

Accidental doping. Prevention strategies

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Summary

There is growing consumption of nutritional supplements aimed at improving performance because the number of athletes, mainly amateurs, is growing very significantly.

This great demand supposes a market of huge proportions, supposing an economic activity that in Spain reached 920 million Euros in the year 2018.

This consumption occurs at all levels of sport, from 13% in global numbers, to 100% in some groups of professional sportsmen and women.

However, the use of these substances in very few circumstances is done under the advice of a professional, and the athlete takes them on their own. This fact, with the possibility that the product to be taken may contain prohibited substances that do not appear on the labeling, means that an adverse analytical finding can occur in a doping control through so-called accidental doping, which is the use of adulterated or contaminated nutritional supplements containing substances prohibited in sport that have not been declared on the labeling.

Between 11.6% and 25.8% of nutritional supplements contaminated with anabolic androgenic steroids have been found to exist. This paper describes the various causes of accidental doping, the substances most frequently used, paying particular attention to the ways of preventing this type of doping based on information and education, product certification and information, the form of prescription, criteria for use and safety of the origin of the products, and precautions followed in case of consumption.

Key words:

Doping. Accidental doping.
Amateur sport. Recreational sport.
Prevention.

Dopaje accidental. Estrategias de prevención

Resumen

Hay un consumo creciente de suplementos nutricionales destinados a mejorar el rendimiento porque el número de deportistas, fundamentalmente aficionados, está creciendo de forma muy importante.

Esta gran demanda supone un mercado de proporciones gigantescas, suponiendo un actividad económica que en España alcanzó los 920 millones de euros en el año 2018.

Este consumo se produce en todos los niveles deportivos, desde el 13 % en cifras globales, hasta el 100 % en algunos grupos de deportistas profesionales.

Sin embargo, el uso de estas sustancias en muy pocas circunstancias se realiza bajo el asesoramiento de un profesional y el deportista los toma por su cuenta. Este hecho, junto a la posibilidad de que el producto que se vaya a tomar pueda contener sustancias prohibidas que no figuran en el etiquetado supone que se pueda producir un hallazgo analítico adverso en un control de dopaje a través del denominado dopaje accidental que consiste en el que se produce por consumir suplementos nutricionales adulterados o contaminados que contienen sustancias prohibidas en el deporte que no se han declarado en el etiquetado. Se ha comprobado que existe entre el 11,6 y el 25,8% de suplementos nutricionales contaminados con esteroides androgénicos anabolizantes.

En este trabajo se describen las diversas causas de dopaje accidental, las sustancias más frecuentemente utilizadas prestando una especial atención a las formas de prevención de este tipo de dopaje que se basan en la información y educación, en la certificación e información de los productos, en la forma de prescripción, en los criterios de uso y seguridad del origen de los productos y en las precauciones que se deben tomar en caso de consumirlos.

Palabras clave:

Dopaje. Dopaje accidental.
Deporte aficionado.
Deporte recreacional. Prevención.

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Introduction

An increasing number of citizens engage in recreational sports activities, while federated competitive sport shows an increasing trend of 28% from 3,000,000 to 3,850,000 federated licenses between the years 2000-2018¹. The most practiced as free time sports are cycling, swimming, running and hiking/mountaineering. Despite the recreational nature of these activities, many practitioners invest many hours of dedication and show a high sense of competition². These athletes often use a variety of strategies to improve performance, to recover from exertion and to reduce fatigue, including the use of nutritional supplements³⁻⁸. These supplements are defined by the term "ergogenic aids".

Ergogenic aids are very varied and their consumption depends on a variety of factors, including the type of sport, sex, and age of the athlete, with the simultaneous consumption of several of them being very common. The most commonly used are vitamins, minerals, proteins, creatine, carnitine, caffeine and sports drinks^{6,9,10}. The market of nutritional supplements has acquired a very important development, assuming at world level an economic activity of hundred twenty-seven thousand sixty thousand million dollars in the year 2016 according to the Association of Dietetics and Food Supplements Companies (AFEPADI)¹¹ and 920 million in Spain, according to the survey of the Organization of Consumers and Users (OCU), January 2018¹², with a prevalence of very high consumption in sport of all levels¹³⁻¹⁶, being 58% in North American athletes¹⁷ and 44-100% in professional athletes, all of which supposes a business of enormous magnitude¹⁸.

However, athletes rarely seek professional advice on the use of these substances⁹ and a third part resort to self-administration^{19,20}.

On one hand, there is a lack of certainty that the product actually contains the substance or dose intended to be used and, on the other hand, the possibility that the preparation contains substances not described on the label that could lead to an adverse analytical finding (AAF) in doping control. In addition, this practice poses a health risk.

But not only the intake of ergogenic aids contaminated with doping substances is a risk for the athlete but also accidental doping can reach them in many ways. Certain meats from some countries with lax legislation and implementation of preventive policies may be contaminated with doping products and end up producing an AAF.

It is possible to take a drug with a perfectly normal medical prescription and engage in accidental doping. Substances on the Prohibited List may be consumed by an ill athlete, but a therapeutic use authorization (TUA) must first be applied for and granted by a therapeutic use authorization Committee (TUAC).

Passive taking and abuse of recreational-type substances can also cause a major problem by ingesting substances on the Prohibited List and producing an AAF.

Athletes who have been notified that they are in a monitoring group of an Anti-Doping Organization and therefore must be traced should also be considered. These athletes must be present at the time and place they have chosen to undergo out-of-competition doping control. Failure to do so several times may be considered an anti-doping rule violation and may result in a sanction.

It must be taken into account that there is a list of people (athletes and their environment) who are already suspended for doping and with

whom you can not collaborate (work, hire, train, etc...). Failure to do so could be considered an anti-doping rule violation.

Finally, it cannot be ruled out that, unconsciously (a spectator who passes a drink in good faith) or consciously (an enemy of any kind), may give a drink or food containing doping substances and an AAF may be produced.

This paper aims to describe what is called accidental doping, the ways in which it can occur and how to avoid it.

Accidental doping

Accidental doping is one of the unintentional forms of doping in which a prohibited substance is consumed by chance. It is basically the case of doping caused by the consumption of adulterated or contaminated nutritional supplements containing substances prohibited in a sport that has not been declared on the label.

Contaminated ergogenic aids

It is difficult to know the prevalence of nutritional supplement contamination. A meta-analysis that has investigated studies on this prevalence finds that, in studies conducted with a number of samples greater than 30 products in different countries, in the years 2001-2002, there were between 11.6 and 25.8% of nutritional supplements contaminated with anabolic androgenic steroids (AAS)²¹.

In addition, many of these products contain undeclared substances and their concentrations are also not as indicated on the labeling. Geyer *et al.*²², analyzed 634 nutritional supplements in 13 countries purchased in stores, on the Internet and by telephone from 215 manufacturing companies. Of the 634 samples analyzed, 94 (14.8%) contained prohormones not declared on the label. Thirty-two percent of all contaminated supplements contained nandrolone pro-hormones.

In some cases, especially dehydroepiandrosterone (DHEA), concentrations below 0.01 µg/g could be detected. The amounts of AAS in the tested supplements were much lower than those found in commercially available pharmacological preparations containing at least 10,000 µg DHEA. These low concentrations found in some cases may be interpreted as not intended to improve performance and may be due to cross-contamination, but may lead to adverse analytical findings in doping controls.

Most of the contaminated products found in this study were sold in the United States and Germany, and most of the contaminated supplements were manufactured by companies located in the United States, although in most cases, the label did not clearly indicate where the supplement was produced.

There have been several findings of products contaminated by these substances²³⁻²⁷ and the supplements that are contaminated are shown in Table 1.

The presence of doping substances in nutritional supplements is mainly due to the following three circumstances:

- Deliberate presence of substances prohibited by doping. In other words, these substances appear clearly on the product label.
- Presence of doping prohibited substances that the manufacturer has deliberately included in the product without indicating it on the label.

Table 1. Examples of nutrition supplements that have been contaminated by doping substances (retrieved from De Hon & Coumans²⁸).

- Branched-chain amino acids (BCAAs)
- Carnitine
- Chrysine
- Conjugated linoleic acid (CLA)
- Creatine
- Glutamine
- Guarana
- Minerals
- Ornithine-alpha-ketoglutarate (OKG)
- Proteins
- Pyruvate
- Ribose
- Saw palmetto
- Tribulus terrestris
- Vitamins
- Zinc

- The presence of doping prohibited substances found in the product without the manufacturer's knowledge (although it is the manufacturer's responsibility not to do so) and, logically, are not indicated on the label. This may be due to inadvertent contamination in the manufacturing process or contamination of active ingredients at source.

Most accidental doping comes from contaminated nutritional supplements. A nutritional supplement²⁹ is a product taken orally that contains a "dietary ingredient" intended to supplement the diet. Dietary ingredients³⁰ are vitamins, minerals, botanicals, amino acids and substances such as enzymes, organic tissues, glandulars, and metabolites.

Nutritional supplements may be extracts or concentrate in the form of tablets, capsules, gel capsules, gelatine capsules, liquids, powders or bars. They lack the safety requirements that are demanded for medicines and/or pharmaceutical products and, in them, the manufacturer does not have to demonstrate the efficacy and safety of the product, although it cannot advertise that they are products for diagnosis, cure, relief, treatment or prevention of diseases.

It should be noted that most supplements provide neither performance improvement nor health benefit, and many can be harmful. Some supplements contain excessive doses of potentially hazardous ingredients, while others do not contain significant amounts of the ingredients listed on the label. Some of the apparently legitimate nutritional supplements on sale contain ingredients that are not declared on the label but are prohibited by doping regulations.

Contaminants that have been identified include a variety of anabolic androgenic steroids (including testosterone and nandrolone, as well as the prohormones of these compounds) and ephedrine³⁰. Stimulants and other substances have also been detected²⁸. Tables 2 and 3 show the majority of contaminants found since 2002.

Contaminations by anabolic agents other than steroids have recently been described as selective androgen receptor modulators (MRSAs), e.g. andarin, LGD-4033, enobosarm (ostarin). These are principles with

Table 2. Steroids detected in nutritional supplements since 2002 (extracted from Geyer et al.^{21,28}).

- 17β-hydroxy-2α,17α -dimethyl-5α-androstan-3-one (methasterone)
- 17β -hydroxy-17α-methyl-5 α-androst-1-en-3-one (methyl-1-testosterone)
- 4-hydroxyandrost-4-ene-3,17-dione (formestane)
- 4,17 β-dihydroxyandrost-4-ene-3-one (4-hydroxytestosterone)
- 5α-androstane-3β,17α-diol
- Androst-4-ene-3β,17α -diol
- 5β-androst-1-ene-3β,17β-diol
- 5β-androst-1-ene-3α,17 β-diol
- 17β-hydroxy-5α-androstano-[3,2-c]-pyrazol (prostanazol)
- 6α-methylandrost-4-ene-3,17-dione (6α-methylandrostendione)
- 3β-hydroxy-5 β-androstan-17-one (epietiocholanolone)
- 17β-hydroxy-17α-methyl-5β-androstan-3-one (5β-mestanolone)
- 17α-methyl-5α-androst-2-en-17β-ol (desoxymethyltestosterone)
- 4-Chloro-17α-methylandrost-4-ene-3ε,17β-diol
- Androst-4-ene-3,6,17-trione (6-oxo-androstendione)
- Androsta-1,4,6-trien-3,17-dione (androstatrienedione)
- 3β-hydroxyandrost-4-ene-7,17-dione (7-keto-dehydroepiandrosterone)
- 6ε-Bromandrost-4-ene-3,17-dione
- 17α-Methyl-5α-androstane-3α, 17β-diol
- 1 7β-Hydroxy-5α-androstano-[3,2-c]-isoxazol
- 17β-Hydroxy-5α-androstano-[2,3-d]-isoxazol
- Estra-4,9-diene-3,17-dione
- 19-Nor-4-androsten-3,17-diol
- 19-Nor-4-androsten-3,17-dion
- 19-Nor-5-androsten-3,17-diol
- 19-Nortestosterone (nandrolone)
- Methandienone
- Stanozolol
- Testosterone

Table 3. Stimulants and other substances detected in nutritional supplements since 2002 (taken from De Hon et al.²⁸).

- Benzylpiperazine
- Caffeine (off the WADA doping list since 1 January 2004)
- Ephedrine
- Methylenedioxymethylamphetamine (MDMA or XTC)
- Nor-pseudo-ephedrine
- Sibutramine

powerful effects and it should be taken into account that these substances are mostly in clinical or pre-clinical study phases, and they are not approved for human use and some of them are directly discarded for that use. They are highly dangerous for health.

In sports or activities where it is necessary to increase muscle size or strength (strength, speed, power, combat and bodybuilding sports, among others) often resort to the use of nutritional supplements of protein origin. Many of these products are advertised offering an enormous development of muscle mass and strength, the result of new ingredients and formulas that have not actually been approved, possibly non-existent, based on fantasy and ignorance of the user. The reality is that

analysis of many of these products shows that they contain endogenous or exogenous AAS in doses even suprathereapeutic (more than 1 mg / g) and that they have not been declared on the label. As the manufacturers of these products also prepare other nutritional supplements on the same production line, the risk of cross-contamination with anabolic agents is very high. Such contaminations have been found in vitamin C, magnesium and multivitamin tablets containing small amounts of stanozolol and methandienone with the potential to produce an HAA³¹.

Since the early 2000s, designer steroid supplements can be found that are not in any medication or on the lists of banned substances. They were synthesized in the 1960s and did not go through the animal research phase because of their anabolic and androgenic effects. Turinabol, protagonist of the recent doping scandal organized in Russia, and coming from the years of the cold war and doping in Eastern European countries, is worth mentioning. Currently they are only produced for the nutritional supplement market and they are advertised for their anabolic capabilities or as aromatase inhibitors. Their effects on performance and side effects are unknown. In most cases, the labelling of these products contains unapproved and suggestive names and more than 40 designer steroids have been detected³¹.

Dehydroepiandrosterone (prasterone, DHEA), androstenedione, androstenediol and similar latestosterone precursors are widely accepted by athletes who want to increase muscle mass and strength and, at least in the United States of America, are legally sold products, although leastways androstenedione and other steroids require a prescription³². However, they are widely used³³.

However, it should keep in mind that in Spain the crime of Doping is described in the Penal Code. Article 362 quinquies states that those who, without therapeutic justification, prescribe, provide, dispense, supply, administer, offer or facilitate non-competitive federated sportsmen and sportswomen, non-federated sportsmen and sportswomen who practice sport for recreation, or sportswomen and sportswomen who participate in competitions organized in Spain by prohibited sports entities, substances or pharmacological groups, as well as non-regulatory methods, aimed at increasing their physical abilities or modifying the results of competitions, which due to their content, repetition of intake or other concurrent circumstances, endanger the life or health thereof, will be punished with prison sentences of six months to two years, a fine of six to eighteen months and special disqualification for employment or public office, profession or trade, for two to five years.

In addition, this article explicitly states that special penalties will be imposed when the crime is committed in the event of any of the following circumstances:

- The victim is under-age (minor)
- Deception or intimidation used.
- That the person in charge has prevalidated a relationship of work or professional superiority.

Nutritional supplements adulterated with clenbuterol have also been detected, which are advertised for their weight loss effects as a fat burning effect, specifically a product with a therapeutic dose of 30 micrograms per tablet³⁴ and another with a suprathereapeutic dose, 100 times higher than the therapeutic dose (2 mg / capsule), without being declared on the label, with the consequent health risk posed by its consumption³¹.

One study collected the analysis of 19 such products confiscated or purchased on the Internet³⁵ that were mostly advertised as erythropoietic products or oxygen transport and utilization boosters, and which declared on the label that they contained "cyanocobalamin". However, the analysis revealed the presence of nickel in one product and cobalt in another 11 products (cobalt was only declared on the labeling of two of these products). Cobalt is included in the list of banned substances as a hypoxia-inducible factor-activating agent (HIF) and has various side effects such as nausea, vomiting, hypothyroidism, goitre and heart failure^{36,37}. Nickel is not on the list of prohibited substances, but it has side effects such as contact dermatitis and can cause respiratory tract cancer³⁸.

In other research on black market products conducted in Germany³⁹, among other substances, clandestine products related to an increase in erythropoiesis were found, not stated on the label. Specifically they were EPO, (recombinant erythropoietin), hGH (recombinant human growth hormone), CJC-1295, GHRP-2 (pralmorelin), GHRP-6 and ipamorelin which are secretagogues, releasing hormones and growth hormone releasing peptides. Large quantities of anabolic agents and other banned and very dangerous substances such as fibroblastic growth factor, chorionic gonadotrophin, insulin, AICAR (a metabolic modulator) and tamoxifen (an estrogen receptor modulator or SERM) were also found. Another important problem is the contamination of ergogenic aids with stimulants, which would be used as "fat burners" to reduce weight, to improve mood or directly as stimulants before exercise. These contaminated supplements usually contain mainly ephedrine and analogues, sibutramine, methylhexaneamine and methylenedioxymetamphetamine^{21,24,30,32,40}.

These products are presented in the market in an attractive way, attributing to them an extraordinary power of elimination of body fat, with capacity to suppress appetite, stimulation of the central nervous system and as hormonal boosters of testosterone.

They are presented as amino acids and herbal extracts, designed with a cutting edge formula. Many times pictures of health and medical professionals are used to give them credibility and show certificates of authenticity that are totally false.

Stimulants are on the list of banned substances and cause AAF when detected in doping controls performed in a sport competition.

There are many products that contain these substances and the risk of AAF is due to:

1. Using generic names on labelling. In the case of ephedrine-containing supplements, natural sources of ephedrine such as Ma Huang or ephedra sinica are frequently mentioned on the label instead of the names of the active ingredients (ephedrine, pseudoephedrine, methylephedrine, etc.). In the case of sibutramine-enriched supplements, the ingredient is not showed on the label and the consumer is only provided with information that the product contains 'pure herbal ingredients' that have considerable weight-loss capabilities. Sibutramine can be found in therapeutic or even suprathereapeutic doses in capsules, powders and slimming infusions^{41,42}. Sibutramine is a synthetic anorexic, approved as a pharmaceutical preparation and available only by prescription. Due to its enormous side effects (risk of stroke and heart attack), the European Medicines Agency recommended in January 2010 that this drug be withdrawn from the market³².

- Using substances that have several names and only one of them appears on the lists of banned substances. This is what happens with methylhexanamine, a stimulant included in the list of doping substances as a specific stimulant and which can cause AAF if detected in competition controls. This substance can be found on the labels of products containing it under numerous different names, such as dimethylamylamine, dimethylpentylamine, pentylamine, geranamine, forthane and 2-amino-4-methylhexane^{17,32}.

The list of prohibited substances only mentions the names dimethylphenylamine and methylhexanamine in the group of stimulants, which complicates the identification of the substance as a prohibited compound³².

In some supplements, geranium root extract or geranium oil is mentioned as a purported natural source of methylhexanamine. However, methylhexanamine has been shown not to be a natural ingredient of geranium oil⁴³, meaning that synthetic methylhexanamine must have been added. Despite warnings, many elite athletes have been adversely affected by HAA in competition.

Food Contamination

Until the 1990s, cases of intoxication by meat products, mostly beef liver, by clenbuterol were not uncommon.

Clenbuterol is a type of beta-2 agonist, which in the list of prohibited substances is listed in the group of "other anabolic agents" because its stimulating effect on protein synthesis. This is especially noticeable in striated muscle as a consequence of the superior effects of this drug respect to the other of the same group of drugs. These effects are mainly used to increase muscle weight in cattle before slaughter

This substance causes symptoms after 30 minutes to 6 hours of ingestion consisting of palpitations, tachycardia, agitation, nervousness, tremors, myalgia and headache^{44,45}. Cases of massive intoxications have been described in restaurants, family parties, etc. Today veterinary inspections in advanced countries have tried to solve this problem, but the World Anti-Doping Agency still admits its presence and possible food contamination in China, Guatemala and Mexico.

In the years 2000, and in the sports perspective, clenbuterol acquired a great notoriety for a AAF from a famous cyclist who, as a justification, argued that its origin was from a beef steak, something he could not prove, so it was sanctioned.

In 2010, low amounts of clenbuterol were found in an entire team of non-athletes returning from that country, and clenbuterol was found in 22 (79%) of the samples analyzed⁴⁶.

In 2011 the Mexican national soccer team had 5 AAFs per clenbuterol in out-of-competition controls. Given the high number of AAFs, FIFA conducted an investigation into potential food contamination as Mexico was to host the 2011 U-17 World Cup. A total of 208 doping controls were carried out and 47 meat samples were analysed in team hotels during the tournament period. In 14 of the 47 meat samples (30%), clenbuterol was detected at concentrations between 0.06 and 11 mg/kg and, during the competition, 109 urine samples from the doping controls (52%) detected the substance at concentrations of 1-1556 pg/ml. Only 5 of the 24 teams had urine samples without clenbuterol. At least one of these teams followed a strict "meatless" diet

(due to knowledge of clenbuterol contamination in Mexico). Extensive evidence showed that meat contamination was the most predictable reason for the extraordinarily high prevalence of findings and no player was sanctioned⁴⁷.

In May 2019 the World Anti-Doping Agency published rules for Anti-Doping Laboratories and Anti-Doping Organisations on how to investigate cases of urine analysis in clenbuterol concentrations. Now it is necessary to analyze possible previous cases in China, Guatemala or Mexico, to prevent the application of potentially unfair sanctions⁴⁸.

A substance with similar characteristics to clenbuterol is zearalenone⁴⁹, a mycotoxin found in fungi used in American pastures (Mexico, Argentina and other countries in the area) and which presents the risk of AAF from metabolites of zeranone⁵⁰. It is a natural non-hormonal anabolic obtained from the corn fungus (*Gibberella zeae*) and is a catabolic inhibitor that induces anabolic metabolism in cattle, which causes increased muscle mass. In calves and steers it induces muscle weight gains of between 6.5 and 35 kg.

On the other hand, although the use of any hormonal product to increase growth in animal production is prohibited in the European Union, no AAF attributed to the presence of hormones in animal products has been described. It should be taken into consideration that in the USA it is legal to use six hormones or hormone derivatives in cattle farming (17 beta-estradiol, testosterone, progesterone, trenbolone, zeranone and melengestrol acetate) and another one for the pork (ractopamine)⁵¹.

There is one case of AED contamination detected by an atypical steroid profile in which, at the Women's World Cup in Germany in 2011, five players from one team had AED to AED, with enormous amounts of 16 endogenous AEDs listed on the banned substances list. The source of the contamination was considered to be extracts of musk deer meat, used by the team with the aim of improving "mental strength" without knowing that their consumption could cause AAF⁵².

Passive doping by Inhalation

Cannabinoids (natural and synthetic, except cannabidiol) are included in doping lists and may cause AAF if detected in competition. Passive inhalation of these substances would be an accidental form of doping which, from 2013, is to be avoided by setting the THC detection threshold at 150 ng/ml.

The use of cannabis in food preparation is a growing practice that includes a large number of products such as home-made foods (biscuits, cakes, macaroni...), hemp oil and hemp seed products, tea and commercialized foods (chocolate, lollipops, chewing gum, salt...). In addition, it has been argued that some AAF to tetrahydrocannabinol could be consequence of the ingestion of foods that contained marijuana without realising, in what has been denominated passive ingestion⁵³.

Since the ingestion of edible products containing tetrahydrocannabinol causes its presence in urine samples^{54,55}, the athlete must take into account this circumstance.

Finally, it should be remembered that in Spain there is an approved pharmacological preparation (Sativex-Almirall) whose active ingredient is delta-9-tetrahydrocannabinol/cannabidiol, whose only indication is the treatment for the improvement of symptoms in adult patients with

moderate or severe spasticity due to multiple sclerosis (MS) who have not responded adequately to other anti-spasticity drugs⁵⁶. This use requires therapeutic use authorisation (TUE).

Intentional contamination by rival

There are athletes willing to do anything to achieve their goals, so some resort to doping. But there have been some cases in which the athlete or the athlete's environment has administered substances to the rival without notifying him, in some cases substances included in the doping lists, which have caused HAA. We want to highlight some cases in football.

The best known took place in the Round of 16 of the 1990 World Championship in Italy when Argentina eliminated Brazil with a Caniggia goal. Branco, a player from Brazil, continues to accuse Argentina of giving Brazilians "water poisoned with narcotics," specifically Rohypnol (flunitrazepam). The player, after drinking water provided by the assistance of the Argentine team, felt bad and, when reproaching the Argentine coach, he said Branco in football anything goes. Apparently, with the game stopped, the Argentine coach and masseur offered the Brazilian players bottles of water with a substance that produced drowsiness. This event was confirmed by Maradona himself^{57,58}.

The other case concerned the administration of Haldol (haloperidol) injected into the bottles drunk by players from Paris Saint Germain by Marc Fratani, a member of Olympique de Marseille⁵⁹.

In the pre-Olympic classification of female field hockey in 2008 in Baku (Azerbaijan) HAA by derivatives of the ecstasy family were detected in two Spanish players. The Spanish team thought they had been intoxicated because they had sudden blackouts from their international players in the night before the final against the hosts. Intentional intoxication was demonstrated by the championship organization and neither the players nor the team was sanctioned⁶⁰.

Another case is that of a Japanese canoeist who sabotaged a rival by putting a forbidden substance in his bottle so that he would be suspended and could not compete in the Tokyo 2020 Olympic Games and could go to fifth place for the Japanese selection of K4⁶¹.

Other cases of accidental doping

Three curious cases of accidental doping have been described. The first is a closet HAA that occurred in an athlete as a result of sexual intercourse with a woman taking an intravaginal medication containing clostebol⁶².

The second⁶³ corresponds to an American athlete who showed a probenecid AAF. The sportsman was exonerated because the sanctioning procedure ended admitting that the analytical finding was a consequence of the kisses that were given with his partner who was taking a medication that was transmitted to the sportsman.

The third corresponds to a French tennis player of the highest level who had a HAA to cocaine in 2009 the day he retired from the Miami Masters 1000 for a right shoulder injury, and was sanctioned with a year of suspension, punishment that appealed and that the Court of Arbitration for Sport (CAS) in Lausanne reduced to two and a half months. The court ruled that the sportsman ingested the cocaine for which he tested positive (1.46 micrograms) "unintentionally" by kissing a woman seven times⁶⁴.

Athletes who have been notified that they are on an Anti-Doping Organisation Monitoring Group and therefore must be traced should also be considered. These athletes must be at the time and place they have chosen to undergo out-of-competition doping control. Failure to do so several times may be considered an anti-doping rule violation.

It should be borne in mind that there is a list of people (athletes and their environment) who are already suspended for doping and with whom you can not collaborate (work, hire, train, etc ...). An inadvertent failure to ascertain this could be considered an anti-doping rule violation, in that case the athlete would receive a warning and if it persisted he could be sanctioned for doping.

Prevention strategies

By its very nature, accidental doping is avoidable and every effort should be made to prevent such cases of unintentional doping.

Prevention consists of several aspects such as publication of results, education of athletes and development of methods to differentiate between intentional and inadvertent doping³¹.

The prevention of accidental doping, focused on the consumption of nutritional supplements, is based on information and Table 4 describes the main methods of prevention.

Education and information

It is essential that the athlete and athlete support personnel have been trained and informed, preferably through a comprehensive anti-doping education program, to warn athletes not to take supplements that may contain prohibited substances and ways to learn about these aspects⁶⁵.

Product information and certification

The first step in preventing accidental doping is to obtain information about the substances contained in the product (food supplement) and to ensure that none are on the lists of substances prohibited by doping. The World Anti-Doping Agency (AMA-WADA) publishes this list every year (<https://www.wada-ama.org/en/content/what-is-prohibited>). If the substance in question is listed, it should not be used. In Spain, the list is published in the Official State Gazette and is also available on the website of the Spanish Agency for Health Protection in Sport (AEPSAD): <https://aepsad.culturaydeporte.gob.es/inicio.html>. There are computer applications that provide information about substances and medicines (<https://aepsad.culturaydeporte.gob.es/inicio/nodopapp-nodopweb.html>).

Table 4. Methods to prevent accidental doping.

- Education and information.
- Product information and certification.
- Product prescription.
- Criteria of risk of use and safety on the origin of the product.
- Precautions.

The World Anti-Doping Agency recommends not taking a product if you are unsure of its contents. Ignorance is never an excuse and the athlete will be responsible for the consequences of a positive test caused by a badly labelled supplement⁶⁶.

It is advisable to check on the various websites dedicated to the evaluation of the purity of supplements that the product purchased, with its corresponding batch, is free of prohibited substances. Examples of websites of interest are: informedsport, informedchoice (InformedSport. Global Sports Supplement Testing Program, <http://www.informed-sport.com/> Informed choice. Banned Substance Testing Service. <http://informedchoice.org/>). It is also necessary to verify that the products to acquire have some certification that guarantees the absence of doping products in its composition (<http://blog.aepsad.es/complementos-alimenticios/>).

The European Committee for Standardisation (CEN) is currently working on a project to harmonize the manufacturing methods of sports supplements in Europe, in order to ensure that they are free of doping substances⁶⁷.

Product prescription

Nutritional supplements should only be used if they have been prescribed by a doctor or recommended by health professionals, but if it is decided to use these products without advice, special attention should be paid to the rest of the recommendations in this section, considering, moreover, that nutritional supplements are not exempt from health risks and bearing in mind that the combination of substances, which is common in many sportsmen and women can modify the effects of each of the substances by boosting or attenuating them but, in any case, increasing the health risks.

If changes in performance related to the consumption of these substances are noted, the trainer/preparer should be consulted and if symptoms appear in relation to the consumption of these substances, the doctor should be consulted.

Criteria of risk of use and safety on the origin of the product

The purchase of nutritional supplements in unreliable contexts, such as the internet, sports facilities without sales authorization and private individuals, should be avoided. Similarly, products that are advertised with extreme claims of muscle growth, strength gain, and weight loss have an enormous risk of containing prohibited substances⁶⁸.

The purchase of nutritional supplements should be avoided if the packaging does not specify components and doses and does not indicate an objectifiable tax domicile²².

Products that use generic names on the label are at risk. In the case of ephedrine-containing supplements, natural sources of ephedrine such as Ma Huang or ephedra sinica are frequently mentioned on the label instead of the names of the active ingredients (ephedrine, pseudoephedrine, methylephedrine, etc.). In the case of sibutramine-enriched supplements, the ingredient is not declared on the label and the consumer is only provided with the information that the product contains "pure herbal ingredients"³².

Precautions

It is recommended to keep the purchase receipt of the product, together with a package of the sealed product and the same lot, of which you are going to consume. In this way, if an adverse analytical finding were to appear, it would be possible to verify the legal purchase and that the product consumed contained the substance or substances not indicated on the labeling, provided that it is sealed. These measures, in the event of an adverse anti-doping result being determined by the doping control, may result in a reduction of the sanction.

However, there is no absolute certainty that with all the precautions indicated there is no product that could be contaminated with substances prohibited by doping.

Conflict of interest

The authors do not declare a conflict of interest.

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