

Risky Business

Dietary Supplement Use by Athletes

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Sports nutrition supplements tempt athletes with promises of sleek, powerful bodies produced by pills, potions, and powders. However, many supplements are risky for athletes because an estimated 5% to 20% contain prohibited substances and unlabeled pharmaceuticals. Dietary supplements considered most at risk of containing unlabeled drugs and prohibited substances include those for sexual enhancement, weight loss, and muscle building. Sports governing bodies have banned or prohibited certain substances for athletes competing in all levels of sports; high school, college, elite, professional, and master athletes can all be tested. The banned ingredients can be in products unintentionally, due to poor hygiene in producing the supplement, or intentionally by the purposeful addition of unlabeled substances, such as anabolic steroids. Regardless of how the prohibited ingredient found its way into a dietary supplement, all sports organizations have a “strict liability” policy; that is, athletes are responsible for anything they put in their bodies, including dietary supplements. This article examines the issue of sports supplement contamination and provides athletes with resources to evaluate risky dietary supplements. *Nutr Today*. 2015;50(5):240–246

- Pro cycling team board member and chief team doctor receive lifetime ban for multiple antidoping rule violations

The list goes on... Brazilian jiu-jitsu athlete, Chinese swimmer, Russian race walker, UK track athlete, US handball athlete, US weightlifter, US wrestler, US judo athlete.¹ While many of these athletes violate doping rules intentionally, it is not uncommon for athletes to inadvertently fall victim to dietary supplements contaminated with prohibited substances.

The marketplace for dietary supplements—estimated at more than \$30 billion annual sales in the United States² in 2013—is often characterized as a consumer product category in which junk science abounds, benefit claims are not to be trusted, products are sometimes contaminated with banned substances, and the reputations of truly efficacious supplements are tainted by their snake-oil brethren. That scenario is certainly the case with sports nutrition supplements, a sizable subset of the overall dietary supplement market, which often tempt athletes with promises of sleek, powerful bodies produced by pills, potions, and powders.

Athletes and coaches are willing to consider almost any idea that promises improved performance. New ideas involving sports equipment, training techniques, and nutritional interventions are often greeted enthusiastically by coaches and athletes, put into practice before adequate scientific testing has occurred, and touted anecdotally as the latest and greatest idea to hit the sporting world. While most sports-health and sports-science professionals would advise a more cautious approach to integrating new ideas into an athlete’s training regimen, the fact is that coaches and athletes have always been—and will always be—the initial arbiters of proposed innovations. For that reason, it should not be surprising that athletes frequently ingest dietary supplements of one sort or another despite the known risks.³ Coaches and athletes are exposed to a constantly churning mix of new ideas and products, most of which have a short life-span; an idea that was once new is rapidly superseded by the next “improvement.” This is particularly so in the area of sports nutrition supplements, where there has historically been a rapid and seemingly endless series of product introductions, many of which make remarkable claims for superior performance and are at times accompanied by equally remarkable health and eligibility risks.

It seems as if shortly after major sports competition the following headlines appear:

- US ice hockey athlete accepts sanction for antidoping rule violation
- US triathlon athlete accepts sanction for antidoping violation
- Kenyan track-and-field athlete accepts sanction for antidoping violation

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Dietary supplements considered most at risk of containing unlabeled drugs and prohibited substances include those for sexual enhancement, weight loss, and muscle building.⁴ One needs only to scan the Food and Drug Administration's (FDA's) MedWatch Web site to understand the serious risks athletes face when using dietary supplements. For example, in April 2015, the FDA issued warning letters to 5 supplement companies requesting they recall and reformulate their products containing BMPEA (β -methylphenethylamine). BMPEA is an illegal stimulant, not a dietary substance, often listed on product label by a variety of indecipherable alias names (eg, 2-phenylpropylamine, 1-amino-2-phenylpropane, etc). In addition, some companies have falsely claimed that the botanical *Acacia rigidula* was the source of the BMPEA.⁵

Dietary supplements for muscle building, weight loss, and sexual enhancement are at the highest risk of containing prohibited substances.

As 1 more example from 2015, the FDA posted a voluntary recall of SmartLipo365 capsules, a product marketed for weight loss. The FDA found the SmartLipo products contained undeclared sibutramine, desmethylsibutramine, and phenolphthalein. Sibutramine, an appetite suppressant, was withdrawn from the US market in October 2010. Phenolphthalein, an ingredient previously used in over-the-counter laxatives, is not approved for dietary use in the United States because of concerns of carcinogenicity. These undeclared ingredients make these products unapproved new drugs for which safety and efficacy have not been established.⁶

Who Uses Dietary Supplements?

Approximately 50% of the US population reportedly consumes dietary supplements,⁷ and use in athletes is higher, particularly with sports nutrition supplements. Use of dietary supplements by high school athletes is prevalent despite strong opposition for use of dietary supplements by high school sports organizations.⁸ Braun and colleagues⁹ surveyed elite young German athletes (average age, 16.6 years) and found that 80% reported current or past use of dietary supplements, whereas only 36% of those surveyed were aware of the problem of supplement contamination. Approximately 40% of college students use protein powders or protein supplements,¹⁰ and the prevalence of use among elite athletes is even higher. Most surveys find supplement use reported between 80% and 90% in elite athletes around the world.¹¹⁻¹³ Of growing concern is the

use of dietary supplements in the military. Sometimes called "warrior athletes," soldiers have unique physical challenges and must achieve fitness and body weight standards. One survey of 990 active duty soldiers at 11 army bases throughout the world found that 53% of soldiers used dietary supplements, with high use of performance-enhancing and weight-loss supplements.¹⁴

Why Do Athletes Use Supplements?

Athletes cite many reasons for dietary supplement use, including to promote recovery from training, to improve health, to prevent or treat illness (even though dietary supplements cannot claim to prevent or treat illness), and to compensate for a poor diet.¹³ In addition to these reasons, Morente-Sánchez and Zabala¹⁵ conducted a systematic literature review on elite athletes and attitudes, beliefs, and/or knowledge of doping in sport. They cite athletic success as the number 1 reason for supplement use, but also found financial gain and increasing self-confidence were important motivators. Athletes who knowingly take banned substances for improving sports performance report what Dunn et al¹⁶ call the "false consensus effect." Athletes tend to overestimate the number of competitors who use illicit substances and therefore believe that they need to use banned ingredients to even the playing field.

Athletes can also fall under the spell of dietary supplement marketing. Unsubstantiated claims for the extraordinary benefits of supplements are astounding and abound in print and Internet advertising. Consider these tantalizing benefits:

- "Want a killer physique? This supplement has 5 times the muscle building power of 1 workout"
- "Drop body fat in a single dose"
- "Increase testosterone by 99%"
- "Boost muscle growth 600%"
- "Raises the anabolic threshold without weight gain"
- "Incinerates excess fat"
- "Produces immediate results in energy, size, strength, pumps, performance, mental focus, and training intensity"

Each of these product claims involves a structural or functional benefit that is testable through scientific experimentation. Although a few of these advertising claims are accompanied by relevant scientific references, the vast majority are not, an observation that appears to be consistent with historical practice. This conclusion is supported by the work of Grunewald and Bailey,¹⁷ who evaluated the advertising claims for 624 products targeted at body builders. The products were associated with more than 800 performance-related claims, the vast majority of which were unsubstantiated by scientific research.

It is far easier to make a benefit claim for a dietary supplement than to substantiate it. Science is too slow a process for supplement manufacturers that develop products

and make claims based on an incomplete understanding of potential benefits. The competitive nature of the supplement industry fuels this impatience, as manufacturers vie to be first to get new products and compelling claims into the marketplace. Eventually, science catches up, and product claims are either substantiated or discredited. We should keep in mind that 1 study, or even a handful of studies, is insufficient to accept or reject a claim for a product benefit. Dozens of studies, and the years it takes to accomplish them, are required to adequately determine whether a benefit truly exists. Case in point: it took almost 50 years of research to gain a broad understanding of the physiological and performance benefits of remaining euhydrated during physical activity, and that scientific literature continues to grow.

The Problem of Contamination of Dietary Supplements

Performance-enhancing drugs (PEDs) were first prohibited by the International Association of Athletics Federation in 1928, long before dietary supplements were readily available.¹⁸ The use of amphetamines, common in the past in many sports, was linked to the death of a cyclist in the 1960 Olympic Games and another death in the 1967 Tour de France, leading the International Olympic Committee (IOC) to establish a medical commission. The IOC commission subsequently published the first list of prohibited (banned) substances in 1967. In 1999, the IOC convened a world conference on doping, and that led to the formation of the World Anti-Doping Agency (WADA).¹⁸ The World Anti-Doping Agency is the most recognized agency responsible for identifying prohibited substances, creating the framework for athlete drug testing, and establishing standards for the analyses of biological samples.¹⁹ It revises and publishes a prohibited substances list annually. To be considered a prohibited substance, a substance or method must satisfy any 2 of the following 3 criteria:

1. potential to enhance or enhances sports performance
2. an actual or potential health risk to the athlete
3. use violates the spirit of sport (outlined in the World Anti-Doping Code)²⁰

Sports organizations that are not affiliated with the IOC or WADA have their own banned substances lists, although most are similar to the WADA prohibited list, which is considered the International Standard.¹⁹ The National Collegiate Athletic Association (NCAA) has its own banned drugs list and testing procedures that are closely aligned with WADA standards. Other professional sports organizations (Major League Baseball, National Football League, and NASCAR, to name a few) publish lists of banned substances and test athletes in or out of season (or both).

It is estimated that between 5% and 20% of dietary supplements contain prohibited substances.

Dietary supplements are risky for athletes because an estimated 5% to 20% contain prohibited substances.¹⁸ The banned ingredients can be in products unintentionally, due to poor hygiene in producing the supplement, or intentionally by the purposeful addition of unlabeled substances, such as anabolic steroids. Regardless of how the prohibited ingredient found its way into a dietary supplement, all sports organizations have a “strict liability” policy; that is, athletes are responsible for anything they put in their bodies, including dietary supplements. For example, the NCAA clearly tells collegiate athletes about the risks with this statement:

NCAA Nutritional/Dietary Supplements Warning: Before consuming any nutritional/dietary supplement product, student athletes should review the product with the athletics department staff.

- Dietary supplements are not well regulated and may cause a positive drug test result.
- Student-athletes have tested positive and lost their eligibility using dietary supplements.
- Many dietary supplements are contaminated with banned drugs not listed on the label.
- Any product containing a dietary supplement ingredient is taken at your own risk.²¹

Even stark warnings are often not enough to dissuade athletes from using dietary supplements without first seeking professional advice. Consider this statement from Major League Baseball player, David Ortiz, who has previously tested positive for banned substances:

Most MLB (Major League Baseball) players take a dozen pills a day just to get them through the season—multivitamins, creatine, amino acids, nitric oxide, all kinds of stuff. Whatever you tell them is legal, they’ll take it. But back in the early 2000s, you’d go into GNC, and the guy working there would say, “Hey, take this stuff. It’s great. It builds muscle, helps with soreness, burns fat, whatever.” Okay, sure, I’ll take that. I’m buying an over-the-f***ing-counter supplement in the United States of America. I’m buying this stuff in line next to doctors and lawyers. Now all of a sudden MLB comes out and says there’s some ingredient in GNC pills that have a form of steroid in them. I don’t know anything about it. If you think I’m full of it, go to your kitchen cabinet right now and read the back of a supplement bottle, and honestly, tell me you know what all of that stuff is. I’m not driving across the border to Mexico

buying some shady pills from a drug dealer. I'm in a strip mall across from the Dunkin' Donuts, bro.²²

Sanctions for athletes who test positive for prohibited substances vary in severity and depend on the sport governing body. Sanctions can include formal reprimands, mandatory treatment programs, suspensions from competition of varying lengths, or a lifetime ban from competition.¹⁹ Lance Armstrong was stripped of his 7 Tour de France cycling titles and barred for life from competition for intentional doping. Marion Jones, winner of 3 gold medals in the 2000 summer Olympic Games, had her medals taken away when she pleaded guilty to intentionally using PEDs. Sometimes even the hint of doping, even though never formally proven, can taint an athlete's reputation. Calcaterra²³ writes of what he dubbed the "PED Eight;" 8 baseball players, including Mark McGwire and Sammy Sosa, who will most likely never be in the MLB Hall of Fame because of their association with PEDs.

Many people think dietary supplements are not regulated by the FDA, but they are, just not as well as some would like. The FDA oversees the dietary supplement industry but does not require manufacturers to provide evidence of product purity, safety, or efficacy prior to introducing a product to market, an approach similar to that with foods and beverages. Recalls of dietary supplements with unapproved pharmaceutical ingredients are increasing.²⁴ Between January 2009 and December 31, 2012, the FDA recalled 274 dietary supplements (about one-half of all FDA recalls since 2004 involve dietary supplements). Even after an FDA recall for banned substances or unlabeled drugs, 66.7% of recalled supplements were still available for purchase at least 6 months after the recall.²⁵ FDA MedWatch and Health Canada examined regulatory alerts of dietary supplements from 2003 to 2013 and identified 1560 dietary supplements issued for alerts. The most common supplements for which alerts were issued were for products marketed for sexual enhancement, weight loss, and athletic performance.²⁶

The Challenge for Health Professionals and Athletes

What is an athlete to do when coaches, teammates, and even parents encourage supplement use to make him/her faster and stronger and perform better than the competition? Consider the following:

1. Some ingredients are both illegal and banned. In 1 analysis, 24 dietary supplements suspected of containing controlled substances were analyzed, and 23 were found to contain steroids. Sixteen steroids were identified that were different than what was on the label. Overall, 13 different steroids were detected in the samples.²⁷
2. Some ingredients are legal but banned. The stimulants oxilofrine and synephrine (bitter orange) are legal substances and

can be used in dietary supplements but are on the prohibited lists of WADA and the NCAA, respectively.

3. Many ingredients have aliases. Steroids can be referred to many things, such as prohormones, natural steroids, testosterone boosters, growth factors, androgen stabilizers, or androgen analogs, along with more than 200 chemical aliases.
4. Some ingredients are dangerous. In 2013, the FDA advised consumers not to use supplements containing DMAA (1,3-dimethylamylamine), also called geranium extract, because it is an illegal stimulant sometimes found in dietary supplements. Touted as a "natural stimulant," DMAA can elevate blood pressure that can lead to shortness of breath, chest tightness, and heart attack.²⁸
5. Supplement use may make the jump to PED use easier. There may be an association between dietary supplement use and progression to using illegal substances. Barkoukis and colleagues²⁹ suggest that athletes who use dietary supplement progressively view doping more favorably than nonusers and that they exhibit a stronger intent to future doping.

Resources for Evaluating Dietary Supplements for Health Professionals and Athletes

While it is challenging to keep up with unscrupulous manufacturers, there are reputable supplement manufacturers who produce clean products with substantial research to support their use in at least some athletes. Specific sports supplements have been discussed before in this publication (see Rosenbloom and Rosbruck³⁰). Increasingly, sport supplements are being analyzed for banned substances by independent laboratories, and a logo of the certifying agency is placed on the product. While this method is not fool-proof, it can guide an athlete and health professional to supplements that are significantly less likely to lead to a failed drug test. Currently, there are 4 such third-party certifications for dietary supplements. The certification, logo, Web site, and brief description of each are found in the Figure. It is important to know that "certified" means that a specific production batch of a product was certified; certification does not extend to other batches of the product. The analysis can test for only what is in the certifying agency's test panel, so there is no 100% guarantee that a supplement is free of banned substances. Lastly, at present, these are the only 4 agencies certifying dietary supplements for prohibited substances in the United States; some supplements use bogus label and Web site claims, such as "WADA certified" or "IOC approved," but neither the IOC or WADA certifies or approves specific products.

Mobile phone apps are also available to help the athlete make an informed decision about purchasing a supplement. Currently, Aegis Shield and NSF have such apps, and the WADA prohibited substances list is available for downloading, as are lists for other sports governing bodies such as the NCAA, NFL, and so on.

The National Athletic Trainers' Association has an algorithm in its position paper that can help athletes avoid risks and harms of dietary supplement use.³¹ The position paper is

Certification Programs in the United States

Name of Certification	Logo	Comments
Aegis Shield CERTIFIED™		<p>The Aegis Shield CERTIFIED logo on a supplement product label indicates that the product has been tested by the Aegis Sciences Corporation and certified to be free of the 180 or more banned substances included in the Aegis Shield CERTIFIED testing panel.</p>
Banned Substances Control Group (BSCG) Certified Drug Free®		<p>The BSCG Certified Drug Free logo on a supplement product label indicates that it is free of drugs or other agents that can lead to health concerns or positive drug tests. BSCG Certified Drug Free supplement certification includes batch testing for more than 392 drugs, including 207 banned in sport and 185 prescription and over-the-counter drugs not banned in sport.</p>
Informed-Choice		<p>Informed-Choice is a certification program for sports supplements, ingredients, and manufacturing facilities that assures athletes that products carrying the Informed-Choice logo have been regularly tested for more than 146 substances considered prohibited in sport.</p>
NSF Certified for Sport®		<p>NSF International created the NSF Certified for Sport Program. This specially designed NSF program is a focused solution designed to minimize the risk that a dietary supplement or sports nutrition product contains banned substances by testing for more than 200 substances. The program also includes label claim verification, contaminant testing, and biannual GMP audits of the product's manufacturing facility.</p>

Source: Academy of Nutrition and Dietetics Sports Nutrition Care Manual©. Used with permission from the Academy of Nutrition and Dietetics. Certification programs in the United States. Sports Nutrition Care Manual.
https://sports.nutritioncaremanual.org/topic.cfm?ncm_category_id=25&lv1=255436&ncm_toc_id=255436&ncm_heading=&. Accessed July 15, 2015.

FIGURE. Current dietary supplement certification programs in the United States. The certification programs listed in the figure certify that dietary supplements marketed to and used by athletes are free of certain banned substances. While no testing can guarantee that a supplement is 100% free of banned substances, certification drastically reduces the risk of athletes using products containing banned substances. All the certifications listed in the figure have analytic laboratories that meet ISO 17025 accreditation standards. This is an international standard for ensuring integrity and consistency of analytic results. Sports dietitians and other health and sports professionals may be aware of other dietary supplement certification programs, such as USP verified (through the United States Pharmacopeia) or CL Approved (through ConsumerLab). While both of these programs provide certification on dietary supplement quality, purity, and potency, neither certification tests for substances that are banned for sport. This is an important distinction, and they should not be confused with sports supplement certification programs. Source: *Academy of Nutrition and Dietetics Sports Nutrition Care Manual*. Used with permission from the Academy of Nutrition and Dietetics. Certification programs in the United States. https://sports.nutritioncaremanual.org/topic.cfm?ncm_category_id=25&lv1=255436&ncm_toc_id=255436&ncm_heading=&. Accessed July 15, 2015.

available at the National Athletic Trainers' Association Web site (<http://www.nata.org/position-statements>).

There are many other organizations that provide education on dietary supplements, and these are listed in the Table.

CONCLUSION

Athletes frequently ask if a supplement is “safe” (which is code for “will I test positive if I take this supplement?”). There is no guarantee that a supplement is safe, but using the resources listed in this article will substantially decrease the risk. It is also important to remind athletes that dietary supplements cannot replace a good training and nutrition program. No supplement will make up for a poor diet and lazy training. Encourage athletes to ask these questions before taking a supplement that promises a quick fix.

TABLE Resources on Dietary Supplements

• Academy of Nutrition and Dietetics. <i>Sports Nutrition Care Manual</i> (online) (https://sports.nutritioncaremanual.org/)
• Aegis Shield (www.aegisshield.com)
• Australian Institute of Sport (www.ausport.gov.au/ais/nutrition/supplements)
• Banned Substance Control Group (bscg.com)
• Consumer Lab (http://www.consumerlab.com/results/index.asp)
• Human Performance Research Center (hprc-online.org/dietary-supplements)
• Informed Choice (informed-choice.org)
• National Center for Alternative and Complimentary Medicine (http://nccam.nih.gov/health/supplements/wiseuse.htm)
• National Sanitation Foundation (nsf.com/services/by-industry/dietary-supplements/)
• Office of Dietary Supplements (ods.od.nih.gov)
• REC (www.drugfreesport.com/drug-resources/dietary-supplements-resources.asp)
• Sports, Cardiovascular and Wellness Nutrition (scandpg.org)
• Chapter 7, Ergogenic aids, dietary supplements, and exercise. In: <i>Sports Nutrition: A Practice Manual for Professionals</i> . 5th ed. Chicago, IL: Academy of Nutrition and Dietetics; 2012
• US Anti-Doping Association (www.usada.org/supplement411)
• World Anti-Doping Agency (https://www.wada-ama.org/)

- Is my diet all that it could be in terms of eating a variety of healthy foods, including at least 5 servings of fruits and vegetables each day?
- Am I consuming enough calories (energy) every day? (Some athletes have a difficult time maintaining body weight and muscle mass over the course of the season. Progressive weight loss means loss of muscle mass and is a sure sign the athlete is not getting enough to eat).
- Am I getting enough carbohydrates in my diet to help keep my muscles optimally fueled? (Carbohydrate intake for athletes in training should be at least 6 g/kg per day; that is 2.7 g of carbohydrate per pound of body weight per day; for example, a 180-lb athlete should consume roughly 400 g of carbohydrates from a variety of foods and beverages each training day.)
- Am I eating a snack containing carbohydrates and protein after each workout to help speed recovery and stimulate muscle growth and repair?
- Am I hydrating properly throughout the day, especially during training and competition?
- Am I getting enough rest during the day and at least 8 hours of sleep each night?
- Am I focused and working hard during every practice, paying close attention to my coach's suggestions and instructions?
- Am I doing enough of the right type of strength training?
- What specifically do I want to accomplish by using a sports nutrition supplement?
- Can my coach recommend a registered dietitian nutritionist who specializes in sports nutrition to help me optimize my diet and choose the right supplements?

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