

## ORIGINAL SCIENTIFIC PAPER

# Sport, Drugs and Health promotion: Pharmacological and Epidemiological aspects

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## Abstract

Sport activity, must be directed to the promotion of individual and collective health. Thus, there is no doubt that drugs and pharmacological nutriment have been used by sportsmen and women to improve his physical performance. Doping is defined as "use of substances or adoption of medical practices not justified by pathological conditions, aimed at improving competitive performance". It occurs not only in professional sport, but also affects amateur athletes. The effects of the abuse of add-on substances or the intake of substances that alter the outcome of the competition are in the educational interest of the school and it is a problem concerning not only sports ethics, but also public health. Over time, doping has shown a great ability to discover and always use new substances and appropriated the new scientific discoveries. Unfortunately, new discoveries for the human health are been used in distorted way by the athletes. In fact, the athletes may be able to use gene therapy to re-engineer their bodies for better performances. Drugs dependence depends on several factors: the socio-environmental context of the subject and what effects have the substance in the body. The purpose of the study was to reviewed the use of performance-enhancing drugs in sport in relating to the protection of the health of athletes. We focus our analysis on pharmacological and epidemiological issue.

**Key words:** *drugs, sport, ergogenic aids, health, prevention*

## Introduction

Doping in sport is defined as "the administration to sportsmen or sportswomen, or the use by them, of pharmacological classes of agents or methods doping" (Mazzeo et al., 2016; Mazzeo et al., 2018a). Today the intake illicit and potentially harmful substances in the sporting practice is an important problem for the public health, given the considerable spread of the phenomenon. The current prevalence estimates are inaccurate, since the survey tools used reveal statistical power limited (Valkenburg, de Hon, & van Hilvoorde 2014; Stubbe, Chorus, Frank, de Hon, & van der Heijden, 2014). Nevertheless, the emerging scenario reflects a disturbing underestimation by national organizations. For limited resources, prevention and the fight against doping must presuppose rational strategies,

with the aim to identify suitable contests and accurate procedures, considering carefully ethical issues that may arise from the positivity of the athletes to antidoping controls (Mazzeo et al., 2018a). There are a variety of pharmacological substance and nutriment which are commonly used in sport medicine in competition (Mazzeo, 2016). These are usually used to manage pain or in an attempt to reduce inflammation (Schenone et al., 2003; Motola et al., 2001). Elite athletes may be subject to drug testing. Athletes has always tried to improve his physical performance by any method: legal or illegal, healthy or harmful to health (Sjöqvist, Garle, & Rane, 2008; Mazzeo, 2018). The reasons of these attempts are various and they are changed over time: from to get best results in the hunting to obtain profit. In fact, best performances mean, great earnings (Lippi, Longo, & Maffulli, 2009). Scientific research has also recently



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demonstrated the addictive effects of some doping agents such as anabolic steroids, together with typical drugs of abuse (e.g. stimulants, narcotics) in the past present in the list of prohibited doping substances (Mazzeo & Raiola, 2018; Mazzeo, 2018; Marcellay, Mangin, Margot, & Saugy, 2013).

In elite athletes, it involves the repeated and excessive use of substances to realize a certain effect. Furthermore, the desire to enhance their physical abilities did not even spare the disabled athletes (Mazzeo, Santamaria, & Iavarone, 2015; Montesano, Tafari, Mazzeo, 2013).

In our times, in the search for substances able to make it stronger than others, the athlete was matched and complicity in different professionals: coaches, managers, doctors and pharmacists, nutritionist, equally interested in increasing their power, in a common and economic perspective. In the last quarter of the twentieth century, the use of doping in sport activities has become considerable and organized (Mazzeo et al., 2015). With the advent of sponsors and mass media, the success in major sports competitions (Olympics, World Championships, and so on) has been playing an increasingly significant social and economic goal, such as to encourage the use of all means, legal and illegal to catch up (Esseiva et al., 2007). It seriously affects the image of the industry and represents a serious threat to individual health (Mazzeo et al., 2016). Unfortunately, in the past and for a long time, doping was underestimated and public institutions considered it as a problem exclusively of sports organizations that alone had to vanquish a phenomenon in continuous expansion (Møller & Dimeo, 2014).

### Pharmacological issues

The misuse and abuse of pharmacologically active substances have become so widespread in present day sports that the safety and the health of far too many athletes are now compromised (Mazzeo et al., 2013). Ergogenic aids are substances used by athletes to increase athletic performance in the face of physical and emotional challenges in a sports competition.

Botrè (2008) distinguishes three main periods about the evolution of substances to identify. The first one – the early age – includes “in competition drugs”; the second period – the andro-

genic anabolic steroids age – includes “in and out competition drugs”. The third age - protein chemistry and molecular biology age- includes the newly discovered in genetic engineering used for the treatment of diseases too. Now, in the “gene doping age”, the new frontier of doping is the use of cells, genes, genetic elements, or the modulation of gene expression with the aim to increase the performance and not easy to detect (Botrè, 2008; Mazzeo & Volpe, 2016). This last period includes the blood doping. Indeed, the blood transfusion and administration can boost the capacity to transport the oxygen to the muscles.

Already in the early 1900s it was realized that the use of substances to increase physical performance, not only falsified the results of competitive sport but it was also very dangerous for the health (Mazzeo, 2016). For this reason, in 1928 the International Association of Athletics Federations became the first International Sport Federation (IF) to ban the use of stimulating substances. Only after the death of a cyclist at the Olympic Games in Rome in 1960 urged the relevant authorities to introduce the first anti-doping test (Mazzeo et al., 2018a).

After eight years, during the Olympic Games of Mexico City, there was a pilot project with the aim to analyze the efficacy of anti-doping tests and thanks to their success, the first official anti-doping screening started in 1972 during the Summer Olympic Games of Munich (Botrè, 2008). At beginning, the tests were sporadic and not completely reliable. But in 1999, thanks to the creation of the World Anti-Doping Agency (WADA), it finally created an organization with the sole purpose to fight this “cancer” of sport and consequently the situation of tests is changed (Dvorak et al., 2014; Valkenburg et al., 2014). One of most important WADA function was to harmonize the Olympic anti-doping code and develop a single and complete code applicable and acceptable for all the stakeholders. The world anti-doping code developed by WADA introduced several international standards (ISs) with the main goal to harmonize the anti-doping disciplines from each country (Mazzeo et al., 2016). The Agency has compiled a list of banned substances and practices that is constantly updated. Now, WADA, for example, has identified more than two hundred banned substances currently divided into 10 classes (including the class S0) and three methods (Table 1).

**Table 1.** Wada 2018 Prohibited List

<b>Substances and methods prohibited (in and out competition)</b>
S1 Anabolic agents
S2 Peptide hormones, growth factors, related substances and mimetics
S3 Beta- 2 agonists
S4 Hormone and metabolic modulators
S5 Diuretics and masking agents
M1 Manipulation of blood and blood components
M2 Chemical and physical manipulation
M3 Gene doping
<b>Substances and methods prohibited in competition</b>
<i>In addition to the categories S1 to S5 and M1 to M3,</i>
S6 Stimulants
S7 Narcotics
S8 Cannabinoids
S9 Glucocorticosteroids
<b>Substances prohibited in particular sport</b>
P1 Alcohol
P2 Beta-blockers

Athletes are generally in optimal physical condition. However, some athletes may have long- or short-term conditions, such as asthma and sports injuries, that require medi-

cal intervention. Drug treatment for any of these conditions requires vigilance in relation to athletes (Table 2).

**Table 2.** Medical Condition for which athletes may require drug treatment and drugs that are in WADA Prohibited List regulations

Common Medical condition	Drug classes commonly used
Asthma	Beta-2 agonists Glucocorticosteroids
Diabetes Mellitus (Type1)	Insulin
Hypertension	Diuretics Beta-blockers
Viral cough and cold	Decongestant stimulants
Musculo-skeletal damage and inflammation	Narcotic analgesics Glucocorticosteroids

The list presented below includes the main substances or classes of substances that cause well documented side effects on the human organism. Moreover, these substances are more and more used by athletes not only in competitive sports, but also in fitness and recreational sports. It is important to ask why athletes dope (Stella et al., 2005). One thing is certain the substances that give pleasant sensations or help the subject in his activity will bring him to repeat the consumption. But, not all people develop drug dependence. It depends on several factors: the socio-environmental context of the subject and what effects have the substance in the body. The knowledge about certain Performance-enhancing effects of substance used by athletes is still very fragmentary and we have omitted them from our compilation. Moreo-

ver, besides the substances listed here, there are many other pharmacologically active compounds or medical drugs that also have specific side effects (Mazzeo, 2016). The motivation for drug abuse, the choice of substance and the prototype of use are sensitive to historical, sociocultural and psychological variables. The most common use in relation to sport activities are: restorative drugs or substances; additive drugs or substances; recreational drugs or substances (Morente-Sánchez & Zabala, 2013). Numerous research studies have suggested that attitudes toward doping and actual doping abuse are principally influenced by sports motivation; i.e., the subjective reasons underlying why athletes participate in sports affect the decision to use drugs. Athlete's Doping Objectives are different and diverse for sport (Table 3).

**Table 3.** Athlete's Doping Objectives. The substances prescribed for treating specific medical conditions are used in manners that are contrary to conventional clinical practice

#### Objectives

Aid workout/injury recovery  
Alter intensity and aggression  
Sharpen focus and concentration  
Combat exhaustion and fatigue  
Reduce weight/body fat  
Relieve aches and pains  
Increase muscle mass/oxygenation  
Increase strength and endurance

Moreover, many substances have various gratifications' effects, such as stimulants, anabolic, narcotics and cannabinoids. Stimulants are used to increase the concentration, alertness and safety. They also increase the aggressiveness and the sense of competitiveness (Stella et al., 2005). Anabolic are recognized for the following effects: euphoria, sense of wellbeing, glee, increased motivation and self-esteem. Moreover, the athlete doesn't get bored during the training (Mazzeo, 2018). Cannabinoids, such as cannabis, hashish and marijuana, cause changes in mood and perception, euphoria, happiness, relaxation and deep sleep and reducing anxiety. They are considered drugs to use social-recreational increased sociability and sense of wellbeing (Stella et al., 2005).

The last doping's method is the use of genes. Gene therapy may be defined as the transfer of genetic material to human cells for the treatment or prevention of a disease or disorders (Doessing & Kjaer, 2005). Its principle is based on the delivery to a cell, of a therapeutic gene which may compensate an absent or abnormal gene (Mazzeo & Volpe, 2016). Gene therapy is currently an experimental therapy

and its use is strictly regulated (Beerens et al., 2003).

Unfortunately these new important discoveries for the human health are being used in a distorted way by the athletes. In fact, the athletes may be able to use gene therapy to re-engineer their bodies for better performances (Oliveira, T.F. Collares, Smith, T.V. Collares, & Seixas, 2011). Gene doping is defined, for the first time in the 2003, in the IOC List of Prohibited Substances and Methods, as the "Gene or cell doping is defined as the non-therapeutic use of genes, genetic elements and /or cells that have the capacity to enhance athletic performance" (World Anti-Doping Agency, 2010; Zhang, Chen, Meng, & Chen 2008). Now, in the 2013 WADA Prohibited List, gene doping, is "the transfer of polymers or nucleic acid analogues" and "the use of normal or genetically modified cells" (World Anti-Doping Agency, 2013).

Doessing and Kjaer (2005) also suggest a role for GH as an anabolic agent in connective tissue in human skeletal muscle and tendon. Recombinant GH, is already being used as a doping agent in sports. Insulin-like growth factor 1 is a protein that stimulates cellular proliferation, somatic growth and differentiation (Doessing & Kjaer, 2005).

The Biological Passport is a tool for indirect detection of the presence of a doping substance in biological samples of an athlete (Mazzeo & Volpe 2016). With it, in fact, the changes of certain bio-markers of doping are recorded and monitored. If the data, combined with the personal data localization in a given period, exceeded a certain range, the athlete would assume the banned substances (WADA, 2015). The Anti-Doping Administration and Management System (ADAMS) is an on-line database system where are recorded all data: laboratory results, therapeutic use exemptions (TUEs) and information on anti-doping rule violations. It allows the sharing of information amongst the organizations and promotes efficiency, transparency and effectiveness in all anti-doping activities (Møller et al., 2014).

Moreover, the use of some performance-enhancing drugs, for some banned drugs do have potentially serious adverse side effects if used in long periods and high doses. Many studies have been carried out on the health effects of anabolic steroid use, erythropoietin (EPO) and others.

The importance of the right to the health is also underlined by the fact that it cannot be undermined by individuals and by public authorities or by other private entities. This right does not mean only to take care of illness but it also means ensuring better living and working conditions. Today's approach to anti-doping is mostly centered on the judicial process, despite pursuing a further goal in the detection, reduction, solving and/or prevention of doping (WADA, 2009).

### Epidemiological data

The 2017 Report summarizes the results of all the samples WADA-accredited laboratories analyzed and reported into WADA's Anti-Doping Administration and Management System (ADAMS) in 2017. The 2017 Report – which includes this Executive Summary and sub-reports by Laboratory, Sport, Testing Authority (TA) and Athlete Biological Passport (ABP) Blood Analysis – includes in- and out-of-competition urine samples; blood and ABP blood data; and, the resulting Adverse Analytical Findings (AAFs) and Atypical Findings (ATFs).

#### Report Highlights

- A 7.1% increase in the overall number of samples analyzed: 300,565 in 2016 to 322,050 in 2017.
- A decrease in the number of AAFs: 1.60% in 2016 (4,822 AAFs from 300,565 samples) to 1.43% in 2017 (4,596 AAFs from 322,050 samples). This is primarily due to the significant decrease in the reported cases of meldonium.
- About 80% of WADA-accredited laboratories saw an increase in the total number of samples.
- A relative increase in the overall number of (non-ABP) blood samples analyzed: 7.75% in 2016 (23,298 of 300,565) to 8.62% in 2017 (27,759 of 322,050).
- An increase of 3% in the number of ABP samples tested: 28,173 in 2016 to 29,130 in 2017.

In Italy, the REPORTING SYSTEM - DOPING ANTIDOPING 2017, published by the Ministry of Health, carries out the control activity by collecting data through an integrated information system and processes them in collaboration with Istituto Superiore di Sanità.

In 2017, 287 sporting events were scheduled: 89.5% (257 events) were regularly held, while 30 demonstrations were not completed (10.5%). The controls concerned the events of the National Sports Federations, the Associate Sports Disciplines and the Sports Promotion Agencies.

1,211 athletes were subjected to doping control, 821 males (67.8%) and 390 females (32.2%). The average age of the population under doping control is 27.7 years (28.6 males and 25.7 females).

Of 1,211 athletes tested, 30 tested positive for doping (2.5%) with a substantial gender difference (4 females and 26 males). The gender difference emerges (even if not statistically significant) also as regards the average age of athletes positive results: 35 years for men and 31.8 for women.

The highest percentage of active substances detected in doping controls belongs to:

- anabolic agents (48.3%)
- stimulants (17.2%)
- corticosteroids (8.6%)
- diuretics and masking agents (8.6%).

The most controlled events concerned events related to cycling (17.9%), calcium (17.1%) and light athletics (13.6%).

Crossfit and Powerlifting, disciplines related to gyms world, had the highest positive rate, respectively 16.7% and 12.5%, although with a very low number of checks, while in cycling the rate is 5, 5%, even less than canoeing and rugby.

The surveillance on sports competitions is more stringent, but amateur doping escapes the controls more easily and it is very difficult to study the gyms.

Amateur doping is completely underestimated because it takes place in gyms, closed environments where there is connivance between those who take the substances and those who advise them. It is possible to record the cases of people who arrive at the hospital admitting the use of doping substances but it is obviously the tip of an iceberg, because many are silent and even with the toxicological examinations it is not possible to identify what assumed. Complex pathways have proposed to make the most of the clinical performance in chronic disability disease (Catalano et al., 2017). Therefore it is very difficult to do prevention in gyms. So many guys have no idea of the risks they run. One should start from the schools, from the little boys, to try to explain and understand the dangers of doping.

### Conclusion

Athletes used pharmaceuticals to improve performance, commonly known as doping. By doping, athletes violate the World Anti-Doping Agency's (WADA's) regulation forbidding use of pharmaceutical products in competitive sports. Unfortunately, today, despite the technological advancement that characterizes the field of scientific research, the analytical methods are not sufficiently reliable for the search of the entire group of substances included in the anti-doping lists (Mazzeo, 2016). As new detection methods for illicit substances are developed, new doping methods appear.

Professional athletes must serve as role models and spokesmen for drug-free sport and lifestyle (Gomez, 2005). Doping is not limited to professional sports. Increasingly, public health officials are concerned that amateur and recreational athletes are also doping.

In addition, it is impossible to anticipate the moves of the opponent and this, therefore, is not easy to understand what new substances will be taken and what new methods will be adopted.

Close collaboration among the laboratories themselves would enable them to keep up to date and exchange new techniques. Closer ties with the pharmaceutical industry and those involved in basic research are also vital if they are able to anticipate new tendencies and forms of doping by means of a sort of scientific "vigil". The instrumentation and measurements industry would be also able to give them the benefit of recent progress in their domain.

Continuing, updates educational programs developed for these at-risk populations by national Olympic organizations and athletic federations are important first steps to curb and to control these dangerous behaviours. Still today, and increasingly strongly, the educational role of preventive medicine is very important (Mazzeo et al., 2018; D'elia, Mazzeo, & Raiola, 2018).

Prevention is one of the weapons more powerful than medicine; a valid preventive campaign can promote health, reducing prevalence, incidence and severity of diseases and limiting expenses at the same time.

The repression implemented by expansion and strengthening of anti-doping tests can be used as a valid deterrent; nevertheless, education compliance with the rules and, above all, information on damages health should play a priority role, as awareness and self-congratulation allow to achieve results superior to coercion and repressive methods.

All this presupposes an accurate knowledge of the subject, about the epidemiological, pharmacological and medical aspects. All professional figures involved are important; however, the role of medicine preventive appears decisive. Coaches and officials also need to be educated about their role (passive or active) in advocating drug-free sport.

Therefore, it is crucial the training of teachers of physical education should consider the problem and the use of educational tools to solve the problem adequately.

Moreover, additional research in this field will help athletes and physically active subjects to identify the medication and their side effects.

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#### Conflict of Interest

The authors declare that there are no conflicts of interest.

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