Anabolic Steroid Use, Misuse And Addiction

Introduction

Anabolic steroids have an important role to play in the treatment of medical conditions. There is, however, an illicit use of anabolic steroids. Today, most athletes, involved in sports activities that require greater strength, take anabolic steroids to increase their weight and strength. These sports include competitive sports like weight lifting, wrestling, and other strength based contests. In addition, people who are obsessed about having a “perfect” physical appearance also misuse anabolic steroids. The number of individuals using anabolic steroids for sports or to improve their looks is growing. This increased use of anabolic steroids is driven by the perception that they may give a person an edge when it comes to sports activities. Unfortunately, many individuals use anabolic steroids without regard for the disastrous impacts it can have on their bodies.

Anabolic Steroids And Testosterone: An Overview

Anabolic steroids are an androgenic hormone, and is also known by its proper name anabolic-androgen steroids (AAS). Testosterone is a natural anabolic steroid and it is the primary sex hormone in males. In order to understand anabolic steroids, it is important to know how testosterone works.

Testosterone is vital for the development of reproductive organs like the prostate and testes. It enhances male sexual features such as increased bone mass, muscles and body hair growth. Testosterone also promotes health and overall wellbeing. For example, it helps
prevent osteoporosis. Many abnormalities in the body, such as bone loss or frailty, are associated with testosterone deficiency. Synthetic anabolic steroids are an artificial form of the male hormone testosterone. The two major impacts they have on the body are 1) an anabolic impact (the muscle building effect), and 2) an androgenic impact (the masculinizing effect).

Anabolic steroids differ from corticosteroids such as prednisolone and cortisone. Corticosteroids do not deliver masculinizing or muscle building results. These corticosteroids are prescribed for asthma patients and people having skin problems. They are often medically prescribed as anti-inflammatories.

Testosterone Formation and Impact

Testosterone is produced by the adrenal glands, testes, placenta and ovaries. It is made from cholesterol through a complicated process that takes place in the steroid-producing glands. The total testosterone production in an adult male is around 7 milligrams per day.

The stimulus for the formation of testosterone arises in the brain, specifically in the hypothalamus. The hypothalamus is a part of the brain where various hormones are produced. These hormones are linked to the function of other glands. For example, the hypothalamus secretes Gonadotrophin Releasing Hormone (GnRH), which is sent to the pituitary gland by special veins called the portal system. Once transmitted, the pituitary gland forms Luteinizing Hormone (LH). Luteinizing Hormone is then released into the blood. This hormone is sent to the testis, which is the gland where Leydig cells produce testosterone from stored cholesterol.
The feedback mechanism in the pituitary gland controls the rate of hormone production and it is regulated by the blood level of testosterone. With an increase in this level, the secretion of GnRH and LH hormone is reduced or may stop completely. This results in a decline in hormone production. If the opposite happens, i.e., if testosterone blood levels fall, then pituitary secretion is enhanced. In this way, the body maintains an equilibrium in hormone levels.

Mode of Mechanism

After the formation and secretion of testosterone into the blood stream, a greater percentage of the hormone is tied to protein as it is sent throughout the body. Only the untied or free-state testosterone is biologically active. The free-state testosterone in the blood makes up around 1 to 3 percent of the total amount of hormone found in circulation so only 1 to 3 percent of the testosterone level in the blood can interact with tissue receptors.

Testosterone’s half-life (the time it takes for half of a substance to degrade or decay) is around 10 minutes. Once testosterone reaches the cell, it is turned into 5 alpha di-hydrotosterone (DHT). The hormone is then bound to androgen receptors (AR) present in the cells. Finally, it is transported into the nucleus where critical muscle building reactions take place.

Receptors for injectable or oral steroids works in the same manner. The actual protein production is based on the cell where the reaction takes place. Hence, a muscle cell may only produce muscle protein, irrespective of the kind of anabolic steroid used. After the formation of this complex material, it is then sent to the nucleus activating the
genes to form the appropriate proteins. These proteins are released into the cytoplasm of the cell to carry out their function.

The features of the specific cell impact the response; for example, muscle cells only make muscle proteins and prostate cells are only able to form prostate protein due to steroid use. Variations in different drugs occur because of the impact of excess substances being freed into the bloodstream. Excess substances impact other organs like the brain. This may lead to abnormal emotional reactions.⁸

There is a limited number of receptors in a cell. Once the receptors are saturated, they are unable to combine with additional material, therefore limiting the anabolic impact of excessive doses and extended courses. This is called the refractory stage.

Studies reveal that some steroids might bind to several receptors at a time. The most common receptor is the glucocorticoid receptor, where steroids replace cortisone. Corticosteroids impact the brain by breaking down tissues, and any hindrance in this activity is helpful for body building.⁹ Once the steroid course ends, the reverse action is initiated and an increase in catabolism results because of corticosteroids being used by the receptors again. This might be one of the reasons behind the weight loss experienced by some steroid users at the end of their course.

After the metabolization of steroid in the nucleus, it is taken from the cell and degraded in the liver, where it is excreted in the urine or bile. The excreted byproducts differ from one androgen to another. These products are identified in sports through drug testing. The liver uses
testosterone fast, making it powerless as an oral anabolic agent until it is tied with another radical. For testosterone to be used orally, a chemical group is included with the molecule to enable its absorption in the stomach and to pass through the liver. This leads to an increased time frame of the testosterone action enabling more active substance to be in contact with the muscle cells.

**Impact of Testosterone**

Testosterone is vital for the development of external genitalia prior to birth and for the formation of sexual differentiation. These are the androgenic impacts of testosterone. In the puberty stage, it causes growth of masculine features like the deepening of the voice, muscularity, development of hair and secondary sexual characteristics. Testosterone secretion is increased in puberty leading to lightening of long bones and finally their closure of epiphyses. It also enhances the sebaceous glands secretions.

The other major impact of testosterone is anabolic and the enhanced muscle growth that results. This muscle growth is the major attraction for athletes. All steroids hold androgenic and anabolic actions and the review of the chemical structure of widely used anabolic steroids shows these similarities.

**How do Anabolic Steroids Work?**

The following diagram explains how steroids work, starting with brain signals to produce testosterone that is eventually released into the bloodstream where they attach to certain cell receptors and function to regulate the production of testosterone.
Anabolic Steroid Drug Prescribing And Use

When anabolic steroids are prescribed for a person to use, he or she must have a full understanding of its positive and negative effects. For the non-medical user, the expectations may be unrealistic. Every person has different genetic structure. Diet regulation, stress, training and illness determine the body’s response to anabolic steroids.

Steroids are usually given in cycles and are taken in stacks. Stacking implies a practice of using various drugs simultaneously. Stacking is
common among steroid users and can also include the use of other drugs besides steroids. Cycling refers to a steroid usage pattern, where drugs are being taken in cycles of a period for weeks followed by a drug free tenure. A key factor is the number and spread of androgen receptors in the muscles.\(^{13}\)

There is no exact pattern of distribution of receptors but a majority of people have a greater concentration in their upper body, leading to a greater response in the arms than in the legs. The number slightly increases with the growth of muscle and this might be the reason why some athletes face greater pains with later courses.

A weight-training session leads to greater strength and more muscle mass. Steroids are most effective when an athlete has plateaued. An athlete has plateaued when there is no longer an increase in strength and weight even though the athlete is training extensively. The significance of diet cannot be overstated and must include enough carbohydrates to support the training.\(^ {14}\) The muscles require protein for their growth but they are unable to work efficiently unless provided with carbohydrates. Carbohydrates pull water in the muscle cell, resulting in an increase muscle bulk. All steroids lead to the same outcomes at the end of the course. They trigger the cell nucleus to form protein characteristic of the cell. In muscle cells, this is the muscle protein. This is the result that athletes want from using steroids.

Indeed, there are variations among steroids in terms of their impact when used in a single dose and observed for some weeks. In terms of testosterone preparation, there are variations in the rate at which they
are absorbed and used at the site of the injection. At the time of testosterone preparation, there are variations in the rate at which steroids are taken up from the site of injections. These absorption and use rates are calculated based on one dose; however, steroids are usually given in a series of doses for a specific period, which makes these calculations or conclusions invalid.

There is a question of whether a drug should be taken orally or via injection. In terms of overall impact, there is no difference. Results differ or are improved if the athlete trains correctly. Hence, route administration is not the most important factor; training correctly is more important.

Another feature of different steroids is the rate of the uptake by the receptors. The rate of uptake is not a determining factor for choosing a steroid because steroids are used over a tenure and any gain that one steroid may have on the earlier dose is not significant when the course is extended for several weeks. Anabolic steroids may be stored for a second or later drug course. The body does not develop a tolerance for a specific steroid so outcomes may be achieved with the same steroid, if the training and diet programs are adequate.

**Anabolic Steroid Dosage**

As far as the dosage of anabolic steroid is concerned, there is no specific research that has been performed to determine the impact of a specific quantity of steroid on a weight-training session. The available information is based on the use of steroid in medicine and the expectations and results are different from those using steroids for
weight gain. It must be noted that if weight gain is achieved with a large steroid dose, it is not necessarily true that the dose was appropriate. There are steroids that produce the same effects in large doses as other steroids produce in smaller doses. The spread of excess steroid throughout the body produces side effects before the material is degraded in the liver. There are certain limits to the amount that the cell nuclei and androgen receptors can take up. Once these are saturated, they are temporarily unable to take-up or manage any more steroids.¹⁷

In animals, the impact of steroids may be doubled by increasing the dose by ten but in humans this increase causes excessive negative effects. There is a dose at which negligible benefits accrue. At this point, continually increasing a steroid dose or changing the type of steroid used does not lead to improved results. Increasing steroid dose may not enhance muscle building, but it will surely increase the risk of associated side effects. To enhance muscle building, the key factors to consider are a blend of a correct diet and an optimal training program.

**Length And Frequency of Drug Use**

Long, extended anabolic steroid courses do not result in continued muscles and strength gain. Some athletes may experience immediate response to drugs, while others might take 3-4 weeks to show any result. A continuous growth pattern is seen that lasts for around 6 to 8 weeks.¹⁸ Once the steroid receptors have reached their dose limits, they become fatigued. Muscle growth and strength reach a plateau at this stage and further steroid use will produce zero or negligible benefit. Therefore, steroid courses should be no longer than 8 weeks. If a person does not see muscle gain during an 8-week course, it is not
because he/she did not inject or ingest enough steroids, it is more likely that there was not the proper training or an inadequate diet.

The frequency of use is not a simple question to answer. It is important that a person has certain goals in mind before using anabolic steroids since this will enable the person to assess the progress. If there is no progress seen as required, chances are the person’s goals are unrealistic. A strength gain of about 5 percent in 6 to 8 weeks is fine in an initial course, though it is usually hard to project strength gains with any accurate level. In subsequent courses, it becomes harder to attain these kinds of gains since the body reaches the plateau state and it is not possible for it to increase strength on a continual basis.

A majority of people experience weight loss after the end of a course and many users struggle to maintain the results after a course. The result is usually weight loss. In few athletes, water retention is seen during and at the end of a course. Water is lost and weight loss is observed after a few weeks.

The idea of using another steroid course must be assessed carefully and a new goal set. The quicker a person starts a new course, the less likely he/she will see gains. This is because the receptors have not fully recovered. People who have maintained an extensive training program should keep the intervals between courses as long as the length of the prior course. By example, if an athlete has just completed an 8-week course, the next course should not begin for 8 weeks. This gives the body a reasonable time to recover from the previous course.
Prescription Uses

Since the inception of the anabolic steroids in the 1950s, testosterone and anabolic-androgenic analogues were used, often improperly or illegally, by individuals seeking to boost their androgenic and anabolic potential. Their goals were to improve their physical appearance and enhance performance as athletes. The extent to which anabolic steroids affect the appearance and performance in healthy athletes is hotly debated, as are the precise modes of action. Anecdotal evidences like increases in lean body mass (LBM) and strength has been observed, yet steroid impact is hard to examine in a true placebo-controlled and double-blind study.21

Indeed, the use of anabolic steroids has become a global phenomenon, extending to high school, college and even junior school levels.22 The early notion suggested by the medical community that anabolic steroids have not been observed to improve athletic ability contributed to skepticism in people who used steroids. Technically, the statement is correct; however, people who have used steroids, often illegally, developed their opinion of the performance enhancing impact of steroids, and they were quickly dismissive of the medical community’s warnings and recommendations.23 Health clinicians can prescribe anabolic steroids for treating hormonal issues like delayed puberty, diseases causing muscle loss like AIDS and cancer. Steroids may improve physical appearance and strength in these cases.

Medical Uses Of Anabolic Steroids
Anabolic steroid, technically called anabolic-androgenic steroids (AAS), invented in 1930s, are widely being used therapeutically in a range of medicines for improving appetite and stimulating muscles growth. It has been acknowledged by the American College of Sports Medicine that AAS can greatly contribute to weight gain, often increase lean mass and increased muscular strength achieved through extensive exercise and proper diet. An adequate diet and effective training program are the prerequisite for the steroids to work faster and deliver the required results.

As stated above, the term anabolic refers to muscle building, while androgenic refers to an increase in male sex characteristics. A physician can prescribe anabolic steroids for people whose bodies are unable to produce sufficient testosterone. They also prescribe steroids to those that have lost muscle mass as a result of various health conditions.

Anabolic steroids that athletes use are synthetic testosterone hormones, which facilitate muscle building by enhancing nitrogen retention and protein development. They produce the effects like those of natural hormones, helping boosting appetite and accelerating bone growth. In recent times, various kinds of anabolic steroids (hormones) have been developed and introduced. Besides testosterone, some synthetically made hormones include those noted below.

- Xymetholone
- Methyltestosterone
- Fluoxymesterone
- Nandrolone
- Oxandrolone
Steroids multiply the nitrogen content in the human body. Once the nitrogen level is increased, it facilitates more protein production in the body. Protein is a critical component for developing muscles. Muscles may start to develop without extensive exercise; however, extensive training will lead to dramatic results in terms of body strength, lean mass and muscle development. Anabolic steroids are also prescribed by pediatric endocrinologists for treating children with growth problems. However, the synthetic growth hormone carries a few side effects, making it a secondary treatment in most cases.

**Forms and Routes of Medication Administration**

Anabolic steroids come in a complete range of forms including gels, tablets, capsules, liquid drops, creams, water or oil based injectable solutions and transdermal patches.

*Oil or Water-based Injectable*

The injectable form is the most common administration route for using steroids. The steroid is injected intravenously (directly into bloodstream) or intramuscularly (into muscle). The steroid is injected at least three times a week.

*Oral Medication*
Oral medication is usually in the form of gel tablets and capsules and prescribed for daily use.

*Creams*

Creams are the least invasive form as creams are rubbed onto the skin directly.

*Transdermal Patches*

Transdermal patches are attached to the arms or buttocks of the users for a continuous release of anabolic steroids.

**Dosage Patterns**

The doses used by athletes may be 10 to 100 times higher than those prescribed for treating medical conditions.27 Steroids are usually prescribed in complex patterns to try to avoid their side effects; however, there is no scientific evidence showing that these patterns reduce the side effects of anabolic steroids. These patterns include those outlined below.

*Stacking*

In the stacking pattern, users are prescribed to use two or more different steroids at a time.

*Cycling*

In the cycling pattern, users are prescribed steroids for over a certain time period, then stop and restart them again.
Pyramiding

In the pyramiding pattern, the dosage is steadily but methodically increased in frequency until the user reaches a plateau state, and then use is tapered off gradually.

Treatment of Wasting Conditions

Anabolic steroids are prescribed for specific medical conditions including treating chronic muscle wasting conditions. Anabolic steroids are used for treating: 28

- Hypogonadism in males
- Breast cancer in females
- Osteoporosis
- Conditions leading to hormonal imbalances
- Endometriosis

In addition, arthritis is also treated with controlled dosages of anabolic steroids. Steroids may be used to treat obesity. Steroids decrease body fats, which helps an obese patient shed extra pounds faster. Steroids are also used to treat injuries caused by a major accident since they may speed up recovery, and reduce inflammation. An overactive immune system in the body may cause inflammation; steroids help regulate an overactive immune system.

Anabolic steroids contribute to the production of red blood cells. 29 The amount of red blood cells is dependent on the oxygen carrying ability of blood. An increased production of red blood cells will address anemia when the body is unable to produce sufficient red blood cells.
Steroids are also prescribed to human immunodeficiency virus (HIV) positive and cancer patients. They have been shown to restore appetite and help regulate declining muscle mass in these patients.\(^{29}\) This provides HIV and cancer patients with better health and an enhanced sense of wellbeing.

Anabolic steroids are prescribed for treating conditions like HIV but due to their various short-term and long-term impacts, people that suffer from the following conditions or have a medical history of these conditions, are not prescribed steroids:\(^{30}\) 1) Mental disorders, 2) Heart conditions, 3) Blood clotting and other related disorders, 4) Stroke, 5) Liver disease, and 6) Kidney disease.

**Inducement of Male Puberty**

Steroids are used for a number of medical circumstances, such as to regulate male sexual characteristics, after the testes have been surgically removed to treat testicular cancer. Also, steroids are medically prescribed for treating adolescent males who have cancer or issues with their pituitary gland.\(^{31}\) This helps deal with muscle degradation, which may result from pituitary gland dysfunction or failure. Anabolic steroids promote growth in skeletal muscles and treat problems like late puberty.

Anabolic steroids are also prescribed for men that have sexual performance issues. Testosterone replacement treatment is used to provide testosterone to a patient whose body is not capable of producing testosterone in sufficient quantities.\(^{30}\) The testosterone is given through steroids. Because testosterone production varies from
patient to patient, there is no exact standard for the quantity of testosterone a body is required to produce; however, external administration of testosterone has helped patients who do not produce sufficient testosterone on their own.

Anabolic steroids are prescribed for treating gender dysphoria. A person with gender dysphoria has strong, persistent feelings of identification with the opposite gender. This is accompanied by a discomfort by that person with his or her assigned sex. The result of these feelings and the associated discomfort is that the person experiences significant distress or impairment. The use of anabolic steroids leads to the development of secondary male features like increased muscle mass and bones mass, deeper voice, increased red blood cell levels, and facial hair; steroids cause clitoral enlargement in transgender users, or among women and those developing female sexual features but who wish to look ambiguous or male.32

The Risks Of Anabolic Steroid Use

Recent studies show that there is an alarming increase in steroid use by people across various ethnicities and cultures for the physical advantages and muscles gain steroids may bring. A study carried out in the year 2000 revealed that around 2.5 percent of the people in 12th grade reported that they had been using steroid for this purpose; this number increased to 4 percent in 2002.33 Most of those studies involved participants in their teens. A majority of them used steroids to enhance their physical appearance, while others used steroids to enhance their athletic performance.
Steroids are increasingly being taken as a recreational drug since steroids may induce euphoria in people and give them a sense of power. International black markets have arisen to get around the prescription requirements. Unauthorized use of steroids is illegal but not uncommonly users ignore the law.

While steroids are believed to offer significant benefits, new research has revealed that there are risks associated with its use as well. Steroid use is permitted for individuals who are under a medical clinician’s care and access to steroids must be through a prescription. In sports, athletes rely on mega steroid doses, sometimes up to 100 times greater than what is recommended by health clinicians for medical use.  

Some athletes and body builders believe training is insufficient to prepare them for success. They think their competitors may be using steroids and they will have an unfair advantage over them. Athletes and body builders are not the only steroid users; football players, street skaters, discus throwers and many people in similar fields are known to use steroids to build their muscles, gain strength and enhance the efficiency of training sessions. This practice may be illegal, and it is extremely risky.

Athletes who are involved in illegal steroid use are in a continuous cat and mouse game with doping and testing authorities. For example, a body builder may plan steroid use to try to make sure that the drug is out of his/her system before a scheduled drug test takes place. Sometimes, masking drugs are also taken by users to fool a doping test by producing a negative result even though the athlete used
steroids. Black market dealers have been introducing and distributing steroids called designer steroids that make the steroids undetectable or unidentifiable during testing.\textsuperscript{35}

It is not recommended to use two kinds of steroids at one time; however, many body builders worldwide ignore the instructions and manuals prepared by steroid manufacturers. New users seek information from commercial sources, \textit{i.e.}, sales persons, instead of health professionals. Some people also use steroids because of peer-pressure. They get steroids from the black market where these drugs may be adulterated. There are reports of dye or vials of water being passed to unsuspecting individuals as steroids.

\textbf{Misuse of Steroids in the General Population}

Body builders and athletes are not the only individuals who misuse steroids. As stated by one of the recent surveys, around 78.4 percent of steroid users are non-athletes and non-body builders.\textsuperscript{36} Only 13 percent reported that they have used unsafe injection procedures like reusing needles, sharing syringes, and using multi-dose vials.\textsuperscript{36} Early studies also found that needle-sharing is not common among people using anabolic steroids for non-medical uses; they are less than 1 percent.\textsuperscript{37} In the same study, the typical non-medical, steroid user was educated; 74 percent of steroid users had post-secondary degrees, and a majority had completed college while very few had failed to complete their high school degrees.\textsuperscript{37}

Early studies found that needle sharing is not common among people using anabolic steroids for non-medical uses; they are less than 1
percent. Another study carried out in the same year revealed that 74 percent of non-medical steroid users had post-secondary degrees; the majority had completed college while fewer had failed to complete their high school degrees. Steroid users tend to be disappointed by the exhibition of steroids as deadly in politics and the media. According to a recent study, steroid users distrust their medical clinician and in the sample raised above, around 56 percent reported that they had not disclosed steroid use to their medical clinician.

Another study showed that 92 percent of users think that the medical community has insufficient knowledge of non-medical use of anabolic steroids, while 99 percent think that the public has an overstated view of the negative effects of steroid use. Steroid users usually tend to have signs of muscle dysmorphia and exhibit stronger endorsement of the conventional male role. The *Journal of Health Psychology* also published one study that showed a lot of users believe anabolic steroid use is safe in moderation.

Anabolic steroids are used both by men and women in various types of professional sports in order to gain competitive advantage or to have rapid recovery from sports-based injuries. These sports include weight lifting, body building, shot put, cycling, and wrestling, track and field, mixed martial arts, cricket, football and boxing. This use of steroids is unauthorized according to the rules and regulations of the governing committees of most sports organizations. Anabolic steroid usage is seen among adolescents, particularly those taking part in competitive sports and contests. It has been recommended that the use of anabolic steroids among high school students in the United States can be around 2.7 percent.
Male students take steroids more frequently than females while, on the average, those taking part in sports use steroids, and show even higher frequency of steroid use. People who use steroids usually take them orally or by muscle injection. These doses are usually 10 to 100 times higher than the dose prescribed by a physician for treating medical conditions.³⁴

### Anabolic Steroids And Addiction

Though anabolic steroids are not addictive like other drugs, they do have addictive properties. According to studies, people may self-administer steroids if they have a chance, just as they do in the case of other drugs. There are many motivating factors that lead to self-administration of anabolic steroids, and it is this self-administration that leads to misuse and addiction. People may continue using steroids irrespective of physical problems, high cost, and negative impacts on relationships. These behaviors show addictive potential of anabolic steroids. Research has found that some steroid users transition to other drugs like opioids, for reducing irritability and sleep problems resulted from steroids.⁴²

In addition, steroid users go through illegal channels and they expend time and money to get steroids. This is similar to the actions of individuals with other substance use disorders. People who use steroids for non-medical purposes may encounter withdrawal symptoms once they stop. These symptoms include fatigue, mood swings, loss of appetite, restlessness, reduced sex drive, insomnia, and craving for the drugs.⁴³ The most hazardous withdrawal symptom
is depression since it often leads to suicide cases. If left as it is, certain depressive symptoms linked with anabolic steroid withdrawal are believed to remain for a year or so after use stops.

On the basis of the number of reports and studies carried out periodically, it has been revealed that when anabolic steroids are used in extremely high doses, they lead to aggression and irritability to a risky extent, making users dangerous for their surroundings. The non-medical use of steroids can result in users acting more aggressively, as evidenced by reports of aggressive acts such as armed robbery, physical fighting, burglary, theft and vandalism by prior users. Users also report that they have such behavioral tendencies when they are on steroids. One of the recent studies suggests that the behavioral effects and mood swings observed during anabolic steroid use might come from secondary hormonal changes. There are certain medications used for treating this withdrawal, to restore the body’s hormonal system after its interruption by steroid use. Other medications also target particular withdrawal; for example, analgesics for muscle and joint pain and headaches, and antidepressant for treating depression.\textsuperscript{44}

**Physical Effects of Steroid Use**

Among users, steroids have been reported to produce euphoria (a feeling of well-being) as well as aggression, increased libido, enhanced self-image and most generally, an improvement in muscular movement and athletic performance.\textsuperscript{45} It is hard to know whether the self-reported cases present discernible and immediate effects of anabolic steroids or the expectations that the use of steroid with time
will lead to these effects. This uncertainty is due to the inherent limitations found in the design of most of the studies conducted to date.

Since anabolic steroids include the artificial forms of the hormone testosterone, they affect many gender features in a person who uses them. In people taking doses around 100 times higher than the medically prescribed levels, many side effects are seen. Overall, the side effects (both short-term and long-term) of steroid use include:  

- Testicles shrinking in men
- Excessive growth of hair in women
- Deepened voice in women
- Breast growth tissue in men
- Fertility problems
- Heart problems
- High blood pressure
- Fast mood swings
- Mania
- Strokes
- Irregularities in menstrual cycle

In the following section, the short-term effects of anabolic steroids will be listed. These are the effects that appear the week after starting the doses and they are often visible.

**Thought and Mood Disorders**

Thought disorders can occur with steroid use. Paranoia is one of the most common side effects of steroids. Paranoia conditions like
unreasonable or excessive jealousy, delusions, extreme irritability, hypomanic or manic symptoms like extreme mood changes, tension and suicidal tendencies. Aggressive behaviors such as “road rage” may be observed in men and woman who misuse anabolic steroids on a frequent basis outside of the medically recommended and prescribed dosages.\textsuperscript{47}

The explosive and irrational behavior that is seen with road rage is particularly evident in those who are extremely androgenic.\textsuperscript{47} Extreme mood swings that are experienced by steroid users also affect their relationships, especially during stressful, difficult times in the relationship. The irritability shown by men and women on steroids are paralleled by the condition that millions of women every month face, generally called premenstrual tension syndrome. Anabolic steroids, though, also have the opposite psychological impact in a lot of non-medical steroid users.

Anabolic steroids act like a potent mood elevator; they mimic the impact felt when using antidepressants. When the steroid cycle is discontinued, a lot of male athletes are faced with a condition called “estrogen outbound.”\textsuperscript{48} Estrogen is the other hormone produced by males but males produce it in smaller quantities than do females. Estrogen quantities are affected during the anabolic steroid cycle as well. Once this cycle is discontinued, estrogen production, which was curbed during the steroid cycle, is released in huge quantities. The impact of an estrogen rebound becomes more extreme based on the anabolic steroid dosage and the length of time it is used; the higher the dosage and the longer steroids are used, the greater the estrogen rebound.
Dr. Brain Corrigan, a renowned consultant physician at the Institute of Sports Medicine, Concord Hospital, Australia, places the psychological impacts of steroids into three key classes. The immediate effects are most commonly seen in euphoria and mood swings, as mentioned earlier. A boost in energy, confidence, enthusiasm, motivation and self-esteem are common.\textsuperscript{49} One user, 23 years old, claimed that anabolic steroid use made him feel like the strongest man in the world.\textsuperscript{50} Corrigan\textsuperscript{49} also stated that users may face increased libido, anger, irritability, as well as agitation. Anabolic steroid generated aggression may take various forms including physical assault, irritability, negativism, indirect hospitality, resentment, suspicion, and verbal hospitality.

It is therefore important that a user of anabolic steroids must study how his/her body reacts to these drugs. When it is evident that any of the mentioned conditions is visible, the user should stop taking steroids. The user should also take some time to evaluate his/her position. Not all drugs lead to the same feelings, since there are slight chemical differences between these drugs and their impact on metabolism in the emotional sections of the brain. Extensive doses of steroids are not just wasteful but also cause more serious emotional symptoms.

\textbf{Impaired Judgment}

As anabolic steroid duration and doses are increased with time, the user shows a loss of inhibitions and the lack of judgment through grandiosity and mood swings.\textsuperscript{49} Many steroid users report the feeling that no one in the world can hurt them.\textsuperscript{50} However, they do often
become highly quarrelsome, suspicious, impulsive and aggressive. Steroids are known to produce impaired judgment, violent behavior, and even psychosis. It also causes changes in sexual characteristics and will stop growth in teens.\textsuperscript{51}

Users increase the dosages and seek more exotic results, when muscle building is no longer achievable. This is the addictive side of steroids. The exact impact of anabolic steroids on the brain is unknown. The brain works on a delicate balance in which nutrients flow across the blood brain barrier, such as amino acids, especially glutamine, taurine, tyrosine, tryptophan and phenylalanine and fatty acids that have an immediate impact on the brain.\textsuperscript{54}

During the steroid cycle, necessary amino acids are either blocked or completely inhibited to the brain. These amino acids help in the development of neurotransmitters such as serotonin, norepinephrine, epinephrine and cholecystokinin. These critically essential neurotransmitters were interrupted due to an increase in the urea and ammonia levels in the blood,\textsuperscript{52} which are the direct consequence of anabolic, androgenic steroid use. In addition, the diet of an athlete usually consists of a high intake of protein along with training at an extensive level. Both of these actions enhance the plasma concentration of the protein fragments, which lead to higher ammonia levels in the steroid user’s body. Anabolic steroids are also believed to cause side effects that are visible on the face and body of a user.

Research has revealed that steroid use can cause higher water retention in the body of the user, leading a user to develop a round face with unusually puffy eyes. Facial hair eruptions among females
Bad breath is also one of the common side effects. Women who use steroids will commonly have their voice deepen. Acne problems on the face and all over the body are among the easily visible, negative impacts caused by anabolic steroid use. In addition, steroids are harmful to the eyes, leading to eye damage. Corticosteroids are reported to case permanent damage to the eyes, especially among long-term drug users. Eye infections are also reported by short-term users. Complex and chronic eye disorders like glaucoma and cataracts can result from anabolic steroid use. Clearly, anabolic steroids impact various target organs through specific steroid receptors. These organs include the muscles, brain and secondary sex organs.

### Commonly Used Steroids

This section discusses some details about a few of the most commonly used steroids and the associated performance improvement drugs.

### Boldenone Undecenoate

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<thead>
<tr>
<th>Administration</th>
<th>Injectable</th>
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<tr>
<td>Alternative Names</td>
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<td>Products</td>
<td>Boldebal-H (50mg/ml), Equipoise (25, 50mg/ml), Ganabol (25, 50mg/ml), Pace (50mg/ml), Sybolin (25mg/ml), Vebonol (25mg/ml).</td>
</tr>
<tr>
<td>The Lowdown</td>
<td>It is an oil based steroid that is applied in veterinary practice. It contains Methandriol Dipropionate and Boldenone undecenoate</td>
</tr>
<tr>
<td>Street Info</td>
<td>Equipoise is usually believed to be effective in generating high increases in muscle mass and strength and has also been used for the “cutting” before competition.</td>
</tr>
</tbody>
</table>

### Nandrolone Decanoate

<table>
<thead>
<tr>
<th>Administration</th>
<th>Injectable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative Names</td>
<td>Nortestosterone Decanoate and Nortestosterone Decylate</td>
</tr>
</tbody>
</table>
Products
Anabolicum, Norandren; Nandrolone Decanoate is a form of the Organon product. DecaDurabolin is an old drug that has been in use for over thirty years. Since Nandrolone is not C17 alpha-alkylated, this steroid does not have a strong connection with liver dysfunction occurrence and cholestasis. It may, however, lead to edema/fluid retention due to kidney sodium retention.

Proprietary Names
Anaboline (50mg/ml), Anabolin LA-100Deca-Durabol (25, 50, 100mg/ml), Deca-Durabolin (25, 50, 100, 200mg/ml), Deject (25, 50mg/ml), Elpihormo (50mg/ml), Extraboline (50mg/ml), Hybolin Decanoate (50, 100mg/ml), Jebolan (50mg/ml), Nandrolone Decanoate (50,100, 200mg/ml), Nurezan (50mg/ml), Retabolil (25, 50mg/ml), Retabolin (50mg/ml), Turinabol Depot (50mg/ml), Ziremilon (50mg/ml).

Street Info
Nandrolone Decanoate (Deca) is believed to be the most widely used anabolic steroid (injectable), which is used for improving performance. It also has a reputation of being one of the most detectable banned drugs; metabolites can be identified even after one year.

Due to its popularity, this steroid is widely counterfeited. Because of its comparatively low androgenic characteristics, it is also generally thought to aromatize just at high doses. Deca is also commonly taken for body-building and it’s known to promote strength and size.

The reported cases mentioned side effects including acne, hypertension, reproductive and sexual issues. The side effects are recurring more in females than men and their extent is largely based on dosage used.

Methandrostenolone

<table>
<thead>
<tr>
<th>Administration</th>
<th>Oral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative Names</td>
<td>Methandrostenolone</td>
</tr>
<tr>
<td>Injectable 25 mg/ml</td>
<td>Anabolikum, Metandiabol.</td>
</tr>
<tr>
<td>Proprietary Names</td>
<td>Anabol (5mg), Andoredan (5mg), Bionabol (2, 5mg), Encepan (5mg), Metabol (5mg), Metaboline (5mg) also contains multivitamins and nutrients, Metanabol (1, 5mg), Methandrostenolonum (5mg), Naposim (5mg), Nerobol (5mg), Pronabol (5mg), Stenolon(1, 5mg),Trinergic (5mg capsules).</td>
</tr>
<tr>
<td>Street Info</td>
<td>Many users of this anabolic steroids have mentioned dramatic gains both in their size and strength. However, this</td>
</tr>
</tbody>
</table>
drug aromatizes even when taken in small dosage and develops gynaecomastia as a common problem. Another side effect reported is the problem of high water retention, causing hypertension. Among females, the usage of these drugs can lead to vitalization because these drugs have androgenic properties. The masculinizing impacts may result even at low dosages in few cases where users have sensitivity to androgens.

Oxandrolone

<table>
<thead>
<tr>
<th>Administration</th>
<th>Oral</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The Lowdown</strong></td>
<td>Oxandrolone is C-17 alpha-alkylated so there is the potential for liver damage.</td>
</tr>
<tr>
<td><strong>Proprietary Names</strong></td>
<td>Anavar (2.5mg), Lipidex (2.5mg), Lonavar (2mg), Oxandrin (2.5mg), Vasorome (2.5mg).</td>
</tr>
<tr>
<td><strong>Street Info</strong></td>
<td>Oxandrolone has relatively low androgenic properties, with little aromatisation in males. It has a reputation for increasing strength but not size. It is popular among women because of its low incidence of side effects due to virilisation, however some cases of facial hair growth and deepening of the voice have been reported following prolonged dosages. Gastrointestinal irritation, including pain and diarrhea are commonly reported side effects in both male and female users</td>
</tr>
</tbody>
</table>

Oxymetholone

<table>
<thead>
<tr>
<th>Administration</th>
<th>Oral</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Proprietary Names</strong></td>
<td>Adroyd (50mg), Anadrol 50 (50mg), Anapolon (5mg), Anapalon 50 (50mg) Hemogenin (50mg), Oxitosona (50mg), Plenastril (50mg), Roborol (50mg), Synasteron (50mg)</td>
</tr>
<tr>
<td><strong>The Lowdown</strong></td>
<td>Oxymetholone is a C-17 alpha-alkylated, associated with liver jaundice/disturbances that sometimes occurs even with therapeutic doses. There are the Links reported in between Oxymetholone treatment and growth of leukemia.</td>
</tr>
</tbody>
</table>
### Oxymetholone

**Street Info**
Oxymetholone, is the derivative of dihydrotestosterone (DHT) and it is usually believed to be the most powerful oral anabolic steroid. It is highly anabolic and androgenic. It is a C-17 alpha-alkylated, and is highly toxic for the liver. Cases have also reported the problems of acne and hair loss (because of high levels of DHT), due to its strong tendency for causing liver damage and gynecomastia.

Other side effects that are associated with its extended use include stomach pains and headaches. Many evidences are available of loss of weight and size, implying the drug is too hard for the body. Only a few women can have enough tolerance for oxymetholone since it has high virilizing impacts.

### Stanozolol

<table>
<thead>
<tr>
<th>Administration</th>
<th>Oral</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alternative Names</strong></td>
<td>Androstanazole and Methylstanazole</td>
</tr>
<tr>
<td><strong>The Lowdown</strong></td>
<td>Stanozolol, if taken for an extended time, leads to elevated liver function due to C-17 alpha-alkylated compound.</td>
</tr>
<tr>
<td><strong>Proprietary Names</strong></td>
<td>Stromba (5mg), Winstrol (2mg)</td>
</tr>
<tr>
<td><strong>Street Info</strong></td>
<td>Stanozolol tablets may cause gastrointestinal discomfort after extended use. Both injection form and tablets don’t aromatize. Tablets are usually taken in different doses equally divided to decrease the chances of gastric irritation. This is a popular practice among female users, since it decreases the chances of virilization, which is linked with high doses of androgens in the female body.</td>
</tr>
</tbody>
</table>

### Sustanon 250

<table>
<thead>
<tr>
<th>Administration</th>
<th>Injectable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Make Up</strong></td>
<td>Sustanon has four testosterones: Testosterone Propionate 30MG Testosterone Phenylpropionate 60MG Testosterone Isocaproate 60MG Testosterone Decanoate 100MG</td>
</tr>
</tbody>
</table>
### Deposterone

<table>
<thead>
<tr>
<th><strong>Proprietary Names</strong></th>
<th>Sostenon 250, Sustenon 250</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The Lowdown</strong></td>
<td>Sustanon 250 holds both anabolic and androgenic characteristics. It was made to maximize the combined impacts of using the testosterones mentioned above. The difference in half-life times of these testosterones implies that the product acts fast and stays effective for a number of years.</td>
</tr>
<tr>
<td><strong>Street Info</strong></td>
<td>Sustanon 250 is known to be highly effective for increasing weight and size. The negative impacts of aromatization and water retention leading to gynaecomastia are taken to be less noticeable than in the long-acting injections of testosterone.</td>
</tr>
</tbody>
</table>

### Testosterone Enanthate

<table>
<thead>
<tr>
<th><strong>Administration</strong></th>
<th>Injectable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alternative Names</strong></td>
<td>Testosterone Enantate and Testosterone Heptanoate</td>
</tr>
<tr>
<td></td>
<td>Testosterona 200 (200mg/ml.10ml vial)</td>
</tr>
<tr>
<td><strong>Proprietary Names</strong></td>
<td>Androtardyl (250mg/ml), Delatestryl (200mg/ml), Durathate (200mg/ml), Malogen (100, 200mg/ml), Primoteston Depot (100, 180mg/ml), Testo-Enant (100, 250mg/ml), Testosteron Depot (50, 100, 250 mg/ml), Testoviron Depot (100, 250mg/ml)</td>
</tr>
<tr>
<td><strong>Street Info</strong></td>
<td>Testosterone Enanthate is very similar to Testosterone Cypionate; however, it brings lower chances of water retention than Testosterone Cypionate.</td>
</tr>
</tbody>
</table>

### Testosterone Cypionate

<table>
<thead>
<tr>
<th><strong>Administration</strong></th>
<th>Injectable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alternative Names</strong></td>
<td>Testosterone Cypionate and Testosterone Cyclopentylpropionate</td>
</tr>
<tr>
<td><strong>Proprietary Names</strong></td>
<td>Andro-Cyp (100, 200mg/ml), Depo-Testosterone (50, 100, 200mg/ml), Depotest (100, 200mg/ml), Duratest (100, 200mg/ml), Testa-C (200mg/ml), Testex Leo (100, 250mg/2ml)</td>
</tr>
<tr>
<td><strong>The Lowdown</strong></td>
<td>Testosterone Cypionate is a testosterone that has high anabolic and androgenic traits. It is an oil based steroid and long acting.</td>
</tr>
<tr>
<td><strong>Street Info</strong></td>
<td>Testosterone Cypionate aromatizes easily causing problems like gynaecomastia. Large dosages are associated with</td>
</tr>
</tbody>
</table>
psychological effects such as aggression, hypertension and premature balding. Acne are also a widely reported problems

### Methenolone Acetate

<table>
<thead>
<tr>
<th><strong>Administration</strong></th>
<th>Oral</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alternative Names</strong></td>
<td>Metenolone Acetate</td>
</tr>
<tr>
<td><strong>Proprietary Names</strong></td>
<td>Primobolan (5mg), Primobolan S (25mg)</td>
</tr>
<tr>
<td><strong>The Lowdown</strong></td>
<td>Primobolan tablets are not the C-17 alpha-alkylated. They don't possess liver toxicity linked with many of the oral anabolic steroids.</td>
</tr>
<tr>
<td><strong>Street Info</strong></td>
<td>Primobolan holds low androgenic properties leading to little aromatization, liver damage or water retention. It is usually taken as one of the safest anabolic steroids till date. Muscle gains have been reported as slow but of fine quality.</td>
</tr>
</tbody>
</table>

The wide range of drugs and dose combination steroid users makes it difficult to determine the agent responsible for an adverse effect. More reliable and concrete information on androgen impacts is available from the male contraceptive trials using higher number of replacement doses of androgens, from therapeutic methods of specific diseases like aplastic anemias with high dose androgen treatment, and the male hypogonadism with replacement-dose method of treatment. Even the replacement dose treatments cause side effects due to non-androgenic traits of the synthetic steroids like 17-alkylated testosterone, and some of the impacts will be commonly visible to androgen using sportspersons and athletes.

### Poor Techniques and Consequences of Steroid Use

Non-medical steroid users tend to self-administer the drugs, and most of them are unaware of proper injecting techniques. The drugs must not be used without the supervision of health medical experts.

Injecting drugs improperly can be a risky process with serious dangers
of disease and injury. The consequences of poor injecting methods are listed below.

*Infection*

Many non-medical steroid users have reported using the same injecting equipment, or using the same equipment on a repeated basis. This leads to a number of infections including life-threatening conditions like human immunodeficiency virus (HIV) and Hepatitis B. Poor hygiene or unsterile equipment also causes abscesses and inflammation at the site of the injection, which may be difficult to heal.

*Ligament, Tendon and Nerve Damage*

Improper injection procedures cause severe damage to ligaments and tendons causing impairment and pain during training. Nerve damage may result, which may cause impaired sensation and paralysis. Long-term mobility issues also occur due to poor intramuscular injection.

*Muscle Damage*

Injecting the same muscle repeatedly can lead to a breakdown and destruction of muscle tissue, causing impaired muscle function. Any consequential injection in these damaged muscles will be both highly painful and poorly absorbed by scarred tissue.

*Hemorrhage*

An accidental puncturing of a blood vessel inside a muscle can cause severe bleeding and the development of bruising deep within the muscle. This may cause discomfort and stiffness, limiting the ability to train and to perform.
Anabolic steroids function differently when compared to other drugs that may be misused. Anabolic steroids do not have a short-term impact on the brain, as do other drugs; for example, other substances are misused because they increase the presence of dopamine in the brain whereas steroids do not. However, long-term use of steroid use can impact some of the brain’s chemicals and pathways, including opioid systems, serotonin and dopamine. This could result in a significant impact on behavior and mood. In response to steroid addiction, some individuals have sought treatment. They report that behavioral therapy has been useful. However, more research is needed to determine the most effective and scientifically proven treatment options.

In some cases of severe substance use and addiction, patients have taken drugs to help treat the symptoms of steroid withdrawal, discussed below. For instance, health professionals have medically prescribed antidepressants to treat depression and sadness, or pain medication for muscle and joint pain and headaches. Other medications have been prescribed to help restore the hormonal system of the patient.

The short-term, negative impacts of anabolic steroids must be taken into account. These impacts occur if a person uses dose amounts that exceed medically prescribed numbers, which are specifically calculated for medical purposes by a health clinician. The clinician that prescribes steroids for patients must monitor the dosages and any side effects, so they can guard against potential steroid misuse and addiction.
Chronic Effects Of Anabolic Steroid Use

Anabolic steroid use can lead to extreme, permanent health issues including kidney failure, liver damage, an enlarged heart and conditions like high cholesterol and blood pressure. It also increases the risk of heart attack and stroke, even among young people.

Activational and Organizational Impacts of Steroids

Just as muscles may be sensitive to the impacts of steroid hormones, the brain also responds to steroid hormones during phases of development, differentiation and growth. These organizational impacts of steroid hormones on the growth and structure of the brain are irreversible; they take place either prenatally or much earlier in postnatal life (before the complete development of neural systems).

The activational impacts of steroids are those that happen during adulthood. They initiate short-term, reversible activation of formerly formed neural pathways. The activation impacts of steroids are based on the kind of specific organizational impacts of steroids that occurred earlier in life. Reference to activational and organizational impacts of steroids is backed by extensive experimental data and is referenced more frequently now to explain not just hormone impacts on behavior, as they were originally used, but also a range of hormonally mediated functional and structural dimorphisms of the human nervous system.

To attempt an explanation of the organizational-activational impact of steroids in humans, recent studies have evaluated their impact on non-human mammals. One study found that steroids can lead to long lasting and often permanent changes in brain behavior and
morphology even when administered to adult animals. For instance, in adult animals, androgen impacts the size of nuclei and somas of the androgen-sensitive motor neurons of the spinal nucleus of bulbocavemosus in mice. Apart from changes that result in brain morphology, short periods of exposure to anabolic steroids in adulthood may lead to long-lasting transformations in behavioral responsiveness. For instance, in female rodents, small periods of hormonal exposure may have facilitated a behavioral responsiveness to a later hormone injection.

**Steroid Action of Mechanism**

A key mechanism of steroid action in the brain is based on the interaction of hormone specific receptor complexes with the acceptor sites on the DNA. Due to these interactions, steroids affect the formation of a specific message and protein production by cells. Steroid actions involving changes in the protein formation are slow changes that need hours or sometimes days to cause observable physiological impacts. For instance, after an estradiol injection, at least 11 to 18 hours were needed by estradiol to trigger the nervous system for rodents to display sexual behavior, and optimal behavioral displays did not occur until 36 to 40 hours after the estradiol exposure.

Steroids also directly influence cell membranes mediated by specific receptors for the steroids on cell membranes or through interactions with the neurotransmitter receptors. Membrane effects by steroids seem to be fast and comparatively of shorter duration. Indeed, the presence of two distinct and separate action mechanisms of steroids in the nervous system, where one is very fast while another is quite
slow, needs to be considered to elucidate the potential misuse of steroids.

**Kidney Conditions**

The kidneys are responsible for excreting waste from the blood. They have a vital role of regulating salt and water quantities in the body and of regulating blood pressure. High blood pressure leads to significant damage to blood vessels and the filtration system of the kidneys. Anabolic steroids may affect the kidneys and their function. Steroids suppress blood clotting factors so in steroid users there is a noticeable increase in the average time it takes for blood to clot.

Oral steroid use leads to hormone dilution in the blood stream, making kidney function more difficult, which strains the kidneys. In addition, steroid users who are body builders or other type of athlete are usually on a high protein diet and they take high doses of protein supplements. This leads to the formation of kidney stones, which may require surgery to be removed. Kidney stones obstruct the urinary tract opening, blocking the ability of the user to expel urine and this may lead to the accumulation of harmful and poisonous waste in the blood. High blood pressure results, which damages blood vessels in the kidney by changing their proportion. Disruptive blood vessels lead to poor blood circulation and repress the filtration ability of the kidneys.

At the Columbia University Medical Center, Leal Herlitz, M.D. and her team recently conducted the study explaining kidney damage after extended misuse of steroids. The investigators examined 10 body
builders who had been on steroids for many years and who had
developed protein leakage in their urine, which affected their kidney
functions. The kidney tests showed that nine out of ten bodybuilders
were suffering from a condition called focal segmental
glomerulosclerosis, which is a kind of scarring in the kidneys. This
disease usually results in the kidneys overworking for extended time
periods.

The damage to the body builders’ kidneys were similar to damage
observed in morbidly obese patients only more extreme. After
discontinuing steroid use for a period of time, the kidneys’
abnormalities improved, except for one patient (body builder) who had
advanced kidney disease, i.e., end-stage kidney failure. This patient
required dialysis. In addition, one of the respondents started steroids
again and his kidney dysfunction returned. The researchers proposed
that extreme elevations in muscle mass require the kidneys to
increase their filtration rate, putting harmful levels of stress on these
organs. It had also been asserted that steroids hold direct toxic
impacts over the kidneys. Athletes using steroids and their health
clinicians should be informed of the potentially severe risks steroids
pose to the kidneys.

**Liver Damage and Failure**

Steroids are known to have negative consequences in the liver. The
liver filters harmful waste and toxins from the blood. The liver also
serves as a storage unit for some important nutrients such as minerals
and vitamins. It regulates the levels of various chemicals such as
proteins, cholesterol, and sugars.
The liver produces bile, which is a digestive juice that is extremely important for the human body’s food digestion. Extended and unsupervised steroid use is likely to cause long-term liver damage and may also cause liver cancer. It is extremely difficult for the liver to metabolize oral steroids. This blocks its ability to filtrate waste products in an efficient way; instead, waste material is retained and the accumulation causes severe complications.

Fake or counterfeit steroids are easily available in the black market, and are known to have different types of viruses and bacteria that negatively impact liver functioning. Ailments such as hepatocellular jaundice are caused by a malfunctioning liver. The symptoms include yellowing skin and eyes, which occurs because the liver is unable to filter toxins from the human body effectively.

Oral steroids such as Dianabol that are C-17 alpha alkylated steroids, are ingested and absorbed into the body’s circulation in the intestines, then transported to the liver. The liver is the primary deactivator (and metabolizer) of androgens like testosterone. This leads to elevated enzyme levels in the liver as observed in a patient through liver function tests. There are reported cases of jaundice caused by steroid use; however, this condition is more frequently seen among patients who take unusually high doses or who are suffering from a comorbidity. Peliosis hepatica has been confirmed in individuals who use steroids. This is a condition where blood-filled sacs are observed in the liver. Liver tumors have also been seen in non-medical steroid users. It is hard to prove the cause and effect, but in many people the tumors were reduced after steroid withdrawal. This suggests that steroids may trigger tumor growth instead of causing the tumor.
Case Study

A 30-year old male, working as a sports planner, has a medical checkup because he had been experiencing abdominal pain and general malaise for two months, which was followed by a two-week period by choluria, jaundice, intense pruritus and oligocholia. A weight loss of 14 kilograms was also reported. Family history seemed irrelevant and no evidence of alcohol consumption was found. Sexual contacts were reported with both males and females with condom protection and he was immunized against Hepatitis B. The patient was asked about any herbal remedy, self-administered drugs, natural product or health supplement he had been using. He reported the use of various AAS including the veterinary formulations during the last 32.5 months. The steroids used included those listed below:

- mesterolone (25 mg daily)
- testosterone undecanoate (40 mg daily)
- nandrolone undecanoate (30 mg daily)
- oxymetholone (50 mg daily)
- stanozolol (10 mg daily)
- testosterone (400 mg twice daily)

He reported that his physical trainer had prescribed these steroids for improving his body appearance and strength. The physical examination of the patient did not show any abnormality except liver enlargement (18 cm), jaundice and acne lesions on the upper torso. The laboratory observations were as follows:

- total bilirubin 29 mg/dL (conjugated bilirubin 25 mg/Dl)
- alanineaminotransferase 54 IU/L
• aspartate aminotransferase 65 IU/L
• alkaline phosphatase 694 IU/L
• g-glutamyl-transferase 69 IU/L
• total protein 7.4 g/Dl
• albumin 2.8 g/Dl

In addition, partial prothrombin and thromboplastin time were extended between 3 to 4 times the reference values. Hepatomegaly was confirmed by ultrasonography and ruled out vascular abnormality and related finding. A percutaneous liver biopsy was also conducted, showing histopathological changes with drug-triggered cholestasis of the canalicular type.75

Due to the temporal association between clinical abnormalities and steroid use, and because of these biopsy results, it was inferred that the use of steroids caused liver toxicity. The steroids were stopped and ursodeoxycholic acid treatment was started, although he consistently showed symptoms and cholestasis for the next two months. In the sixth month of the treatment, it was observed that the patient was doing better, his physical examination came out normal and the laboratory abnormalities returned to the reference values.74

**Heart Enlargement and Failure**

The use of steroids is associated with the enlargement of the left ventricle of the heart. Heart enlargement is more problematic if it occurs in the left ventricle and this is the area steroids are more likely to damage. Heart enlargement occurs on a gradual basis. A single dose does not lead to this problem. However, long-term use of high
doses of steroids is likely to cause harmful structural changes in the heart, eventually leading to heart failure.\textsuperscript{75}

There are a lot of factors and theories behind why anabolic steroids lead to heart enlargement. Firstly, extended periods of high blood pressure are believed to cause the left ventricle to enlarge, leading to high blood pressure. High blood pressure increases the size of the left ventricle since the heart has to work harder to pump an equal quantity of blood throughout the body.\textsuperscript{76} Since the left ventricle must struggle harder to pump blood, it slowly increases its size to balance the extra force being exerted on it. Long-term steroid use can lead to chronic high blood pressure, one of the major causes of left ventricle enlargement.

Secondly, anabolic steroids can also encourage heart cells to damage themselves. Some laboratory tests conducted on mice revealed that some steroids have toxic impacts on cardiac tissue. As a consequence of steroid misuse, some cardiac cells in these mice died. The same can happen in humans.\textsuperscript{76} As the dead heart cells are repaired, they are replaced with strong cartilage that can reasonably hinder the heart from working properly. This cartilage can also block heart tissue from contracting. Therefore, the heart has to compensate by making itself larger to achieve balance.

An enlarged heart hinders blood flow in the heart and raises blood pressure in the lungs. The left ventricle enlargement leads to congestive heart failure (CHF) if left untreated.\textsuperscript{77} Congestive heart failure arises when the left ventricle muscle has grown so big that it decreases the size of the ventricle itself. This decreases the amount of
blood that can enter the ventricle, and a chronic blood back-up develops. As blood backs up at the left ventricle, it does not have any place to go except the lungs. Because the right ventricle has already pumped blood to the lungs, blood pressure builds between the left ventricle of the heart and the lungs. If neglected, this condition may cause blood fluid to diffuse in the lungs.\textsuperscript{78}

In the middle and final stages of CHF, the affected patient develops a cracking voice as the presence of blood plasma in the lungs creates an audible sound as the patient breathes in and out.\textsuperscript{79} Again, it is noted that steroids do not cause this immediately. They increase the likelihood of an enlarged heart and heart failure over time due to the extended use of high doses of steroids.

Consequent changes of organ physiology and cellular pathology are similar to those observed in cardiomyopathy and heart failure. Ventricular remodeling, hypertension, sudden cardiac event and myocardial ischemia have been casually and temporally linked with anabolic steroids usage. These impacts stay long after the withdrawal of steroids and have a significant effect on subsequent mortality and morbidity.\textsuperscript{80}

**High Blood Pressure**

Steroid users must be informed of the complications that extended steroid use may cause to their heart. Recent research showed that most steroid users do not take this danger seriously, at least not until they experience a severe cardiovascular condition. Steroids cause heart ailments and it is more evident with a constant increase in cholesterol levels. Cholesterol accumulation has been seen on blood
vessel walls in steroid users. This condition may lead to a fatal heart attack or stroke.\textsuperscript{81}

Steroids also cause massive decreases in good cholesterol levels, high-density lipoproteins (HDL), and a radical increase in bad cholesterol levels, low-density lipoproteins (LDL).\textsuperscript{81} Blood pressure is also observed to be higher in steroid users and they are more vulnerable to increased blood clots. This condition eventually disrupts blood flow, impacting the muscle of the heart and elevating the risk of a heart attack. The resulting high blood pressure of steroid misuse also damages the inner lining of the arteries, called the endothelium. This leads to atherosclerosis, which is when the arteries narrow. The result may be a heart attack or stroke.

Studies of the side effects of steroid use have recommended that the thing that can increase blood pressure is a users’ sodium retention ability. High doses of steroids block the enzyme 11-beta hydroxylase, leading to a higher than required production of deoxycorticosterone, which is a mineralocorticoid found in the adrenal glands.\textsuperscript{82} This leads to water and sodium retention. The condition can also cause high blood pressure. In some cases, steroid users try to circumvent water and sodium retention by taking diuretic drugs but this led to other issues such as mineral imbalances and dehydration.

One of the latest case studies also highlighted unique problems among steroid users. Some users developed mysterious masses at the injection sites. The masses were thought to be sarcomas or connective tissue cancers.\textsuperscript{82} However, an analysis of the tissue samples disclosed
that the patient had a tumor. This is important because surgery to remove the tumor may not be indicated.

**High Cholesterol**

High dosing of anabolic steroids may raise low-density lipoprotein levels by almost 20 percent and decrease the high-density ones by 20 to 70 percent. This may be a result of the impact anabolic steroids has on other hormones. A majority of studies that considered the association between anabolic steroids and cholesterol levels found that testosterone, progesterone, DHT and estrogen have a significant impact on cholesterol levels.\(^{83}\)

Estrogen especially seems to be responsible for keeping the level of high-density lipoproteins (HDL) high. Though other hormones like testosterone, in particular DHT, may increase total cholesterol and high-density lipoproteins (LDL) cholesterol. It seems that this is done by overpowering the estrogen. For example, DHT holds anti-estrogenic properties. Hence, by decreasing estrogen, HDL decreases, which should result in raising LDL and total cholesterol.\(^{84}\)

Under usual circumstances, the human body limits the amount of hormones secreted by endocrine glands. However, steroids add hormones above these limits. Besides blocking natural hormone production, steroids negatively affect cholesterol levels.

The oral steroid greatly affects an enzyme found in the liver that breaks down high density lipoproteins. The lipoproteins prevent cardiovascular diseases.\(^{85}\) High-density lipoproteins carries cholesterol from the blood to the liver, where it is broken down into bile.
Cholesterol cannot be oxidized like fats so this process is the only way the body can rid itself of extra cholesterol. Steroids also increase low-density lipoproteins, which are the major carriers of cholesterol in the blood. Having high LDL means a higher chance of atherosclerosis particularly when LDL is oxidized.\textsuperscript{86}

A decline in high-density lipoproteins cholesterol is mostly seen with the use of nonaromatizable androgens such as stanozolol. This decline is significantly lower with the use of aromatizable androgens like testosterone.\textsuperscript{87}

The high blood pressure and cholesterol levels in steroid users, especially among non-medical steroid users, have been shown to contribute to a number of cardiovascular problems. In most of the reported cases, taken from different, recent studies and research, steroid use leads to high levels of both blood pressure and cholesterol, usually on a simultaneous basis. Health clinicians that are prescribing steroids to patients for medical purposes must monitor these conditions on a regular basis. In addition, before prescribing steroids to any patient, the clinician must check the patient’s blood pressure and cholesterol levels.

**Long-term Effects of Steroid Use in Men**

A number of long-term side effects are found among male steroid users. In this section, we will study the most common ones. These long-term effects usually arise due to extended use of anabolic steroids, and may appear within a few months after anabolic steroid use.
Testosterone Production

When a male takes steroids to increase testosterone levels, the steroids affect the balance of the body’s natural hormones, shutting down the body’s natural testosterone production. It eventually leads to smaller testicles.\textsuperscript{88}

Even after steroid use is stopped, a male will require time to recover normal testosterone production. It is a general rule of thumb that higher doses and extended use of steroids mean suppression of gonads for longer periods of time. It is unknown how often this condition becomes permanent in men. However, patients have had low testosterone production for two years after they discontinued steroids.\textsuperscript{89} In certain cases, though, males may develop long-lasting sexual and fertility dysfunction problems.

Testicular Atrophy

Testicular atrophy is the proper and scientific term used for testicles shrinking. It is the pathological condition in which testicles start off healthy, however slowly reduce in size. The condition can be caused due to injury, age, medical conditions like autoimmune illness and inguinal hernia. It generally occurs with loss of function.\textsuperscript{90} It is also one of the common side effects of steroid use. Trainers and bodybuilders exhibit smaller testes as compared to pre-pubertal boys.

Two kinds of cells make up the testicles: germ cells and Leydig cells. The task of the Leydig cell is to form testosterone, while germ cells form sperm.\textsuperscript{91} If cell production is even, then the testes stay full, round and firm. In case of reduced cell production, in either type, testicular atrophy results.
Testosterone formation is regulated in the body through the hypothalamic pituitary gonadal axis (HPG). The HPG mechanism works in the feedback loop, meaning that if the body is not forming sufficient testosterone, then the hypothalamus triggers the body to form more, and similarly, if the body is producing excessively, it suppresses the production. Steroids uplift the levels, causing the hypothalamus to send signals to the testicles not to produce testosterone. This is done by dumping excessive testosterone in the body, due to the use of steroids. The testicles react by necessarily becoming dormant. This also leads to a number of side effects such as erectile dysfunction, a loss of libido and smaller testes.

Most of the research and data on steroids, bodybuilders and testicular atrophy arises from case reports instead of cohort or longitudinal studies. For instance, a case report described a competitive body builder, who was 30 years old and who collapsed and died in his home after a weight-training session. The report revealed a number of side effects of extended steroid use, including liver problems, abnormal muscle growth and testicular atrophy. He had been on anabolic steroids for 6 months. This was not the only case. There are more severe cases recorded.

A study was conducted taking into account 100 steroid-using bodybuilders and athletes to determine (through a questionnaire) their dosage regime and associated side effects. Out of the the total, 88 percent reported that they had steroid side effects, while 40 percent specifically reported testicular atrophy. This was the highest reported side effect, after acne.
According to the *Journal Urology*, exogenous testosterone usually leads to atrophy of the germinal cells in normal men with different degrees of suppression of the spermatogenesis. When high doses of anabolic steroids are used, the semen levels (in quantity and quality) decrease significantly. This often causes infertility in later stages of life. As testosterone levels decrease and testes shrink, the ability to have and maintain an erection decreases, and overall libido levels fall. For instance, in 30 bodybuilders with high dose anabolic steroid use, a report revealed that just 17.7 percent of the respondents showed normal sperm levels.³⁴

It must be noted that in a majority of cases, testicular atrophy is a temporary condition. Once the body’s HPG feedback mechanism is stimulated because the body is not receiving anabolic steroids anymore, it will begin forming testosterone again, causing the testes to become larger and firmer, and return to normal.³³ It is to be noted though that the time consumed for full recovery could be as long as a few months. The changes in hormones are reversible once steroid use is discontinued but the long-term impacts on the hypothalamus-pituitary-testicular axis are not yet known.

One could say, “the bigger the steroid dose, the longer the recovery period.” Heavy steroid doses, for an extended time period, could mean that the user will not recover completely.³³

One way to accelerate the recovery process is to administer post-cycle therapy by taking testosterone boosters like TestoFuel, containing D-Aspartic acid (DAA). D-Aspartic acid is a compound that is clinically
proven to enhance testosterone production by an average 30 to 60 percent. It also stimulates the testes to form more testosterone, as well as to enhance seminal count by 100 percent. Since it is an amino acid, there are no side effects.\textsuperscript{94}

\textit{Decreased Sperm Count}

Steroids are also believed to cause impotence. Anabolic steroids obstruct the normal functioning of the testes. Administration of the hormone testosterone artificially causes the pituitary gland to trigger the testes to stop producing testosterone. When a user stops steroids, the testes take time to resume their usual function. In certain cases, the testes may never recover their normal function.\textsuperscript{95} Long-term use of steroids can lead to erectile dysfunction since it disrupts the flow of blood to the penile region.

Sperm is produced in the body when brain hormones like luteinizing hormone (LH) and stimulating follicle hormone (FSH) act directly on the testicles. The Leydig cells are then triggered to produce the male hormone testosterone.\textsuperscript{96} When this happens, there are extremely high levels of testosterone present in the testicle, though there is a normal testosterone level in the bloodstream. When males use steroids, the body is tricked into thinking that the testicles do not need to form testosterone. This way, the testosterone level in the testicles becomes severely low, in spite of very high or normal levels in the bloodstream. When this condition occurs, the follicle triggering hormone is not released. This leads to the testes shrinking and a lower sperm count.
When a man uses artificial forms of testosterone, the hypothalamus reacts by disrupting the body’s testosterone production process. One of the side effects of this action, even from therapeutic or conservative doses of testosterone, is a rapid reduction in sperm production, usually seen after 2 or 3 weeks. Due to this, testosterone is under strict consideration by the World Health Organization (WHO) as a male contraceptive.

Sperm production starts again if the injections of steroids are discontinued, and it is generally restored to normal degrees when the hormone has been totally cleared from the body. Even sperm production is restored but this is based on the timeframe of the testosterone injections and the male’s response.

In a case of a 31-year-old bodybuilder who was infertile for 6 years because of a low sperm count, it was found that he had consumed 8-week cycles of steroids for 5 years. An examination showed testicular atrophy, a low level of follicle-stimulating hormone (FSH), luteinizing hormone (LH) and testosterone. He was advised to stop using steroids immediately. Within a year, the sperm count and motility of the sperm observed were highly improved. His LH and FSH levels went back to normal range, though his testosterone level remained below normal. After 2 years, his sperm count was normal, but the testosterone still lagged. In spite of this, his wife became pregnant 20 months after the discontinuation of steroids.

In another case of a 33-year-old male diagnosed as infertile, with a zero sperm level, though his LH and FSH levels were below standard, his testosterone levels were normal because of the anabolic steroids
he was consuming at the time of physical examination. He quit using steroids and was reassessed after six months. After six months, his LH and FSH were below normal but his testosterone level was slightly measurable. Two months later, however, his testosterone level went back to normal range and his sperm count improved.99

The effect of anabolic steroids in males is dramatic. Men using steroids in addition to other health issues can face significantly lower sperm counts. They are unable to produce sperm for the simple reason that the testosterone in synthetic steroids decreases the brain’s stimulation of the testes.

Though anabolic steroids use can hinder sperm production, there are many cases where the problem was reversible. Higher doses for extended time periods increases the recovery time. It also affects the body’s recovery ability, and may lead to irreversible problems. Once the drugs are discontinued, sperm formation starts again but will not appear in the ejaculate for at least 3 months after steroids are discontinued.100 In fact, in a patient who used steroids for years, it often takes a year or so for sperm production to return to normal.

After discontinuing steroids for a period of time, medical therapy can also be used to enhance the body’s ability to restore sperm production. This is generally executed with human chorionic gonadotropin or HCG. In many cases, if HCG does not trigger sperm production, a kind of follicle-stimulating hormone (FSH) known as menopausal gonadotropin might be added to enhance the chance of normal sperm production.101
There are substances that play a role in stimulating the body to produce testosterone. Substances like Clomid or Climiphene, which are often used in females to enhance healthy eggs, can also promote sperm formation. Aromatase inhibitors may also promote sperm formation.\textsuperscript{102}

Hence, the condition of decreased sperm count can be treated in most cases. At least 80 percent of the males, even those who have been on extremely high doses of steroids, can recover completely. Sperm may not appear in their ejaculate but sperm may be extracted directly from a testicle in a process known as testicular sperm extraction. Even if the sperm count is low, there should be enough to be used with \textit{in vitro} fertilization.

Some researchers propose that if fertility is not improved within 6 months of discontinuing steroid use, medical intervention is necessary. Such treatments are usually based on the administration of gonadotropins to accelerate endogenous testosterone production and sperm count. These treatments utilize intramuscular injections of human chorionic gonadotropin (HCG), which act like LG, and also human menopausal gonadotropin, which promotes pregnancy in females and sperm count in males.

\textit{Baldness}

Steroids are also believed to cause hair damage. The male pattern of baldness has been seen in steroid users of both genders. Steroids encourage production of dihydrotestosterone or DHT, which weakens hair follicles and makes them shrink drastically. As a consequence, the hair follicles can produce fine hair only.\textsuperscript{103} Slowly, with steady use of...
anabolic steroids, the user is expected to face permanent hair loss and decreased hair follicles. It is mistakenly believed that steroids are responsible for hair loss; they lead to potential hair loss through hair follicles that are vulnerable to male pattern baldness.

Some athletes and bodybuilders give preference to human growth hormone (HGH) to run-of-the-mill steroids. The human growth hormone had been developed by the medical science to help people with hormone deficiencies. Patients who are unable to develop hormones, normally due to thyroid gland malfunction, are prescribed monthly or quarterly doses of HGH.¹⁰⁴

The oily, yellow-hued HGH is now being taken extensively by bodybuilders, as discussed earlier. A side effect of HGH is baldness.¹⁰⁴ There are a number of factors that determine if steroids will cause hair loss or baldness. Some factors are genetic and some are environmental. The latest theory of androgenetic alopecia (i.e., the male pattern baldness or hair loss) states that hormone dihydrotestosterone (DHT) is the culprit. This hormone ties the receptors in the hair follicle. With time, this makes the hair follicle shrink. In the end, it becomes so tiny that it stops producing hair.¹⁰⁵ However, DHT does not always equal hair loss.

Genetics also plays a role on the effects of DHT on hair follicles.¹⁰⁵ In rare cases, an individual may have hair that is resistant to DHT; even with high DHT hormone levels, this individual will not lose his hair.

Steroids act like the hormone testosterone, which naturally does not damage hair but an enzyme called 5-alpha reductase ties to
testosterone and turns it into DHT, which may then damage hair.
Since synthetic steroids are similar to testosterone in terms of structure, they can also be turned into DHT by 5-alpha reductase. Many steroids also include injection of a testosterone base. This additional testosterone can be turned into DHT. This means that taking steroids can enhance DHT levels.

Individuals who have hair that is genetically vulnerable to hair loss will lose more hair than normal with DHT from steroid use. If a person is prone to male pattern baldness genetically, he should not use the following steroids:

Anadrol (oxymetholone):

In spite of having a comparatively high anabolic to androgenic ratio, Anadrol is highly damaging to hair. It is rapidly metabolized into DHT and estrogen, facilitating hair loss at a much faster rate.

Dianabol (methandrostenolone):

Dianabol holds an anabolic-to-androgenic ratio of 90-210:40-60. In simple words, this steroid is more androgenic than anabolic so it is highly damaging to hair. The 5-alpha reductase inhibitors such as dutasteride and finasteride will not slow hair damage.

Trenbolone:

Trenbolone is another anabolic steroid that may damage hair. It is a derivative of DHT.
Winstrol:

Winstrol is perhaps the worst anabolic steroid for hair damage. Like Dinabol and Trenbolone, even heavy doses of dutasteride and finasteride taken with this steroid will not stop hair loss. Even users who were not specifically vulnerable to androgenic alopecia showed hair loss while using this steroid. Other steroids that damage the hair include masteron, primobolan, proviron and anavar.

Gynecomastia

Gynecomastia, or breast growth, is one of the most common side effects of anabolic steroid use. It is usually seen in steroid users having extended steroid use or those using steroids in heavy doses. Breast tissue develops in the chest of men that slowly takes the form of lumps under the nipples. Timely surgical intervention is required to eliminate the lumps and avoid further complications, such as cancerous growth. In females using steroids, the breasts will shrink.

Steroids are transformed into estrogen by the body’s fat cells. The increased estrogen levels cause male steroid users to develop unfavorable breast tissue. There are a lot of companies that sell estrogen blocks with the claim that estrogen conversion will be blocked and gynecomastia prevented. Many body builders and athletes are taking steroids, relying on this claim. Another misconception in the community is the belief that even if breasts are enlarged while using steroids, they will go back to their smaller size after steroid use is stopped. This is not true. Breast tissue that develops from steroid use does not go away. It becomes permanent. Not even chest workouts
and diet can remedy this issue. The only solution to remove this breast tissue, as mentioned earlier, is gynecomastia surgery.\textsuperscript{110}

Anabolic steroids, hormone enhancers and growth promoters can all lead to gynecomastia as early as one week after use. Usually, the condition is diagnosed in the presence of sensitivity in the nipple area. This often turns into significant discomfort, leading men to consult with their physician. Tissue develops in the breast, causing the area to swell and to be painful. The breast keeps extending under the arm, making arm movements and weight lifting painful.\textsuperscript{110} The condition is less severe when there is a mass underneath the nipple. The most serious cases are those where full, coning breasts are observed. Not all anabolic steroids cause gynecomastia, however, they all have side effects. Steroids that aromatize cause this condition, which include Sustanon, Anadrol and Dianabol.\textsuperscript{111} The duration it takes and its severity are based on steroid dose and strength.

Steroids lead to high estrogen levels and a decrease in testosterone levels, which cause breast tissue development. Steroid use is guaranteed to cause this condition and treatment is expensive. Estrogen blockers like Nolvadex and Arimidex also prevent this\textsuperscript{111} but once breasts are fully developed, surgery is the only treatment option.

The following are the most common options for treating gynecomastia:\textsuperscript{112}

<table>
<thead>
<tr>
<th>TREATMENT</th>
<th>HOW</th>
<th>DOWNTIME</th>
<th>COST</th>
<th>EFFECT</th>
</tr>
</thead>
</table>

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The following are the pros and cons of the various treatment options:

<table>
<thead>
<tr>
<th>TREATMENT OPTIONS</th>
<th>PROS</th>
<th>CONS</th>
<th>EFFECTIVENESS</th>
<th>COST</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gynecomastia Surgery</strong></td>
<td>Guaranteed results Tailored treatment as per patient’s age, medical history, physical state, and stage of gynecomastia. The program involves post-surgery care recommendations that can be life changing such as nutritional advising.</td>
<td>Minimal scarring May cause bruising, swelling and pain Less sleep High Cost No weight lifting Post-surgery care</td>
<td>Permanent</td>
<td>Around $6500 - $7000</td>
</tr>
</tbody>
</table>
**Increased Risk of Prostate Cancer**

Steroids damage the prostate gland in men. The prostate gland produces prostatic fluid. This fluid is the major element of semen and controls seminal activity. Steroids lead to an engorged prostate gland. The swelling of the prostate gland disrupts the flow of urine as it surrounds the urethra. Males are prone to experience affected sexual
activity because of the changes in the gland.\textsuperscript{113} Sperm count and quality are also affected. Harm to the prostate gland makes the male impotent.

Before the connection between prostate cancer and steroids can be addressed, consideration must be given to the possible actions of steroids on prostate growth. The prostate develops during puberty.\textsuperscript{114} At the age of 25, the prostate begins to grow again in a second phase, which eventually leads to enlargement of the prostate. Research indicates that 50 percent of men will have prostate enlargement after reaching age 60.

Steroids trigger androgen receptors in the prostate. High doses of androgenic steroids may cause prostate enlargement or growth called Benign Prostate Hyperplasia (BPH) in a small period of time.\textsuperscript{115} As levels of androgenic steroids fall, the prostate will shrink again; however, it may not shrink to its earlier size.

It is to be noted that prostate cancer and BPH are not the same. Benign Prostate Hyperplasia is a condition to describe prostate enlargement. Prostate cancer is more common in men using steroids than non-steroid users.\textsuperscript{116} Prostate cancer takes time to grow. Elderly men may live decades with this condition and not even know they have it.

Low levels of testosterone are linked with more serious prostate disease, not high serum testosterone levels.\textsuperscript{116} A higher occurrence of prostate cancer has been observed in males having low anabolic steroid levels. In a study involving 238 people, patients with prostate
cancer were observed to have lower serum anabolic steroids than others within the study group.\textsuperscript{117}

The prostate is affected by the serum levels of testosterone and the use of anabolic steroids can also lead to morphological changes in prostate tissue. These findings suggest that anabolic steroids can initiate functional changes and chronic diseases of the prostate and lower fertility.\textsuperscript{118}

Research shows that at the age of sexual maturity, the secretory activity of the epithelium and the differentiation of the smooth muscles are also well maintained and controlled by androgens. In the prostate gland, the basal and luminal epithelium and smooth muscle cells and stroma express androgen receptors at sexual development, and therefore they are able to mediate androgenic functions.\textsuperscript{119} As a response to androgen, the prostate cells mingle in an autocrine-paracrine manner, affecting different aspects of the growth of the prostate gland in normal and diseased conditions.

Studies also depict that the prostate passes through varied alterations in stromal and epithelial compartments after surgical and hormonal ablation. These processes cause a decrease in glandular function with an immediate decline in stromal volume and epithelium thickness.\textsuperscript{120}

**Long-term Effects of Steroid Use in Women**

Anabolic steroids are artificial versions of the hormone testosterone, as already mentioned. Steroids are prescribed by medical clinicians to treat strict medical conditions like wasting diseases and delayed puberty. However, steroids are also used illegally to enhance physical
appearance and athletic ability. Though steroids are popular mainly among body builders, it is used by females, as revealed by the United States Department of Justice. In this section, various side effects of steroids in women are discussed.

*Excessive Facial/Body Hair*

Because of the androgenic properties of steroids, females may encounter side effects similar to pubescent males, like increased facial or body hair and a deeper voice. As stated by one of the latest studies from the Mayo Clinic, anabolic steroids may also lead to reduced breast size. These changes, such as a deeper voice, may be permanent.

The development of a deeper voice is a symptom of virilization. Once this is diagnosed, the drug should be discontinued to enable recovery. The recovery may be complete but hoarseness that persists for 3 months after discontinuation of steroids is likely to be permanent.

Skin changes are obvious in many cases. In addition, changes in skin texture is the first abnormal symptom seen. The growth of facial hair is of two kinds: 1) A fine soft hair all over the face that would vanish on discontinuation of the drug, and 2) A darker thicker hair in the beard area, which is likely to be permanent.

Testosterone controls hair growth by impacting the follicles. It can develop various hair types, like pubic, scalp hair and facial hair. The higher the testosterone levels are in vitro, the greater are the chances a female steroid user will grow hair.
Male Pattern Baldness

As discussed in the earlier section on male pattern baldness, one of the possible causes of hair loss is anabolic steroids. Not all anabolic steroids carry this side effect, but most of them do. If a person has hair loss while using steroids, chances are the steroids are the culprit.

Hair loss experts and medical clinicians assert that androgenic alopecia, also called male pattern baldness, usually results due to DHT (dihydrotestosterone) and some other hormonal factors, although DHT is considered the major cause. This happens when the DHT ties to hair follicles that are not programmed genetically to handle the hormone. This causes inflammation and weakened hair. Eventually hair sheds as the process continues. In simple words, it can be said that DHT causes male pattern baldness.

When a woman is genetically vulnerable to male pattern baldness, the use of steroids will likely facilitate potential hair loss because of high DHT levels. As mentioned, there is a widespread misconception that anabolic steroids cause hair loss by themselves. Steroids cause hair loss in those follicles that are genetically vulnerable to male pattern baldness. It means that if a female is not genetically vulnerable to hair loss, hair loss may not occur.

Primarily, androgenic compounds lead to DHT side effects, i.e., accelerated, genetic hair loss. Most steroids are DHT based, hence, one of the potential side effects associated with them is hair loss. The higher the steroid’s androgenic rating, the higher the chances are for genetic hair loss. Steroids that accelerated genetic hair loss include:
Menstruation Changes

Irregularity in the menstrual cycle, and often complete cessation of menstruation, might be caused by steroids. With steroid courses of 6-week duration, it is harder to determine if the menstrual disturbance is due to steroid use. Steroid courses that are of longer duration are more likely to cause longer durations of amenorrhea and thus a longer period of steroid cessation is needed.\textsuperscript{125} It is critical to note that if another steroid course is contemplated, the patient should wait until menstruation is restored prior to beginning a new course of steroids. Pregnancy is the most common cause for menstrual absence and should be eliminated before any other treatment is started. Once this is done, glandular abnormality must be inspected.

In recent reported cases, it has been established that steroids can seriously interfere with a female’s menstrual cycle. Many women have reported experiencing irregular menstrual cycles after using steroids for extended time periods. In addition, some women reported heavy bleeding, upset stomach, and abdominal cramps while using steroids. Steroid users must be aware that steroids may cause hormonal changes in the user’s body. Steroids are known to cause various
hormonal imbalances leading to emotional problems. For instance, users may experience severe depression, labile moods, higher anxiety and other related signs of mood dysregulation.

Various anabolic steroids such as Oxymetholone, Ethylestrenol and Nandrolone are believed to block ovulation and initiate amenorrhea. However, the quantity of these elements used also play an important role in blocking menstruation. The effect anabolic steroids have on the reproductive system is also largely a factor of body chemistry. Many cases reported the use of small amounts of testosterone with the result that the woman’s regular menstrual cycle was maintained; however, there are also cases where women stopped menstruating permanently even with small quantities of steroids. This means that steroids interfere with estrogen/progesterone cycles.

Menstrual cycles may end up being absent, intermittent, or very infrequent. On discontinuation of the anabolic steroid use, the menstrual cycle should return to normal condition, though some patients may need several months for the restoration of the menstrual cycle, while others might have a rapid restoration of normal function.

**Clitoris Hypertrophy**

The male and female sex organs are developmentally associated in various ways, and so they have the same reactions to hormonal activity going on in a body even though sex organs of male and female differentiate during the development phase in the womb. The female sex organ is responsive to androgenic hormones into adulthood, and a
radical increase in androgen levels through exogenous sources may result in clitoris enlargement,\textsuperscript{127} known as clitoromegaly.

Being very closely related to the penis, the clitoris may eventually increase in size to the point that it starts resembling a penis and can even have similar features (like enlargement during sexual arousal).\textsuperscript{127} As with all such side effects, this development is based on the potency of the androgen used, its dosage and the tenure of use. The impacts of all these factors should be obvious to a user. Heavy doses of strong steroids for extended use provides radical hormonal stimulation to clitoral tissue and rapid and considerable clitoral hypertrophy (enlargement of the clitoris) may arise.

It should be kept in mind that stronger androgens like Trenbolone, Dianabol and testosterone, \textit{etc.}, are likely to result in rapid and large hormonal stimulation as compared to anabolic steroids that are milder in terms of their androgenic strength, such as Primoboloan, Anavar, Nandrolone, \textit{etc}. Clitoromegaly may develop from slight and unnoticeable growth to excessive enlargement of clitoris when the levels of androgen in women remain high for long periods of time.\textsuperscript{128}

Just like dysphonia (deepening of a female’s voice), changes in the size of the clitoris are reversible if steroid use is immediately discontinued when the early signs and symptoms of clitoromegaly are noticed. However, if left as it is, growth can be more pronounced as anabolic steroid use is not discontinued, leading to the stage when surgical reconstruction is the only available treatment option.\textsuperscript{128}

\textit{Deepened Voice}
Androgens are responsible for male secondary sex features. One of these features is a deeper voice. Androgen receptors are present in the larynx tissues and muscles. These are involved in the human’s vocal function. Prolonged and heavy exposure to androgenic anabolic steroids deepens the voice in males during their adulthood and puberty; and the same is the case for females who are engaged in chronic anabolic steroid consumption.129

Because females are not exposed naturally to this degree of androgen exposure, they do not develop vocal changes naturally. The use of exogenous steroids, however, may cause a woman’s voice to deepen. The deepening of the voice is based on the course, duration and dose, and is usually slow to grow with early symptoms.129 The first symptom is a noticeable hoarsening and cracking of the voice. These changes are usually similar to the same changes seen in pubescent males. If steroid use is not stopped, the development of these changes, a male-like voice with the same tone and pitch, may fully develop. Anabolic steroids that are more powerful androgens are the highest risk for causing this side effect, since the stronger androgenic substances may lead to a faster manifestation of dysphonia than those steroids that are milder in terms of androgenicity.130 The strongest androgenic compounds that cause this side effect in females are testosterone, dianabol, trenbolone, and fluoxymesterone.

Steroids with lower androgenic strength ratings do not cause dysphonia; however, as demonstrated in some studies, extended exposure to steroids like Deca-Durabolin (Nandrolone Decanoate) and Anavar (Oxandrolone) have caused dysphonia in females even when given as therapeutic dosages and under a medical prescription.131
Immediate discontinuation of anabolic steroids should occur after the appearance of dysphonia to stop its continuous development. Most of the dysphonic changes up to a certain point can reverse, though it must be noted that certain vocal changes might be permanent, in particular when the development of dysphonia reaches the later stages.

**Long-term Effects of Steroid Use in Teens**

The illegal use of anabolic steroids can lead to both temporary and permanent side effects to anyone using these. Teens, whose bodies are in the development phase, are at extreme risk. An increasing number of teens are turning to steroids for improving their physical appearance and athletic performance.

As stated above, anabolic steroids function like testosterone, the male sex hormone. This includes accelerating cell growth, especially in the muscles, and it includes maintaining or enhancing a male physique and male characteristics. A number of studies published by the Youth Risk and Behavior Surveillance System, showed that 4.9 percent of males and 2.4 percent of females in high school have used anabolic steroids at least once in their lives. This means that over 300,000 male teens and over 100,000 females have used steroids.\(^{132}\)

Anabolic steroids are believed to have numerous serious impacts on a number of organ systems, and in various cases the damage is not reversible. These include impotence, fertility problems, cholesterol, high blood pressure and liver and heart abnormalities.\(^{133}\) Teenage boys experience shrinkage of their testes or the development of breast tissue, while girls may encounter menstrual irregularities and growth of masculine features like body and facial hair. Acne, mood swings,
aggression and depression may be present in male and female steroid users.

*Stunted Growth*

Anabolic steroids have been established as a leading cause of stunted growth in adolescents. Steroids may cause premature closure of the epiphyses of the bones. This is the developmental part of the bone and as soon as closure at that site happens, no further growth is possible.\(^{133}\) This decreases the potential advantages of steroids for people interested in body building contests and appearance. Once this occurs, no method is available so far to reverse it.

An excessive level of testosterone is released into the male body quite early, and it triggers puberty at an early stage.\(^{134}\) It implies that the duration and time for height increase or growth is decreased, and so this decreases the child’s final height. As the majority of boys start puberty between the ages of 10-12 years, a boy would need to start consuming steroids at the age of 10-11 years to test whether steroids decrease an individual’s final height by any significant amount.\(^{134}\)

If the anabolic steroids are taken once puberty starts, while the person is still growing, testosterone may have a minimal effect. The chondrocytes number is already decreasing and are limited in the resting area; and an influx of the testosterone aromatized into an estrogen is expected to saturate the system because there are just so many estrogen receptors on the growth area. In general, and in a majority of cases, the high intake of hormone testosterone is more likely to stop growth than enhance it.
Steroid Withdrawal Symptoms

Steroid withdrawal occurs when the user’s body starts to adjust and respond to a reduction in consumption of steroids through the time the user stops taking steroids completely. During this time frame, the body slowly starts manufacturing its hormones to fill the gaps that arise due to steroid level reductions.

Withdrawal symptoms can be observed in users who have not been using steroids for a long time. It is quite important for the steroid user to keep consulting their medical clinician while using any steroid. A patient should carry the prescription issued by his/her medical clinician in order to be helped if an issue arises. The clinician must decide in advance when to start and when to stop steroid administration to decrease the impact of the symptoms and reduce the chance of a severe complication that may result due to withdrawals. Patients who discontinue high-dose steroid courses are at a higher risk of facing a major complication.

A number of steroid hormones are produced in the body by the adrenal gland. Most often than not this hormone production fails to meet the needs of the body, for a couple of reasons. In these medical cases a patient may be prescribed steroids as a supplement to accelerate the patient’s natural production of hormone.

In certain cases, a medical clinician intentionally increases the steroid levels in a patient’s body for the effective treatment of inflammation. Due to the external steroid administration, the body tries to adjust to the changes by decreasing natural steroid formation. When this external administration is decreased, and finally stopped, the adrenal
gland reacts to low hormone levels by forming hormones and the hormone production is increased.\textsuperscript{135}

Impacts of steroid withdrawal are known to bring various other medical complications. Loss of appetite, weakness, weight loss, fatigue, nausea, vomiting, abdominal pain as well as diarrhea are some of the common complications associated with steroid withdrawal. A steady decline in blood pressure is another complication. This complication may cause a patient to faint or feel dizzy.

In addition, blood sugar levels are also seen to be dropped in many users.\textsuperscript{136} In women, menstrual cycles may be disrupted or even stop completely. Joints and muscle pain, changes in thoughts, fever and higher calcium levels have also been reported. Gastrointestinal contractions are reduced radically, leading to intestinal swelling. During the period of withdrawal, users must keep checking with their medical clinician to be updated on a continuous basis regarding their body changes caused when steroid use is stopped. Patients must follow their medical clinician’s prescription and should discuss any questions or issues during medical follow up visits.

All suspected or unfavorable complications must be reported. This helps to diagnose potential complications that may arise due to steroid withdrawal before they can develop into a non-treatable form. Some of the most common signs of steroid withdrawals include severe acne, paranoia, conditions like unreasonable or excessive jealousy, delusions, extreme irritability, hypomanic or manic symptoms like extreme mood changes, tension and suicidal tendencies.
Mood Swings

Mood swings are one of the most common side effects of steroids. Many relationships have been negatively affected as a result of extreme mood swings that are experienced by steroid users. The irritability shown by men and women on steroids are similar to premenstrual tension syndrome. Anabolic steroids, though, also have the opposite psychological impact.

Anabolic steroids act like a potent mood elevator, hence mimicking the impacts that are faced while using antidepressant medications. When the steroid cycle is discontinued, a lot of male athletes are faced with the condition called an “estrogen outbound.” The other hormone produced by a male in smaller quantities than females is affected during the anabolic steroid cycle. Once this cycle is discontinued, the estrogen production that has been affected during the steroid cycle is then released in a huge quantity. The higher the dosage of the anabolic steroids taken for an extended period of time, the more extreme the estrogen rebound will be.

In users who have been on steroid doses higher than 30 milligrams per day, mood swings are more frequent, as reported in some studies. Some users also reported a feeling of depression, while others experienced labile emotions (of up and down) without any apparent reason. Some users reported feeling anxious and irritable.

Just knowing that steroid withdrawal results in mood swings makes it easier to bear; however, avoiding this side effect requires that the user decrease steroid usage over time. If a steroid dose is necessary to treat a medical condition, then another medication may be added by
the physician to treat mood swings. The patient should make sure that family and friends are aware of this side effect so that they will understand the mood symptoms as they arise. Informing others about this problem also helps the patient identify the changes in his/her behavior.

_Fatigue, Restlessness and Loss of Appetite_

Fast withdrawal of steroids, especially if the patient has been using them for more than 3 weeks, may cause fatigue, along with restlessness, loss of appetite, muscle stiffness, joint pain, muscle tenderness, and fever. These signs could be difficult to separate from those of an underlying disease. Therefore, steroids should be withdrawn slowly over time.

If a person stops or reduces taking steroids, the person will likely experience fatigue. The patient must consult with a medical clinician on a regular basis for any needed adjustment of the steroid dose. Lifestyle changes such as a good diet, and exercise may also help decrease depression, fatigue and dizziness.

_Sleep Problems_

Steroid withdrawal also decreases the ability of the user to fall asleep, especially when the steroids are consumed in the evening. A patient may require a dose in the morning, which a medical clinician may prescribe if appropriate. Regular sleep times also help reduce sleep problems. Other things patients may do include improving their environment so it is more conducive to sleep, and learn relaxation exercises. The combination of decreased steroid use and these
measures, may reduce sleep problems. However, when sleep problems persist a patient must consult with his or her prescribing clinician.

*Decreased Sex Drive and Steroid Cravings*

Steroid withdrawal leads to steroid cravings, since the patient is accustomed to taking steroids in expected doses. When the patient does not get the expected dose, a hormonal imbalance occurs in the body, leading to depression, anxiety, anger, aggression and cravings for steroids. These steroid withdrawal symptoms, especially steroid craving, also negatively affect the relationships of the user, impacting his or her sexual and social life.

The patient must consult with a medical clinician to report these physical conditions and to discuss solutions on how to cope with cravings. Also, the patient should discuss these issues with his or her partner.

*Management of Steroid Withdrawal*

Some patients claim to have successfully turned to behavioral therapy to curb anabolic steroid addiction. More research is required in this area to identify the most successful treatment options. In some cases of severe addiction, users have taken medications to help treat withdrawal symptoms. For instance, health experts often prescribe antidepressants to treat restlessness and depression and pain killers for muscle and joint pain and headaches. Other specific medications are also used to restore a user’s hormonal system.

As shown by various studies, the withdrawal symptoms of steroids can be managed and controlled to a large extent by working in
collaboration with a medical specialist or clinical team and having an effective and timely health plan. Patients who are under steroid medication must work towards handling the side effect to avoid unfavorable conditions that are linked with steroid use and withdrawal. It is critically important to evaluate and analyze the long-term impacts that follow the usage of steroids and withdrawal. Some of the measures users can take to manage the side effects of anabolic steroids and to cope with withdrawal are given below.

**Well Regulated and Healthy Diet**

A healthy, well-regulated and improved diet is the first step towards managing steroid withdrawal symptoms. Steroids enhance blood sugar levels and that leaves the body exposed to diabetes risk. When the sugar content is high in the blood stream, it may cause fatigue, migraines and confusion. It is recommended to regulate carbohydrates and sugar intake during withdrawal. During this period, a patient should have blood sugar tests on a regular basis and consult his or her medical clinician to update the patient’s diet chart accordingly. This is especially recommended to those who have been long-term steroid users. It is important to keep salt intake low since high salt intake also causes higher blood pressure.

**Regular Exercise**

Exercise is another measure that helps to fight the symptoms of steroid withdrawal. Steroid use is known to cause muscle stiffness and weakness. The same occurs when a patient gradually decreases the doses. Exercise and physical activities that test the joints and muscles are recommended to strengthen muscles effectively. However, an individual should not push the limits, especially since steroids give a
person a false feeling of strength at times. An exercise plan must be developed and implemented in consultation with the patient’s medical clinician for appropriate exercises and techniques. Exercise also helps reduce the risk of osteoporosis, which is another withdrawal symptom of steroids.

**Supplements**

There are the supplements that help reduce mineral deficiencies. These supplements may be used by a patient to normalize the mineral resources in the body, which may have been decreased because of steroid use. Users should also stock up on Vitamin D and Calcium, since these are the primary minerals that prevent bone loss; a symptom of steroid withdrawal.

**Avoid Stress**

During steroid withdrawal, users should also take measures to reduce stress. They must participate in the activities they enjoy the most and do it daily. Ideally, meditation and yoga serve as great stress relievers; however, users may start with something simple like reading, or another activity that they are comfortable with. It is important that users exert an effort to maintain their physical as well as emotional health, since both go hand-in-hand.

**Avoid Unhealthy Habits**

Steroid users who have been passing through steroid withdrawal should also avoid bad habits like drinking, smoking, etc. They must do it especially if they want their steroid therapy to be successful. Steroids do not interact with the toxins from tobacco and alcohol in a
positive way.\textsuperscript{143} In order to avoid severe complications that may arise, a patient should avoid tobacco and alcohol.

\textit{Maintaining an Instructional Manual}

Steroids users that are under steroid withdrawal, should keep an instructional manual of steroids.\textsuperscript{144} This helps them respond to the withdrawal symptoms on a timely basis and avoid mistakes about doses.

Steroid withdrawal can only be addressed by planning, and may only be executed properly if patients consult with their medical clinician. There are various symptoms that become visible after a person discontinues steroids.\textsuperscript{145} A patient may require prescription medication to address these symptoms and to recover.

\textbf{Summary}

The perception that anabolic steroids can be used to accelerate the body’s strength and weight has led to their increased use in sports today. Most athletes and those involved in strength sports are taking doses of anabolic steroids. Anabolic steroids, being available from illicit sources, are now readily accessible to people pursuing extensive training and participating in competitions like weight lifting, wrestling, and other strength based contests. In addition, people who are obsessed with having perfect physical appearances are also misusing anabolic steroids.

There is no current available research to help determine the impact of a specific quantity of steroid in a weight training session. If gain is
achieved with large steroid dosing it is not essentially true that the
dose was the most appropriate one. There are steroids that produce
the same effects in large doses as other steroids produce in small
doses. The spread of excess steroid throughout the body produces side
effects before the material is damaged in the liver.

The wide range of drugs and dose combinations used by steroid users
make it harder to determine the agent liable for an adverse effect.
Anabolic steroid use can affect several organs and their functions,
including the kidneys, blood and clotting factors, long-term liver
damage, and may also cause cancerous growth in the liver. The use of
steroids is associated with the enlargement of the left ventricle of the
heart. Heart enlargement is more problematic if it occurs in the left
ventricle. Steroids cause heart ailments and it is more evident with
constant increase in cholesterol levels. Cholesterol accumulation has
been seen on the blood vessels walls in steroid users, which may
cause fatal heart strokes. As found by the majority of studies
regarding the association between anabolic steroids and cholesterol
levels, testosterone, progesterone, DHT and estrogen have found to
have significant impact on cholesterol levels of steroid users.

Though anabolic steroids are not as addictive as some other drugs,
they still have addictive potential. As revealed by studies, people may
self-administer steroids if they have a chance, just as they do in cases
of other drug use and addiction. People might keep on using steroids
irrespective of the physical problems, high cost, and negative impacts
on their relationships. These behaviors show addictive potential of
anabolic steroids. Research has found that some steroids users also
start using other drugs like opioids, for reducing irritability and sleep problems resulting from steroids.

Withdrawal symptoms have been observed in steroid users who have stopped using steroids, such as mood swings, fatigue, restlessness and loss of appetite, insomnia, decreased sex drive and steroid cravings.

This article highlighted that often athletes who are involved in steroid use are in a continuous cat and mouse game with doping and testing authorities. Body builders will try and plan steroid use to make sure that the drug is out of their system before the scheduled drug test takes place. Black market dealers have been introducing and distributing steroids called designer steroids that make the steroids undetectable or unidentifiable during testing. It is important that individuals opting to use anabolic steroids consult with a medical clinician on proper treatment and on how to report physical conditions or potential side effects and the development of cravings and addiction.

The role of health professionals during evaluation and follow-up in cases of anabolic steroid use, especially in the setting of complications related to physical and mental health, including substance use and addiction, was raised. Patients and their families should be encouraged to participate in a professional health plan that includes ongoing medical monitoring and health education of the benefits and risks of varied types of anabolic steroid use.
References

The reference section of in-text citations include published works intended as helpful material for further reading.


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