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Performance-Enhancing drugs and their adverse health consequences

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Abstract
Performance enhancing drugs have a lot of side-effects on the human body. In some cases, it leads to the death if it is taken in excessive quantity. It is noticed that most of the wrestlers take steroid to gain the weight quickly. Their weight is increased but is found that if they stop taking steroid then their weight goes decreased and a lot of side-effects such as skin problem, stomach problem have evolved.
The mostly used performance enhancing drugs are promyogenic drugs which are used to increase the muscle or decrease the fat of the body. These are pharmacologic agents which are normally used by the athletes or non-athletes weightlifters to gain weight. The current article highlights the adverse effects of taking performance enhancing drugs in excessive quantity.

Keywords: drug, health, performance

Introduction
The use of performance enhancing drugs is quite common in the field of sports and these drugs are popular from ancient times. It is reported that in the past, athletes used to have some kind of special plants or leaves in order to enhance their performance in the competitive sports.
A case of taking excessive amount of drugs was reported in Greece where an athlete, Senator George, took the drugs in higher quantity which caused to death. So it is prohibited for the players to take these performance enhancing drugs as these are very harmful for the health. But, some players take these drugs so as to perform better in the competitive sports and in the later stage of their lives; they have to pass through very serious health problems.
Normally, these performance enhancing drugs are mixture of multiple drugs having the classical drugs like opiates. As mentioned above, these drugs are very disease prone and may lead to health problem like joint pain. It is also observed that if these drugs are taken with the mixture of stimulants then the athlete has to do a lot of physical training which may lead to musculoskeletal injuries.
The following figure represents the type of performance enhancing drugs used by the athletes in competitive sports.

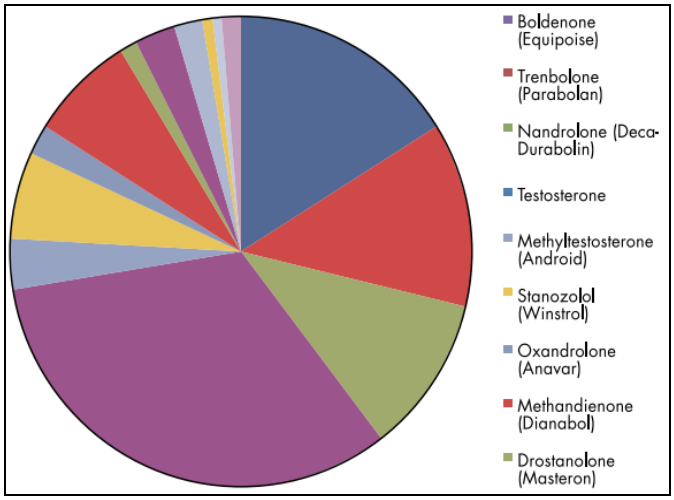

Fig 1: Type of performance enhancing drugs used by the athletes in competitive sports

The following figure shows the substances found in drug class 'Anabolic agents'.

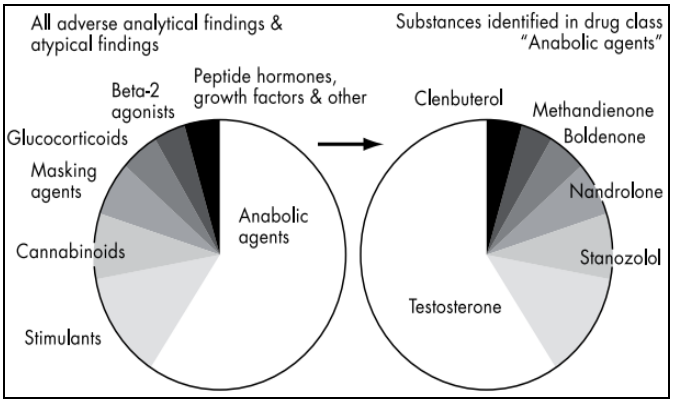

Fig 2: Type of performance enhancing drugs used by the athletes in competitive sports

Adverse health effects of performance enhancing drugs

Because Steroids, hGH, insulin, and erythropoietins are the most frequently used PEDs, we address the medical consequences of their use in detail below.

An androgen is a sex hormone that promotes the development and maintenance of the male sex characteris tics; testosterone is the principal secreted androgen in men. Androgens have both androgenic (masculinizing) effects (development of male secondary sex characteristics, including hair growth) and anabolic effects (increase in skeletal muscle mass and strength). For decades, pharmaceutical companies have attempted to develop androgens that have preferential anabolic activity and reduced or no androgenic activity; these compounds have been referred to as anabolic steroids.

Although some steroidal compounds available to date are preferentially anabolic, most generally have both androgenic and anabolic effects. Therefore, for the sake of uniformity and accuracy, we have used the term Steroid to describe these compounds that are structurally related to testosterone, bind to androgen receptor, and exert masculinizing as well as anabolic effects to varying degrees. The literature uses a number of terms (anabolic steroids, androgenic steroids, and androgens) to describe these androgen derivatives.

Testosterone remains popular, both among elite athletes and non-athlete weightlifters, because of its low price, relatively ready access, and the challenges in distinguishing exogenous from endogenous sources of testosterone. Numerous Steroids have been synthesized by structural modifications of the testosterone molecule. These structural modifications may alter the relative anabolic or androgenic activity, the binding affinity for the androgen receptor, coactivator recruitment, metabolic clearance, susceptibility to presystemic metabolism, and aromatization.

Testosterone is metabolized rapidly in the body; however, esterification of the 17-hydroxyl group renders the molecule more hydrophobic. When these esters of testosterone (such as testosterone enanthate and cypionate) are administered in an oily suspension, they are released very slowly into the aqueous plasma because of their hydrophobicity. This extends their duration of action. These esters are readily de-esterified to testosterone in the body.

Investigations of the structure-activity relationships have established that removal of the 19-methyl group increases the anabolic activity; thus, 19-nortestosterone (nandrolone) is a potent Steroid and a very popular training drug that accounts for a large number of positive tests (94). 7-Alkyl substitutions of the 19-nortestosterone molecule may further increase the anabolic to androgenic activity.

17-Alkyl substitutions render the molecule resistant to degradation; thus, 17-alkylated androgens can be administered orally. Stanozolol is a 17- alkylated androgen that can be taken orally or by injection. Orally administered 17-alkylated androgens are hepatotoxic. Stanozolol is also nonaromatizable. Other substitutions in the steroid A ring may alter the susceptibility of the steroid molecule to aromatization. Athletes and nonathlete weightlifters take Steroids orally, transdermally, or by im injection; however, the most popular mode is the im route. Oral preparations have a short half-life and are taken daily, whereas injectable androgens are typically used weekly or biweekly. A number of transdermal testosterone preparations have become available recently, but it is difficult to deliver large amounts of testosterone using the transdermal formulations. Users may supplement their program of injections and pills with topical gels to provide a constant low-level testosterone supply.

The mechanisms by which Steroids improve athletic performance are not fully understood. Testosterone administration increases skeletal muscle mass by inducing the hypertrophy of both type 1 and 2 fibers; testosterone does not change the absolute number or the relative proportion of type 1 and 2 fibers. Testosterone administration increases the number of muscle progenitor cells (satellite cells), which contribute to muscle fiber hypertrophy.

Discussion

Testosterone promotes myogenic differentiation of muscle progenitor cells. Upon binding to its cognate androgen receptor, the liganded androgen receptor associates with catenin and other proteins, and the complex translocates into the nucleus where it binds transcription factor-4 and activates a number of Wnt target genes, including follistatin.

Follistatin blocks the effects of a number of TGF family members, including myostatin and activins, and plays an essential role in mediating testosterone's effects on myogenic differentiation. Most of the anabolic effects of testosterone appear to be mediated through androgen receptor signaling.

Testosterone stimulates circulating GH and IGF-1, although circulating GH is not essential for mediating testosterone's effects on muscle mass. However, in IGF-1 receptor signaling plays an important role in mediating the effects of testosterone on myogenesis. The conversion of testosterone to dihydrotestosterone by steroid 5-reductase is not essential for mediating its effects on the muscle.

Testosterone increases maximal voluntary strength and leg power but does not increase specific force. Testosterone also promotes mitochondrial biogenesis and quality control and increases net oxygen delivery to the tissue by increasing red cell mass and tissue capillarity.

Adverse effects of Steroids on several organ systems have begun to emerge. Of particular concern are cardiovascular effects, hematologic effects, psychiatric and neuropsychologic effects, and hormonal and metabolic effects. There are also a

variety of apparently less frequent effects on various other bodily tissues.

Numerous field studies have described psychiatric symptoms associated with illicit Steroid use, including major mood disorders. These psychological studies have included interview studies assessing psychiatric history in Steroid users, on-drug vs off-drug; comparisons of Steroid users vs nonusers using interviews or psychological rating scales and/or longitudinal assessments of Steroid users over intervals of Steroid use vs intervals of non-exposure.

In general, these field studies have suggested that some Steroid users exhibit hypomanic or manic symptoms during Steroid exposure (characterized by irritability, aggressiveness, exaggerated self-confidence, hyperactivity, reckless behavior, and occasional psychotic symptoms) and depressive symptoms during Steroid withdrawal (characterized by depressed mood, loss of interest in usual activities, hypersomnia, anorexia, loss of libido, and occasional suicidality).

Conclusion

There are no systematic studies of the adverse effects of GH use. Therefore, most of the information is anecdotal, and these reports are often confounded by concurrent use of other PEDs, especially Steroids. The likely adverse effects include edema, excessive sweating, myalgias and arthralgias, carpal tunnel syndrome, and diabetes.

Much of the information about potential adverse effects of rhGH use in supraphysiologic doses has been inferred from the studies of patients with acromegaly, a disease of excessive GH production with elevated GH levels at all times (usually for many years). GH excess in patients with acromegaly is characterized by acral enlargement, excessive sweating, hypertension, congestive heart failure, cardiomyopathy, sleep apnea, arthropathy, carpal tunnel syndrome, increased insulin resistance, neuropathy, diabetes, and increased mortality.

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