipid profiles?*

Testosterone enanthate, cypionate and oral undecanoate preparations have not demonstrated

adverse hepatic effects. Alkylated preparations may cause hepatic toxicity, including cholestatic jaundice or peliosis (blood-filled cysts). A definite connection with hepatoma is unproven.

Supraphysiologic doses of testosterone cause a dose-related decrease in HDL-C but this reaches statistical significance only at extreme doses (600 mg/week).

Other CV risk factors (insulin sensitivity, C-reactive protein) are generally not affected<sup>6</sup>

though studies show variable effects on lipoprotein(a). No effects on the heart, separable from the effects of exercise, have been demonstrated. Temporal associations with arrhythmias, thrombogenesis, hypertension and coronary vasoconstriction have been described,<sup>6</sup> but the true relationships are unclear due to polypharmacy and the lack of controlled studies investigating these effects.

Most sudden deaths in athletes are due to hypertrophic cardiomyopathy and other congenital causes and, again, polypharmacy precludes interpreting the contribution of testosterone.

One definite risk of pharmacologic androgen use is polycythemia with an associated risk of thrombosis. Thus, indicated laboratory tests in an androgen user would include:

- liver function tests (if using alkylated preparations),
- hematocrit and
- lipids.

## *GH*

GH decreases with age and is an indicated replacement therapy for children and adults with proven GH deficiency. Studies<sup>1</sup> demonstrate increasing use among athletes and perhaps 5% of male American high school students have used GH.

Replacement therapy in GH-deficient adults results in definite improvements in:

- lipid profiles (increased HDL-C, decreased LDL-C),
- bone density,
- increased muscle and decreased fat proportions,

**Table 3**

### **Side-effects and risks of GH replacement therapy<sup>7,8</sup>**

Fluid retention causing paresthesias, joint stiffness, edema, arthralgia, myalgia	5%-46%
Carpal tunnel syndrome	2%
Impaired glucose tolerance	13%
Diabetes	4%
Retinopathy	Rare
Benign intracranial hypertension	Very rare
Gynecomastia	10%
Increased cancer incidence	Unproven

- increased exercise capacity and duration (small and variable effects),
- decreased C-reactive protein and
- cardiac function.<sup>7</sup>

Side-effects of these physiological replacement regimens are listed in Table 3.<sup>7,8</sup>

### *A health professional's perspective*

#### *Question 1: Does GH increase strength, muscle size and endurance in normal persons?*

As there are inadequate data, we do not know. The short-term (one month) administration of low or high dose GH does not increase maximum endurance exercise capacity in healthy young men and women. Similarly, short-term studies of physiologic replacement doses indicate no definite effect on strength in young adults. There are no long-term studies of high dose GH as used by athletes in healthy young adults to determine strength or endurance effects. In elderly men and women treated for

## Take-home message

- Testosterone does have positive dose-response effects on strength and muscle mass and is indicated for true testosterone deficiency, but not for sports-enhancement
- GH has, as yet, no proven effects on strength and endurance in normal individuals, but studies utilizing the high doses used by athletes have not been done
- Both testosterone and GH have potential side-effects, the most serious documented ones being with GH

six months, muscle strength and aerobic capacity did not increase with physiologic GH doses. However, these two parameters increased by 6.8% and 8.3% respectively in GH and testosterone-treated men (but not women), suggesting testosterone is responsible for these effects.<sup>8</sup> Long-term dose-response studies of strength, muscle size and endurance have not been done.


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## Conclusions

Testosterone and GH use in sports remains widespread and shows no evidence of abating, despite the efforts of WADA. The physician's

role in prescribing these drugs remains clearly restricted to medical indications.

Testosterone has definite dose-related effects on strength and muscle size though with some cost in side-effects. Comparative studies of GH dose-response on strength, muscle size and endurance are unfortunately lacking, but even studies of physiologic replacement doses demonstrate a significant incidence of side-effects, suggesting that higher doses would pose significant additional health risks.

Polypharmacy by athletes has obscured the assessment of potential risks of many of the compounds used. 

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