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Review Article

Review on Abuse Drugs used in Athlete

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ABSTRACT

Due to its possible implications on athlete health, competitive fairness, and the general integrity of athletic events, drug misuse in sports has grown in importance on a global scale. The hazardous or improper use of substances, including illegal narcotics and prescription or over-the-counter pharmaceuticals, for reasons other than those for which they are designed is referred to as drug abuse. Athletes may abuse these drugs in order to improve performance, speed up recuperation, lessen tiredness, or obtain a competitive edge. The use of performance-enhancing drugs (PEDs) such anabolic steroids, stimulants, erythropoietin (EPO), insulin, and other hormonal substances is known as doping. While some athletes use these drugs on purpose to enhance their physical performance, others may inadvertently ingest prohibited chemicals through tainted dietary supplements. The extensive usage of supplements by athletes of all ages and competitive levels has been facilitated by their growing accessibility through retail establishments and internet marketplaces. According to research, many athletes routinely use ergogenic or nutritional supplements like multivitamins, sports drinks, protein powders, and creatine to enhance their ability to train, recover, and perform better overall. However, prohormones, anabolic steroids, and stimulants—substances that are forbidden in professional sports—have been found in various supplements, according to a number of studies. Such contamination can result in inadvertent doping and have major repercussions for athletes, such as long-term health hazards, competition suspension, and disqualification. The abuse of performance-enhancing drugs can have a number of negative health impacts in addition to ethical and legal issues. Hormonal imbalance, reduced fertility, liver toxicity, cardiovascular issues, psychiatric disorders, and metabolic consequences are a few of them. For instance, stimulants may raise the risk of hypertension and cardiac problems, anabolic steroids may harm the liver and create reproductive issues, and insulin abuse may result in severe hypoglycemia and potentially fatal situations. To find athletes using banned drugs, anti-doping organizations and regulatory agencies have implemented a number of testing techniques

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and surveillance initiatives. In order to guarantee fairness and openness in sporting events, doping control analysis is frequently employed. It is now easier to identify prohibited chemicals and their metabolites in biological samples because to modern detection techniques such electroanalytical methods and fluorescence-based sensors. With an emphasis on frequently used performance-enhancing drugs, their modes of action, related health hazards, and the problem of tainted dietary supplements, this review article attempts to give a thorough overview of drug usage in sports. Current doping detection techniques and the difficulties anti-doping agencies confront are also covered. This review's data came from official reports from international organizations as well as scientific sources including PubMed, Google Scholar, and Scopus. Promoting athlete health, raising awareness of the dangers of performance-enhancing substances, and assisting in the creation of efficient laws and educational initiatives to stop doping in sports all depend on an understanding of the scope and effects of substance misuse in sports.

INTRODUCTION

Drug abuse is described as “the use of illicit drugs or the abuse of prescription or over-the-counter drugs for purposes other than those for which they are indicated or in a manner or in quantities other than directed” in Medline's medical encyclopedia. “The harmful use of any substance” for the intention of modifying mood is considered substance Abuse. In accordance with The World Health Organization (WHO) defined substance abuse as “the harmful or hazardous use of psychoactive substances, including alcohol and illicit drugs” (1).

Drug abuse occurs in all sports and at most levels of competition. Drug abuse in the athlete inhabitants may involve doping in an effort to acquire a competitive advantage. Alternatively, as athletes can acquire substance use disorders just like any non-athlete, it could involve using drugs like alcohol or marijuana without the intention of strengthening performance (2). Doping, which is defined as using drugs or other substances to meliorate performance, has become a significant issue in almost every athlete of various ages and competitive levels exhibit sport citation (3,4). Athletes who consume drugs may dope in an attempt to obtain a competitive edge (2). Essentially, performance-enhancing drugs (PEDs) encompass not only illicit substances but also prescription pharmaceuticals, including anabolic steroids (5). These consist of a range of substances and dietary supplements that may be purchased online and at grocery and health food stores (6). The results of this study showed that most of drug users were male which is predictable due to social and cultural situation in Iran and this fact that women refer to these centres less than men (7). In sport—understood as a set of motor situations codified in the form of competition, and institutionalized athletes use ergogenic aids (any nutritional, physical, mechanical, psychological, or pharmacological maneuver or method) in order to increase their ability to perform physical work and improve performance (8).

Both the general public and athletes have seen an upsurge in the sale and use of supplements. A research of 3168 troops in the British Royal Army revealed a supplement use rate of 38% during the time of the survey, which increased to 54% when the use of supplements was compared to the 12 months (1 year) before to the study (9). Protein powders and bars (66%), isotonic sports drinks (49%), creatine (38%), recovery drinks (35%), multivitamins (31%), and vitamin C (25%) were the most merchantable (marketable) supplements. A total of 6523 supplements were consumed by the 3887 athletes in Tscholl et al.’s study (1.7 per athlete) (10). In athletics, dietary supplements, often referred to as ergo nutritional aids, have been utilized since the Olympic Games; however, there has recently been a significant rise in their use among specific demographic groups (11). An example of contamination with doping substances is reported in a study by Geyer et al. (2003), in

which 94 out of 634 dietary supplements examined (14.8%) were found to contain prohormones that were not listed on the product labels (12). A more recent study by Judkins et al. found that out of the 58 supplements examined, 25% had low amounts of contaminating steroids, and 11% were tainted with stimulants (13). Numerous doping drugs really improve performance, according to a body of studies. However, there isn't much evidence to support the efficacy of several drugs used to improve performance, such as selective androgen receptor modulators, anti-estrogens, and aromatase inhibitors (14).

The use of drugs and supplements in sport has increased noticeably in recent years, raising concerns about athlete health and fair competition. Athletes may use substances either to enhance performance or for reasons unrelated to sport, similar to the general population. The easy availability of performance-enhancing drugs and dietary supplements has made substance use more common across all levels of sport. Many supplements are poorly regulated, and some have been shown to contain banned or harmful substances without proper labelling. This creates a risk of unintentional doping and serious health consequences for athletes. Social and cultural factors also influence patterns of drug use and access to treatment, particularly among male and female athletes. Despite their widespread use, the effectiveness of many performance-enhancing substances remains scientifically uncertain. Limited awareness of risks and misinformation further contribute to misuse. Understanding the extent and nature of drug abuse in sport is essential for protecting athlete well-being. Examining current evidence can help identify gaps in knowledge and prevention strategies. This article aims to highlight key issues related to substance abuse, doping, and supplement use in athletes. The findings may support better education, policy development, and ethical practices in sport.

The Risk of Contaminated Supplements in Sport:

Included among the substances present, but not mentioned, on the label are prohormones, anabolic steroids, cognitive enhancers, and 1,3-dimethylamylamine. All of these are prohibited by the World Anti-Doping Agency (WADA) and would cause a positive result on an anti-doping test in athletes who consume them. Several studies examined the occurrence of contaminants in human subjects following the intake of tainted supplements or ergo nutritional products; in other research, the products were analyzed directly (15).

Performance-enhancing effects of substances used by athletes

ANDROGENS:

Androgens include exogenous testosterone, synthetic androgens (e.g., danazol, nandrolone, stanozolol), androgen precursors (e.g., androstenedione, dehydroepiandrosterone), selective androgen receptor modulators, and other types of androgen stimulation. Athletes have utilized the latter types of chemicals to boost endogenous testosterone in an attempt to avoid WADA's restriction on natural or synthetic androgens[16]. Dehydroepiandrosterone (DHEA) and androstenedione are examples of androgen precursors. We couldn't find any proof that androstenedione makes muscles stronger[17]. Exogenous human chorionic gonadotropin, antiestrogens like tamoxifen, clomiphene, and raloxifene, and aromatase inhibitors like testolactone, letrozole, and anastrozole are further methods of androgen stimulation. Serum testosterone levels may rise as a result of certain drugs[18].

ADVERSE EFFECTS:

I. Decreased fertility

II. Prostate cancer

III. Depression

IV. Mania

V. Amenorrhea in women

VI. Hepatotoxicity (19)

STIMULANTS:

According to research, Stimulants are used to improved anaerobic performance, less tiredness, improved response time, increased alertness, improved endurance, and cause weight loss[20]. Notably, there has been a noticeable rise in the number of athletes who have been found to use stimulant medicines in recent years, particularly at the highest levels of competition[21]. 61 men were randomly assigned to five different dosages of testosterone enanthate, ranging from 25 mg to 600 mg, as well as therapy with a gonadotropin-releasing hormone agonist to decrease endogenous testosterone release, in another double-blind study of exogenous testosterone. Similar to the previous trial, that one showed a dose-dependent increase in leg power and leg press strength that was connected with serum total testosterone concentrations[22]. A wide range of stimulants and other chemicals, such as caffeine, the amino acids taurine and L-carnitine, glucuronolactone, ginkgo biloba, ginseng, and others, are now frequently included in energy drinks[23].

• **Caffeine:** The consumption of caffeine is rising more and more globally. The primary underlining motives are improving physical performance and improving focus and memory[24].

COMPLICATIONS:

I. Hypertension

II. Tachycardia

III. Myocardial infarction

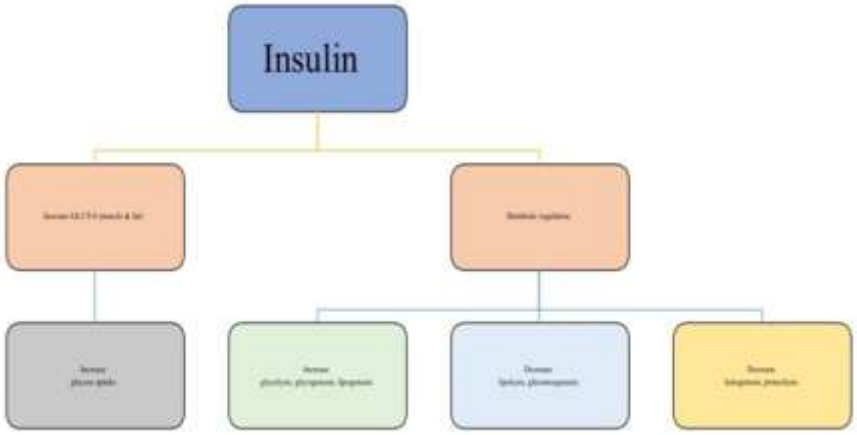
IV. Stroke

V. Weight loss

VI. Anxiety/Panic attacks (25).

INSULIN:

Insulin increases the amount of glucose transporters (Glut-4) at the cell membrane, which increases the flow of glucose into the cell's interior and promotes the uptake of glucose into muscle and fat (26). Since insulin is a powerful hormone that promotes the absorption of glucose and the subsequent store of glycogen in muscle, using it should allow for longer periods of exercise. Exercise duration should increase with the amount of glycogen stored in the body for better performance (27).



ADVERSE EFFECTS:

- Hypoglycemia is the primary adverse effect and the most noticeable. When injecting fast-acting insulin analogs, the majority of athletes who misuse insulin are probably skilled at controlling their carbohydrate intake.
- Despite being easily accessible, a large portion of insulin use is probably secret, even from friends and relatives.
- When young, healthy, non-diabetic people arrive for medical assessment in a state of disorientation or coma, it is rare that they will be diagnosed with hypoglycemia.
- That might be a deadly error(28) .

Erythropoietin (EPO):

The primary regulator of erythropoiesis is the hormone EPO, a circulating glycosylated protein. It is mostly generated by the kidney and is inversely correlated with blood oxygen levels. After rHuEPO is administered to rats and humans, there is a direct correlation between elevated hemoglobin levels and improved performance. Hypoxia and hypoxia-mimetics are doping techniques. Training at altitude is one such technique; but, due to hypoxic-mediated exhaustion, one may not be able to exercise as vigorously as at lower altitudes. There are variations on this subject, such as sleeping in a tent or chamber with reduced oxygen tension (at lower altitude) and training at the same elevation, or living at altitude and training at sea level. These techniques are not regarded as doping[29].

ADVERSE EFFECTS:

- Changes in blood flow characteristics as the hematocrit increases have been directly connected to deaths in professional cyclists.
- Although rHuEPO and its associated proteins have not been studied in child or adolescent athletes, theoretically, the reactions should be identical to those of older adolescents or young adults.
- The main problems are related to pulmonary emboli, slow blood flow in the tiny capillaries of vital organs, and elevated hematocrit (30).

ANABOLIC STERIODS:

A sex hormone that encourages the development and maintenance of male sex traits is called an anabolic steroid. The main androgen that males secrete is testosterone. Androgens have both

anabolic (an increase in skeletal muscle mass and strength) and masculinizing (the development of masculine secondary sex traits, such as hair growth) effects. Pharmaceutical firms have been trying to create androgens with selective anabolic action and little to no androgenic activity for decades; these substances are known as anabolic steroids. Testosterone is mostly attached to sex-hormone binding globulin (SHBG), loosely associated with albumin, although a minor fraction exists as the unbound hormone. It is believed that the loosely bound (albumin-bound) and free fractions contain the biological activity (31). Muscle fibers enlarge (32) as a result of testosterone. and a rise in the quantity of satellite cells and myonuclei (33).

AFTER EFFECTS:

- Nevertheless, because testosterone is a precursor to estrogens, the long bones' epiphyseal development will be accelerated, and the adult stature will be lower than expected. Even very low dosages of anabolic steroids can cause hirsutism and irregular menstruation and ovarian cycles in women and girls (34).

CONSUMPTION AND CONTAMINATION OF ERGONUTRITIONAL SUPPLEMENTS:

- Because phosphodiesterase-5 inhibitors have vasodilatory effects, athletes may also use them to try to boost oxygenation and exercise capacity(35).

- Depending on the sport, up to 90% of athletes may utilize them (36).

- Most athletes include the use of these supplements in their daily routines, but before consuming any kind of dietary supplement, they should be fully certain of its safety and effectiveness as well as its precise composition. The information presented by certain research is significant; for example, in samples examined between 2002 and 2005, the percentage of contamination in ergonutritional supplements ranged from 12% to 58%, and in 216 instances, hormones were discovered in dietary supplements that shouldn't have had them (37).

- According to a survey of 567 Canadian athletes aged 11 to 25, 28% of them use supplements everyday with the primary objective of increasing their intake of vitamins and minerals and enhancing their performance (38).

- Another research that included 292 Portuguese athletes from 13 different federations revealed a 66% consumption rate, with an average of four supplements per athlete. The primary motivations for use were improved performance (62%) and accelerated recuperation (63%) (39).

- The first research on the quality of nutritional supplements was conducted in 2000, when the issues brought on by accidental doping started to gain attention (40).

- Numerous studies have shown that the contamination rate from labeling errors—whether from the omission of compounds contained in the product or from mistakes in the estimation of the concentrations—is comparatively high (41).

- Diuretics, probenecid, 5-alpha reductase inhibitors, epitestosterone (to normalize urine testosterone to epitestosterone ratios), and plasma expanders (e.g., glycerol, intravenous administration of albumin, dextra, and mannitol) are examples of masking agents that

generally hide prohibited substances in urine or other body samples(42).

DOPING TEST IN ATHLETES:

Doping testing is not only done to get positive results, which provide analytical proof of the use of illegal drugs or techniques. Even if the techniques for analyzing biological samples from athletes are constantly evolving (43) testing itself still has a number of drawbacks when it comes to revealing doping, such as a restricted detection window, low test sensitivity for specific compounds, and high test predictability (44). Such a hypothetical scheme would not only be financially feasible, but it would also be morally dubious. It has been stated that the worldwide testing program is mostly predicated on discouraging athletes from choosing to dope by threatening them with detection and harsh penalties, given the challenges of the detection-based method (45).

Doping, a phrase that initially referred to the use of drug stimulants to enhance athletes' performance, has expanded to include all illegal narcotics (46). Doping control analysis is now a standard method used to guarantee sports' justice and fairness (47). The two primary forms of doping that exist today are drug doping and gene doping, which are based on the various methods that illegal substances might enter athletes (48). Gene doping is the use of drugs or technologies to introduce alien genes or cells into athletes for nontherapeutic purposes in an attempt to improperly enhance their sports performance (48). Genetic modification technologies are become more sophisticated as science and technology continue to advance. Consequently, doping techniques and varieties have grown increasingly intricate, including the most modern kind, gene doping (49).

DRUG DOPING DETECTION:

- **FLUROSCENCE METHOD**:

Cheng's team successfully developed a unique fluorescence technique to detect drug doping with methamphetamine hydrochloride by using fluorescent covalent polymers (CPs) as the signal carrier travel. Quantitative fluorescence quenching of CPs was made possible by the intrinsic interactions between the target molecules and signal probes, demonstrating the method's exceptional performance (50). However, sensors that rely on this "signal-off" method are susceptible to interference from many sources or unknown media. As a result, scientists have created several "signal-on" fluorescence sensors for detection of doping. Hof's research team, for instance, described a method for developing a family of self-assembling dimeric supramolecular chemosensors that is powered by parallel synthesis. "Signal-on" fluorescence detection of drug doping is made possible by the functional unit dimer-dyes, which allow the sensors to emit fluorescence when they detect micromolar amounts of a variety of illegal substances in saliva and water (51).

- **ELECTROANALYTICAL METHOD**:

Electroanalytical procedures are highly sensitive, just like fluorescence approaches.

As a result, throughout the past ten years, they have been extensively utilized in the anti-doping area, particularly for certain doping substances or associated metabolites with electrochemical activity (52). Simple, quick, inexpensive, and user-friendly, these techniques have been gaining popularity. They also offer minimal matrix effects and the potential to employ portable electrochemical devices and reduce the size of the experimental setup (53). Furthermore,

electrochemical analytical techniques are consistently at the forefront of the doping control analysis area due to their perceived adequate sensitivity, precision, and accuracy (54).

Because sodium dodecyl sulfate, an auxiliary reagent, was included, the produced electrochemical sensors demonstrated exceptional interference resistance. Additionally, the new technique was used on synthetic samples, and its accuracy was assessed by comparing it to liquid chromatography using a diode array detector as the reference method (55).

METHODOLOGY:

A narrative literature review technique was used to compile and examine the body of knowledge about drug misuse and doping in sports for this review paper. From reputable electronic sources including PubMed, Google Scholar, and Scopus, pertinent scientific material was gathered. These databases were chosen because they offer a variety of peer-reviewed research papers, reviews, and scientific reports pertaining to public health, pharmacology, and sports medicine. A number of keywords and search terms, such as "drug abuse in athletes," "performance-enhancing drugs," "doping in sports," "anabolic steroids," "erythropoietin," "stimulants," "insulin misuse," "dietary supplements," and "doping detection methods," were used to find relevant papers. English-language publications published in peer-reviewed journals, together with pertinent reviews and reports, were the main focus of the search. To make sure the data in the evaluation was correct and current, official guidelines and reports from international organizations like the World Health Organization and the World Anti-Doping Agency were also reviewed in addition to scholarly publications.

The study covered studies on the incidence of drug addiction, performance-enhancing substance kinds, dietary supplement contamination, health effects, and doping detection methods. Articles unrelated to athletes or athletic performance were not included. Following the collection of pertinent research, the data was meticulously examined, arranged, and summarized to highlight important conclusions about substance abuse, its consequences on health, and contemporary anti-doping tactics in sports. This approach made it possible to present a thorough summary of the data on drug usage and doping among athletes.

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