

The Use of Performance Enhancers in Sport

Inass El-Gaafarawi*

Competition is a natural part of human nature and the desire to win is, naturally, ever present. Techniques and substances employed to enhance athletic performance and to achieve unfair success in sport have a long history, and there has been little knowledge or acceptance of their potential harmful effects. The aim of this article is to discuss the existing evidence regarding the risks and benefits of performance enhancers, and the importance of implementing effective education, intervention and prevention efforts.

Introduction

Through time pharmaco-therapeutic developments have had a profound impact on health and quality of life. Unfortunately, the illicit and incorrect use of some substances can turn a positive influence into inappropriate and even dangerous scenario. The use of performance enhancers, not for legitimate medical purposes but for their ergogenic effects- increased strength, power, speed, and endurance- and/ or to alter body weight or composition is one such example.

Performance enhancing substances are drugs and dietary supplements used to boost athletic performance, ward off fatigue, and enhance physical appearance. These substances are dangerous, damaging and potentially deadly. Their use is a significant issue in the world because both athletes and non- athletes use and /or abuse some of them. Their use also is by no means restricted to elite athletes and adolescent sport participants (Rhea *et al.*, 2008).

* Prof. of Biochemistry, Narcotic Research Dep. The National Center for Social and Criminological Research.

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Although the phrase Performance Enhancing Drugs used in reference to anabolic steroids, World Anti-Doping Organizations apply the term broadly. The phrase has been used to refer to several classes of drugs. The use of these drugs in sport is commonly referred to by the term doping; particularly by those organizations that regulate competitions (Wikipedia, 2010). There are many suggestions to the origin of the term doping (Higgins, 2006). Doping often refers to Marijuana usage, as a common alternate name for Marijuana is dope. The word referring to drug use was probably derived from dope (Wikipedia, 2010). Also, doping defines as the use of a drug or blood product to improve athletic performance, or any use of drugs and of the nonfood substances to improve performance (Thefreedictionary.com). However, doping here refers to an athlete's use of prohibited drugs or methods to improve training and sporting results.

Athletes face enormous pressure to excel in competition. They also know that winning can reap them more than a gold medal. A star athlete can earn money and a lot of fame. Athletes only have a short time to do their best work. They know the training is the best path to victory, but they also get the message that some drugs and other practices can boost their efforts and give them shortcut, even as they risk their health and their athletic careers. Success in sports involves obtaining an edge over the competition. However, sometimes the drive for success can be also engrossing and so compelling that a person can easily lose sight of what is fair and right.

History

Since ancient Greco- Roman times, fame, celebrity, and economic benefit arising from success in fighting or competition have persuaded some athletes to use artificial and often unfair and dangerous means to enhance their athletic performance (Verroken, 2000). Greek and Roman civilization used mushrooms and herbs to improve their performance. The ancient Greek also drank wine potions, used

hallucinogens and ate animal hearts or testicles in search of potency (Jenkins, 2007). Gladiators in ancient Roman ingested hallucinogens and stimulants such as strychnine (fatal in high doses) to stave off fatigue and injury and to improve the intensity of their fights. Late in 19th century substances including alcohol, coca leaves, opium and caffeine were used (Abdul Aziz, 2006).

The more recent forms of performance enhancing drugs have roots from World War II where Amphetamines were used by American soldiers to keep them alert and Germans used anabolic steroids (testosterone derivatives) to increase their aggressive behavior (Noakes, 2004; Yesalis, 2007; Sports illustrated, 2008).

A number of deaths and allegations of drug taking created pressure on sporting agencies to take action against doping. A Danish cyclist, Knut Jensen, died in Aug.26, 1960 at the Summer Olympics in Rome due to doping (NBC, 2009) and a British cyclist, Tommy Simpson died during the 13th stage of the Tour de France on July 13, 1967 due to doping (Slater, 2008). Accordingly, The International Olympic Committee (IOC) established the Medical Commission in 1967 to fight against doping in sports, which banned the use of drugs and other performance enhancing substances. The Commission was given three guiding principles: protection of the health of athletes, respect for medical and sport ethics, and equality for all competing athletes (IOC, 2009).

The IOC instituted its first compulsory doping controls at the Winter Olympic Games in Grenoble, France in 1968 and again at the Summer Olympic Games in Mexico City in the same year. Small-scale testing was introduced that year, followed by a full- scale testing at the next games in Munich, 1972. In 1975, anabolic steroids use was banned following the development of a test, after which there was a surge of disqualifications through steroid use. In 1983, caffeine and testosterone were added to the prohibited list, followed in 1986 by blood doping and Erythropoietin (EPO) in 1990, despite reliable tests

for their detection not being available until 2000 (Mottram and Verroken, 2005).

Following a large number of doping offences being committed in the mid- nineties, e. g. Ben Johnson stripped of Gold Medal after positive drug test and later was banned for life after a second positive test in 1993 (BBC, 2009), and the existence of several conflicting organizations, the World Conference on Doping was held in Switzerland in 1999. As a result, the World Anti-Doping Agency (WADA) was formed to promote and coordinate the fight against drug use in sport on an international level, across all sports. WADA was set-up under the initiative of the IOC and with the support of other international organizations and governments. The organization is formed by individuals from the IOC and public authorities (WADA, 2009). At the 2008 Beijing Olympics WADA and IOC perform 4,500 drug tests. They are saving the urine and blood samples for eight years so they can be retested when better detection methods are available (IOC, 2009).

Some athletes get away with using drugs, others wind up suspended from their sport or even in jail and still others die prematurely (Berry, 2008). It is a risky and complex game within a game that plays itself out on a public stage. But it is now well established that athletes are not the only individuals to use and abuse these drugs. Abuse has now appeared in adult non-athletes and even in young boys who may be using them to simply improve their appearance. Women are also using these drugs, but all estimates indicate that the percentage is lower than in males (Lukas, 2009; Fernandez and Hosey, 2009). So, the aim of this article is to discuss the existing evidence regarding the risks and benefits of performance enhancers, and the importance of implementing effective education, intervention and prevention efforts.

Classes of Performance Enhancers (Wikipedia, 2010)

A performance- enhancing substance is any substance taken in non-pharmacological doses specially for the purpose of improving sports performance. They include the following:

1. Anabolic steroids (AAS) - synthetic modification of testosterone, e.g., tetrahydrogestrinone (THG), used to amplify the growth of muscle and lean body mass.
2. Creatine - naturally occurring compound produced by your body, used to provide energy to the skeletal muscles.
3. Stimulants - amphetamines, ephedrine, etc.
4. Diuretics - drugs that change body's natural balance of fluids.
5. Painkillers - ranging from non-steroidal anti-inflammatory drugs to narcotics.
6. Masking drugs - drugs that prevent the detection of other classes of drugs, e.g. epitestosterone, a drug with no performance-enhancing effects, to restore the testosterone/ epitestosterone ratio (a common criterion in steroid testing) to normal levels after anabolic steroid supplementation (osterone).

New- Generation Performance Enhancers

With the advent of more sophisticated urine testing procedures, the likelihood that an athlete can avoid being caught using AAS is decreasing somewhat. This situation has yielded to the increased popularity of an entirely new generation of performance enhancing drugs and nutritional supplements that are not currently illegal or banned substances (Lukas, 2009). Moreover, some of these agents have been extremely difficult to detect using standard laboratory procedures, not because the technology is limited but because these substances are found naturally in the body (McHugh *et al.*, 2005). So carbon isotope mass spectrometry is needed (Graham *et al.*, 2008). These include:

1. Human growth hormones- human growth hormone (HGH), human chorionic gonadotropin (HCG), and Insulin- like growth factor (ILF-1), used to build mass and strength.

2. Physiologic agents or other strategies- used to enhance oxygen-carrying capacity, including erythropoietin and red blood cell transfusions (blood doping).
3. Nutritional supplements- taken at supra- physiologic doses or at levels greater than required to replace deficits created by a disease state, training, and/ or participation in sports.

Why do athletes take drugs?

There are a large number of reasons why an athlete may decide to take drugs. A selection is listed:

- Pressure to succeed, either from themselves or coaches/ family.
- Belief that their competitors are taking drugs.
- Pressure from governments/ national authorities (as occurred in the financial rewards for outstanding performance.
- Lack of access to, or funding for training facilities and additional support (nutrition, psychological support).
- Community and media attitudes and expectation of success.

(The National Sport Information Center Web Archive, 2011).

Muscular Energetics (Rose and Richter, 2005; Freudenrich, 2006).

When you exercise or compete in sports, you notice several things about your body. You breathe heavier and faster, your heart beats faster, your muscles hurt and you sweat. These are all normal responses to exercise whether you work out regularly or only once in a while or whether you are a "weekend warrior" or a trained athlete. When you watch world-class athletes compete, you see the same responses, only magnified. The body has an incredibly complex set of processes to meet the demands of working muscles. Every system in the body is involved.

Any type of exercise uses your muscles. Running, swimming, weightlifting - any sport you can imagine - uses different muscle groups to generate motion. In running and swimming, your muscles are working to accelerate your body and keep it moving. In weightlifting, your muscles are working to move a weight, exercise means muscle activity!

When you exercise, your muscles act something like electric motors. Your muscles take in a source of energy and they use it to generate force. An electric motor uses electricity to supply its energy. Your muscles are biochemical motors, and they use a chemical called adenosine tri-phosphate (ATP) for their energy source. During the process of "burning" ATP, your muscles need three things:

- They need oxygen, because chemical reactions require ATP and oxygen is consumed to produce ATP.
- They need to eliminate metabolic wastes (carbon dioxide, lactic acid) that the chemical reactions generate.
- They need to get rid of heat. Just like an electric motor, a working muscle generates heat that it needs to get rid of.

Because ATP is so important, the body has several different systems to create ATP. These systems work together in phases. The interesting thing is that different forms of exercise use different systems, so a sprinter is getting ATP in a completely different way from a marathon runner!

ATP comes from three different biochemical systems in the muscle, in this order:

- 1- Phosphagen system.
- 2- Glycogen-lactic acid system.
- 3- Aerobic respiration.

Exercise and the Phosphagen System

A muscle cell has some amount of ATP floating around that it can use immediately, but not very much - only enough to last for about three seconds. To replenish the ATP levels quickly, muscle cells contain a high-energy phosphate compound called creatine phosphate. Together, the ATP levels and creatine phosphate levels are called the phosphagen system. The phosphagen system can supply the energy needs of working muscle at a high rate, but only for **8 to 10 seconds**.

Exercise and the Glycogen-Lactic Acid System

Muscles also have big reserves of a complex carbohydrate called glycogen. Glycogen is a chain of glucose molecules. A cell splits glycogen into glucose. Then the cell uses anaerobic metabolism (anaerobic means "without oxygen") to make ATP and a byproduct called lactic acid from the glucose. There is a definite limit to anaerobic respiration because of the lactic acid. The acid is what makes your muscles hurt. Lactic acid builds up in the muscle tissue and causes the fatigue and soreness you feel in your exercising muscles. The system can still act and produce enough ATP to last about **90 seconds**.

Exercise and Aerobic Respiration

By two minutes of exercise, the body responds to supply working muscles with oxygen. When oxygen is present, glucose can be completely broken down into carbon dioxide and water in a process called aerobic respiration. Aerobic respiration produces ATP at the slowest rate of the three systems, but it can continue to supply ATP for **several hours or longer**, so long as the fuel supply lasts.



Sprinter

Phosphagen system

8-10 seconds (100 m)



Swimmer

Glycogen-lactic acid system

1.3-1.6 minutes (400 m)



Marathon runner

Aerobic respiration

Unlimited time (15 Km)

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An athlete may want to: build mass and strength of muscles and/or bones; increase delivery of oxygen to exercising tissues; mask pain; stimulate the body; relax; reduce weight or hide the use of other drugs. The classes of drugs used for these purposes are mentioned above.

The present article will focus on some commonly used and potentially harmful performance enhancers (anabolic steroids, Human growth hormone, and creatine), erythropoietin, blood and gene doping, and drug testing in sport.

Anabolic Steroids

Anabolic - androgenic steroids (AAS) are synthetically produced variants of the naturally occurring male sex hormone testosterone. **Anabolic** refers to muscle- building, and **androgenic** refers to increased male sexual characteristics. **Steroids** refer to the class of drugs. These drugs can be legally prescribed to treat conditions resulting from steroid hormone deficiency, such as delayed puberty, as well as diseases that result in loss of lean muscle mass, such as cancer and AIDS (NIDA INFO FACTS, 2009).

Some people, both athletes and non-athletes, abuse AAS in an attempt to enhance performance and/or improve physical appearance. AAS are taken orally or injected. Lately other methods of delivery have been used, including tablets, nasal sprays, skin patches, and creams. Doses taken by abusers can be 10 to 100 times higher than the doses used for medical conditions (Hoffman *et al.*, 2008).

Teenagers may refer to AAS as pumpers, gym candy, or juice. Trade names for AAS are Dianbol, Anadrol, Deca Durabolin..etc. AAS are often used with nutritional supplements like creatine, multivitamins, and energy drinks, in the belief that those regimes will make the user stronger, more muscular and a better athlete (Hoffman *et al.*, 2008).

However, the use of nutritional supplements has increased dramatically. Components of the various supplements available are

not uniform. A study analyzing several nutritional supplements revealed the presence of AAS (14.8% of 634 products) not mentioned in the labeling. Using supplements can result in positive drug tests for banned substances and unwanted side effects (Geyer *et al.*, 2004).

A significant number of the boys are unaware of the most dangerous risks associated with AAS use. Unfortunately, these young people know that only small percentage of users actually experience a very serious and deadly outcomes and that it will not happen to them. For others, the side effects (except for some effects in women) are largely reversible. In general the doses used by adolescents and other who want to improve their appearance are substantially lower than those used by adult athletes (Lukas, 2009).

In the world of professional weightlifting and body building AAS are used in three basic patterns: **cycling** which refers to a pattern of use in which steroids are taken for periods of weeks or months, after which use is stopped for a period of time and then restarted. In addition, users often combine several different types of steroids in an attempt to maximize their effectiveness, a practice referred to as **stacking**. Another mode of steroid abuse is referred to as **pyramiding**, in which the user increasing the number of steroids or the dose and frequency of one or more steroids used at one time, reaching a peak amount at mid-cycle and gradually tapering the dose toward the end. Steroids used in a cyclical pattern with 6-12 weeks of heavy use followed by periods of between 1 and 12 months, drug-free. During the heavy use period a pyramid system is usually followed where a gradual increase in daily dose reaches a peak and is then reversed (NIDA Research Report Series, 2006).

Steroids are most commonly used by athletes involved in power sports, for example weightlifting, throwing and sprinting events. Field sports such as American Football and Rugby also demonstrate a high incidence of use, as do body building. The perceived benefits of AAS use include: Increased muscle bulk, increased muscle strength, faster

muscle recovery, and reduced muscle catabolism (breakdown of muscle) following intense exercise which aids muscle recovery and development (Not proven as yet).

Side Effects of AAS (NIDA INFO FACTS, 2009).

Steroid abuse can lead to serious, even irreversible health problems. Some of the most dangerous among these include liver damage; jaundice (yellowish pigmentation of skin, tissues, and body fluids); fluid retention; high blood pressure; increases in LDL (bad cholesterol); and decreases in HDL (good cholesterol). Other reported effects include renal failure, severe acne, and trembling. In addition, there are some gender- and age- specific adverse effects:

- For men_shrinking of the testicles, reduced sperm count, infertility, baldness, development of breasts, increased risk for prostate cancer.
- For women_growth of facial hair, male-pattern baldness, changes in or cessation of the menstrual cycle, enlargement of the clitoris, deepened voice.
- For adolescents_stunted growth due to premature skeletal maturation and accelerated puberty changes; risk of not reaching expected height if AAS is taken before the typical adolescent growth spurt.

In addition, people who inject AAS run the added risk of contracting or transmitting HIV/AIDS or hepatitis, which causes serious damage to the liver.

These factors encourage the US Congress to enact the Anabolic Steroids Control Act, which effectively placed all of these compounds, including testosterone and its analogues, in schedule III of the federal Controlled Substances Act. Schedule III includes opioids, stimulants and depressants (Lukas, 2009).

Human Growth Hormone

Human Growth hormone (HGH) is also sometimes known as somatotrophic hormone or somatotrophin. It is produced by the pituitary gland and is essential for normal growth and development. HGH is anabolic, meaning it accelerates protein synthesis and also aids the metabolism (breaking down) of fat stores. Use of HGH has become increasingly popular because it is difficult to detect (Dean, 2002).

Athletes involved in powerful, strength demanding sports and events (weightlifting, body building, American football, etc.) are most likely to use HGH due to its perceived anabolic effects: increase muscle mass by stimulating protein synthesis, decrease fat stores by stimulating the breakdown of fat cells, strengthen bones by stimulating bone growth and accelerated muscle recovery (Dean, 2002; Boyce, 2003).

Many small studies however, have shown no increases in muscle size or strength following injection with HGH. A common practice among body-builders and weight-lifters is to combine HGH and anabolic steroids, with recent research demonstrating beneficial effects (Dean, 2002; Boyce, 2003).

The side-effects of HGH (Myers and Cuneo, 2003) are vast and some serious, which include:

- Gigantism in younger athletes (or pituitary gigantism), refers to abnormally excessive growth in height, considerably above average;
- Acromegaly in adult athletes (a condition where the pituitary gland produces too much HGH), resulting in the growth and swelling of body parts, typically hands, feet, nose but can progress to brow and jaw protrusion and swelling of internal organs;
- Hypothyroidism (low production of the thyroid hormone) which disrupts metabolic rate and protein production;
- Hypercholesterolemia (presence of high levels of cholesterol in the blood);

- Cardiomyopathy (disease of the cardiac muscle), increasing the risk of arrhythmia and sudden cardiac death; cardiac failure and ischemic heart disease (a lack of blood to the heart often due to coronary artery disease) (Myers and Cuneo, 2003; Dhar *et al.*, 2005);
- Myopathies (neuromuscular diseases affecting the function of muscle fibers);
- Menstrual irregularities in women;
- CJB (Creutzfeldt - Jakob disease or mad cow disease). This is only possible when the HGH is maintained from cadaver (corpses) rather than synthetic production, in addition to arthritis; diabetes; impotence and osteoporosis.

Creatine

Creatine is a popular supplement used by athletes and recreational bodybuilders to provide energy to skeletal muscles in short-duration, maximal exercise (Kraemer and Volek, 1999). It is an endogenous substance found mainly in skeletal muscle and is synthesized by the liver from the amino acids glycine, arginine, and methionine (Kraemer and Volek, 1999, McDevitt, 2003). Creatine monohydrate supplements have been found to increase creatine stores in muscles. In the phosphorylated form, creatine serves as a substrate for adenosine triphosphate re-synthesis during intense anaerobic exercise (Kraemer and Volek, 1999; Demant and Rhodes, 1999 and McDevitt, 2003).

This supplement is sold in many forms under such names as Rejuvinix, Cell Tec Hardcore, Muscle Marketing, Femme Advantage, and NOZ (Femandez and Hosey, 2009).

Oral creatine supplementation has become a popular practice among athletes of all ages, although not recommended for those under age 18, surveys on creatine use report that 28% of collegiate athletes use this supplement regularly, and creatine use has been reported by athletes as young as 10 years of age (Metzl *et al.*, 2001).

Typical use of creatine involves a loading period of 20 g/ day for 5 days, followed by a maintenance dose of 2 to 5 g/ day (Juhn and Tranopolsky, 1998).

Reported side effects of creatine include muscle cramps, weight gain, and some minor gastrointestinal upset. No large-scale safety studies have been conducted on the long term effects of chronic creatine supplementation; so long term studies on creatine supplementation are still needed (Fernandez and Hosey, 2009).

Blood Doping

Blood doping is defined by World Anti-Doping Agency as the misuse of techniques and/or substances to increase one's red blood cell count. Most commonly this involves the removal of two units (approximately 2 pints) of the **athlete's blood** several weeks prior to competition. The blood is then frozen until 1-2 days before the competition, when it is thawed and injected back into the athlete. This is known as **autologous** blood doping. **Homologous** doping is the injection of fresh blood, removed from a second person, straight into the athlete. A second method of blood doping involves the use of **artificial oxygen carriers**. Hemoglobin oxygen carriers (HBOC's) and Per-fluorocarbons (PFC's) are chemicals or purified proteins which have the ability to carry oxygen. They have been developed for therapeutic use, but are now being misused as performance enhancers. However, transfusions carry significant risks, such as the contraction of infectious diseases and life-threatening immune reactions (Noakes, 2004).

Tests were introduced in 2002 which are capable of detecting the use of homologous transfusions and the use of artificial oxygen carriers. Although a suitable test has not yet been developed to detect autologous blood doping (Nelson *et al.*, 2002; Nelson *et al.*, 2003; Drexler *et al.*, 2005).

Erythropoietin

Erythropoietin (often shortened to EPO) is a naturally occurring hormone, secreted by the kidneys, that stimulates production of red blood cells (erythropoiesis). It is marketed under the brand names Epogen and Procrit (Fernandez and Hosey, 2009). EPO stimulates bone marrow to produce more red blood cells (RBC) and therefore hemoglobin. For this reason EPO is most commonly used amongst endurance athletes as a higher RBC count means better oxygen transportation and so a higher rate of aerobic respiration. The faster the rate of aerobic respiration, the higher the level at which the athlete can work without utilizing the anaerobic systems which produce lactic acid and cause fatigue (Joyner, 2003; Noakes, 2004).

The use of EPO started in the 1980's as a quicker, cleaner alternative to blood doping. Testing for EPO only became possible in 2000, by using blood and urine samples, prior to this, comparisons to a 'normal level' were used to highlight a possible cheat! (Lippi and Guidi, 2000; Lippi *et al.*, 2005; Mottram and Verroken, 2005).

Adverse effects of using erythropoietin are attributed to increased blood viscosity (thickness) of the blood and thrombotic potential. Pulmonary embolism, stroke, myocardial infarction, and sudden death can occur (Dhar *et al.*, 2005). Cases of death due to severe bradycardia, usually occurring during night, have also been reported (Noakes, 2004). Development of anti-EPO antibodies may also occur, causing paradoxical anemia (Noakes, 2004). Athletes found to use recombinant EPO are banned from competition by sports- governing organizations.

Gene Doping

Several potential scenarios for blood doping have succeeded over the past decades. Nowadays, these effective performance-enhancing techniques have been replaced by gene doping (Lippi and Guidi, 2003; 2004; Unal and Ozer, 2004; Pincock, 2005). Since the early

1990s, experimental and revolutionary gene therapies have become available for the treatment of inherited pathologies and single- gene disorders such as hemophilia and hemoglobinopathies. Unfortunately, these promising therapies may embrace sports medicine and be used to boost or optimize athletic performance. Thus, gene or cell doping is currently defined by the World Anti-Doping Agency as the capacity to enhance athletic performance and had already banned gene doping in 2003 (Unal and Ozer, 2004). On Dec.29, 2006, President Bush signs into law HR 6344, the "Office of National Drug Control Policy Reauthorization Act of 2006", which prohibits the use of gene doping and bans from athletic competition anyone who uses genetic modification for performance enhancement.

Although there is as yet no definite evidence of genetic manipulation in athletes, gene doping is a serious health concern as gene therapy is not safe from side effects, most of which are not predictable and are potentially deleterious. Gene transfection could be ethically justified for the treatment of patients with serious, life-threatening disorders, but it is an unacceptable risk for healthy individuals who seek to enhance athletic performance (Emanuel *et al.*, 2000).

Banned Substances and Methods

The prohibited substances list is a list of all drugs, supplements and other substances and methods which are banned from use in sports. World Anti-Doping Agency is responsible for maintaining and updating this list. Some substances are banned only during competition, while others depend on the method of administration (for example inhalation versus tablet or injection form). The list of prohibited substances is updated annually to keep up with advances in science and technology, with a new list being issued on the 1st of January. A substance is added to the list if it meets two of the three criteria: the potential for enhanced performance; the potential for being detrimental to health and violation of the spirit of sport.

In some cases an athlete may have a pre-existing medical condition which requires them to take medication which is listed. In this case the athlete can apply to their International Federation for a Therapeutic Use Exemption which must be verified by their physician. In order to be accepted, the following must be true: the athlete would suffer significant health problems if they do not take the medication; there is no suitable alternative which is not listed and there are no considerable performance enhancing benefits.

Currently the prohibited list contains 5 classes of substances and 3 methods of doping which are banned at all times and a further 4 substances banned during competition.

Substances Banned at All Times:

- Anabolic steroids including: Tetrahydrogestrinone (THG).
- Hormones including: Erythropoietin (EPO), Human growth hormone (HGH), Insulin like growth factor (ILF-1), Human chorionic gonadotrophin (HCG), and Adrenocorticotrophic hormone (ACTH).
- Beta-2 agonists.
- Hormone antagonists and modulators.
- Diuretics.

Methods Banned at All Times:

- Enhancement of Oxygen Transfer including: Blood doping and artificial oxygen carriers.
- Chemical and Physical Manipulation including: tampering with samples and intravenous infusion: Gene doping.

Substances Banned in Competition:

- Stimulants including: Amphetamines, Ephedra, Cocaine and Caffeine (currently permitted).
- Narcotics.
- Cannabinoids.
- Glucocorticosteroids.

(Australian Sports Anti-Doping Authority (ASADA), 2008; US Anti-Doping Agency (USADA), Dec. 2007).

Drug Testing in Sports

Many athletes who want to increase their athletic prowess take drugs that are prohibited and restricted. The current methods of testing for drugs include: urine tests, blood tests, saliva tests, sweat patch tests, and hair tests. All of the present methods have benefits and limitations. Specific drugs can only be detected over a certain period of time. Knowing this, athletes have developed many sophisticated tricks to avoid detections and positive results.

Nonetheless, drug testing is becoming an increasingly integral part of sports competitions. As new performance-enhancing drugs are developed, new tests are developed to detect these drugs, and the struggle to keep sports clean continues indefinitely.

Drug Tests Used in Sports

I. Drug tests in use as of Dec.22, 2008

Background	Test Type	Test for
1.Liquid Chromatography	Hair	Multiple Illegal Substances
2. Gas Chromatography/ Mass Spectrometry	Urine	Multiple Illegal Substances
3.Testosterone/ Epitestosterone Ratio	Urine	Testosterone
4.Carbon Isotope Ratio	Urine	Testosterone
5.Human Growth Hormone (HGH/rHGH)	Blood	HGH/ rHGH
6.Isoelectric Erythropoietin (EPO)Focusing	Urine	Erythropoietin (EPO)
7. Continuous Erythropoiesis Receptor Activator (CERA)	Blood	CERA EPO

II. Drug tests in development as of Dec.22, 2008

8. Hydroxyprolysis	Urine	Steroids
9. Nanotraps	Urine	HGH/rHGH
10. Selective Androgen Receptor Modulator (SARMs)	Blood	Testosterone Masking Agents
11. Myostatin Inhibitor	Blood	Gene Manipulation
12. Gene Doping	Blood/Tissue/ Urine	Gene Manipulation

(Sources: National Collegiate Athletic Association, 2008; Australian Sports Anti-Doping Authority (ASADA), 2008; US Anti-Doping Agency (USADA), Dec. 2007).

International Convention against Doping in Sport

The Convention represents the first time that governments around the world have agreed to apply the force of international law to anti-doping. This is important because there are specific areas where only governments possess the means to take the fight against doping forward.

The Convention also helps to ensure the effectiveness of the World Anti-Doping Code (WADA, 2009). As the Code is a non-governmental document that applies only to members of sports organizations, the Convention provides the legal framework under which governments can address specific areas of the doping problem that are outside the domain of the sports movement. As such, the Convention helps to formalize global anti-doping rules, policies and guidelines in order to provide an honest and equitable playing environment for all athletes.

There is a degree of flexibility as to how governments can give effect to the Convention, either by way of legislation, regulation, policies or administrative practices. However, signatory governments are required to take specific action to:

- Restrict the availability of prohibited substances or methods to athletes (except for legitimate medical purposes) including measures against trafficking;
- Facilitate doping controls and support national testing programs;
- Withhold financial support from athletes and athlete support personnel who commit an anti-doping rule violation, or from sporting organizations that are not in compliance with the Code;
- Encourage producers and distributors of nutritional - supplements to establish best practice in the labeling, marketing and distribution of products which might contain prohibited substances;
- Support the provision of anti-doping education to athletes and the wider sporting community. (UNESCO, 2011).

Education, Intervention

The use of performance-enhancing drugs compromises the integrity of sport and the health of athletes at all levels. With the ever-increasing commercialization of sports and intervention of high-tech, the issue of anti-doping might become more and more complex. World Anti-Doping Association enforces laws to fight against doping which include drug testing among athletes at several levels; however, due to the blurred concept and unsatisfactory system, a lot of problems stand in the way of anti-doping actions (Shi-yong and Huai-quan, 2008).

Recently, Anti-doping activities in sport have shifted from secondary prevention (intervening after athletes have used) to educational strategies focused on primary prevention through promoting abstinence. There is no empirical evidence to guide targeting of anti-doping education initiatives. Therefore, Mazanov and others re-analyze a series of interviews with athletes, coaches, sports managers, physiotherapists and sports nutritionists. The findings indicate primary prevention of doping may be enhanced by timing it around periods of career instability where athlete vulnerability to doping may increase as a function of winning or losing sponsorship. This provides a basis for targeting education interventions to promote abstinence (Mazanov *et al.*, 2011).

Recommendations

It is important to protect the rights of athletes to compete in doping-free sport. However, delivering this objective requires education, awareness, testing, research and compliance- not just from athletes themselves but also from government, national sporting bodies and athlete support groups. It is also important for young people to know about the harm doping does to both sport and the individual concerned. Developing and implementing comprehensive education programs is an essential component in the prevention of doping behavior among athletes and non-athletes too. So, the study

offers the following recommendations:

- 1-Use of performance-enhancing substances for athletic or other purposes should be strongly discouraged.
- 2-Schools and other sports organizations should be proactive in discouraging the use of performance- enhancing substances, incorporating this message into policy and educational materials for coaches, parents, and athletes.
- 3-Schools and sports clubs should provide ideal learning environments for young people to learn about fair play and teamwork and other positive values associated with sport.
- 4-Interventions for encouraging substance- free competition should be developed that are more positive than punitive, such as programs that teach sound nutrition and training practices along with skills to resist the social pressures (e. g. impact of media, peer pressure and teasing/ comments from parents) to use performance- enhancing substances.
- 5-Health professional should balance the discussion about anabolic androgenic steroids abuse with the straight facts and not try to overstate the degree of harm.
- 6-Educational programs should incorporate performance enhancing- drugs in the lesson plan.
- 7-Inquiries about the use of performance-enhancing substances should be made in a manner similar to inquiries about use tobacco, alcohol, or other substances of abuse.

Finally, you and only you are responsible for what goes into your body.

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استخدام محسنات الأداء البدني في الرياضة

إيناس الجعفرأوى

إن التطور في صناعة العقاقير الطبية للأغراض العلاجية له مردود جيد على الصحة ونوعية الحياة . ولكن إساءة استخدام بعض هذه العقاقير يؤثر سلبا على الصحة و يعرض الإنسان لمخاطر جسيمة . ويعد استخدام محسنات الأداء البدني في غير الأغراض العلاجية من أجل زيادة القدرة ، وقوة الاحتمال ، و الانتباه إلخ ، خير مثال على ذلك .

وقد ازداد الاهتمام عالميا بمشكلة إساءة استخدام هذه النوعية من العقاقير حيث إن استخدامها لم يعد قاصرا على اللاعبين الرياضيين ، بل امتد ليشمل فئات ومراحل عمرية متنوعة من النشء والشباب من غير الرياضيين .

ولذا يهدف هذا المقال إلى عرض الحقائق الكاملة عن استخدام محسنات الأداء البدني في مجال الرياضة ، أو ما تطلق عليه المنظمات الرياضية الدولية ؛ تعاطى المنشطات - Doping . ويقصد هنا بتعاطى المنشطات ؛ قيام لاعب رياضى باستخدام عقاقير أو وسائل محظورة لتحسين نتائج التدريب والأداء في مجال الرياضة .

ويرجع استخدام محسنات الأداء البدني - المنشطات الرياضية - إلى عهد الأغرقيق والرومان حيث قاموا باستخدام بعض النباتات المنشطة كالمشروم ، وأكلوا قلوب وخصى الحيوانات من أجل زيادة القوة وتحسين الكفاءة القتالية . ثم تلى ذلك في أواخر القرن التاسع عشر استخدام الكحول ، وأوراق الكوكا ، والكافيين ، والأفيون . ومع التقدم التكنولوجي في صناعة العقاقير الطبية استخدم الجنود الأمريكيون مادة الأمفيتامينات المنشطة أثناء الحرب العالمية الثانية للبقاء في حالة يقظة ، كما استخدم الألمان الستيرويدات البناءة لزيادة السلوك العنيف .

وقد زاد انتشار هذه العقاقير واشتدت وطأة استخدامها ، وألقت بظلالها على المسابقات والألعاب الأولمبية ، حيث أرجعت وفاة اللاعب الدنماركي "كنت جنسن" في سباق الدراجات بروما عام ١٩٦٠ إلى تعاطى المنشطات ، كما أرجعت وفاة اللاعب الإنجليزي "تومي سيمبسون" في سباق الدراجات بفرنسا عام ١٩٦٧ إلى نفس السبب ؛ مما دفع باللجنة الأولمبية الدولية (IOC) إلى إنشاء لجنة طبية عام ١٩٦٧ لمواجهة استخدام المنشطات في مجال الرياضة ، والتي حظرت استخدام العقاقير المحسنة للأداء البدني . وأعلنت ثلاثة مبادئ أساسية للمنافسة الشريفة وهي :

◊ الحفاظ على صحة اللاعبين الرياضيين ؛

◊ احترام الأخلاق الطبية والرياضية ؛

◊ المساواة في المنافسات الرياضية .

وفى أوليمبياد عام ١٩٦٨ اتخذت اللجنة الأولمبية الدولية أول إجراءاتها لمواجهة تعاطى المنشطات وذلك بإخضاع اللاعبين لاختبارات الكشف عن تعاطى المنشطات . ومع تزايد الاتهامات ضد اللاعبين باستخدام المنشطات فى منتصف التسعينيات تم سحب الميدالية الذهبية من العداء الشهير "بن جونسون" بعد ثبوت تعاطيه المنشطات ، كما أوقف عن اللعب نهائيا بعد ثبوت تعاطيه المنشطات مرة أخرى عام ١٩٩٣ .

ولواجهة تبعات تعاطى المنشطات تم عقد مؤتمر ضم عدد من المنظمات الرياضية الدولية فى سويسرا نتج عنه الإعلان عن إنشاء الوكالة العالمية لمكافحة المنشطات (WADA) عام ١٩٩٩ لمكافحة استخدام المنشطات فى الرياضة ووضع النظم والقواعد لمراقبتها والإشراف على تطوير وتحسين الطرق للكشف عن تعاطيها . وتقوم الوكالة كل عام بإعداد قائمة بالعقاقير المحظور استخدامها فى مجال الرياضة بسبب الأضرار التى يمكن أن تلحقها بصحة اللاعبين الرياضيين وبالروح الرياضية ، وتدرج هذه العقاقير والوسائل ضمن المجموعات التالية :

١ - مواد محظور استخدامها تماما

- أ - الستيرويدات البناءة : يمكن أن تزيد فى حجم العضلات وفى مستوى القوة ؛ ولكنها أيضا يمكن أن تضر بالقلب والكبد و الجهاز التناسلى ، كما يمكن أن تؤدى إلى الموت المفاجئ .
- ب - الهرمونات بجميع أنواعها : لها مجموعة من الأغراض الطبية المفيدة ، ولكنها يمكن أن تكون مؤذية إذا ما كان الشخص صغير السن أو فى طور النمو .
- ج - مدرات البول : يمكن أن تساعد فى انقاص الوزن ، ولكنها يمكن أن تشكل غطاء لاستخدام عقاقير محظورة أخرى ، كما يمكن أن تؤدى إلى الجفاف والشعور بالإعياء .

٢- وسائل وطرق محظور استخدامها تماما

- أ - نقل الدم .
- ب - التنشيط الجينى .

٣- مواد محظور استخدامها أثناء المنافسات

- أ - المنبهات (الأمفيتامينات) : يمكن أن تزيد فى التركيز ، وفى التخفيف من الشعور بالتعب ، ولكنها من الممكن أيضا أن تضر بالقلب .
- ب - قاتلات الألم (المسكنات المخدرة) : يمكن أن تسكن الألم ، ولكنها يمكن أن تؤدى إلى حدوث ضرر دائم (الإدمان) .
- ج - القنبيات (الحشيش و الماريجوانا) : يمكن أن تعمل كمواد مساعدة على الاسترخاء ، ولكنها قد تؤدى أيضا إلى تقليل التنسيق والتركيز ، كما يمكن أن تسبب الإدمان .

ويعتبر دائما تناول مادة ما بصورة عرضية بمثابة تعاطى للمنشطات . كما يجب تجنب تناول أى عقاقير لا يصفها الطبيب الرياضى ، فبعض هذه العقاقير التى يمكن شراؤها من الصيدليات والمتاجر الكبرى يمكن أن تحتوى على مواد محظورة ، حتى وإن كانت العلامة التى يحملها المنتج تذكر أنه طبيعى تماما .

وسنعرض بالتفصيل للعقاقير الأكثر رواجاً وشعبية فى الاستخدام بين الرياضيين لسهولة الحصول عليها ، ولصعوبة الكشف عن تعاطيها لأن معظمها مواد توجد فى الجسم بصورة طبيعية كما ينتشر استخدامها بين النشء والشباب من غير الرياضيين ، ويتم تناولها بكميات كبيرة تفوق كثيرا الجرعات العلاجية ، وهى : الستيرويدات البناءة ، و الهرمونات ، و الكرياتين . ثم سنلقى الضوء بعد ذلك على عمليات نقل الدم والتنشيط الجينى .

الستيرويدات البنائة

من مشتقات هرمون الذكورة الستيروستيرون ، وتعمل على بناء الجسم وزيادة حجم العضلات وبالتالي زيادة القوة البدنية . وقد بدأ استخدامها فى رياضات الجرى ورفع الأثقال وكمال الأجسام وسباقات الدراجات من أجل الحصول على تأثيرها الإيجابى . كما استخدمها الشباب من الفتيان والفتيات من أجل الحصول على شكل أفضل للعضلات والتكوين الجسدى . ويؤدى الاستخدام غير الطبى للستيرويدات إلى العديد من الأعراض الجانبية ومنها : ارتفاع ضغط الدم ، وزيادة معدل الكوليسترول فى الدم مما يؤثر على القلب والأوعية الدموية . وأيضاً ظهور كميات من حب الشباب على الجسم كله ولاسيما منطقة الظهر . وفيما يخص الرجال : ضمور الخصية ، والصلع المبكر وكبر حجم الثدي ؛ وفى السيدات : ظهور عضلات تشبه الرجال ، وشعر كثيف على الجسم ، وغلظة الصوت ، وضمور الثدي . وعندما تستخدم الستيرويدات فى سن المراهقة فإنها تساعد على الالتحام المبكر للعظام وبالتالي توقف النمو . والمشكلة أن كثيراً من هذه الأعراض لا يزول بعد التوقف عن التعاطى ، كما ثبت أنها تسبب الإدمان .

الهرمونات

من أكثرها استخداماً هرمون النمو البشرى الذى تنتجه الغدة النخامية بالجسم ، وهو ضرورى للنمو الطبيعى للجسم حيث يعمل على بناء الجسم ونموه وتقويته . وله شعبية كبيرة بين لاعبي كمال الأجسام ورفع الأثقال فهو يعمل على زيادة حجم العضلات ونموها وتقليل الدهون بالجسم ، كما أنه يسرع بشفاء العضلات . ومن الأعراض الجانبية لاستخدامه :

- ◊ الزيادة غير الطبيعية فى الطول عند المراهقين .
- ◊ يؤدى إلى كبر حجم الأطراف (الكفين ، والقدمين) و الأعضاء الداخلية بالجسم .
- ◊ يؤدى إلى زيادة معدل الكوليسترول فى الدم مما يؤثر على القلب و الأوعية الدموية .
- ◊ يؤدى إلى العقم وإلى اضطراب الدورة الشهرية عند السيدات .
- ◊ يؤدى إلى تليف العضلات وهشاشة العظام والتهاب المفاصل .
- ◊ يؤدى إلى الإصابة بمرض السكر .

الكرياتين

من المكملات المعروفة عند لاعبي كمال الأجسام لأنها تمد العضلات بالطاقة اللازمة لنشاطها ، وهى مادة طبيعية توجد بالعضلات و يقوم الكبد بإنتاجها من الأحماض الأمينية (مكونات البروتين بالجسم) ؛ ويؤدى استخدامه إلى أعراض جانبية منها : زيادة وزن الجسم ، وتقلص بالعضلات ، وبعض المشاكل بالجهاز الهضمى والكلى .

عمليات نقل الدم

تعرف فى الرياضة بأنها إساءة استخدام الطرق والمواد التى تؤدى إلى زيادة عدد كرات الدم الحمراء بالجسم وبالتالي زيادة معدلات الأكسجين بالدم . ويتم نقل الدم إما من الشخص لنفسه وفيها يتم أخذ حوالى ٢ كيس من الدم من الشخص ثم حفظها بالتجميد ، وقبل المسابقة بيومين يتم إعادتهم إلى نفس الشخص مرة أخرى ؛ أو من شخص إلى آخر كما هو متعارف عليه .

كما يتم أيضاً استخدام هرمون الأيريثروبيوتين (EPO) وهو هرمون تفرزه الكلى ، حيث يحث نخاع العظم على إنتاج كرات الدم الحمراء مما يؤدى إلى زيادة عددها وزيادة معدلات الأكسجين بالدم . ويؤدى استخدام الأيريثروبيوتين إلى زيادة كثافة الدم مما يندرج حدوث انسداد فى الأوعية الدموية الرئوية ، و الذبحة الصدرية ، و الجلطات ، والسكتة الدماغية ، وأيضاً الموت المفاجئ .

التشيط الجيني

أصبح العلاج الجيني متاحاً و خاصة للأمراض الوراثية ، ولكن لسوء الحظ فإن النجاح المبشر للعلاج الجيني ممكن أن يغرى العاملون بالطب الرياضى على استخدامه لتعزيز الأداء الرياضى . ولذا قامت الوكالة العالمية لمكافحة المنشطات بوضعه على قوائم المحظورات ، على الرغم من عدم حدوث أى تلاعب جينى ، وذلك تحسباً للمستقبل .

اختبارات الكشف عن تعاطى المنشطات فى الرياضة

قد أصبح إجراء اختبارات الكشف عن تعاطى المنشطات جزءاً لا يتجزأ من المنافسات الرياضية ، ويمكن أن يجرى الاختبار أثناء مسابقة أو خلال التدريب أو خارج إطار المسابقات ، ويجرى من دون إخطار مسبق، ومن يرفض الخضوع للاختبار يتلقى نفس العقوبة التى يحكم بها على اللاعب الذى يكون اختباره إيجابياً .

ويتولى إجراء هذه الاختبارات مسئول معتمد لمراقبة تعاطى المنشطات . يقوم بأخذ عينة من البول وفى بعض الأحيان يتم أخذ عينة دم وكذلك عينة بول ، وترسل العينات إلى مختبر معتمد لتحليلها . ويمكن الكشف عن بعض العقاقير التى يكون قد تم تناولها ، ويمكن إقامة الدليل على استخدام بعض العقاقير الأخرى نظراً للتغيرات التى تحدثها داخل الجسم . وطوال الوقت تجرى البحوث لتحسين وسائل وتقنيات الكشف عن تعاطى المنشطات ، واستحداث تقنيات جديدة للكشف عن كل ما يستحدث من عقاقير .

البرامج التعليمية و الوقائية

إن تعاطى المنشطات يعرض الرياضة كما يعرض صحة اللاعبين للخطر ، فمع توالى استحداث عقاقير ووسائل جديدة واستخدامها للغش فى مجال الرياضة ، كان من الضرورى الحفاظ على منافسة شريفة ، وحماية حق المتسابقين فى لعب نظيف خالى من الغش . لهذا لزم التدخل ببرامج تعليمية وقائية لحماية اللاعبين من الخيارات الخاطئة : والعمل على توعية وتثقيف النشء والشباب من مخاطر استخدام مثل هذه الوسائل على الصحة والأخلاقيات . **وفى هذا الصدد تقدم الدراسة التوصيات التالية :**

- 1- عدم تشجيع استخدام المنشطات لأغراض الرياضة أو لأغراض أخرى غير العلاجية .
 - 2- أن تكون المدارس و المنظمات الرياضية حازمة فى عدم تشجيع استخدام المنشطات وذلك عن طريق وضع سياسة واضحة للمدربين والآباء و الرياضيين .
 - 3- أن تعمل المدارس والنوادر الرياضية على تهيئة أجواء تعليمية للنشء لتعلمهم التحلى بالسلوك السليم والالتزام ، والعمل الجماعى ، واللعب النظيف ، والروح الرياضية ، والقيم الإيجابية فى الرياضة .
 - 4- التدخل لخلق بيئة نظيفة من تعاطى المنشطات وذلك عن طريق برامج لتعليم طرق التغذية الصحيحة ، والتدريب السليم مع تنمية مهارات مواجهة الضغوط المجتمعية ، ووسائل الإعلام ، وضغط الأقران ، ومضايقات المدربين والآباء التى تدفع إلى استخدام المنشطات .
 - 5- أن يقوم الأطباء والمسئولين عن الصحة بتوضيح الحقائق الكاملة عن تعاطى المنشطات وخاصة الستيرويدات البناءة ، لانتشار استخدامها بين جميع الفئات ، الفوائد والمخاطر على حد سواء .
 - 6- ضرورة إدراج دروس تعليمية بالمناهج الدراسية للتعريف بمخاطر تعاطى المنشطات .
 - 7- يجب التعامل مع تعاطى المنشطات بالطريقة ذاتها التى يتم التعامل بها مع تدخين السجائر، وشرب الكحوليات ، والمواد الإدمانية الأخرى .
- و أخيراً ، على الإنسان أن يدرك أنه وحده هو المسئول عن كل ما يدخل إلى جسمه .