

“MUSCLE BUILDER” SUPPLEMENTS

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KEY POINTS

- Protein powders, protein-carbohydrate "weight gainers," creatine, and various "andro" products are popular among athletes and others who hope to gain muscle mass by using these supplements.
- Scientific evidence is sparse that any of these "muscle builder" supplements produces noticeable muscle growth beyond that achieved with a sound program of resistance training and overall good nutrition. However, many athletes fail to follow even the most basic principles of good training and nutrition.
- Athletes, especially the young, should be taught to expect gradual improvements in performance from many years of hard training and good nutrition; supplements will not give a "quick fix" to performance problems.

INTRODUCTION

Competitive athletes and others interested in fitness spend hundreds of millions of dollars each year on "dietary supplements" in hopes of increasing their muscle mass, strength, and power. To the concern of many experts in medicine and science, the US government defines "dietary supplement" so broadly that many products that previously might have been considered to be prescription drugs are now legally marketed as dietary supplements. In 1994, the US Congress passed the Dietary Supplement Health and Education Act that essentially defines a dietary supplement as any product that contains a vitamin; a mineral; an amino acid; an herb or other botanical; or a concentrate, metabolite, constituent, extract, or combination of any of these ingredients. In other words, if a pharmaceutical agent is detected in some herb or other type of plant, a manufacturer can label and sell that drug as a dietary supplement, unless the product falls under some other Federal act as a dangerous drug. Although manufacturers are prohibited from making direct claims that their products can be used to treat diseases, manufacturers' claims concerning the purity, safety, and efficacy of dietary supplements to improve performance are otherwise essentially unregulated. Our expert panel agreed to discuss the use and misuse of several "muscle builder" supplements and to provide their views on the extent to which coaches, personal trainers, physicians and others in leadership positions should recommend dietary supplements to athletes.

Dr. Eichner is an internationally recognized expert in sports medicine, especially that related to hematology. He is a team physician at The University of Oklahoma and was a participant in a recent roundtable on creatine supplementation that was sponsored by the American College of Sports Medicine. Dr. King and Dr. Ziegenfuss have completed several recent research projects on sports supplements,

including various "andro" products. They have both received research grant support from supplement manufacturers. Dr. Myhal recently completed his Ph.D. in exercise physiology, has extensive experience as a personal trainer, and is currently employed as a fitness director at a large commercial fitness center at which nutritional supplements are sold. Dr. Prentice has many years of experience as an educator and as an athletic trainer at a university whose athletic teams have achieved great success at the national level.

1. In your experience with athletes and fitness enthusiasts who want to gain muscle mass, what is the relative popularity of protein, creatine, dehydroepiandrosterone (DHEA) and other "andro" compounds, and hydroxy methyl butyrate (HMB)?

Myhal: In commercial fitness centers, the most popular supplement for increasing muscle mass for men and women—but mostly men—seems to be protein (primarily whey protein). Protein/carbohydrate "weight-gainer" supplements are popular with younger males who struggle to increase body weight. Young and old athletes use creatine extensively. Men ranging in age from about 21-35 years are the primary users of the prohormone "andro" products. My impression is that one of the first of the "andros," androstenedione, had been popular until users determined that it was doing nothing to increase muscle mass and until recent research indicated that this particular form of "andro" could increase circulating estrogen. However, at least in our region, two other types of "andro" prohormones, androstenediol and norandrostenediol, remain quite popular. DHEA was never popular as a supplement for increasing muscle mass, and our clients rarely request it. HMB sales declined rapidly after it was introduced because it had no perceived effect on muscle mass and was expensive.

Ziegenfuss: I agree with Dr. Myhal's comments about the relative popularity of these supplements.

King: There is no clear scientific evidence documenting the popularity of these supplements, but a recent survey in a national newspaper indicated that DHEA and androstenedione are among the six supplements most used to enhance performance.

Prentice: Creatine is hands down the most popular supplement used by collegiate athletes, particularly those competing in football, wrestling, track and field, and swimming.

Eichner: My experience is as "team internist" for 450 college varsity athletes. Among athletes who want to gain muscle mass, protein and creatine supplements are popular, especially in football, wrestling, and track and field. HMB and the banned substances DHEA and the "andros" are used by few or none.

2. For most athletes and fitness participants who wish to gain muscle mass, what degree of emphasis should be placed on dietary supplements compared to optimal resistance training, adequate energy intake, and sound overall nutrition?

Prentice: Every two or three years the newest and most fashionable "wonder supplement" creates anticipatory excitement that it will produce quick and gratifying results. However, science eventually shows that, like others before it, the supplement just does not live up to the claims and hype. There is no substitute for engaging in an optimal resistance training program and consuming a sound overall diet. Dietary supplements should play a minor role, if any, in the training of athletes.

Ziegenfuss: The vast majority of us will never compete at a level where small improvements in performance (like those that may be afforded by a few supplements) would make a difference. Receiving sound advice from a healthcare professional with credentials in training and nutrition is the ideal way to maximize performance, especially in younger athletes who have not yet realized their genetic ceiling of potential. However, elite athletes who have every other aspect of their performance package "tuned in" may benefit from a sound supplement program.

Myhal: Far too much emphasis is placed upon dietary supplements. This sends a message to young athletes that drugs and supplements are the foundation of optimal performance rather than proper diet, training, and years of practice in their particular sports. Generally, when athletes inquire about supplements, my first response is to ask about their training and dietary intake. Most often, their training programs are mediocre, and they are not consuming enough energy from food sources. Overall, my recommendations to young athletes include personal training, training program design, and a consultation with a sports nutritionist. With the exception of weight-gainers and fluid-replacement beverages, I generally steer them away from supplements.

Eichner: No emphasis should be placed on dietary supplements compared to optimal training and nutrition.

King: Since it is likely that any benefit of these supplements is small relative to sound training practices, athletes should place most of their emphasis on training and optimal nutrition. People taking supplements may neglect their diets in the belief that supplements are taking care of their nutritional needs.

3. Assume that an individual participates in an optimal resistance-training program and is consuming a sound overall diet. Based on your knowledge of the scientific literature and anecdotal evidence, what is the likelihood that any of these supplements will contribute noticeably to muscle growth in that person?

Eichner: For athletes who eat optimal diets, there is no solid evidence that protein powders or amino acids build muscle mass. On creatine, laboratory studies are many and mixed; field studies are few and mixed; and new studies appear fast. I've reviewed several dozen reports and conclude that judicious creatine supplementation can produce a small positive effect on resistance training—and muscle growth—in top strength and power athletes. I am dubious of any benefit from HMB. DHEA and the "andro" products are prohormones and should not be classified as dietary supplements. To me, the limited published research on DHEA and androstenedione, taken as a whole, suggests that, depending on dose, both compounds are likely androgenic and possibly anabolic, especially in women but maybe also in men. Anecdotal evidence suggests the same for the other andros.

King: Two studies have reported enhanced gains in muscle mass during strength training with creatine supplementation, whereas one report showed no effect. To date only one paper has demonstrated increased strength gains with HMB. In my opinion, more studies are required before these compounds can be considered to be important for gaining muscle mass in those who undergo optimal training and consume sound diets. The likelihood that androstenedione increases

muscle growth during resistance training in young men is remote. Although blood testosterone levels may be increased in women following androstenedione supplementation, in our recently published research we did not observe any increase in blood testosterone levels in healthy young men with either acute or chronic androstenedione intake. The lack of any ergogenic effect of androstenedione during resistance training is therefore not surprising. When consumed at maximal doses typically recommended by manufacturers, androstenedione should not be considered to be an anabolic agent, at least in men, because it has no anabolic properties, either by its own action or by increasing serum testosterone levels. The use of DHEA is also unlikely to produce any noticeable benefits beyond those associated with an optimal training and nutrition program. While DHEA ingestion in men has been reported to reduce percent body fat in some studies, others have reported no indication of increased basal metabolic rate, reduced body fat, or increased lean body mass. Additionally, ingestion of DHEA does not seem to increase testosterone levels in men, further providing evidence of a lack of an anabolic-androgenic effect. In contrast to men, women may have marked increases in serum testosterone with DHEA use. There is little information on the efficacy of DHEA during resistance or aerobic training, but I believe research will show that in men, DHEA has no effect on blood testosterone or on muscular adaptations to resistance training.

Prentice: It is my judgement that there is no conclusive evidence that dietary supplements are effective in enhancing muscle mass as long as the individual eats well and does high-quality resistance training. Despite a wealth of anecdotal evidence that a particular supplement may be effective, we should remain skeptical until sufficient research supports those claims.

Ziegenfuss: Some research supports the anabolic effects of consuming about 2.0-2.5 g of protein/kg of body weight each day during resistance training, but many strength/power athletes consume this amount of protein or more in their normal diets, so they probably do not require protein supplements. Although long-term studies are few, I believe the scientific evidence is convincing that creatine ingestion during resistance training also promotes muscle growth. Preliminary information on "andro" is mixed, partly because there is a relative scarcity of data and also because at least six different chemical forms of "andro" products are being marketed as dietary supplements, some containing other compounds that are claimed to minimize potential side effects. At the present time, published research suggests that the androstenedione form of "andro" is not anabolic. However, I think research will eventually be published demonstrating that some forms of androstenediol are anabolic and are without apparent side effects. I do not believe that DHEA or HMB are effective in promoting muscular development in young men.

Myhal: The scientific literature supporting the ergogenic effects of creatine is mixed, but the anecdotal evidence is overwhelmingly in favor of creatine. In my opinion, DHEA has no growth-promoting properties, especially in men. Recent studies in older men show no increase in circulating testosterone—but increases in circulating estrogen—and no changes in body composition with DHEA administration. Although DHEA can increase circulating testosterone in women, generally the changes are small, within normal limits, and unlikely to have a performance-enhancing effect. Likewise, HMB has not lived up to its marketing hype as an anabolic agent. Both the scientific data and the anecdotal evidence show that the androstenedione form of "andro" is not an effective anabolic agent. However, in the gym setting I have observed what seem to be positive effects of androstenediol and norandrostenediol on muscle mass, especially among women, and also among men who use high doses of these two forms of "andro."

4. Given that supplement users may consume much greater amounts of a product than recommended by the manufacturer, what are the most dangerous potential adverse side effects of these dietary supplements?

Eichner: Assuming purity, I doubt that protein powders, amino acids, and HMB are health hazards, other than potential dose-related or idio-

syncratic gastrointestinal upset or dehydration. Creatine, too, seems relatively safe so far. However, because creatine takes plasma water into muscles with it, large doses may be a hazard in the heat, and some kids take huge doses—up to 86 g/day! Concern exists about long-term safety. Anecdotal reports of gastrointestinal upset and of muscle cramping or strains have not yet been firmly tied to creatine, per se. Two case reports of renal toxicity associated with the use of creatine supplements are short on detail and have no clear interpretation, but they call for caution and further study. DHEA and "andro" compounds, being androgenic prohormones, can have dose-related adverse effects on the liver, prostate, and cholesterol profile, not to mention mood. I worry about the potential for "rage reactions" in young men on high doses of these compounds.

King: I believe that protein and creatine supplements are generally benign. Although androstenedione is not an effective anabolic agent, it does share some negative side effects with anabolic steroids. We observed a 5 mg/dL decrease in the serum HDL-cholesterol (HDL-C) levels during 8 wk of supplementation with 300 mg androstenedione per day. This depression in HDL-C, although smaller than that observed with anabolic steroid use, nevertheless would be associated with a 10-15% increase in the risk for cardiovascular disease. Less clear is the clinical significance of the increased levels of estrogens in the blood associated with androstenedione intake, although increased estrogens may raise the risk for cardiovascular disease and pancreatic cancer in men. In addition, androstenedione itself may increase the risk for prostate and pancreatic cancer. Furthermore, at least in rats, androstenedione has effects equal in potency to testosterone on the part of the brain that has been shown to promote aggressive behavior. In my opinion, the addition of herbal extracts designed to minimize potential side effects of androstenedione supplements has no such effect. Furthermore, I believe that research will eventually show that androstenediol is no more anabolic or ergogenic than androstenedione and will have the same side effects as androstenedione. In women, use of DHEA in doses of 50 mg and 100 mg/day may cause excess facial hair growth, oily skin, acne and decreased HDL-C. For DHEA use, the possibility of cardiovascular disease complications due to the reduced serum HDL-C is probably the most severe risk. Although DHEA has not been shown to cause negative side effects in men, there is evidence that ingestion of DHEA could cause an athlete to fail a urinary drug profile. Ingestion of DHEA by men increases the serum androstenedione concentration, which has been associated with prostate cancer and pancreatic cancer. HMB does not appear to have any serious side effects.

Ziegenfuss: Like many pharmaceuticals, the risks from long-term, high-dose use of any supplement are likely to be much greater than those resulting from short-term use. High protein intake has been reported to exacerbate existing kidney disease, but is unlikely to have any harmful effects in healthy people. Creatine loading, e.g., 20 g/day for 5 days, can cause acute weight gain that could adversely affect performance in weight-bearing sports such as running, and long-term supplementation may impair the natural synthesis of creatine by the body. Prudence dictates a cautious stance with "andro" compounds and DHEA, but in my opinion, at this point the adverse effects of many months or years of supplementation with androstenedione and DHEA have not been firmly established. There is not yet any published evidence of adverse effects from androstenediol supplementation in athletes, but at high doses, the potential exists for changes in the integrative function of the hypothalamus, pituitary, and testes. I am not aware of any adverse effects of using HMB.

Myhal: For protein and carbohydrate supplements, intestinal distress and an increase in body fat are the most likely adverse side effects of excess consumption. Diets containing more than three grams of protein per kilogram of body mass may increase the risk of kidney damage in dehydrated athletes, especially those susceptible to kidney stones. Otherwise, there is no concrete evidence that high-protein diets cause kidney dysfunction in healthy athletes. The adverse effects of chronic high doses of creatine are unknown. "Andro" products are relatively weak over-the-counter anabolic steroids, but in high enough doses, some of these products may exhibit side effects similar to those of testosterone and its analogues. I am not convinced that the relatively small changes in HDL-C and estrogen shown with 300 mg daily doses of androstenedione will ultimately lead to heart disease or

cancer, but we don't know what might happen with larger doses and/or longer durations of supplementation.

5. Do you recommend any of these supplements to mature athletes or clients? Would you recommend any of them to young athletes? Why or why not?

Prentice: No one should recommend the use of any of these supplements to young athletes under any circumstances. We simply do not know enough about either the short-term or the long-term effects of these supplements on the immature athlete. Additionally, I have some serious concerns about the message that health and fitness professionals would send out to these young athletes by recommending supplements. Thus, I believe that it is our professional as well as our ethical responsibility to do whatever we can to discourage use of these supplements, especially by young athletes.

King: Our experience is mostly with androstenedione and DHEA. Because our research tells us that these prohormones are not anabolic and because there is insufficient evidence guaranteeing their safety, we do not recommend androstenedione or DHEA supplementation to anyone.

Eichner: I do not recommend any of these supplements to anybody, least of all kids. The consensus of the ACSM Creatine Roundtable is that kids under 18 should not take creatine. At the least, giving kids creatine sends a wrong message: You need a supplement to train, compete, and win.

Myhal: I generally do not recommend supplements other than weight-gainers, meal-replacement products, and occasionally a multivitamin/mineral supplement. Moreover, I strongly discourage the use of any "andro" products to those under the age of 21. Furthermore, if they are competitive athletes, I inform them that these products are banned and will likely result in a positive drug test. When people ask me about supplements such as prohormones and creatine, I discuss what I know from the scientific literature, and I relay some of the anecdotes of other users. However, the decision and responsibility for intelligent use is ultimately theirs. I also advise athletes and clients of absolute contraindications to supplement use, such as pregnancy, underlying medical conditions, and drug interactions. Finally, before clients begin using supplements, I suggest that they consult a physician who is familiar with exercise, nutrition, and dietary supplements.

Ziegenfuss: I agree with Dr. Myhal 100%. Rather than recommending supplements to specific athletes, I prefer to educate them and let them make their own decisions. This educational process includes a comparison between the peer-reviewed original research on a given supplement and the claims associated with the product, so that the athletes can begin to separate facts from "leaps of faith." Obviously, this approach works best with rational, responsible individuals who value science. Unfortunately, the vast majority of consumers make up their minds based on tenuous, media-filtered information—yet another reason for athletes to seek a qualified professional. Athletes under 18 years of age should never be encouraged to use supplements because their use degrades the ethics of sport by fostering the "win at all costs" mentality.

6. Should content, purity and quality of these and other dietary supplements be monitored or regulated?

Myhal: Yes, to some degree. As far as I am concerned, the purity and content of many dietary supplements cannot be trusted anymore than the purity and content of black-market steroids. For example, an analysis of 16 brands of DHEA found that only 44% contained what was stated on the label. A manufacturer may "spike" products with stimulants and/or with flavor-enhancing agents such as sugar or fat in an attempt to capture a larger market share. In addition to problems with the purity of supplements, the claims made by supplement manufacturers regarding the potential ergogenic effects of their products are often outrageous. Supplement manufacturers should be required to cite peer-reviewed studies of human beings who have actually used the product if the manufacturer is to make any claims of performance effects. If this documentation cannot be provided, then the labeling

should list contents only, and no claims should be permitted. Furthermore, I would like to see supplements, particularly those with drug-like effects such as the "andro" compounds, dispensed by physicians who are well versed in the areas of sports nutrition, muscle physiology, endocrinology, and performance-enhancing drugs. I strongly believe that "andro" products, like scheduled anabolic steroids, should be controlled by the FDA and physicians, not health-food store clerks and black marketers. Although I think these products should be regulated, I am opposed to banning any supplements simply because they have some potential for abuse or may elicit side effects when consumed in high doses. Banning substances, particularly those that enhance performance, has little effect on demand and/or long-term supply and may actually promote additional interest among young athletes. Moreover, while the immediate effects of a ban may reduce supply, once the product becomes entrenched on the black market, it becomes largely uncontrollable, use escalates, and additional problems arise beyond those of the drugs themselves.

Ziegenfuss: Unfortunately, a wide disparity exists in the content, purity, and quality of dietary supplements among different companies. Ideally, consumers should seek out supplement manufacturers that have been certified as adhering to Current Good Manufacturing Practices and are pharmaceutically registered. All pharmaceutical companies that manufacture drugs regulated by the US Food and Drug Administration must meet these provisions, which assure that a system of government inspected, quality manufacturing standards are in effect. To put this in perspective, only about 30% of companies that sell nutritional supplements have these ratings. Supplement companies should be encouraged (or even required by the government) to interact with a scientific advisory board consisting of physicians and scientists with academic training in human nutrition and exercise science. One of the roles of the board could be to review label and marketing information for scientific merit. A rating system could even be developed by scientists to evaluate specific supplements and their claims.

King: It would seem prudent for the purity of supplements to be monitored and regulated in order to protect the public. We have heard of several incidences where individuals, including physicians, have purchased supplements and have subsequently learned that the supplement did not contain the ingredients advertised, or it contained additives not indicated on the package.

Prentice: I believe the FDA should assume the responsibility for monitoring and regulating dietary supplements. In addition, only health and fitness professionals who have an academic background in nutrition should be allowed to make recommendations or provide information on supplements

Eichner: Yes, these products should be monitored and regulated by the FDA. DHEA and "andro" should come under the Anabolic Steroid Control Act of 1990. As for the other "dietary supplements,"

the Dietary Supplement Health and Education Act of 1994 needs changing, because it allows the marketing of products not proven effective or safe.

SUGGESTED ADDITIONAL READING

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“MUSCLE BUILDER” SUPPLEMENTS

TRAIN HARD

Follow a strenuous resistance training program under the guidance of an expert coach or personal trainer. Depending on your training experience, you may need to begin by lifting relatively light loads for many repetitions before building up to heavier loads and few repetitions. An experienced supervisor can help determine what type of resistance training schedule is appropriate for you and can reduce the risk that you will injure yourself by lifting too much too soon.



FOLLOW A SOUND DIET

Eat a regular diet that contains sufficient energy (calories), protein, and carbohydrate, with the balance containing mostly unsaturated fat. Consult a nutritionist or a dietitian to make certain you are choosing foods wisely.



Energy:

To gain one pound of body mass each week, consume about 500 calories each day above and beyond the amount of calories that allows you to maintain a stable body weight. If you want to gain two pounds per week, consume 1000 extra calories each day. Most athletes can consume this much extra energy simply by eating larger portions of their normal diets, but some find that it is easier if they supplement their normal foods with energy-dense protein/carbohydrate "weight gainer" products or meal-replacement drinks. Remember, if you don't train hard, extra energy intake will eventually show up as extra body fat!



Protein:

Consume 1.0-1.25 grams of protein per pound of body weight (2.0-2.5 g/kg) on a daily basis. This protein can come from normal foods. Most athletes do not require protein supplements for optimal muscle growth.

Carbohydrate:

Every day, eat about 3.5-4.5 grams of carbohydrate per pound of body weight (8-10 g/kg). Emphasize cereals, fruits and vegetables as carbohydrate sources because they contain more nutrients than do sugars and sweets. Carbohydrate-rich foods tend to be very bulky, so if you have diffi-



culty consuming this much carbohydrate in normal foods, you may wish to supplement your normal diet with high-carbohydrate energy drinks or energy bars.

Fat:

Consume about 0.2-0.4 grams of fat per pound (0.45-0.9 g/kg) of body weight per day. Most of this fat should come from unsaturated sources (e.g., olive, canola, and flax oils).

DON'T EXPECT MIRACLES

Although muscle size may increase substantially in the first few months of a sound program of training and nutrition, eventually the gains in muscle mass will slow down. This is normal. You should expect to gain muscle mass gradually over years of hard training and good nutrition. There is no quick and easy way to get big and strong.

DON'T RELY ON DIETARY SUPPLEMENTS

Don't fall into the trap of spending lots of money on various "muscle builder" supplements in hopes of finding an easy road to greater muscle mass. There is no substitute for rigorous resistance training and good overall nutrition. Hundreds of supplements are marketed as muscle builders, and almost all of them have no effect whatsoever on muscle mass. Those few supplements that are supported by scientific research are noticeably effective mostly in elite athletes who have undergone many years of training. For non-elite athletes, the effects are usually trivial when compared to the much greater effects of sound training and sound overall nutrition. Furthermore, some supplements have the potential to cause serious side effects.



IF YOU ARE CONSIDERING SUPPLEMENTS, CONSULT EXPERTS

Highly trained athletes who are considering the use of dietary supplements should consult regularly with a knowledgeable exercise physiologist, with a sports medicine physician who is familiar with dietary supplements and with a competent sports nutritionist or sports dietitian. Don't rely on clerks at the health food store, magazine ads, the Internet, or gym rats. Stay alert for adverse side effects.

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