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# HEALTH RISKS OF ANABOLIC STEROIDS: UPDATE 2003

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## ABSTRACT

This review focused on the effects of supra-physiological doses of anabolic steroids and their possible effects on longevity, heart disease, and cancer. Many early studies on anabolic steroids showed that the drugs did not improve performance or enhance muscle mass, which was not consistent with empirical observations in athletes. Recent studies using supraphysiological doses of testosterone (600 mg/wk) showed that gains in strength and muscle mass are proportional to serum levels of the hormone. Lower doses do not work because the control system regulating testosterone secretion depresses testicular hormone production, which replaces natural testosterone with exogenous testosterone. Steroid side-effects increase with dosage. One study of weight lifters, who were active in the 1970s showed an increased mortality rate compared to age-matched controls. But, these results are ambiguous. Several animal studies link steroids to cardiomyopathy, cardiac enlargement, and some types of cancer, but these results have not been definitively replicated in humans. Athletes take much higher doses of these drugs than their counterparts did 20-30 years ago. Well-controlled epidemiological and experimental studies are needed to accurately assess the health risks of these drugs.

*Key words: longevity, cancer, heart disease, power athletes, sport, doping*

## Introduction

Athletes often have trouble getting accurate information from physicians and scientists about the side effects of anabolic steroids. This is not surprising because we really do not know how dangerous these drugs are — particularly the way modern bodybuilders and power athletes use them. Steroids are so politicized that it is impossible to get an honest assessment of their risks from health experts. Their typical reaction is to advise athletes to stay away from steroids because the drugs are illegal and dangerous. There is a long list of side effects associated with anabolic steroid use, including acne, testicular atrophy, arteriosclerosis, prostate and liver cancers, and psychiatric disturbances. This review will focus on new information about the effects of supra-physiological doses of anabolic steroids and their possible effects on longevity, heart disease, and cancer.

## Changing anabolic steroid use patterns in athletes

Bodybuilding and power sports have changed dramatically during the past 50-years. Modern athletes are much bigger and faster than before — champion bodybuilders of the past could not even compete in modern bodybuilding contests (19). In college and professional American football, 140 kg linemen are ordinary. Modern bodybuilders and power athletes did not get that way through better training methods alone; they received help from taking hi-

gher doses (600-2000 mg/wk) of anabolic steroids, growth hormone, and other supplements (3).

Bodybuilders and power athletes have used anabolic steroids since the 1960s. It was not until the early 1970s that scientists began studying the effects of anabolic steroids on body composition and athletic performance. Surprisingly, many of these studies showed that the drugs did not enhance performance (12, 18, 26). Scientists believed that most of the perceived gains were due more too psychological effects than any biological action of the drugs.

An early study (18) administered 50 mg a week of Deca Durabolin. The subjects taking the drug made greater gains than the placebo subjects who were given saline injections, but the gains in strength were not large enough to be accepted as scientific proof that steroids increased muscle mass and strength. Other studies using similar research methods and drug doses found almost identical results (26).

**New studies using supra-physiological doses of testosterone**

The discrepancy between empirical observations and the results of scientific studies raised the question, "How could anabolic steroids appear to be so effective in bodybuilders and power athletes but fail to show similar results in scientific studies?" That question was answered by a series of studies by Bhasin and co-workers (2, 3, 4, 5, 6, 9, 10, 34, 37). They found that steroid dosage was the key to the effectiveness of the drugs. In the first of a series of studies, they gave 600 mg/wk of testosterone enanthate or placebo to subjects who were either lifting weights or sedentary (not lifting weights) for 10 weeks (3). Unlike many previous studies, their research showed that steroids increased strength and muscle mass. Subjects who took large doses of testosterone gained increased lean mass, strength, and muscle size, even if they did not lift weights. The experimental group improved 10 kg in the bench press, 15 kg in the back squat, and made substantial gains in arm and thigh muscle size without lifting any weights.

Subjects who lifted weights and took the testosterone showed even greater gains. They increased nearly 22 kg in the bench press and 35 kg in the back squat and put on more than 5 kg of lean tissue. The improvements made by subjects in this study were similar to empirical observations made of athletes taking anabolic steroids on their own. Older studies showing that anabolic steroids did not work were refuted because the doses in them were too low to show significant effects.

**Why low doses of testosterone do not work**

Other studies from Bhasin's group showed that gains in strength vary directly with blood testosterone levels — the higher the serum testosterone, the greater the gains in strength and muscle size — particularly in weight-trained subjects (2, 4, 6, 37). These studies showed that using low doses of testosterone or anabolic steroids depressed testicular testosterone production (2).

The body controls testosterone levels through negative feedback between the hypothalamus, pituitary, and testes (8). When blood testosterone levels are low, the hypothalamus secretes gonadotropin-releasing hormone (GRH), which triggers leutinizing hormone (LH) and follicle stimulating hormone (FSH) release from the pituitary, which stimulates the testes to produce testosterone. High testosterone levels inhibit this feedback mechanism, which slows down normal testosterone production in the testes (2).

Why was there a failure to make any gains in muscle size and strength in studies that used low doses of anabolic stero-

ids or testosterone esters? Initially, the low dose administration increased blood testosterone levels. This gives the training program a temporary boost. The body's hormone control system takes over, which decreases the levels of testosterone control hormones (GRH, LH, FSH) and lowers blood testosterone back to normal (2). The reduction in testosterone production results is lower than normal blood testosterone concentrations and establishes a lag-time in the restoration of natural balance.

Normal blood testosterone in young men (18-40 yr) varies between 350-1200 ng/dl of blood (6). Even without supplements, the capacity to gain strength depends on testosterone levels present in the blood. Large, rapid increases in strength or muscle mass-depend on large blood concentrations of testosterone. The Bhasin et al. (6) study showed that taking 300 mg/wk of testosterone was necessary to elevate blood testosterone above normal levels. Taking 600 mg/wk increased blood testosterone to 2500 ng/dl of blood, which is more than double the upper levels of the normal range.

Taking 150 mg of testosterone per week never increased blood testosterone above 500 ng/dl. Taking even standard therapeutic doses does not increase blood testosterone to levels needed to promote muscle hypertrophy and strength at a faster rate than normal. It is necessary to take at least 300 mg per week to exceed normal blood testosterone by even small amounts (6). Taking low doses shuts down normal testosterone production, so any gains are quickly lost. Also, athletes may have side effects from the drugs, even at these relatively small doses.

Serious bodybuilders and power athletes who use steroids typically take at least 600-1000 mg per week of various forms of testosterone and anabolic steroids, combined with other anabolic supplements, such as growth hormone, IGF-1, clenbuterol, and creatine monohydrate (8). They also take drugs, such as Nolvadex, to prevent gynecomastia, and human chorionic gonadotropin to boost normal testosterone production (8). These anabolic supplement programs probably account for the noticeable increase in size and strength that have occurred in bodybuilders and other weight trained athletes in recent years.

**The risks of high-dose anabolic steroid use**

Several studies have shown that side effects increase with dosage. They show that high doses of anabolic steroids are associated with large decreases in high-density lipoprotein and APO-A1, which are thought to protect against coronary artery disease (23, 25, 27, 30). These results are not consistent — some studies suggest that these drugs provide beneficial cardiovascular effects (15, 33, 34).

There is little evidence that high dose testosterone supplements cause prostate gland enlargement (2, 6). This is a big fear in the medical community. However, Prostate Specific Antigen (PSA) values (a test used to predict prostate enlargement and cancer) remain normal during high dose testosterone administration (2, 6).

Another risk of anabolic steroid use is psychiatric disturbances — known in popular jargon as "roid rage." Most objective studies show that the risk of steroid-related psychoses are overstated. However, it does occur in susceptible people, particularly at high doses. About 10% or more of people who take more than 600 mg per week of testosterone can expect serious and possibly dangerous psychological effects (31).

Modern bodybuilders and strength athletes — because they take such high doses of the drugs — have changed our perceptions about the anabolic and strength buil-

ding potential of steroids. Unfortunately, high-dose anabolic steroid supplementation may have unknown health consequences. We do not know the long-term or even short-term effects of taking supra-physiological doses of steroids, particularly when combined with other supplements and drugs.

**Anabolic steroids and longevity**

Most athletes do not care about atrophied testicles, acne, or low sperm counts, but they do care about dying 10-20 years prematurely. Athletes have been using steroids for more than forty years, but there has been no obvious epidemic of premature deaths in aging bodybuilders, throwers, and weight lifters.

Widespread steroid use in athletics started in the 1960s. Athletes who competed then post-World War II generation crossed into middle age years ago. Studies are now being completed on the long-term health consequences of steroid use by these athletes. Parssinen and colleagues (29) examined death rates of 62 male power lifters who competed between 1977 and 1982 compared to a control population of over 1000 men. They assumed a high rate of anabolic steroid use in the power lifters. They found that 12,9% of the power lifters died, compared to only 3,1% of the control population. Power lifters died from suicide (3 athletes), myocardial infarction (3 athletes), liver failure (1 athlete), and non-Hodgkin's lymphoma (1 athlete). The authors stated that these findings add to the growing amount of evidence of an association between anabolic steroid abuse and early death, and support the view that measures to decrease steroid misuse in both competitive and amateur athletes is justified.

While the researchers may be correct — steroid users may not live as long as other people do — their conclusions are based on selective evidence. First, they based their conclusions on the deaths of 8 athletes, three of whom died from suicide. Researchers should examine longevity in many more athletes before making such sweeping statements. Also, the lifestyle of former power lifters may have a lot to do with their longevity. Many studies of old athletes show that life-long exercise habits, diet, and health habits are critical for a long life (28, 38). Power lifters may die young because they may not practice endurance exercise regularly. They may have other habits that contribute to early death, such as excessive alcohol consumption or poor diet. Finally, shorter, lighter men may live longer than those who are taller and heavier (32). Power lifters may simply die earlier because they have more muscle than the average person.

This is not to say that steroids will not cause premature death. Some recent studies paint a bleak picture of the long-term use of steroids. Bronson, et al. (7) gave mice anabolic steroids for 6 months at doses either 5 times or 20 times their normal circulating levels of testosterone. Fifty-two percent of the mice given the high dose of steroids died prematurely compared with 35% of the mice given the low dose and only 12% of the control mice given no steroids. Steroid using mice that died showed serious heart and liver damage. On-the-other-hand, hamsters given nandrolone decanoate lived longer than control animals (14). Other studies cast doubt on the long-term health risks of steroids (15, 22). At present, scientists do not know whether anabolic steroid use leads to premature death.

**Cardiovascular implications of high-dose anabolic steroid use**

The biggest unanswered question about the side effects of steroids is whether they damage the heart. Steroids may decrease

HDL (25, 30, 34), increase blood pressure (35, 36), and may damage the myocardium (20, 21, 35, 39). These factors are linked to increased cardiac related morbidity and mortality.

Large doses of anabolic steroids build muscle even in the absence of significant pressure load exercise (3). The heart is a muscle and will hypertrophy in response to heavy weight lifting and anabolic hormones (11, 21, 27). Heart damage appears to be the biggest long-term risk of heavy steroid use.

The evidence for anabolic steroid linked cardiomyopathy and coronary artery disease is not that clear. For example, Dickerman and colleagues (16) found that bodybuilders and power athletes typically have enlarged hearts — regardless of whether or not they take steroids. Also, while high doses of steroids decrease HDL, studies have found either no effects or decreases in LDL and triglycerides — blood lipids that promote coronary artery disease (15, 34).

What is the direct evidence that steroids harm the heart? Several case studies show that some athletes who died from myocardial infarction and heart failure were taking steroids (17, 22). Also, some animal studies show that high doses of steroids can damage heart muscle (39). However, we do not have large epidemiological studies showing cardiac-related increased mortality from anabolic steroid use. This information is critical; without it, blaming heart problems on anabolic steroids is premature.

Prudence dictates that athletes who use steroids should be aware of warning signs of cardiovascular disease, such as high blood pressure, abnormal blood lipids (high cholesterol, LDL, and triglycerides and low HDL), dyspnea, angina pectoris, abnormal blood chemistry values (e.g., elevated creatine kinase, lactate dehydrogenase, C-reactive protein). Also, it is important to distinguish body changes that occur normally with bodybuilding and weight lifting with those that occur with bodybuilding and anabolic steroid use.

**Anabolic steroids and cancer**

When the famous American pro football player Lyle Alzedo died of brain cancer, many people blamed anabolic steroids — even though there was absolutely no evidence of a causal effect. Unfortunately, young people sometimes die from cancer. Just because one of these patients also took anabolic steroids in the past does not mean that steroids caused the problem. High doses of anabolic steroids increase growth factors — such as IGF-1 (6) — that have been linked to cancers of the colon, pancreas, and prostate (24). Oral anabolic steroids can be toxic to the liver and may trigger liver tumors (1, 13). As with heart disease, indirect evidence strongly suggests that taking high doses of steroids may predispose people to various forms of cancer. Anything that triggers high tissue growth rates will increase the growth of cancer cells, too. However, there are no large population studies linking steroid use to increased cancer risk.

**Other side effects**

Anabolic steroids have other side effects, including liver toxicity, psychiatric problems, acne, oily skin, hair loss, abnormal hair growth, gynecomastia, muscle cramping, delayed speed of blood clotting, depressed sperm counts, testicular atrophy, and abnormal increases in red blood cells. Most of these problems are minor and reversible and are beyond the scope of this paper. Some can be troubling and deadly. Increasingly, athletes take higher and higher doses of these drugs, which will take its toll on the health of our young people.

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