



# **Use of Performance Enhancing Agents (PEAs) (Including Anabolic Androgenic Steroids-AASs) among the Male Body Building Community in the Western Province of Sri Lanka a Preliminary Study**

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## **Author's contribution**

*The sole author designed, analysed, interpreted and prepared the manuscript.*

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## **ABSTRACT**

Performance enhancing agents (PEAs) are substances used to improve any form of activity performed by humans. These are widely used by athletes and body builders. Being a frequent subject of controversy in the sporting world, the use of performance-enhancing drugs has shown a disturbing growth over the past fifty years. The use of drugs to enhance human performance in sports has occurred at least since the time of the original Olympic Games (from 776 to 393 BC). In 1860s, a group of swimmers in Amsterdam were charged for taking drugs to speed up their races. For the next 80 years, athletes who wanted to cheat focused mostly on stimulants to speed themselves up. A wide range of PEAs are used today in the sports field. They include Anabolic Androgenic Steroids (AASs), peptide hormones, growth factors, beta-2 agonists, diuretics, masking agents, stimulants, narcotics and even cannabinoids. Though extensive research is being done on the use of PEAs and doping in the sports industry, throughout the developed world, very few published research is available from the third world countries including Sri Lanka. This preliminary

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study revealed that a wide variety of PEAs are being inadvertently used without justifiable scientific reason and without a reasonable understanding of how they work and what their adverse effects are, by the gym users in Sri Lanka. It also showed that a significant proportion of them experience side effects directly attributable to the use of PEAs.

*Keywords: Performance enhancing agents; anabolic androgenic steroids; body-building; sports; gynaecomastia; male subfertility.*

## 1. INTRODUCTION

Anecdotal information suggests widespread use of PEAs by the body building community in Sri Lanka. Despite extensive research elsewhere in the world, little research is available in Sri Lanka to achieve a better picture on this potentially harmful situation. The global life time prevalence of AASs abuse is 6.4% for males and 1.6% for females [1]. The real incidence is difficult to evaluate, but a recent study indicated that more than 1 million Americans are current or former users [1]. Boje in 1939 was the first to suggest that exogenous testosterone administration may enhance athletic performance. By the late 1940's and 1950's testosterone compounds were experimented with by some west-coast bodybuilders. The first dramatic reports of anabolic steroid use occurred following the 1954 weightlifting championships [2]. Their beneficial effects on all sports demanding peak physical performance were noticed in the early 1950s. The International Olympic Committee included AASs on a list of prohibited substances in 1975 and testosterone in 1982; Due to the hidden nature of doping, estimating the extent of doping abuse in modern organized sports is difficult though it is clear that throughout the world, the majority of positive doping test results are due to AASs abuse [2]. In addition to AASs; peptide hormones and growth factors, beta-2 agonists, diuretics, masking agents, stimulants, narcotics and even cannabinoids are among the other substances widely used as performance enhancing agents.

Anabolic Androgenic Steroids are synthetic derivatives of testosterone. They are Appearance and Performance-Enhancing Drugs (APEDs) used in competitive athletics, in recreational sports and by body builders. Many AASs are often obtained from the internet and other dubious sources and they have not undergone proper testing and are consumed at extremely high doses and in irrational combinations along with other drugs [2,3]. They are structurally related to and have similar effects of testosterone in the body. Testosterone has

two primary functions: androgenic functions and anabolic functions. The androgenic functions of testosterone are responsible for the changes in the primary and secondary male sexual characteristics while anabolic functions are responsible for accelerating the growth of muscle tissue, bone and erythrocytes and aid in enhancing the development of neural pathways [4]. Anabolic steroids have been manufactured to enhance the anabolic properties of the androgens and minimize the androgenic properties. Yet, no steroid has eliminated the androgenic effects because the so-called androgenic effects are really the anabolic effects in sex-linked tissues [4]. Steroid hormones stimulate receptors in muscle cells, which activate specific genes to produce proteins. They also affect the activation rate of enzyme systems involved in protein metabolism, thus enhancing protein synthesis and inhibiting protein degradation thus showing an anti-catabolic effect. Heavy resistance training is necessary for anabolic steroids to exert beneficial effects on physical performance. The effectiveness of anabolic steroids is dependent upon unbound receptor sites in muscle. Intense strength training may increase the number of unbound receptor sites. This in turn, could increase the effectiveness of anabolic steroids [5]. Athletes typically tend to use anabolic steroids in a 'stacking' regimen by administering several different drugs simultaneously, thereby increasing the potency of each drug as the potency of one anabolic agent may be enhanced when consumed simultaneously with another anabolic agent. Both oral and parenteral compounds may be consumed at the same time. Most users will take anabolic steroids in a 'cyclic pattern' which means that the athlete will use the drugs for several weeks or months and alternate these cycles with periods of discontinued use. Often the athletes will administer the drugs in a 'pyramid' (step-up) pattern in which dosages are steadily increased over several weeks. Towards the end of the cycle the athlete will 'step-down' to reduce the likelihood of negative side effects. At this point, some athletes will discontinue drug use or perhaps initiate another cycle of different

drugs usually those which may increase endogenous testosterone production to prevent the undesirable drop in testosterone concentrations that follows the discontinuation of the pharmaceutical agents [6]. In a classic study on the dose-response curve of anabolic steroids, Forbes, in 1985, demonstrated that the total dose of anabolic steroids has a logarithmic relationship to increases in lean body mass [5]. Anabolic steroids work differently from other drugs of abuse as they do not have the same short-term effects on the brain. The most important difference is that steroids do not trigger rapid increases in dopamine, which causes the 'high' that drives people to abuse other substances. However, long-term steroid abuse can act brain chemicals including dopamine, serotonin and opioid systems that are affected by narcotics and ethyl alcohol affecting the mood and behavior. Short term psychological effects of abuse of anabolic steroids include mental problems such as paranoid jealousy, extreme irritability, delusions and impaired judgment. Extreme mood swings can also occur, including outbursts of anger and aggression termed 'Roid Rage' leading to violence [7]. Long term steroid abuse may lead to serious and even permanent health problems [7,3]. AASs may exert severe adverse effects on the liver. This is particularly true for orally administered AAS. The parenterally administered AASs seem to have less serious effects on the liver. Testosterone cypionate, testosterone enanthate and other injectable anabolic steroids seem to have little adverse effects on the liver. However, lesions of the liver have been reported after parenteral nor testosterone administration and also occasionally after injection of testosterone esters. Anabolic steroids result in a decreased hepatic excretory function. In addition, intra hepatic cholestasis, reflected by itch and jaundice and hepatic peliosis have been observed [3]. Hepatic peliosis is a hemorrhagic cystic degeneration of the liver, which may lead to fibrosis and portal hypertension. Rupture of a cyst may lead to fatal bleeding. Benign adenomas and malignant tumors (hepatocellular carcinoma) too have been reported among testosterone users. There are rather strong indications that tumors of the liver are caused when the anabolic steroids contain a 17-alpha-alkyl group [3]. Usually, the tumors are benign adenomas that reverse and shrink after stopping the steroid administration. AASs also affect the male reproductive system. Prolonged use of anabolic steroids in relatively high doses will lead to hypo-gonadotrophic hypogonadism with decreased serum concentrations of LH, FSH

and testosterone. A moderate decrease of gonadotropin secretion causes atrophy of the testes as well as a decrease of sperm cell production. Oligospermia, azoospermia and an increased number of abnormal sperm cells have been reported in athletes using AASs, resulting in decreased fertility. This is considered as yet-unestablished and under-detected cause for male sub-fertility among the younger men. After stopping AAS use, the gonadal functions will restore within some months, though it may take several months. A well-known side effect of AASs in males is breast formation (gynaecomastia). Gynaecomastia is caused by increased levels of circulating oestrogens. The oestrogens, oestradiol and oestrone are formed in males by peripheral aromatization and conversion of AASs. These increased levels of oestrogens in males stimulate breast growth. In general, gynaecomastia is irreversible.

As far as the cardiovascular system is concerned, no unanimity exists about the influence of anabolic steroids on the arterial blood pressure. The response is most probably dose dependent. Some data suggest that high doses increase diastolic blood pressure, whereas low doses fail to have a significant effect on diastolic blood pressure. Increases in diastolic blood pressure normalize within 6-8 weeks after abstinence from anabolic steroids. It appears that repeated intermittent use of anabolic steroids does not affect diastolic blood pressure. There is evidence that the use of anabolic steroids does elicit structural changes in the heart and that the ischemic tolerance is decreased. Echocardiographic studies in bodybuilders using anabolic steroids reported a mild hypertrophy of the left ventricle with a decreased diastolic relaxation resulting in a decreased diastolic filling. AAS abusers are at high risk of cardiomyopathy, myocardial infarction and cerebrovascular accidents [3,2]. In most cross-sectional studies serum cholesterol and triglycerides between drug-users and non-users are not different. However, during anabolic steroid use, total cholesterol tends to increase while HDL-cholesterol demonstrates a marked decline well below the normal range. Serum LDL-cholesterol shows a variable response: a slight increase or no change. The response of total cholesterol seems to be influenced by the type of training that is done by the athlete. When a great deal of the work-out consists of aerobic exercise, the increasing effect of AAS is counterbalanced by an exercise-induced increasing effect, which may result in a net decline in total cholesterol.

Aerobic training does not seem to be able to offset the steroid-induced decline in HDL-cholesterol and its sub-fractions HDL-2 and HDL-3. The effect of anabolic steroids on triglycerides is not well known. It is suggested that relatively low doses do not affect the serum triglyceride levels while it cannot be excluded that higher doses elicit an increase. Although the effects of anabolic steroids have an unfavorable influence on the risk factors for cardiovascular disease, no data are available about the long term effects. Most of the aforementioned effects appear to reverse within 6-8 weeks after discontinuation. It is unknown, however, whether the structural changes as reported in the heart are reversible as well.

When psychological effects of AAS use are concerned, increased testosterone levels in the blood are associated with masculine behavior, aggressiveness and increased sexual desire. Increased aggressiveness may be beneficial for athletic training but may also lead to overt violence outside the gym or the track. There are reports of violent, criminal behavior in individuals taking AAS. Other side effects are euphoria, confusion, sleep disorders, pathological anxiety, paranoia and hallucinations.

In addition to above adverse effects, acne is frequently reported, both in males and females, as well as hypertrophy of sebaceous glands, hair loss and alopecia. There is some evidence that anabolic steroid abuse may affect the immune system leading to a decreased effectiveness of the defense mechanisms. These changes seem to be reversible after abstention from the drugs. There are some case reports suggesting a causal relationship between anabolic steroid use and the occurrence of Wilms tumor and prostatic carcinoma. AAS use may affect thyroid functions too.

### 1.1 Objectives of the Study

The aim of the study was to estimate the use of PEAs among the male body building community in the Western Province of Sri Lanka, to find out the types of commonly used agents, to study the demographic characters of the users, to study their knowledge and attitudes regarding the use and to find out the types of adverse effects/outcomes experienced by them in the context of their socio-economic background.

## 2. METHODOLOGY

Twenty-one gymnasias in the Western Province of Sri Lanka have been chosen as the study setting.

A retrospective, descriptive, cross-sectional study was conducted using consenting adult males who are regularly involved in power training in gymnasias. Though the minimal sample size according to calculations was 336, a sample of 610 individuals was taken to cover all three districts in the Western Province. Written informed consent was obtained. Anonymity was maintained. Those who did not give the consent and those who do not visit the gym regularly (at least thrice a week for past six months) were excluded. A random sampling method was employed. Data collection was done using a self-administered questionnaire as the study instrument. Data analysis was carried out using SPSS 21.

## 3. RESULTS

- The age ranged from 16 – 52 years. 65% of the study population was within 20-30year age group. 20% was within 16-20year age group. The youngest in the study population was 16 years and the oldest was 52 (Table 1).

**Table 1. variation in the age of the population**

Age range	Percentage (%)
16-20 year age group	20
20-30 year age group	65
Above 30 year age group	15

- 21% were married and the rest were yet unmarried. Out of the married 21%, only 50% had children. Other 50% (10.5% of the study population) were married for more than two years with no children. (Table 2).

**Table 2. Variation in the marital status of the population**

Marital status	(Percentage %)
Married	21
Unmarried	79

- 94% of the study population has ever used one or more of the performance enhancing agents. 6% has never used. Out of the 94%, 62% were regular users of PEAs while 38% has randomly and occasionally used them. (Table 3).
- Commonly used PEAs were the whey-proteins, creatinine products, beef-proteins, protein-steroid combinations, weight-

reducing substances (so called “fat-burners”), pure anabolic androgenic steroids, multi-vitamins and combined products such as those containing multivitamins, fat burners, steroids, proteins and other substances.

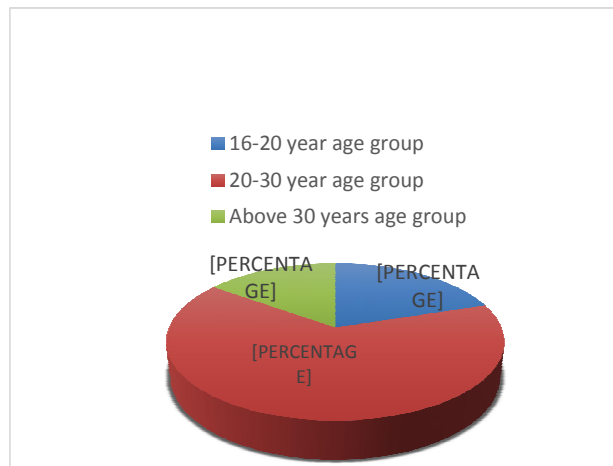
**Table 3. Use of performance enhancing agents**

Use of performance enhancing agents	Percentage (%)
Ever used one or more PEAs	94
never used PEAs	6

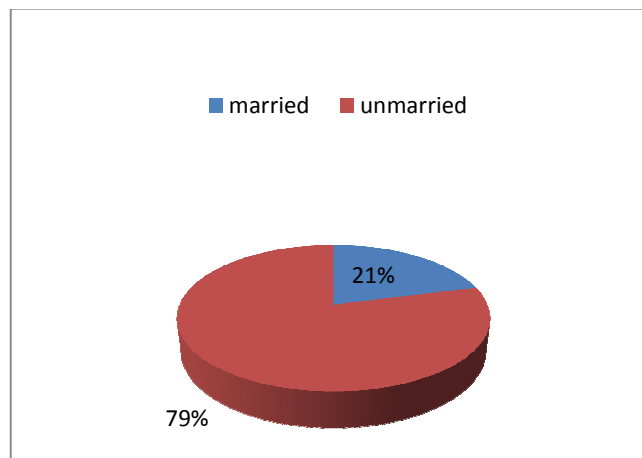
- Commonest substance used was whey protein preparations (92%) followed by creatinine products (80%), protein-steroid combinations (63%), beef proteins (32%),

weight-reducing substances (21%), combined preparations (18%), pure anabolic androgenic steroids (9%) and multivitamins (5%). Advanced formulae in the international market including myostatin ((GDF8) inhibitors etc. were not used by anybody in the study population. (Table 4).

- Out of the 9% of pure anabolic androgenic steroid (AAS) users, 65% administered them exclusively parenterally. 94% of them had never performed/competed on the stage.
- Out of the exclusive parenteral users of AASs, 30% had been injecting the hormones to individual muscles they desired to increase the volume.



**Fig. 1. Variation in the age of the population**



**Fig. 2. Variation in the marital status of the population**

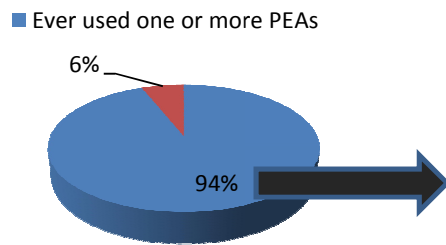


Fig. 3. use of performance enhancing agents

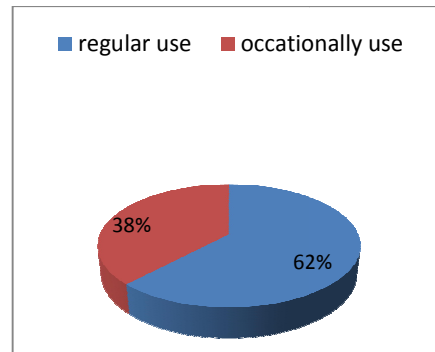


Fig. 4. Frequency of use

Table 4. Types of performance enhancing agents

Type of PEA	Percentage (%)
whey protein preparations	92
creatinine products	80
protein-steroid combinations	63
beef proteins	32
weight-reducing substances	21
combined preparations	18
pure anabolic androgenic steroids	9
multivitamins	5

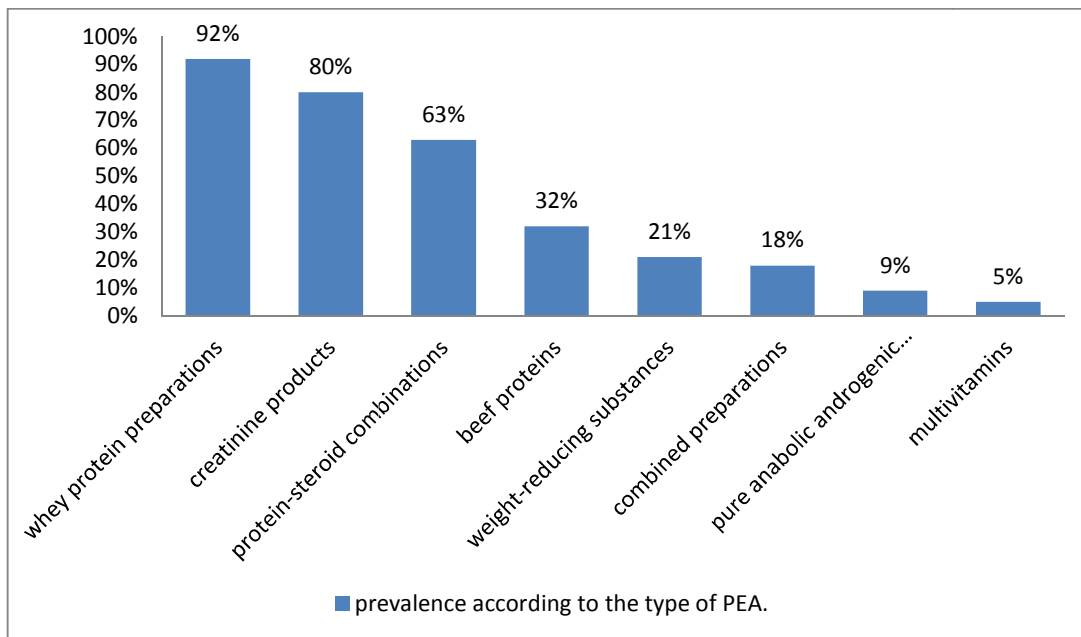


Fig. 5. Graphical representation of types of performance enhancing agents

- 62% of the study population had no satisfactory knowledge as to the chemical nature, actions, effects and adverse effects of the PEAs they have been using. Only 32% had a reasonably satisfactory level of knowledge of the substance/substances they have been using. The level of knowledge they had on what they were using was

measured by asking them to write the substance they used, its chemical nature (protein, vitamin, steroid, etc.) how it acts on the body, its expected outcome and side effects on a piece of paper and cross-checking the accuracy of data and grading according to a score. (Table 5).

**Table 5. Knowledge about the performance enhancing agents**

Knowledge about the PEAs	Percentage (%)
Satisfactory knowledge present	38
Satisfactory knowledge absent	62

- Out of those who have been using AASs, only 4% of the users have resorted to a cyclical usage with drug-free intervals. In other words, 96% of the AAS users have been continuously using them in contrary to the accepted ways of use for minimizing adverse effects. (Table 6).
- Only 15% of the AAS users had used other supportive medications to counteract adverse effects of AAS such as liver protectants and aromatase inhibitors.

- 93% of the regular users of AASs have experienced one or more of the adverse effects attributable to the long-term use of the same. (Table 7).

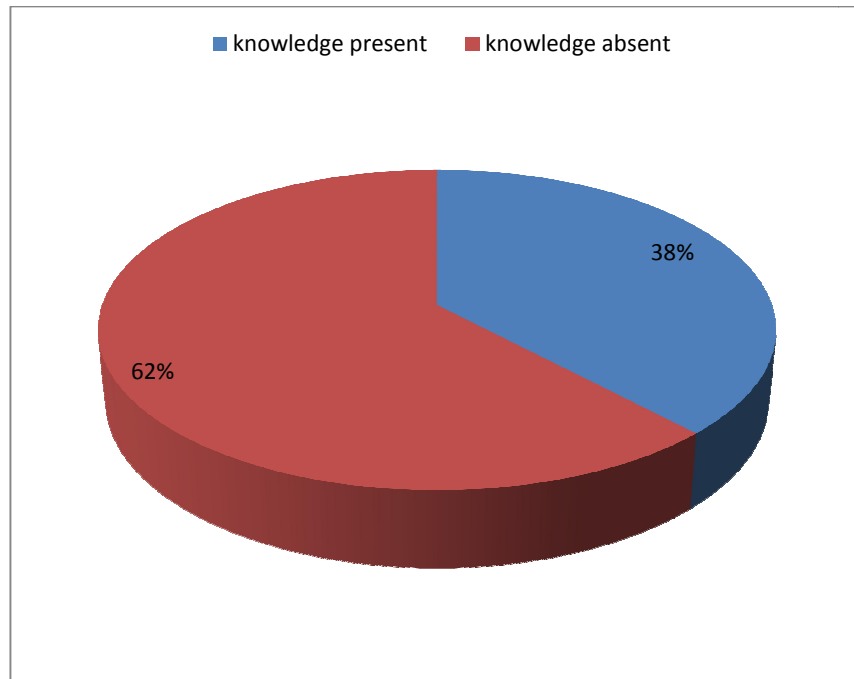
**Table 6. Knowledge about the performance enhancing agents**

Pattern of usage	Percentage (%)
cyclical usage with drug-free intervals	4
continuous usage	96

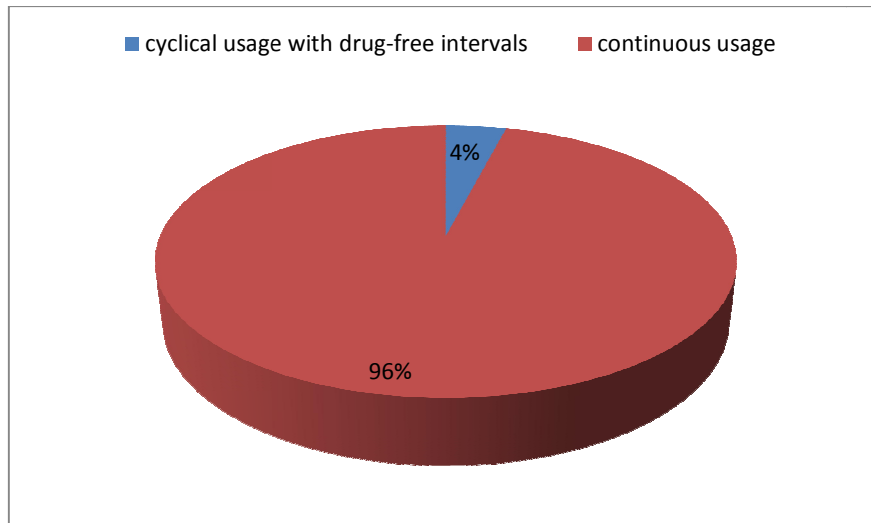
**Table 7. Experience of side effects with prolong use of same PEAs**

Experience of side effects with prolong use of same PEAs	Percentage (%)
Side effects experienced	93
Side effects not experienced	7

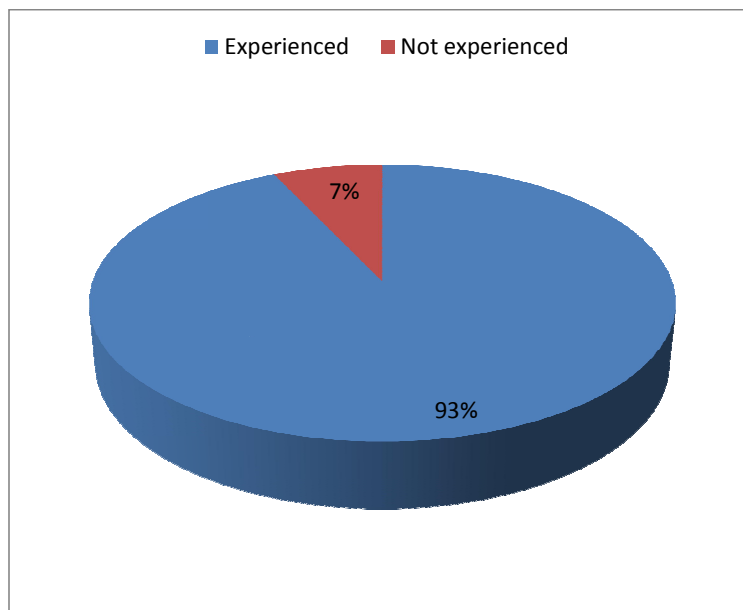
- The common adverse effects experienced by them in the declining order were, acne formation (88%), hair loss (55%), gynaecomastia (30%), aggressiveness (30%), sleep disturbances (25%), increased sex desire (23%), reduced semen volume (12%) and testicular volume reduction (05%).(Table 7).



**Fig. 6. Knowledge about the performance enhancing agents**



**Fig. 7. Pattern of usage**

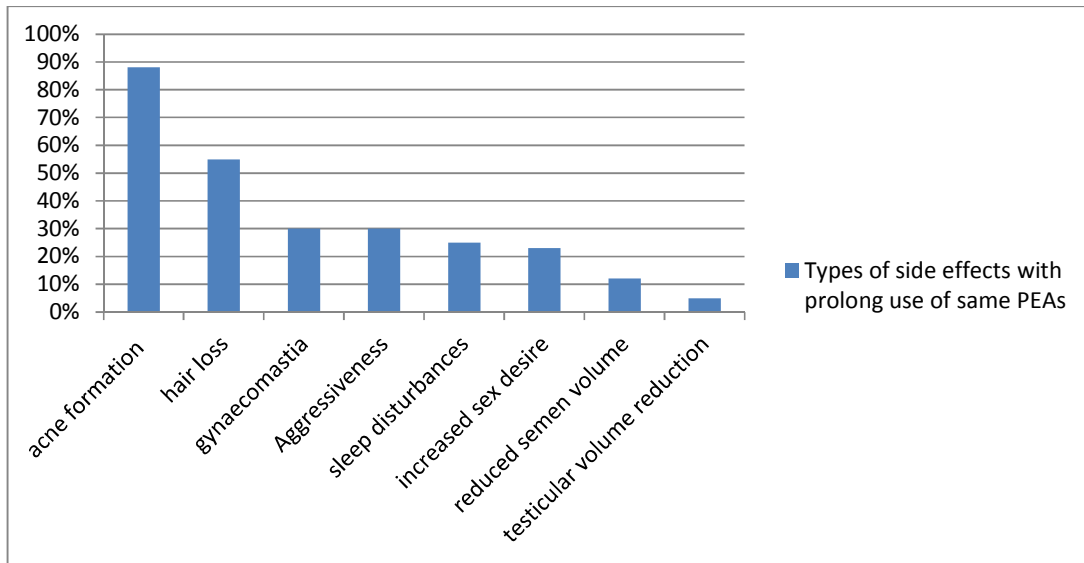


**Fig. 8. Experience of side effects with prolong use of same PEAs**

**Table 8. Types of side effects with prolong use of same PEAs**

<b>Types of side effects</b>	<b>Percentage (%)</b>
acne formation	88
hair loss	55
gynaecomastia	30
Aggressiveness	30
sleep disturbances	25
increased sex desire	23
reduced semen volume	12
testicular volume reduction	05





**Fig. 9. Types of side effects**

#### 4. DISCUSSION

According to the findings of this study 94% of the total study population had used one or more of the performance enhancing agents at least once during their life. Only 6% had never used PEAs. In a study conducted in Iran in 2015 with 453 of male bodybuilding athletes, 51.7% were using or had a history of PEA use [8]. This difference in the findings may be due to the difference of the sample size and also the differences in the cultural and social factors of the populations. The global life time prevalence of AASs abuse is 6.4% for males and 1.6% for females according to a large-scale meta-analysis done in USA. This study considered the general population while in our study, we considered only the population of males who regularly hit the gym. The prevalence of AAS use among this selected (skewed) male population was found to be 94% [1]. Therefore, the results differ from the initial study as we only included the males who regularly attend the gym as our study population. The findings of our study regarding high percentage of AAS use/abuse by males who regularly visit the gym for power exercises, had been repeatedly confirmed by the studies done in relation to Western populations such as USA, Scandinavia, Brazil and British Commonwealth countries though in contrast to this finding, it had been discovered that AAS use is rare in East Asian countries such as China, Korea, and Japan, perhaps because these cultures place less emphasis on the appreciation of male muscularity as explained in recent reports [9]. Another study done in 2018

discusses AAS use among female athletes, their side effects and other related factors [10].

According to the findings of our study, there was a great variation in the types of PEAs used. Only minority of the study population had used pure anabolic androgens which is quite different to a study conducted in Cyprus using 207 gym users majority of whom were pure anabolic androgen users [11]. The reason for the contrast in the findings is the difference in the social and economic background of the study populations.

Due to the existing legal restrictions in the use and sale of AAS, more dangerous and harmful methods of administration and selling in black market have emerged. The shift from pharmacy to online sales even enables to sell fake products. These factors are constant threats to the athletes despite strict laws and precautions [12].

Findings of our study shows that the majority of the study population does not have satisfactory knowledge about the PEAs- their actions and side effects. This is confirmed by the findings in the literature. For example a study done in Saudi Arabia shows that, despite knowing some negative side effects of PEAs, participants had a significant knowledge deficit about the possible harms of PEAs [13]. Adverse effects are a major problem with regard to the prolong use of certain AASs. Findings of the present study showed that majority (97%) of the PEA users have experienced some form of adverse effect

attributable to the use of PEAAs. This is confirmed by the findings of the Iranian study where 76.5% had experienced some form of adverse effect with the use of AASs and only 23.5% of PED users reported negative adverse effects from PED use. Types of most prevalent adverse effects were also similar to those found in our present study [8]. There are several studies done on the side effects of PEDs and AASs. Prominent cardiovascular risks, endocrinological effects and organ impairment are discussed extensively [14,15,16]. Another interesting study done in 2019 reveals the relationship between AASs and risk of imprisonment [17]. Author suggests doing a similar study in Sri Lanka as well.

Age range in our study varies from 16 to 52 years. But an American study done among children says that there is a high prevalence of using PEDs than in the past among high school children. They depict multiple factors for this trend as decrease in the age of participation of competitive sports, peer pressure, pre-occupied mind set on appearance, risk taking behaviour among teenagers [18].

PEDs are used not only in sports but also among non-athletes to improve their 'looks'. Males in the purpose of becoming muscular and females to have more feminine 'thin' looks. David A Baron and colleagues have published an article on the spread of PEDs to at-risk populations [19].

## 5. CONCLUSION

Inadvertent and non-therapeutic use of performance enhancing agents and anabolic androgenic steroids is common among body building community in Sri Lanka. Inadvertent use of anabolic androgenic steroids could be a cause for male subfertility in Sri Lanka. More extensive medical and sociological research is needed in this aspect.

## CONSENT

As per international standard or university standard, Participants' written consent has been collected and preserved by the author(s).

## ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

## COMPETING INTERESTS

Author has declared that no competing interests exist.

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