

DOPING AND PERFORMANCE-ENHANCING AIDS IN SPORTS: A MEDICAL POINT OF VIEW*

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ABSTRACT

According to current rules of the International Olympic Committee (IOC), doping is defined as “the use of an expedient (substance or method) which is potentially harmful to athletes’ health and capable of enhancing their performance, or the presence in the athlete’s body of a prohibited substance or evidence of the use thereof, or evidence of the use of a prohibited method.” From a medical point of view there are nutritional, pharmacological and physiological performance-enhancing aids. Among them there are some prohibited substances and methods as well as some legal ones. Before using performance-enhancing aids one has to answer several questions: Are they **safe** for health? Are they **effective** and **legal** in a particular sport discipline?, Is their use **ethical**? And, most of all, are there any **indications** for using them from a medical point of view?

Key words: doping, ergogenic aids, safety, effectiveness, legality, ethics, indications

Usage of expedients that can enhance athletes’ physical and psychical condition, and as a result boost their performance in non-natural way, has become a very serious problem in present-day sport.

What convinces athletes that it is necessary to use performance-enhancing aids in order to obtain a competitive edge? As we all know, human aspiration for improving one’s own physical efficiency is as old as mankind and is connected not only with sport. It has become a social problem nowadays. For example, youths who are not athletes strengthen themselves in uncontrolled ways. Some of them want to have big muscles and be strong, so they use anabolic-androgenic steroids and readily available over-the-counter steroid pre-

cursors. Youth also make use of other drugs in order to forget about reality for a moment. Adults attempt to cope with the stresses of the present world or to prevent the ageing process by use of revitalization drugs and dietary supplements.

Doping, or use of performance-enhancing substances in sport has a very long history. There are numerous reports informing us that ancient Olympic athletes used various stimulating substances. The word “dope” appeared in the English dictionary in 1889 for the first time. It meant the opium mixture used in horse racing. However the word “dope” does not appear to be of English origin. It may come from the dialect of the Kaffir tribe that lived in southeast Africa. “Dop” referred to a liquid

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drug that was used in religious celebrations. Later on all stimulating drinks were called “dop”. “Doping” may also be derived from the Netherlands’ word “doop” that referred to a liquid brew mixture of herbs and roots enriched with gunpowder. The usage of “doop” was called “dooping” and the word “doop” became understood as a stuporous poison. The word “dop” (short version of doop) appeared in common language and in the 20th century was changed into “doping”. It referred to athletes that used different expedients to enhance their physical and mental condition.

Doping and performance-enhancing aids

The variety of doping expedients and methods used by athletes, the intensive development of modern sport, and the progress of medical science lead to “understanding mess” and “misinformation commotion” two expressions often used alternately concerning doping and performance-enhancing substances (8). Exactly stating what doping is and what the performance-enhancing aids are is nowadays quite complicated (8). What is more, those two expressions are often used alternately.

There have been many proposals connected with doping classification during recent years. One of them has divided doping into two categories: long-term doping (anabolic-androgenic steroids) and short-term doping (stimulating substances). The other has separated doping into “positive”, which can be faked, and “negative” sometimes called “anti-doping”. We can also distinguish mixed or combined doping, which is the connection of pharmacological and psychological doping. Stimulating substances have been divided into “exogenous” and “endogenic”. Traditionally substances used in sport are divided into stimulating poisons (typical doping substances), medicines (legal only under medical

control), and general sports preparations (legal under no circumstances) (6, 16).

One of the ways of ordering “misinformation commotion” was to simplify existing definitions and classifications. The classical definition of doping, according to International Olympic Committee (IOC) says: “it is the use of an expedient (substance or method) which is potentially harmful to athletes’ health and capable of enhancing their performance, or the presence in the athlete’s body of a prohibited substance or evidence of the use therefore, or evidence of the use of a prohibited method.” However, it turned out that this definition is simplified and does not correspond with reality. The sports world is not ethical and does not reflect the Greek idea *“do as good as you can using what you have”* (6, 20). Moreover, currently some medicines, substances, and manipulations that go beyond that classical definition are being used. For example dehydrating medicines do not enhance physical skills, so according to the definition they should not be treated as a doping. Of course you can theorize that a lighter (dehydrated) person will jump higher (it would be easier for him to bring his center of gravity higher) assuming that one won’t lose his power after dehydrating. The matter of using desiccants is to lower the body weight but it is strictly connected with health damage. Body builders explain that water loss is making their muscle sculpture more defined. Usually those excuses are the method to divert attention from the real purpose of using diuretics, which is to rinse away performance-enhancing aids from one’s organism (20).

According to current rules of (IOC) doping is defined as:

1. the use of an expedient (substance or method) which is potentially harmful to athletes’ health and capable of enhancing their performance
2. the presence in the athlete’s body of a

prohibited substances or the evidence of their usage, or the evidence of practicing prohibited method.

There is also a list of prohibited substances and methods, which is a complement for this definition. The list is constantly renewed and completed with new elements. The conclusion from the definition is clear – the most important issue that decides inclusion of the substance on the list is the athletes' safety. The fact that needs to be stressed is that the usage of pharmacological substances and doping methods are harmful for health and life threatening.

Forbidden pharmacological substances

Below are listed some examples of side effects associated with specific substances in various categories.

A. *Simulating aids*: CAFFEINE causes motion anxiety, sleeplessness, irritability, heart-rate disorders, heart-rate acceleration, and coma.

B. *Narcotic pain-relief substances*: MORPHINE causes stupor and coma, decreased concentration (single-mindedness) and physical activity, and respiratory depression which may result in death.

C. *Anabolic substances*: ANABOLIC-ANDROGENIC STEROIDS cause negative influences on the skeletal system, muscle system, skin, water and electrolyte equilibrium, fat metabolism, cardiovascular system, liver, kidneys, and prostate. They also cause dyspeptic and allergic symptoms and disorders in maturation and changes in the reproductive system diversified according to the age and sex.

D. *Diuretics*: FUROSEMIDUM causes hyponatraemia, hypokalaemia, hypomagnesaemia, sudden blood-pressure decrease, heart-rate disorders, headaches and dizziness.

E. *Peptide and glycoprotein hormones*: GROWTH HORMONE causes gigan-

tism, acromegaly, hepatosplenomegaly, diabetes, hyperthyreosis, hypertension, and neurological and osteoarticular changes. ERYTHROPOIETIN induces blood concentration, increases blood stickiness, aggravates its rheological ability, and may lead to thrombus and heart infarction.

Forbidden methods (8, 15, 16, 17, 20)

Blood doping: may sometimes effect allergic reactions, infectious diseases, overwork of circulatory system, gas embolism, and metabolic shock.

Pharmacological (physical or chemical) methods: HES (hydroxyethyl starch) - the increasing of plasma volume give rise to overwork (surcharge) of cardiovascular system.

Categories of substances being under some restriction

A. *Alcohol*: overuse leads to addiction; forbidden in disciplines in which rules restrict it.

B. *Cannabinoids*: forbidden in disciplines in which rules restrict it. MARIHUANA is treated as a delusive (illusory) enhancing substance, causes addiction, may result in toxicological psychosis.

C. *Local anesthetics*: most of them may be used as local injections and in-joints injections except COCAINE.

D. *Glucocorticosteroids*: may be used topically but when administrated orally, rectally, intravascularly, or intramuscularly are prohibited without exception.

E. *Beta-blockers*: prohibited in disciplines in which rules restrict it. PROPRANOLOL causes bradycardia and may lead to heart block and spastic states of the bronchial pathways.

The new look at enhancing

There is an interesting proposal of ordering "misinformation commotion" by Williams. He distinguished - from medical

point of view – only nutritional, pharmacological and physiological enhancing substances (sometimes called ergogenic aids). These are *“the substances that are initiated in order to increase physical strength, mechanical capability, improve psychological resistance by affecting one or more of the processes influencing development of the above listed characteristics”* (20).

Carbohydrates, fats, vitamins, mineral substances and water are included among nutritional enhancing substances. Nutritional enhancing aim is to build the mass of muscle tissue, provide muscle energetic substrate and accelerate energy production. Many of these substances are designed to increase physical strength. Some of them may be helpful to improve mechanical efficiency or to heighten the psychical resistance.

Pharmacological enhancing substances are the agents, which have effects similar to hormones and neurotransmitters in human body. They can heighten mechanical power by influencing metabolism, improve physiological processes engaged in energy production, and increase psychological resistance (20).

Physiological enhancing aids are the substances or techniques whose main role is to intensify the tempo of natural physiological processes generating physical strength (20).

Among nutritional, pharmacological and physiological enhancing aids are to be found some doping agents. It has to be stressed that most of performance-enhancing substances (according to Williams) used to elevate strength have been enumerated by IOC on the list of prohibited substances and methods (15, 20).

Criteria for selecting enhancing aids

From a sports and medical point of view we should think about the effectiveness of legal enhancing substances. In practice effectiveness should be estimated according

to the results arising from scientific researches obeying recommended methodological requirements. Those requirements are:

- reason for using the substance
- subject of the research
- proper experimental methods
- well conducted pilot research
- properly selected group randomly assigned to experimental and placebo groups and use of a double-blind protocol
- proper control of environmental factors and well prepared statistics.

The best sources of information are review articles and meta-analyses by outstanding researchers published in reputable, peer-reviewed journals, not single experiments, which can often be incompatible (3, 20).

In the final decision to use legal enhancing aids, the athlete's health and the reason for using the aids have to be taken into account. One has to remember that **every substance affecting the living organism can be toxic if used in excess**, regardless of use for medical, social or enhancing reasons. Aids that are used are not always properly tested regarding toxic reactions, especially overuse by individuals who are in extreme environmental conditions. Though all people are anatomically and physiologically similar every human being possesses individual biological characteristics derived from inherited differences and environmental influences. That is the reason why the reactions after using various substances may be so varied. Reactions may be even opposite to the intended, and in some cases may be harmful.

Another problem is a positive test result for the presence of prohibited substances in the body after using nutritional supplements containing substances such as ephedrine, pseudoephedrine, strychnine, caffeine or dehydroepiandrosterone and other prohormones.

Some nutritional supplements may heighten the proportion of testosterone compared to epitestosterone or lead to a positive test for nandrolon metabolites. Attention should be paid to many supplements marketed to athletes, such as guarana, Ma Huang or other multiple “anabolic nutrients” and plant prohormones, which when metabolized can change into metabolites of prohibited substances. Moreover an analysis of 16 commercial substances DHEA revealed that only in half of them was the composition compatible with declared contents. The composition of the others was very different from that defined on the package (1, 20).

When one decides to use any kind of performance-enhancing substance, he should take all these remarks into consideration. The reliability of some companies and nutritional products are suspect, particularly regarding the purification level of components and quality control. That is why the safest products are controlled by a Medicine Committee (or Drug Commission) and registered by it as medicines.

Brief overview of legal enhancing aids

The most common substances used by athletes are: sodium bicarbonate, creatine, carnitine, HMB, vitamins, minerals, and caffeine in proper amounts. Some of those substances seem to be effective and relatively safe.

Sodium bicarbonate (12, 14, 20)

- *effectiveness*: causes an increase in systemic buffering capacity, helpful in removing hydrogen ions, delays the appearance of fatigue
- *safety of usage*: relatively safe in recommended amounts
- *sports and physicians comments*: proposed to athletes carrying out repeated intensive efforts lasting 45 seconds to 6 minutes.

Creatine (4, 7, 1, 12, 18, 20)

- *effectiveness*: may be useful in improving processes connected with ATP-CP energetic system. It is suggested that it works as a buffer in muscles and decreases the level of lactic acid in their structure. Lately conducted meta-analysis does not confirm its efficiency.
- *safety of usage*: the newest facts in this topic are alarming – it increases muscles cramping and the risk of liver and kidney damages. It may be harmful for athletes’ of endurance disciplines leading to a predisposition to hot-related illness.
- *sports and physicians comments*: usage may be recommended in very short-term efforts in some sport disciplines.

Carnitine (4, 12, 20)

- *effectiveness*: theoretically it should save glycogen, but it is not yet proven
- *safety of usage*: seems to be safe
- *sports and physicians comments*: is not recommended because of its doubtful capability

HMB (12, 20)

- *effectiveness*: may built up muscles mass and stops their collapse after effort
- *safety of usage*: seems to be safe (till now)
- *sports and physicians comments*: can be taken to increase body mass and muscles strength control.

Vitamins (2, 4, 5, 9, 10, 16, 20)

- *effectiveness*: according to scientific studies usage of vitamins does not heighten endurance abilities in majority of athletes
- *safety of usage*: if taken strictly as recommended appear to be safe. Some vitamins when overdosed can be harmful for health
- *sports and physicians comments*: their

usage is reasoned with athletes who: consume a limited diet, train in sport disciplines in which body mass control is needed and are vegetarians. Some vitamins may be applied for prevention of oxidant stress.

NaCl supplementation (16, 19)

- *effectiveness*: boost physical performance
- *safety of usage*: may be in conflict with hypertension prevention
- *sports and physicians comments*: limited supplementation time.

Plant extracts (1, 20, 21)

- *effectiveness*: suggested skepticism towards questionable “innovations”
- *safety of usage and sports and physicians comments*: only those whose safety has been tested in training conditions substances should be used.

Caffeine (1, 16, 20)

- *effectiveness*: improves psychological processes, used in proper amounts should upgrade metabolic processes which can enhance lipid utilization; caffeine application is advised in endurance disciplines in order to save glycogen
- *safety of usage*: fairly safe for healthy people, overuse leads to addiction to caffeine with side effects
- *sports and physicians comments*: its usage is controversial and lowering of permitted amounts has been recommended by some scientists.

As the above list shows, the usage of legal enhancing aids by athletes is based on the effectiveness of the aid. However, although the usage of some substances is legal (because they aren't on the list of prohibited substances), their use may be in contradiction with the classical definition of doping and fair play rules.

Physicians recommendations towards use of permissible aids should be based on reasonable enhancement connected with individual needs. There are two questionable opinions regarding this subject. One is the statement of nutritionists, who believe that a properly composed diet is able to assure the organism all necessary nutrients. Others think that the increased effort of sport requires multiple supplementation (before, during and after the stress) in order to help maintain the individual's homeostasis (2, 9, 10, 11, 16, 20, 22).

The most important thing is to protect the health and safety of the athlete. That is why both opinions should be taken into consideration. Nutrition and hydration have an essential role for endurance abilities. A special training diet determines the individual's strain ability. Physicians' suggestions for reasonable enhancement with vitamins, macro- and microelements or energetic substances should be individualized in relation to one's state of health, potency, trained sport discipline, charge of training, training cycles and the season of the year (2, 16, 22).

Attention should be paid to proposals that may decrease the amount of positive doping test results. Trainers, athletes, co-operating scientists and physicians should be educated in that matter. All products used by athletes should be of high quality, come from well-known producers and have proper information about its consistency. It has to be reiterated that optimization of the training process is the best way to provide a performance edge. Training is all about increasing physical power, biomechanical efficiency and physical resistance. Unfortunately many athletes connect the ability to improve sports efficiency with the usage of doping, which in their opinion can replace proper training. That is why attempts of trying different ways of boosting the above listed characteristics of

physical efficiency constantly meet with success. We think that acquainting athletes, coaches, physicians and all people engaged in training processes with the fact of present opinion about performance-enhancing substances is essential in order to avoid health loss and unnecessary accidents, to shatter illusory hopes of coaches, and to refute myths about “mysterious aids”.

To sum up, it must be said that from a sports and medical point of view we distinguish prohibited and legal enhancement substances. The legal one is not about its capability, but most of all about its medical reason. Before applying any kind of enhancing aid the athlete has to ask himself some questions about it: if it is effective, safe, legal and ethical, and above all ask his physician if its usage is recommended from a medical point of view.

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