



Science, Movement and Health, Vol. XIV, ISSUE 2 Supplement, 2014  
September 2014, 14 (2, Supplement): 465-469  
*Original article*

## A PHARMAECONOMIC STUDY REGARDING THE DEMAND FOR MUSCLE HYPERTROPHY PARAPHARMACEUTICALS CONSUMED BY YOUNG ATHLETES

MARGARITTI DOINA<sup>1</sup>

### Abstract

The demand for nutritional supplements has registered a continuous growth over the years, due to the population's obsession with food, health and the way they look. Today it has transformed into a billion dollar industry, with hundreds of million people consuming nutritional supplements daily, owing to the development of the pharmaceutical industry.

The demand is for Vitamins, Minerals and Supplements also known as VMS, especially used by young adults to boost their health, image and sport performance. The consumer behavior can be seen in the market quota growth that these products hold on the par pharmaceutical market.

*Key words:* nutritional supplements, market demand growth, muscle mass growth.

### Introduction

Due to the fact that people nowadays are more and more concerned about their health and the way they look the global VMS (Vitamins, Minerals and Supplements) market is one of the fastest growing industries in the world, especially the sports nutrition segment. Today supplement manufactures offer a very wide range of products for young athletes and not only and according the BCC Research report the global supplement market was estimated at about 44.3 billion dollars in 2011 and is expected to reach 52.2 billion dollars by 2016 (BCCResearch). In Romania the supplement market is estimated at 270 million dollars from 78 million dollar estimated during 2007-2008 (Cegedim).

This boom is the result of the wide variety of supplements that existent on the market not only for professional athletes, but also for individuals that participate in recreational workouts and sports. Sports performance products have been directed especially towards the male consumers, but nowadays sports nutrition products exist for both genders and according to a study carried out by the National Health Interview Survey it shows that more and more kids use sports performance formulations. (National Health Interview Survey- cdc.gov.).

Sport endurance supplements are the foundation of the sport supplement market, leading to a substantial growth in this area. Due to the continuous innovation in this industry the line between professional athletes and recreational exercisers are becoming blurrier therefor the market registers a continuous growth.

Nutrition Business Journal (NBJ) separates sports nutrition into three distinct categories: Sports Nutrition Supplements, including powders, pills and "hardcore" bodybuilding ready-to-drink (RTD) products; Nutrition Bars & Gels; and Sports & Energy Drinks & Shots. (Nutrition Business Journal.com)

Currently on the market a large segment is occupied with muscle growth and repair supplements and drugs. Supplement use is widespread among athletes that participate in sports that require strength and power.

### Aim of the study

The aim of the study is to highlight the demand for muscle hypertrophy drugs and supplements.

### Results and discussions

The consumer is often confused because supplements do not undergo the same regulations as pharmaceutical drugs. A few of the supplements and pharmaceutical drugs that are more commonly used by athletes are described in this article.

Researchers recommend athletes to consume food proteins before and after exercising which leads to an increase in muscle mass, that consuming high energy carbohydrates is not enough to maximize protein synthesis. Scientists have proven that consuming certain types of rapid digested proteins and by consuming these immediately after working out helps develop muscle mass. For immediate results often athletes supplement their diet with nutritional supplements and drugs to help enhance their muscle mass. (Clarkson, 1998).

In this paper we present the drugs most used by athletes to increase muscle hypertrophy, these drugs can only be released with a medical prescription and even if it is a legal prescription it is illegal for a professional athlete to use them before a competition, coming into disagreement with the anti-doping laws. Below we present the most commonly used drugs banned by the World Anti-Doping Agency.

**Androstenedione ("Andro")** is a steroid produced in the adrenal glands and the gonads which is converted in the body to testosterone. Medically it aids in the production of testosterone for individuals with

<sup>1</sup>Ovidius" University, Faculty of Pharmacy, Aleea Universitatii Street, no. 1, Constanta, ROMANIA  
Email address: ge\_conta@yahoo.com  
Received 29.03.2014 / Accepted 30.05.2014



hormonal problems and it can only be obtained only with a medical prescription. In improving performance it is used by young athletes to increase muscle strength and mass and to shorten muscle recovery time. (Lemon, 1995).

**Human Growth Hormone (“HGH,” Somatotropin)** it is a hormone produced by the pituitary gland that promotes body growth, it is available only with a medical prescription. Whereas anabolic steroids primarily affect muscles, HGH strengthens bones and tendons as well. It is used by athletes to reduce body fat, thus increasing body muscle, speed recovery from injury and increase resistance to injury. (Cristea, 2006).

**Tetrahydrogestrinone (“THG,” “the Clear”)** medically it is not used, but is very popular with athletes due to the fact that it increases muscle strength and promotes muscle growth.

**Ephedrine (Ephedra, Ma Huang)** is a chemical compound derived from the herb ephedra. Athletes use it to increase energy and alertness and to lose weight by speeding up their metabolism. Medically it is used as a decongestant and for temporary relief of asthma and bronchitis. Ephedrine has been banned by the International Olympic Committee, the National Football League, Major League Baseball and the National Basketball Association. It's illegal to use in dietary supplements and can be obtained only with a medical prescription. (Cristea, 2006).

**Stanozolol (Winstrol)** is a man-made anabolic steroid derived from testosterone, it has been approved for human use but only with a medical prescription. Athletes use it to increase the strength of their muscles, generate lean body mass and to improve endurance. Used medically to promote bone and tissue growth and to treat hormonal problems and skin/tissue swelling.

**Testosterone** is a hormone produced primarily in the testes of males and the ovaries of females. In the sports world it is used to build muscle mass and it also reduces fat and increases bone density and strength. It also can be obtained only with a medical prescription.

**Erythropoietin** is a type of hormone used to treat anemia in people with severe kidney disease. It increases production of red blood cells and hemoglobin, resulting in improved movement of oxygen to the muscles. Epoetin, a synthetic form of erythropoietin, is commonly used by endurance athletes. Erythropoietin use among competitive cyclists was common in the 1990s and allegedly contributed to at least 18 deaths. Inappropriate use of erythropoietin may increase the risk of thrombotic events, such as stroke, heart attack and pulmonary edema.

**Nandrolone (Deca-durabolin)** is an anabolic steroid (a steroid that acts as the hormone testosterone) that occurs in small amounts in the human body. Medically it is used to treat osteoporosis in postmenopausal women, to aid in the growth of blood

cells in bone marrow, and to help tissue and muscle growth in people suffering from degenerative diseases like AIDS. Athletes use it to grow muscle mass and aid in physical recovery from workouts. It can only be obtained with a medical prescription.

**Diuretics** have long served as a way to mask steroid use. A diuretic is any drug that affects kidney function, resulting in increased urine output. The "water pill" chlorthalidone, for example, prevents fluids and salts from being reabsorbed into the kidney tubules and returned to the blood. As a result, more water leaves the body. Acetazolamide works by blocking the uptake of sodium bicarbonate in the kidney tubules. Upon excretion, the bicarbonate ion carries out water, sodium and potassium. In patients with certain conditions, such as heart disease, diuretics can help control high blood pressure and fluid retention. But athletes who take anabolic steroids take diuretics to dilute their urine, which decreases steroid concentration and makes it much more difficult to detect. Weightlifters and boxers may also down water pills to expel large amounts of fluid, which qualifies them to compete in a lower weight category. Then, right before the match, they stop taking the pills to return to their heavier fighting weight, giving them an advantage against their opponents. Of course, an athlete taking diuretics may also get dizzy, become dehydrated or experience a severe drop in blood pressure. (Cristea, 2006).

Many athletes have turned away from anabolic steroids and illegal drugs and toward nutritional supplements in the hope of gaining a competitive edge without threatening their health. Athletes may require slightly more protein than sedentary people do to maintain positive nitrogen balance, but it is dubious whether extra dietary protein will help someone to achieve athletic goals. (Burke, 1994).

Over time athletes have been advised to consume from meat and wine to herbal tonics, from beef juice to egg based protein powder, but nowadays supplements exist that offer a wide range of products for each person's needs (Mertz, 1992). But bodybuilding supplements have also caused health problems, for example in 2012 the best-seller Craze sold on Amazon and in Wall Mart consisted of amphetamine like compounds that lead to liver damage and blindness. In the United States 50,000 reports are filled each year due to dietary supplements. Bodybuilding supplements are the number one cause of liver damage out of all the other supplements. Purified amino acids have become a popular and expensive form of protein supplementation. (cdc.gov) Excessive protein supplementation can lead to dehydration, gout, liver and kidney damage, calcium loss, and gastrointestinal effects. Supplementation with vitamins and minerals in excess of recommended daily allowances appears to have no effect on muscle mass or athletic performance. Other substances touted as having ergogenic properties are carnitine, cobamamide, growth hormone releasers, octacosanol, and ginseng,



but there is no reliable scientific evidence to support claims that products containing these compounds have ergogenic potential, and heavy supplementation may lead to adverse effects. Nutritional supplements are promoted through unsubstantiated claims by magazine advertisements, health food stores, coaches, and other sources. (Clarkson)1998 The FDA considers nutritional supplements to be “foodstuffs”, not drugs, and therefore has not required that they be proved safe and effective. Dosage guidelines are inadequate, and quality control is poor. The FDA has begun to revise regulations governing labeling and health claims for these products. There is little if any evidence that nutritional supplements have ergogenic effects in athletes consuming a balanced diet, and some products have the potential for harm.

Next we present the most commonly used substances in dietary supplements taken to enhance muscle hypertrophy. (fda.gov)

### **Protein**

Athletes need a diet high in protein and numerous studies have found out that there is a higher need for protein when physical activity is carried out. The muscles in our body consist mainly of protein and their role is essential for gaining performance in all sports. Exercise has a well known effect on protein metabolism, and hard exercise damage the muscle tissue and proteins help repair and recover the muscle. These factors are dependent on protein intake in ones diet.

In a number of recent studies it has been proven that protein supplementation is not necessary for the athletes. Deficiencies in protein intake are more likely in the sedentary individual, especially when energy intake is restricted in order to control body weight, than in the athlete training hard who consumes sufficient energy to meet the demand. In spite of this clear relationship between total energy intake and the adequacy of dietary protein intake, however, many athletes ingest large quantities of protein consisting in foods and expensive protein supplements. Protein supplements can be bought in the form of pills, bars, powders, drinks and shakes, but protein powders account for a major part of the nutritional supplement sales to athletes. (Lemon)1995

There are a large number of athletes who take daily protein supplements, the most common being **Whey protein**. Whey protein is a mixture of globular proteins isolated from whey, the liquid material created as a by-product of cheese production -the watery portion of milk that separates from the curds when making cheese. Whey protein is used for improving athletic performance, as a food supplement, as an alternative to milk for people with lactose intolerance, for replacing or supplementing milk-based infant formulas, and for reversing weight loss. Whey protein is commonly marketed and ingested as a dietary supplement, because is a rich source of naturally occurring branched chain amino acids, which are important for those who have an active lifestyle. Whey protein is

likely safe for most adults when used appropriately. High doses can cause some side effects such as increased bowel movements, nausea, thirst, bloating, cramps, reduced appetite, tiredness (fatigue), and headache.

A 2009 study at McMaster University in Ontario, Canada found that, despite being at rest, subjects who consumed whey had nine times greater muscle repair and growth than those who ate other types of protein (casein and soy). After exercise, the same whey group saw a 122 percent greater muscle protein synthesis compared to the casein group and 31 percent greater than the soy group.

**Casein** which is commonly found in mammalian milk, making up 80% of the proteins in cow milk and between 20% and 45% of the proteins in human milk.

An attractive property of the casein molecule is its ability to form a gel or clot in the stomach, which makes it very efficient in nutrient supply. The clot is able to provide a sustained slow release of amino acids into the blood stream, sometimes lasting for several hours, it prevents catabolism while asleep by emptying slowly and steadily. Casein is a great snack for those who want to pack on muscle mass because it doesn't give a feeling of fullness. New research found that casein when it's taken post workout, boosts muscle protein synthesis much like whey does. It's even suggested that a whey and casein protein shake taken after training increases muscle growth better than either protein taken alone. (nyhealth.gov)

### **Amino Acids**

Amino acids are the building blocks of protein, the body breaks consumed protein into amino acids in the stomach and intestines. Amino acids in particular are used specifically to build muscle and can produce impressive results in an entirely natural way. Supplements have become increasingly popular, because nutrient quantities absorbed with normal food generally do not suffice to cover the increased demands of athletes. The most important amino acid for athletes is leucine which is responsible with the regulation with the growth and repair of tissues, skin, bones and muscle. (Cristea, 2006).

**Branched-chain amino acid (BCAA)** are among the nine essential amino acids for humans, accounting for 35% of the essential amino acids in muscle proteins and 40% of the preformed amino acids required by mammals. The term branched-chain amino acids refers to leucine, isoleucine and valine, the absolute most important amino acids for repairing and building muscle tissue. Leucine is the most critical of the three, as research shows that it can stimulate muscle protein synthesis on its own. It is recommended to take all three together, since they work in synergy to provide a multitude of benefits, including muscle growth, increased energy during workouts, the blunting of cortisol (a catabolic hormone that inhibits testosterone and increases muscle breakdown) and decreased delayed-onset muscle soreness. BCAA are



used especially by athletes who want to maintain muscle mass while on a calorie-deficit diet. (Lemon, 1995)

**Carnosine** (beta-alanyl-L-histidine) is a dipeptide of the amino acids beta-alanine and histidine. It is highly concentrated in muscle and brain tissues. Carnosine is important for many normal body functions including the proper function and development of the muscles, heart, liver, kidneys, brain, and many other organs. Research shows that when muscles have higher levels of carnosine, they have more strength and endurance. Carnosine appears to increase the muscle fibers' ability to contract with more force, and to do so longer without fatiguing. Several studies reported increases in muscle strength and power in athletes who took beta-alanine. One recent study found that subjects who took beta-alanine along with creatine gained more muscle mass and lost more bodyfat than subjects who took only creatine.

**ZMA** (Zinc monomethionine and aspartate and Magnesium Aspartate) is a supplement used primarily by athletes, gymnasts, and bodybuilders. It is most often used as a recovery aid. ZMA claims to raise strength levels and may enhance hormonal profiles. The study most often used to support the hormone effects of ZMA is one done at Western Washington University. Dr. Lorrie Brilla (and a ZMA supplement manufacturer) studied 12 football players who took ZMA nightly during an eight-week spring training program and a separate group assigned a placebo pill. The athletes taking the ZMA had 2.5 times greater muscle strength gains than the placebo group; the ZMA group increased by 11.6 percent compared to only 4.6 percent in the placebo group. The ZMA group also had 30 percent increases in testosterone levels (compared to 10 percent in the placebo group).

**Beta-ecdysterone**, also called ecdysterone or 20-hydroxyecdysone, is a naturally occurring steroid found in plants such as spinach, where its main function is to protect the plant from insects. Russian scientists discovered many years ago that beta-ecdysterone has anabolic properties. In fact, it's similar in structure to hormones found in insects and crustaceans, but beta-ecdysterone doesn't behave like a hormone in the body, but rather works by stimulating protein synthesis and therefore muscle growth. Anecdotal reports suggest that it's very effective for producing increases in both muscle size and strength, it's used widely by body builders with hopes to build muscle or lean body tissue. It's also often marketed as a natural alternative to steroids with claims that it's a powerful growth promoter with no negative hormonal consequences.

**High Molecular-Weight Carbs.** Molecular weight is a term that refers to the mass of one molecule of a substance. Therefore, high molecular-weight carbs (HMCs) are essentially made up of very large, heavy molecules. HMCs such as the patented Vitargo brand are typically made from waxy maize (corn) starch. What makes these carbs so special is their ability to

rapidly pass through the stomach to the intestines where they can be absorbed and enter the blood. Research shows that HMCs pass through the stomach at a rate almost 100% faster than sports drinks. This is important after exercise because consuming carbs at this time blunts cortisol levels, prevents muscle breakdown and raises insulin levels to help promote muscle growth and replenish muscle glycogen levels. (Maganaris, 1998).

#### **Creatine**

Creatine. Manufacturers claim they can build muscles, and improve strength and stamina, without the side effects of steroids. Dietary supplements are not regulated by the Food and Drug Administration (FDA) and are not held to the same strict standards as drugs. If abused, they can have harmful effects.

Creatine supplies energy to the cells and muscles for a limited amount of time and it is an organic acid naturally occurring in the body. A number of scientific studies have shown that creatine can improve strength, energy, muscle mass, and recovery times. In addition, recent studies have also shown that creatine improves brain function, and reduces mental fatigue. Unlike steroids or other performance-enhancing drugs, creatine can be found naturally in many common foods such as herring, tuna, salmon, and beef. Creatine increases what is known as cell volumization by drawing water into muscle cells, making them larger. Creatine is sold in a variety of forms, including creatine monohydrate and creatine ethyl ester, amongst others. Though all types of creatine are sold for the same purposes, there are subtle differences between them, such as price and necessary dosage. Used a long period of time it can cause short-term cramping and diarrhea. While less is known about long-term use, creatine has been linked to muscle injury and kidney problems. Creatine has different effects on each individual person. Some people will use it and see effects within a week, others will use this and it will take a longer period of time to see results. There is no determination of how the product will affect a person. (Hultman, 1996)

#### **Conclusions**

Today the supplement market is very large and diverse and it is very hard to predict the future. Sport nutrition companies are in the early stages of developing gender based products in order to reach the mainstream female consumer and today they are more cost-effective, safe, natural and efficacious. Until now the vast majority of products have targeted men as can be seen on the packets as well as the formulation. The new generation represent a new market opportunity and companies are more preoccupied to satisfy the needs of the younger athletes generation when it comes to dietary supplements. Today companies and in a continuous race to offer new products, brands and packaging offering these products in supermarkets, coffee houses, outdoor stores and of course pharmacies.



## References

- Burke LM, Inge K, 1994, Protein requirements for training and “bulking up”, in Burke LM, Deakin V (ed): *Clinical sports nutrition*. Sydney, McGraw Hill, pp 124-150.
- Clarkson PM, 1998, Nutritional supplements for weight gain. *Sports Science Exchange*; 11: 1-10.
- Cristea AN, 2006, *Tratat de Farmacologie Medical*, 723-751
- Green AL, Hultman E, Macdonald IA, Sewell DA, Greenhaff PL, 1996b, Carbohydrate ingestion augments skeletal muscle creatine accumulation during creatine supplementation in humans. *Am J Physiol* 1996b; 271: E821-E826.
- Heymsfield SB, Arteaga C, McManus C, Smith J, Moffitt S, 1983, Measurement of muscle mass in humans. *Am J Clin Nutr*; 37: 478-494.
- Hultman E, Soderlund K, Timmons JA, Cederblad G, Greenhaff PL, 1996, Muscle creatine loading in men. *J Appl Physiol*; 81: 232-237.
- Lemon PWR, 1995, Do athletes need more dietary protein and amino acids? *Int J Sport Nutr S*; S39-S61.
- Maganaris CN, Maughan RJ, 1998, Creatine supplementation enhances maximum voluntary isometric force and endurance capacity in resistance trained men. *Acta Physiol Scand* 1998; 163: 279-287.
- Mertz W, 1992, Chromium: history and nutritional importance. *Biol Trace Elem Res* 1992; 32: 3-8.  
<http://www.bodybuilding.com>  
<https://www.wada-ama.org/en/what-we-do/the-code>  
<http://www.forbes.com/sites/davidlariiviere/2013/04/18/nutritional-supplements-flexing-their-muscles-as-growth-industry/>  
[www.nyhealth.gov](http://www.nyhealth.gov)  
<http://www.bccresearch.com/>  
<http://www.privatelabelnutra.com/supplement-manufacturer-blog/sports-performance-supplements-2013-growth-and-market-trends/>  
<http://www.cdc.gov/nchs/nhis.htm>  
<http://www.fda.gov/>  
<http://archive.nutritionbusinessjournal.com/>  
[http://www.nutraceuticalsworld.com/issues/2012-05/view\\_features/the-next-chapter-in-sports-nutrition/](http://www.nutraceuticalsworld.com/issues/2012-05/view_features/the-next-chapter-in-sports-nutrition/)