AMERICAN COLLEGE of SPORTS MEDICINE
POSITION STAND

# The Use of Anabolic-Androgenic Steroids in Sports

Based on a comprehensive literature survey and a careful analysis of the claims concerning the ergogenic effects and the adverse effects of anabolic-androgenic steroids, it is the position of the American College of Sports Medicine that:

1. Anabolic-androgenic steroids in the presence of an adequate diet can contribute to increases in body weight, often in the lean mass compartment.
2. The gains in muscular strength achieved through high-intensity exercise and proper diet can be increased by the use of anabolic-androgenic steroids in some individuals.
3. Anabolic-androgenic steroids do not increase aerobic power or capacity for muscular exercise.
4. Anabolic-androgenic steroids have been associated with adverse effects on the liver, cardiovascular system, reproductive system, and psychological status in therapeutic trials and in limited research on athletes. Until further research is completed, the potential hazards of the use of the anabolic-androgenic steroids in athletes must include those found in therapeutic trials.
5. The use of anabolic-androgenic steroids by athletes is contrary to the rules and ethical principles of athletic competition as set forth by many of the sports governing bodies. The American College of Sports Medicine supports these ethical principles and deplores the use of anabolic-androgenic steroids by athletes.

This document is a revision of the 1977 position stand of the American College of Sports Medicine concerning anabolic-androgenic steroids (4).

## Background

In 1935 the long-suspected positive effect of androgens on protein anabolism was documented (56). Subsequently, this effect was confirmed (53,77), and the development of 19-nortestosterone heralded the synthesis of steroids that have greater anabohc properties than natural testosterone but less of its virilizing effect (39). The use of androgenic steroids by athletes began in the early 1950s (106) and has increased through the years (60,62,83,98,104,106), despite warnings about potential adverse reactions (4,83,106,112) and the banning of these substances by sports governing bodies.

## Anabolic-Androgenic Steroids, Body Composition and AthleticPerformance

**Body composition. Animal** studies investigating the effect of anabohc-androgenic steroids on body composition have shown increases in lean body mass, nitrogen retention and muscle growth in castrated males (37,57,58) and normal females (26,37,71). The effects of anabolic-androgenic steroids on the body weights of normal, untrained, male animals (37,40,71,105,114), treadmill-trained (43,97) or isometrically-trained rats (82), or strength-trained monkeys (80) have been minimal to absent; however, the effects of steroids on animals undergoing heavy resistance training have not been adequately studied. Human males who are deficient in natural androgens by castration or other causes have shown significant increases in nitrogen retention and muscular development with anabohc-androgenic steroid therapy (23,58,103). Human males and females involved in experimental (38) and therapeutic trials of anabolic steroids (15,16,93) have shown increases in body weight.

The majority of the strength-training studies in which body weight was reported showed greater increases in weight under steroid treatment than under placebo (17,41,42,50,61,74,94,96,107). Other training studies have reported no significant changes in body weight (21,27,31,34,100,108). The weight gained was determined to be lean body mass in three studies that made this determination with hydrostatic weighing techniques (41,42,107). Four other studies found no significant differences in lean body mass between steroid and placebo treatments (17,21,27,34), but in two of those the mean differences favored the steroid treatment (21,27). The extent to which increased water retention accounts for steroid-induced changes in body composition is controversial (17,42) and has yet to be resolved.

In summary, anabohc-androgenic steroids can contribute to an increase in body weight in the lean mass compartment of the body. The amount of weight gained in the training studies has been small but statistically significant.

**Muscular strength. Strength is an important** factor in many athletic events. The literature concerning the efficacy of anabolic steroids for promoting strength development is controversial. Many factors contribute to the development of strength, including heredity,

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intensity of training, diet, and the status of the psyche (112). It is very difficult to control all of these factors in an experimental design. The additional variable of dosage is included when drug research is undertaken. Some athletes claim that doses greater than therapeutic are necessary for strength gains (106) even though positive results have been reported using therapeutic (low-dose) regimens (50,74,94,107). Double-blind studies using anabolic-androgenic steroids are also difficult to conduct because of the physical and/or psychological effects of the drug that, for example, allowed 100% of the participants in one "double-blind" study to correctly identify the steroid phase of the experiment (32). The placebo effect has been shown to be a factor in studies of anabolic-androgenic steroids as in all drug studies (6).

In animal studies, the combination of anabolic-androgenic steroids and overload training has not produced larger gains in force production than training alone (80,97). However, steroid-induced gains in strength have been reported in experienced (42,74, 94,107) and inexperienced weight trainers (50,51,96) with (50,51,74,94) and without dietary control or supplemental protein (42,96). In contrast, no positive effect of steroids on gains in strength over those produced by training alone were reported in other studies involving experienced (21,34,54) and inexperienced weight trainers (17,27,31,41,54,61,100,108) with (21,34,61,100) and without dietary control or supplemental protein (17,27, 31,41,54,108). The studies that reported no changes in strength with anabolic-androgenic steroids have been criticized ( 112) for the use of inexperienced weight trainers, lack of dietary control, low-intensity training (17,27,31,61), and nonspecific testing of strength (21). The studies that have shown strength gains with the use of anabolic-androgenic steroids have been criticized (83) for inadequate numbers of subjects (74,94,107), improper statistical designs, inadequate execution, and the unsatisfactory reporting of experimental results.

There have been no studies of the effects of the massive doses of steroids used by some athletes over periods of several years. Similarly, there have been no studies of the use of anabolic-androgenic steroids and training in women or children. Theoretically, anabolic and androgenic effects would be greater in women and children because they have naturally lower levels of androgens than men.

Three proposed mechanisms for the actions of the anabolic-androgenic steroids for increases in muscle strength are:

1. Increase in protein synthesis in the muscle as a direct action of the anabolic-androgenic steroid (81,82,92).
2. Blocking of the catabolic effect of glucocorticoids after exercise by increasing the amount of anabolic-androgenic hormone available (1,92, I 12).
3. Steroid-induced enhancement of aggressive behavior that promotes a greater quantity and quality of weight training (14).

In spite of the controversial and sometimes contradictory results of the studies in this area, it can be concluded that the use of anabolic-androgenic steroids, especially by experienced weight trainers, can often increase strength gains beyond those seen with training and diet alone. This positive effect on strength is usually small and obviously is not exhibited by all individuals. The explanation for this variability in steroid effects is unclear. When small increments in strength occur, they can be important in athletic competition.

Aerobic capacity. The effect of anabolic-androgenic steroids on aerobic capacity has also been questioned. The potential of these drugs to increase total blood volume and hemoglobin (88) might suggest a positive effect of steroids on aerobic capacity. However, only three studies indicated positive effects (3,51,54), and there has been no substantiation of these results in subsequent studies (27,41,50,52). Thus, the majority of evidence shows no positive effect of anabolic-androgenic steroids on aerobic capacity over aerobic training alone,

## Adverse Effects

Anabolic-androgenic steroids have been associated with many undesirable or adverse effects in laboratory studies and therapeutic trials. The effects of major concern are those on the liver, cardiovascular, and reproductive systems, and on the psychological status of individuals who are using the anabolic-androgenic steroids.

Adverse effects on the liver. Impaired excretory function of the liver, resulting in jaundice, has been associated with anabolic-androgenic steroids in a number of therapeutic trials (76,84,90). The possible cause-and-effect nature of this association is strengthened by the observation of jaundice remission after discontinuance of the drug (76,84). In studies of athletes using anabolic-androgenic steroids (65 athletes tested) (89,98,104), no evidence of cholestasis has been found.

Structural changes in the liver following anabolic steroid treatment have been found in animals (95,101) and in humans (73,86). Conclusions concerning the clinical significance of these changes on a short- or long-term basis have not been drawn. Investigations in athletes for these changes have not been performed, but there is no reason to believe that the athlete using anabolic-androgenic steroids is immune from these effects of the drugs.

The most serious liver complications associated with anabolic-androgenic steroids are peliosis hepatis (blood-filled cysts in the liver of unknown etiology) and liver tumors. Cases of peliosis hepatis have been reported in individuals treated with anabolic-androgenic steroids for various conditions (7–10,13,35,65,66,70,88,102).

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Rupture of the cysts or liver failure resulting from the condition was fatal in some individuals (9,70,102). In other case reports the condition was an incidental finding at autopsy (8,10,66). The possible cause-and-effect nature of the association between peliosis hepatis and the use of anabohc-androgenic steroids is strengthened by the observation of improvement in the condition after discontinuance of drug therapy in some cases (7,35). There are no reported cases of this condition in athletes using anabolic-androgenic steroids, but investigations specific for this disorder have not been performed in athletes.

Liver tumors have been associated with the use of anabohc-androgenic steroids in individuals receiving these drugs as a part of their treatment regimen (28,29,49,67,69,99,115). These tumors are generally benign (29,67,69,115), but there have been malignant lesions associated with individuals using these drugs (28,99,115). The possible cause-and-effect nature of this association between the use of the drug and tumor development is strengthened by a report of tumor regression after cessation of drug treatment (49). The 17-alpha-alkylated compounds are the specific family of anabolic steroids indicted in the development of liver tumors (46,49). There is one reported case of a 26-year-old male body builder who died of liver cancer after having abused a variety of anabolic steroids for at least four years (75). The testing necessary for discovery of these tumors is not commonly performed, and it is possible that other tumors associated with steroid use by athletes have gone undetected.

Blood tests of liver function have been reported to be unchanged with steroid use in some training studies (3 1,41,54,94) and abnormal in other training studies (32,5 1) and in tests performed on athletes known to be using anabolic-androgenic steroids (54,89,104). However, the lesions of peliosis hepatis and liver tumors do not always result in bloot test abnormalities (8,28,29, 49,67,115), and some authors state that liver radioisotope scans, ultrasound, or computed tomography scans are needed for diagnosis (28,29,113).

In summary, liver function tests have been shown to be adversely affected by anabolic-androgenic steroids, especially the 17-alpha-alkylated compounds. The short- and long-term consequences of these changes, though potentially hazardous, have yet to be reported in athletes using these drugs.

**Adverse effects on the cardiovascular system.** The steroid-induced changes that may affect the development of cardiovascular disease include hyperinsulinism and altered glucose tolerance (11 1), decreased high-density lipoprotein cholesterol levels (72,98), and elevated blood pressure (68). These effects are variable for different individuals in various clinical situations. Triglycerides are lowered by anabolic-androgenic steroids in certain individuals (24,72) and are increased in others (18,78). Histological examinations of myotibrils and mitochondria from cardiac tissue obtained from laboratory animals have shown that administration of anabolic steroids leads to pathological alterations in these structures (5,11,12). The cardiovascular effects of the anabolic-androgenic steroids, though potentially hazardous, need further research before any conclusions can be made.

**Adverse effects on the male reproductive system.** The effects of the anabolic-androgenic steroids on the male reproductive system are oligospermia (small number of sperm) and azoospermia (lack of sperm in the semen), decreased testicular size, abnormal appearance of testicular biopsy material, and reductions in testosterone and gonadotropic hormones. These effects have been shown in training studies (19,41,100), studies of normal volunteers (38), therapeutic trials (44), and studies of athletes who were using anabohc-androgenic steroids (55,79,104). In view of the changes shown in the pituitary-gonadal axis, the dysfunction accounting for these abnormalities is believed to be steroid-induced suppression of gonadotrophin production (19,36,38,79). The changes in these hormones are ordinarily reversible after cessation of drug treatment, but the long-term effects of altering the hypothalamic-pituitary-gonadal axis remain unknown. However, there is a report of residual abnormalities in testicular morphology of healthy men 6 months after discontinuing steroid use (38). It has been reported that the metabolism of androgens to estrogenic compounds may lead to gynecomastia in males (23,58,98,112).

**Adverse effects on the female reproductive system.** The effects of androgenic steroids on the female reproductive system include reduction in circulating levels of luteinizing hormone, follicle-stimulating hormone, estrogens, and progesterone; inhibition of folliculogenesis and ovulation; and menstrual cycle changes including prolongation of the follicular phase, shortening of the luteal phase, and amenorrhea (20,63,9 1).

**Adverse effects on psychological status.** In both sexes, psychological effects of anabolic-androgenic steroids include increases or decreases in libidio, mood swings, and aggressive behavior (38,98), which is related to plasma testosterone levels (25,85). Administration of steroids causes changes in the electroencephalogram similar to those seen with psycho-stimulant drugs (47,48). The possible ramifications of uncontrollably aggressive and possible hostile behavior should be considered prior to the use of anabolic-androgenic steroids.

**Other adverse effects. Other side effects associated** with the anabolic-androgenic steroids include: ataxia (2); premature epiphysial closure in youths (23,58,64,109,110); virilization in youths and women, including hirsutism (45), clitoromegaly (63,112), and irreversible deepening of the voice (22,33); acne; temporal hair recession; and alopecia (45). These adverse reactions can occur with the use of anabolic-androgenic steroids and are believed to be dependent on the type

of steroid, dosage and duration of drug use (58). There is no method for predicting which individuals are more likely to develop these adverse effects, some of which are potentially hazardous.

## The Ethical Issue

Equitable competition and fair play are the foundation of athletic competition. If competition is to remain on this foundation, rules are necessary. The International Olympic Committee (IOC) has defined "doping" as "the administration of or the use by a competing athlete of any substance foreign to the body or of any physiological substance taken in abnormal quantity or taken by an abnormal route of entry into the body, with the sole intention of increasing in an artificial and unfair manner his performance in competition." Accordingly, the medically unjustified use of anabolic steroids with the intention of gaining an athletic advantage is clearly unethical. Anabolic-androgenic steroids are listed as banned substances by the IOC in accordance with the rules against doping. The American College of Sports Medicine supports the position that the eradication of anabolic-androgenic steroids use by athletes is in the best interest of sport and endorses the development of effective procedures for drug detection and of policies that exclude from competition those athletes who refuse to abide by the rules.

The "win at all cost" attitude that has pervaded society places the athlete in a precarious situation. Testimonial evidence suggests that some athletes would risk serious harm and even death if they could obtain a drug that would ensure their winning an Olympic gold medal. However, the use of anabolic-androgenic steroids by athletes is contrary to the ethical principles of athletic competition and is deplored.

## REFERENCES


1. AAKVAAG, A., 0. BENTDOL, K. QUIGSTOD, P. WALSTOD, H. RENNINGEN, and F. FONNUM. Testosterone and testosterone binding globulin (TeBg) in young men during prolonged stress. *Int. J. Androl.* 1:22–31, 1978.
2. AGRAWAL, B. L. Ataxia caused by fluoxymesterone therapy in breast cancer. *Arch.Intern.* Med. 141:953–959, 198 1.
3. ALBRECHT, H. and E. ALBRECHT. Ergometric, rheographic, reflexographic and electrographic tests at altitude and effects of drugs on human physical performance. Fed. *Proc.* 28:1262–1267, 1969.
4. American College of Sports Medicine. Position statement on the use and abuse of anabolic-androgenic steroids in sports. *Med. Sci.Sports* 9(4):xi-xiii, 1977.
5. APPELL, H.-J., B. HELLER-UMPFENBACH, M. FERAUDI, and H. WEICKER. Ultrastructural and morphometric investigations on the effects of training and administration of anabolic steroids on the myocardium of guinea pigs. *Int. J. Sports Med. 4:268-274, 1983.*
6. ARIEL, G. and W. SAVILLE. Anabolic steroids: the physiological effects of placebos. *Med. Sci.Sports4:* 124–126, 1972.
7. ARNOLD, G. L. and M. M. KAPLAN. Peliosis hepatis due to oxymetholone—a clinically benign disorder. *Am. J. Gastroenterol.* 71:213–216, 1979.
8. ASANO, A., H. WAKASA, S. KAISE, T. NISHIMAKI, and R. KASUKAWA. Peliosis hepatis. Report on two autopsy cases with a review of literature. *Acta Pathol. Jpn.* 32:861–877, *1982.*
9. BAGHERI, S. and J. BOYER. Peliosis hepatis associated with anabolic-androgenic steroid therapy-a severe form of hepatic injury. *Ann.Intern.Med.* 81:610–618, *1974.*
10. BANK, J. I., D. LYKKEBO, and I. HAGERSTRAND. Peliosis hepatis in a child. *Acta Ped. Scand.* 67:105–107, *1978.*
11. BEHRENDT, H. Effect of anabolic steroid on rat heart muscle cells. I. Intermediate filaments. Cell *Tissue Res.* 180:305–3 15, 1977.
12. BEHRENDT, H. and H. BOFFIN. Myocardial cell lesions caused by anabolic hormone. *CellTissueRes.18* 1:423–426, *1917.*
13. BENJAMIN, D. C. and B. SHUNK. A fatal case of peliosis of the liver and spleen. *Am. J. Dis. Child.* 132:207–208, 1978.
14. BROOKS, R. V. Anabolic steroids and athletes. *Phys. Sportsmed.* 8(3):161–163, *1980.*
15. BUCHWALD, D., S. ARGYRES, R. E. EASTERLING, et al. Effects of Nandrolone Decanoate on the anemia of chronic hemodialysis patients. *Nephron* 18:232–238, 1977.
16. CARTER, C. H. The anaholic steroid, Stanozolol, its evaluation in debilitated children. *Clin. Pediatr.* 4:671–680, *1965.*
17. CASNER, S. W., R. G. EARLY, and B. R. CARLSON. Anabolic steroid effects on body composition in normal young men. *J. SportsMed.Phys. Fitness* 11:98–103, *1971.*
18. CHOI, F. S. K., T. CHING, R. S. MORRISON, C. MYERS, and M. S. GREENBERG. Hypertriglyceridemia in hemodialysis patients during oral dromostanolone therapy for anemia. *Am. J. Clin. Nutr.* 27:901–904, *1974.*
19. CLERICO, A., M. FERDEGHINI, C. PALOMBO, et al. Effects of anabolic treatment on the serum levels of gonadotropins, testosterone, prolactin, thyroid hormones and myoglobin of male athletes under vhysical training. *J. Nuclear Med. Allied Sci.* 25:79–88, *1981:*
20. COX, D. W., W. L. HEINRICHS, C. A. PAULSEN, et al. Perturbations of the human menstrual cycle by oxymetholone *Am. J. Obstet. Gynecol.* 121:121–126, *1975.*
21. CRIST, D. M., P. J. STACKPOLE, and G. T. PEAKE. Effects of androgenic-anabolic steroids on neuromuscular power and body composition. *J. Appl. Physiol.* 54:366–370, 1983.
22. DAMSTE, P. H. Voice change in adult women caused by virilizing agents. *J. SpeechHear. Disord.32:* 126–*132, 1967.*
23. DORFMAN, R. I. and R. A. SHIPLEY. *Androgens: Biochemistry, Physiology and Clinical Significance. New York* J. Wiley and Sons, 1956.
24. DOYLE, A. E., N. B. PINKUS, and J. GREEN. The use of oxandrolone in hyperlipidaemia. *Med.J. Australia* 1:127–*129, 1974.*
25. EHRENKRANZ, J., E. BLISS, and M. H. SHEARD. Plasma testosterone correlation with aggressive behavior and social dominance in man. *Psychosom. Med.* 36:469–475, 1974.
26. EXNER, G. U., H. W. STAUDTE, and D. PETTE. Isometric training of rats—effects upon fast and slow muscle and modification by an anabolic hormone (Nandrolone Decanoate) I. Female rats. *PflügersArch.* 345:1–14, *1973.*
27. FAHEY, T. D. and C. H. BROWN. The effects of an anabolic steroid on the strength, body composition and endurance of college males when accompanied by a weight training program. *Med.Sci.Sports* 5:272–276, *1973.*
28. FALK, H., L. THOMAS, H. POPPER, and H. G. ISHAK. Hepatic angiosarcoma associated with anabolic-androgenic steroids. *Lancet* 2:1120–1123, 1979.
29. FARRELL, G. C., D. E. JOSHUA, R. F. UREN, P. J. BAIRD, K. W. PERKINS, and H. KRONENBERG. Androgen-induced hepatoma. *Lancet* 1:430, *1975.*
30. FORSYTH, B. T. The effect of testosterone propionate at various protein calorie intakes in malnutrition after trauma. *J. Lab. Clin. Med.* 43:732–740, *1954.*
31. FOWLER, W. M., JR., G. W. GARDNER, and G. H. EGSTROM. Effect of an anabolic steroid on physical performance in young men. *J. Appl. Physiol.* 20:1038–1040, 1965.
32. FREED, D. L., A. J. BANKS, D. LONGSON, and D. M. BURLEY. Anabolic steroids in athletics: crossover double-blind trial on weightlifters. *Br.* Med. *J.* 2:471–473, 1975.
33. GELDER, L. V. Psychosomatic aspects of endocrine disorders of the voice. *J. Commun. Disord.* 7:257–262, *1974,*
34. GOLDING, L. A., J. E. FREYDINGER, and S. S. FISHEL. The effect of an androgenic-anabolic steroid and a protein supplement on size, strength, weight and body composition in athletes. *Phys. Sportsmed.* 2(6):39–45, *1974.*


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35. GROOS, G., 0. H. ARNOLD, and G. BRITTINGER. Peliosis hepatis after long-term administration of oxymetholone. *Lancet* 1:874, 1914.
36. HARKNESS, R. A., B. H. KILSHAW, and B. M. HOBSON. Effects of large doses of anabolic steroids. *Br. J. Sports Med.* 9:70–73, *1975.*
37. HEITZMAN, R. J. The effectiveness of anabolic agents in increasing rate of growth in farm animals; report on experiments in cattle. In: *Anabolic Agents in Animal Production*, F. C. Lu and J. Rendel (Eds.). Stuttgart: Georg Thieme Publishers, 1976, pp. 89-98.
38. HELLER, C. G., D. J. MOORE, C. A. PAULSEN, W. 0. NELSON, and W. M. LAIDLAW. Effects of progesterone and synthetic progestins on the reproductive physiology of normal men. *Fed. Proc.* 18:1057–1065, *1959.*
39. HERSHBERGER, J. G., E. G. SHIPLEY, and R. K. MEYER. Myotrophic activity of 19-nortestosterone and other steroids determined by moditied levator ani muscle method. *Proc. Soc. Exper. Biol.* Med. 83:175–180, 1953.
40. HERVEY, G. R. and I. HUTCHINSON. The effects of testosterone on body weight and composition in the rat. *J. Endocrinol.* 57:xxiv-xxv, 1973.
41. HERVEY, G. R., I. HUTCHINSON, A. V. KNIBBS, et al. Anabolic effects of methandienone in men undergoing athletic training. *Lancet* 2:699–702, 1916.
42. HERVEY, G. R., A. V. KNIBBS, L. BURKINSHAW, et al. Effects of methandienone on the performance and body-composition of men undergoing athletic training. *Clin. Sci.* 60:457–46 1. *198* 1.
43. HICKSON, R. C., W. W. HEUSNER, W. D. VAN HUSS, et al. Effects of Diabanol and high-intensity sprint training on body composition of rats. Med. *Sci. Sports* 8:191–195, 1976.
44. HOLMA, P. and H. ALDERCREUTZ. Effect of an anabolic steroid (metandienon) on plasma LH, FSH, and testosterone and on the response to intravenous administration of LRH. *Acta Endocrinol.* 83:856–864, *1976.*
45. HOUSSAY, A. B. Effects of anabolic-androgenic steroids on the skin including hair and sebaceous glands. In: *Anabolic-Androgenic Steroids, C.* D. Kochakan (Ed.). New York: Springer-Verlag, 1976, pp. 155-190.
46. ISHAK, K. G. Hepatic lesions caused by anabolic and contracep tive steroids. Sem. *Liver Dis.* 1:116– *128.* 198 1.
47. ITIL, T. M. Neurophysiological effects of hormones in humans: computer EEG profiles of sex and hypothalamic hormones. In: *Hormones, Behavior and Psychotherapy,* E. J. Sachar (Ed.). New Yorlc Raven Press, 1976, pp. 3 1-40.
48. ITIL, T. M., R. CORA. S. AKPINAR. W. M. HERRMANN. and C. J. PATTERSON. Psychotropic action of sex hormones: computerized EEG in establishing the immediate CNS effects of steroid hormones. *Curr. Ther. Res.* 16: 1147-1170, 1974.
49. JOHNSON, F. L., K. G. LERNER, M. SIEGEL, et al. Association of androgenic-anabolic steroid therapy with development of hep atocellular carcinoma. *Lancet 2:1273, 1972.*
50. JOHNSON, L. C., G. F ISHER, L. J. SILVESTER, and C. C. HOFHEINS. Anabolic steroid: effects of strength, body weight, oxygen uptake and spermatogenesis upon mature males. *Med. Sci. Sports* 4:43–45, *1972.*
51. JOHNSON, L. C. and J. P. O'SHEA. Anabolic steroid: effects on strength development. *Science* 164:957–959, 1969.
52. JOHNSON, L. C., E. S. ROUNDY, P. E. ALLSEN, A. G. FISHER, and L. J. SILVESTER. Effect of anabohc steroid treatment on endurance. *Med. Sci. Sports* 7:287–289, *1975.*
53. KENYON, A. T., K. KNOWLTON, and I. SANDIFORD. The anabolic effects of the androgens and somatic growth in man. *Ann. Intern. Med.* 20:632–654, *1944.*
54. KEUL, J., H. DEUS, and W. KINDERMAN. Anabole hormone: Schadigung, Leistungsfahigkeit und Stoffwechses. *Med. Klin.* 71:497–503, *1976.*
55. KILSHAW, B. H., R. A. HARKNESS, B. M. HOBSON, and A. W. M. SMITH. The effects of large doses of the anabolic steroid, methandrostenolone, on an athlete. *Clin. Endocrinol.* 4:537–*541, 1975.*
56. KOCHAKIAN, C. D. and J. R. MURLIN. The effect of male hormones on the protein and energy metabolism of castrate dogs. J. *Nutr.* 10:437–458, 1935.
57. KOCHAKIAN, C. D. and B. R. ENDAHL. Changes in body weight of normal and castrated rats by different doses of testosterone propionate. *Proc. Soc. Exper. Biol. Med.* 100:520–522, *1959.*
58. KRUSKEMPER, H. L. *Anabolic Steroids. New* Yorlc Academic Press, 1968, pp. 128-133. 162-164. 182.
59. LANDAU, R. L. The metabolic effects of anabolic steroids in man. In: *Anabolic-Androgenic Steroids, C.* D. Kochakian (Ed.). New Yorlc Springer-Verlag, 1976, pp. 45-72.
60. LJUNGQVIST, A. The use of anabolic steroids in top Swedish athletes. *Br. J. Sports Med.* 9:82, 1975.
61. LOUGHTON, S. J. and R.O. RUHLING. Human strength and endurance responses to anabolic steroid and training. *J. Sports Med.* 17:285–296, *1977.*
62. MACDOUGALL, J. D., D. G. SALE, G. C. B. ELDER, and J. R. SUTTON. Muscle ultrastructural characteristics of elite powerlifters and bodybuilders. *Eur. J. Applied Physiol. 48:* 117–126, 1982.
63. MAHER, J. M., E. L. SQUIRES, J. L. VOSS, and R. K. SHIDELER. Effect of anabolic steroids on reproductive function of young mares. J. *Am. Vet. Med. Assoc.* 183:519–524, *1983.*
64. MASON, A. S. Male precocity: the clinician's view. In: *The Endocrine Function of the Human Testis,* V. H. T. James, M. Serra, and L. Martini (Eds.). New Yorlc Academic Press, 1974, pp. 131-143.
65. MCDONALD, E. C. and C. E. SPEICHER. Peliosis hepatis associated with administration of oxymetholone. *JAMA* 240:243–*244, 1978.*
66. MCGIVEN, A. R. Peliosis hepatis: case report and review of pathogenesis. *J. Pathol.* 101:283–285, 1970.
67. MEADOWS, A. T., J. L. NAIMAN, and M. VALDES-DAPENA. Hepatoma associated with androgen therapy for aplastic anemia. *J. Pediatr. 85:* 109–110, 1974.
68. MESSERLI, F. H. and E. D. FROHLICH. High blood pressure: a side effect of drugs, poisons, and food. *Arch. Intern. Med.* 139:682–687, *1979.*
69. MULVIHILL, J. J., R. L. RIDOLFI, F. R. SCHULTZ, M. S. BROZY, and P. B. T. HAUGHTON. Hepatic adenoma in Fanconi anemia treated with oxvmetholone. *J. Pediatr. 81:122-124.* , 1915.
70. NADELL, J. and J. KOSEK. Peliosis hepatis. *Arch. Pathol. Lab. Med.* 101:405–410, *1977.*
71. NESHEIM, M. C. Some observations on the effectiveness of anabolic agents in increasing the growth rate of poultry. In: *Anabolic Agents in Animal Production,* F. C. Lu and J. Rendel (Eds.). Stuttgart: Georg Thieme Publishers, 1976, pp. 110-114.
72. OLSSON, A. G., L. ORO, and S. ROSSNER. Effects of oxandrolone on plasma lipoproteins and the intravenous fat tolerance in man. *Atherosclerosis* 19:337–346, *1914.*
73. ORLANDI, F., A. JEZEQUEL, and A. MELLITI. The action of some anabolic steroids on the structure and the function of human liver cell. *Tijdschr. Gastro-Enterol. 7:* 109–*113. 1964.*
14. O'SHEA, J. P. The effects of an anabolic steroid on dynamic strength levels of weightlifters. *Nutr. Rep. Znt.* 4:363–370, 197 1.
75. OVERLY, W. L.. J. A. DANKOFF, B. K. WANG. and U. D. SINGH. Androgens and hepatocellular carcinoma in an athlete. *Ann. Intern. Med.* 100:158–159, *1984.*
76. PALVA, I. P. and C. WASASTJERNA. Treatment of aplastic anaemia with methenolone. *Acta Haematol.* 47:13–20, *1972.*
77. PAPANICOLAOU, G. N. and G. A. FALK. General muscular hypertrophy induced by androgenic hormone. Science 87:238–239, 1938.
18. REEVES, R. D., M. D. MORRIS, and G. L. BARBOUR. Hyperlipidemia due to oxymetholone therapy. *JAMA* 236:464–472, 1976.
79. REMES, K., P. VUOPIO, M. JARVINEN, M. HARKONEN, and H. ADLERCREUTZ. Effect of short-term treatment with an anabolic steroid (methandienone) and dehydroepiandrosterone sulphate on plasma hormones, red cell volume and 2,3-diphosphoglycerate in athletes. *Scand. J. Clin. Lab. Invest.* 37:577–586, *1977.*
80. RICHARDSON, J. H. A comparison of two drugs on strength increase in monkeys. *J. Sports Med. Phys. Fitness* 17:25*1-254, 1917.*
81. ROGOZKIN, V. A. The role of low molecular weight compounds in the regulation of skeletal muscle genome activity during exercise. *Med. Sci. Sports 8:* 1-4, 1976.
82. ROGOZKIN, V. A. Anabolic steroid metabolism in skeletal muscle. *J. Steroid Biochem.* 11:923–926, *1979.*
83. RYAN, A. J. Anabolic steroids are fool's gold. *Fed. Proc.* 40:2682–2688, *198* 1.
84. SACKS, P., D. GALE, T. H. BOTHWELL, K. STEVENS. Oxymetholone therapy in aplastic and other refractory anaemias. *S. Afr. Med. J.* 46:1607–1615, 1972.

85. SCARAMELLA, T. J. and W. A. BROWN. Serum testosterone and aggressiveness in hockey players. *Psychosom. Med.* 40:262–265, 1978.
86. SCHAFFNER, F.. H. POPPER, and V. PEREZ. Changes in bile canaliculi produced by norethandrolone: electron microscopic study of human and rat liver. J. *Lab. Clin. Med.* 56:623–628. 1960.
87. SHAHIDI, N. T. Androgens and erythropoeisis. N. *Engl. J. Med.* 289:72–80, *1973.*
88. SHAPIRO, P., R. M. IKEDO, B. H. RUEBNER, M. H. CONNERS, C. C. HALSTED, and C. F. ABILDGAARD. Multiple hepatic tumors and peliosis hepatitis in Fanconi's anemia treated with androgens. Am. *J. Dis. Child.* 131:1104–1106, *1977.*
89. SHEPHARD, R. J., D. KILLINGER, and T. FRIED. Responses to sustained use of anabolic steroid. *Br. J. Sports Med.* 11:170–173, 1977.
90. SKARBERG, K. O., L. ENGSTEDT, S. JAMESON, et al. Oxymetholone treatment in hypoproliferative anaemia. *Acta Haematol.* 49:321-330. 1973.
91. SMITH, K. D., L. J. RODRIGUEZ-RIGAU, R. K. TCHOLAKIAN, and E. STEINBERG. The relation between plasma testosterone levels and the lengths of phases of the menstrual cycle. *Fertil. Steril.* 32:403–407, *1979.*
92. SNOCHOWSKI, M., E. DAHLBERG, E. ERIKSSON, and J. A. GUSTAFSSON. Androgen and glucocorticoid receptors in human skeletal muscle cytosol. *J. Steroid Biochem.* 14:765–77 1, 198 1.
93. SPIERS, A. S. D., S. F. DEVITA, M. J. ALLAR, S. RICHARDS, and N. SEDRANSK. Beneficial effects of an anabolic steroid during cytotoxic chemotherapy for metastatic cancer. *J. Med.* 12:433–445, 1981.
94. STAMFORD, B. A. and R. MOFFATT. Anabolic steroid effectiveness as an ergogenic aid to experienced weight trainers. J. Sports Med. Phys. Fitness 14:191–197, 1974.
95. STANG-VOSS, C. and H-J. APPEL. Structural alterations of liver parenchyma induced by anabolic steroids. *Int. J. Sports Med.* 2:101–105, 1981.
96. STEINBACH, M. Uber den Einfluss Anaboler wirkstoffe auf Korpergewicht, Muskelkraft und Muskeltraining. *Sportarzt Sportmed.* 11:485–492, 1968.
97. STONE, M. H., M. E. RUSH, and H. LIPNER. Responses to intensive training and methandrostenolone administration: II. Hormonal, organ weights, muscle weights and body composition, *PflugersArch.* 375:147–151, *1978.*
98. STRAUSS, R. H., H. E. WRIGHT, G. A. M. FINERMAN, and D. H. CATLIN. Side effects of anabolic steroids in weight-trained men. *Phys. Sportsmed.* 11(12):87–96, 1983.
99. STROMEYER, F. W., D. H. SMITH, and K. G. ISHAK. Anabolic steroid therapy and intrahepatic cholangiocarcinoma *Cancer* 43:440–443, *1979.*
100. STROMME, S. B., H. D. MEEN, and A. AAKVAAG. Effects of an androgenic-anabolic steroid on strength development and plasma testosterone levels in normal males. *Med. Sci. Sports* 6:203–208, 1974.
101. TAYLOR, W., S. SNOWBALL, C. M. DICKSON, and M. LESNA. Alterations of liver architecture in mice treated with anabolic androgens and diethylnitrosamine. *NATO Adv. Study Znst. Series, Series A 52279-288, 1982.*
102. TAXY, J. B. Peliosis: a morphologic curiosity becomes an iatrogenic problem. *Hum. Pathol.* 9:33 *1-340,* 1978.
103. TEPPERMAN, J. *Metabolic and Endocrine Physiology.* Chicago: Year Book Medical Publishers. 1973. D. 70.
104. THOMSON, D. P., D. R. PEA&N, and D. L. COSTILL. Use of anabolic steroids by national level athletes. *Med. Sci. Sports Exerc.* 13: 111, 198 1. (Abstract)
105. VANDERWAL, P. General aspects of the effectiveness of anabolic agents in increasing protein production in farm animals, in particular in bull calves. In: *Anabolic Agents in Animal Production,* F. C. Lu and J. Rendel (Eds.). Stuttgart: Georg Thieme Publishers, 1976, pp. 60-78.
106. WADE, N. Anabolic steroids: doctors denounce them, but athletes aren't listening. *Science 176:* 1399-1403, 1972.
107. WARD, P. The effect of an anabolic steroid on strength and lean *body* mass. *Med. Sci. Sports* 5:277–282, 1973.
108. WEISS, V. and H. MULLER. Auf Frage der Beeinflussung des Krafttrainings durch Anabole Hormone. *Schweiz. Z. Sportmed.* 16:79–89, *1968.*
109. WHITELAW, M. J., T. N. FOSTER, and W. H. GRAHAM. Methandrostenolone (Diabanol): a controlled study of its anabolic and androgenic effect in children. *Pediatric Pharm. Ther.* 68:291–296, 1966.
110. WILSON, J. D. and J. E. GRIFFIN. The use and misuse of androgens. *Metabolism 29:* 1278– 1295, 1980.
111. WOODARD. T. L,. G. A. BURGHEN, A. E. KITABCHI, and J. A. WILIMAS. Glucose intolerance and insulin resistance in aplastic anemia treated with oxymetholone. *J. Clin. Endocrinol. Metab.* 53:905–908, 1981.
112. WRIGHT, J. E. Anabolic steroids and athletes. *Exerc. Sport Sci. Rev. 8: 149-202,* 1980.
113. YAMAGISHI, M., A. HIRAOKA, and H. UCHINO. Silent hepatic lesions detected with computed tomography in aplastic anemia patients administered androgens for a long period. *Acta Haematol. Jpn.* 45:703–710, 1982.
114. YOUNG, M., H. R. CROOKSHANK, and L. PONDER. Effects of an anabolic steroid on selected parameters in male albino rats. *Res. Q.* 48:653–656, *1977.*
115. ZEVIN, D., H. TURANI, A. COHEN, and J. LEVI. Androgen-associated hepatoma in a hemodialysis patient. *Nephron* 29:274–276, 198 1.



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