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ORIGINAL RESEARCH

ANABOLIC ANDROGENIC STEROIDS AND DEPENDENCE

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Abstract
Anabolic androgenic steroids are used for sportive, cosmetic, therapeutic and occupational reasons and there are many side effects reported (George, 2005; Nieminen et al., 1996; O'Sullivan et al., 2000). Prevalence of anabolic steroids' use also indicates the importance of this topic. Moreover, it is now known that use of anabolic steroids could lead to dependence which could be psychological or/and physiological (Copeland et al., 2000). It is important to know about all aspects of anabolic steroids including dependence. Therefore, this study has attempted to give an insight into use of anabolic steroids and dependence. The discussion will focus on prevalence, reasons, and side effects of use and physiological and psychological dependence.
Key words: Steroid use, psychological and physiological dependence.

Anabolic androgenic steroids and dependence

Testosterone is the sex hormone that stimulates development of male sex characteristics and growth of muscles and bones. It is produced by the testicles and in smaller amounts by the ovaries. (Özdermir and Gültürk, 2008). Anabolic androgenic steroids (AAS) are synthetically obtained from testosterone (Parkinson and Evans, 2006). Despite the legislation against it (see Word Anti Doping Program by WADA– Word Anti Doping Agency, also AAS are in Schedule III Controlled Substances in the US), the nonmedical use of supraphysiological amount of AAS is prevalent for athletic performance and cosmetic use (Evans, 2004; WADA, 2010). It was found that the use of illicit steroid even extends to children and young adolescents aged 9 to 13 (Faigenbaum et al., 1998). Furthermore, AAS use might be much more dangerous than it seems, it was reported that many of the adolescent users of anabolic steroids in high schools were sharing needles (Durant et al., 1993).

Prevalence of AAS use has risen dramatically in the last twenty years and vastly spread in society (Graham et al., 2008). For example, there are signs showing that use of AAS might be high in the UK (Williamson, 1993) and in the US (Stilger and Yesalis, 1999; Yesalis et al., 1990), this is due to the fact that supraphysiological doses of testosterone increases body mass, muscle size and strength. (Bhasin et al., 1996). Especially athletes, body builders and people who want to be stronger and look better, use AAS.

Prevalence of AAS in international competitions is difficult to find out, but nevertheless, at the 1972 Munich Olympics 68 percent of the athletes who were interviewed admitted use of steroids (Silvester, 1973). Moreover, at the Mexico Olympics, all the weightlifters from the US admitted that they had taken steroids. (George, 2005). Much more cases have occurred so far in which anabolic steroids have been used to enhance athletic performance (see Yesalis and Bahrke, 2005). But, methods of detecting anabolic steroid in sports events have improved over the past years (Fitch, 2008).

Since AAS are used widely, the reasons of the use, effects and side effects of AAS should be known very well by athletes, coaches, teachers, psychiatrists, team doctors, clinicians, WADA and the others in this area. Furthermore, there is evidence, discussed further, that, depending on some other factors, AAS use leads to dependence, which is why, it is also important to know about to what extend AAS use might exhibit characteristic of addiction.

Therapeutic use of AAS

Previous research has shown that anabolic effects of AAS have positive effects on patients (Mauras et al., 1998). Testosterone has anabolic and androgenic properties and chemical modification of testosterone molecule is used in clinical applications for anabolic purposes. Synthetic analogues were initially developed to treat

catabolic medical conditions. The intention of medical companies was to maximize the anabolic effects and to minimize the androgenic effects. Some of the catabolic states of patients for which AAS has been used (as stated in Evans, 2004 and Graham et al., 2008) are;

- Severe burns
- Wasting diseases including HIV-related muscle wasting. Bhasin et al. (2000) suggested that testosterone increases body weight, muscle mass, muscle strength and lean body mass in HIV infected population with weight loss and low testosterone level.
- Endometriosis (Disorder of the female reproductive system)
- Damaged myocardium
- Depression
- Aplastic anaemia (lack of red blood cells)
- Hypogonadism (reduced activity of the testes or ovaries)
- Osteoporosis
- Sarcopenia / loss of muscle mass and strength e.g. age related muscle wasting. Testosterone increases muscle built up and helps old people who are experiencing sarcopenia (Brill et al., 2002).
- Testosterone is also used for some psychic problems (Pope et al., 2003 and Seidman and Rabkin, 1998). For example, testosterone replacement therapy of hypogonadal men was found to improve some of the positive mood parameters such as friendliness, good feelings, and energy level and also the therapy decreases the negative mood parameters such as anger, irritability, nervousness, sadness and tiredness (Wang et al., 1996).

Non - therapeutic use of AAS

There are different reasons of using AAS and some of them are sportive reasons. AAS increase performance, therefore some athletes use them. However, due to the work of WADA to stop drug use in sports and developed techniques to detect drugs, AAS use in athletes is limited (Özdermir and Gültürk, 2008). General reasons of using AAS for non-therapeutic purposes can be seen on Table 1.

Table 1. Reasons of non-therapeutic use of anabolic steroids

1	Sportive reasons	In the sports where athletes need strength and speed (athletics, weight-lifting, rowing, swimming, boxing, cycling).
2	Body building	Body building
3	Cosmetic	Having a good body shape
4	Occupational	Police, security workers, military purposes,

*From Perry et al, 1992 as cited in Özdermir and Gültürk, 2008, p.924.

Previous research showed that there are unsupervised drug habits in order to enhance athletic performance in natural settings (Evans, 1997). However, there is not enough research that has been done among athletes who use AAS. The area related to athletes is less researched compared to the area of therapeutic use of AAS (Özdermir and Gültürk, 2008). This could be because athletes using AAS constitute the smaller percentage of society compared to people suffering from the illnesses that can be cured by AAS or because of the financial support to which might be easier to access for treatment researches.

In Evans' study (1997) 88 out of 100 athletes stated that they take combinations of various anabolic steroids to achieve their desired dose and 64 of the participants admitted the use of AAS for one to four years. Moreover, in a study that was done with high school students, a great number of participants (66 students) out of 93 AAS users, reported athletic reasons for the use of AAS. Improving their performance, keeping up with the competition and recovering from/preventing injuries were the reasons they stated.

Self-reporting method and validity of collecting data from students at high schools has been widely questioned (Stilger and Yesalis, 1999). When the topic is sensitive like steroid use, high school students may not truly answer due to "social desirability effect" where people answer the questions depending on what is true or good according to the public. Another disadvantage might be that, participants' coaches/teachers being in the room while they are answering the questions. The concern that their data might not be accessible only to researchers is also another disadvantage of self-reporting method. Also, participants might be reluctant due to the legal consequences, because AAS are illegal to possess in most countries i.e. U.S. (U.S Drug Enforcement Administration, 2010), Australia (Government of Western Australia Drug and Alcohol Office, 2010), Therefore, the validity of the studies conducted in this area and that used self-reporting questionnaires should be done with utmost care.

In Stilger and Yesalis' study (1999), where a lot of effort was made to assure the validity of the first, state-wide survey of anabolic steroid, 873 high school football players were surveyed. The most important reason to use AAS was found to be improving athletic performance, which was stated by 47 percent of the

students. The other reasons in order from more important to the less important ones are; improving appearance (29 percent), keeping up with the competition (14 percent) and preventing/treating sports injuries.

As it can be seen from the previous research (Evans, 1997; George, 2005; Stilger and Yesalis, 1999) AAS are used for athletic reasons, however, as it was stated before, due to the legislations in this area to stop AAS use, it might be expected that it is limited to fewer athletes. In addition to the sportive reasons, there can also be some social reasons for AAS use. AAS users were found to experience more social problems compared to other people. For example, the higher the negative experiences in school, the higher the chances of AAS use for individuals (Kindlundh et al., 2001). Disconnectedness with family was also more experienced by AAS users compared to the non-users, and AAS users were found to experience physical or mental abuse in their childhood (Kanayama et al., 2003; Skarberg and Engstrom, 2007). Hence, social factors are also important for using AAS. But, not all AAS users have negative childhood experiences or experience disconnectedness with their family, social problems might be just one of the reasons.

SIDE EFFECTS OF AAS

Although it is suggested that health risks of AAS use may have been exaggerated by medical community to preclude it (Hoffman and Ratamess, 2006), there are various side effects of AAS which should be taken into account. The purpose of medical companies is to minimize these effects and maximize the other effects that AAS are used for e.g. muscle gain, looking better.

Instead of discussing various sources and mentioning the side effects separately, it is more useful to present the previously found side effects on a table. Previously observed side effects of AAS from different sources can be seen on Table 2.

Table 2. Side effects of use of anabolic steroids

Author, year	Side Effects
Fred et al., 1975	Acne, high blood pressure, headache and muzziness, urethritis, reduced sexual activity, dizziness and nausea.
Evans, 1997	Acne, gynecomastia, testicular atrophy, striae.
O'Sullivan et al., 2000	Change in libido, mood changes, reduction in testis volume, acne, erectile dysfunction, headaches, hair growth, oedema, fluid retention, prostatitis, parotid swelling, nipple, discharge on cessation, sleeplessness, rash, cutaneous boils, lower back pain, stomach cramps, muscle cramps, increased appetite.
Grace et al., 2001	Hair loss, Nose bleeds, Acne, Aggression, Testicular atrophy, insomnia, Water retention, Loss of libido.
Parkinson and Evans, 2006	Acne, insomnia/sleep disturbances, fluid retention/edema, mood alterations, gynecomastia, testicular atrophy, stretch marks (striae), sexual dysfunction, and injection-site pain. Less frequently reported ones are: alopecia, hypertension and high cholesterol.
Graham et al., 2007	More powerful, more satisfied body image, more confident, increased libido, mood changes, unintended aggression, more relaxed, euphoria, social consequences, urge to harm others, decreased libido, depression, paranoia.

Could AAS use lead to adiction?

Substance dependence is a maladaptive pattern of substance use, resulting in clinically significant impairment or distress, as stemmed from three (or more) of the following, occurring at any time in a 12 month period.

1) Tolerance (either of the following)
    a. A need for markedly increased amounts of the substance.
    b. Markedly diminished effect by continuing the same amount of the substance.
2) Withdrawal
    a. Withdrawal syndrome.
    b. The substance is taken to relieve or avoid the symptoms of withdrawal.
3) Taking the substance in larger amounts or over a longer period than it was initially intended.
4) Persistence desire or unsuccessful efforts to stop the use of substance or reduce the amount.
5) Spending great deal of time to obtain the substance, use the substance or recover from its effects.
6) Giving up or reducing important social, occupational or recreational activities because of substance use.
7) Continuing use of the substance despite knowledge of physiological or psychological problems caused or exacerbated by the substance.

These 7 items can be specified by followings

Physiological dependence: Item 1 or 2 is present

Psychological dependence: No evidence of items 1 or 2 present (American Psychiatric Association, 2000)

When looked at the criterias, it can be seen that psychological dependence is not being able to control the use of drug due to some psychological components and sometimes dependency is even experienced despite having the knowledge of adverse consequences of the substance. Even if there are different criterias for physiological and psychological dependence, these two types of dependency often occur together as well as being experienced separately (Brower, 1993).

When considering the factors which might cause AAS use and which might eventually lead to dependence, we can list the followings:

- Social influences from peers, coaches, trainers and family.
- Cultural values to compete, to win, to look good.
- Genetic and psychiatric vulnerability of the individual. (Individuals with low genetic and psychiatric vulnerability may need higher doses or long time to be addicted) (Brower, 1989).
- Some other social factors such as negative or positive school experience or connectedness with family.

Some case reports that have appeared in the literature showed that AAS use can lead to dependence. Hays et al. (1990) stated that, a 22 years old weight lifter, who had been using AAS for 9 months to improve his strength, admitted that he could not stop taking steroids. He reported experiencing depression, problems in sleeping and lack of energy as well as irritability with some temper outbursts that caused problems between him and his family. When he stopped taking AAS, he experienced craving for steroids, his self-esteem went lower and he felt that he was not fast enough. Every time, all of these problems made him start taking steroids again. This case report suggests that AAS use may result in experiencing dependency signs. Similarly, Tennant et al. (1988) revealed that a 23 years old body-builder could not stop taking anabolic steroids due to the withdrawal symptoms such as depression, fatigue and craving. In another case, Brower et al. (1989a) stated that 24 years old weight lifter could not stop taking anabolic steroids without help from the professionals because of suicidal depression, which he was experiencing, after stopping to take steroids. Also, he met more than 3 of the 7 dependency criteria mentioned above. In the three case reports, discussed above, weight lifters started taking steroids to enhance their performance. The intention of these people was being fit and stronger. But later, they became addicted and could not stop taking the substance without professional help. All of the 3 people, reported, were experiencing symptoms, showing that their use of steroids led them to dependence. Besides dependence, psychological effects of AAS use could also increase the risk of suicide (Brower et al., 1989b).

Psychological components of dependence have been widely discussed, researched and emphasized (see Yesalis et al., 1993). Being fit and happy, feeling good and increasing self-confidence are some of the outcomes of AAS use and, which is why it is attractive to people. Once they start using AAS and experience the desired psychological effects, these individuals could get addicted to good feelings they experience. These effects sometimes might be strongly attractive to people, therefore peoples' initial intention to not continue the substance for a long time might change and they use the substance more then they intended (Yesalis et al., 1990). In this sense psychological components of AAS use make people start using AAS and later desire to feel these psychological outcomes could lead to dependence.

Apart from the psychological components of AAS use there are also physiological components which might cause dependence. For example, AAS were found to increase b-endorphin in a brain area, which was thought to lead to development of dependence (Johansson et al., 1997). AAS act on the regions of brain which control drug dependence. Results of animal studies on AAS indicate the potential for androgen dependence in humans (Wood, 2008). In another study where conditioned-place-preference is used, rats chose to spend time in an environment where they had received AAS (Alexander et al., 1994). Rats preference in Alexander and his friends study (1994) and other previous animal studies seem to be related to only physiological components. When talking about humans, psychological components should be taken into accounts, because humans could take AAS to look better or to be better in a sport but rats dont mind appaerance or athletic performance. Therefore physiological components of AAS dependence can be perfectly understood by animal studies. In another animal study, hamsters self-administered testosterone to the point of death and also tolerance and withdrawal symptoms were observed (Wood, 2006). Moreover, AAS consumption may cause some changes in neurobiological systems which are related to development of morphine dependence (Ce´le´rier, 2003).

Survey studies also showed evidence of AAS dependence. Yesalis et al. (1990) conducted a study with 3403 male high school students and one out of every 4 students, participated in the study, stated that they would take steroids even if there were at the risk of health such as heart attack, sterility and liver cancer. These findings show that despite the stated possible health consequences these students would not stop using steroids. These students' answers also showed that they met the 7th dependence criteria (Continuing the use of substance, despite the knowledge of physiological or psychological problems caused by the substance), mentioned above. Brower et al. (1991) found that 6 out of 8 weightlifters met the criteria for dependence and they all had withdrawal

symptoms when they stopped using steroids. The symptoms which the 6 participants experienced were depressed mood, fatigue, decreased sex drive, insomnia, anorexia and dissatisfaction with their body.

In their self-reporting questionnaire and interview study, with 100 participants in Australia, Copeland et al. (2000) found that a full range of the dependency symptoms were reported by over 78 percent of the participants. The most common symptom was withdrawal (Item 2 that mentioned above), which was followed by 7th item (continuing use despite negative consequences) and the last most important symptom reported was giving up important events or reducing them (6th item). In this study over 78 percent of participants reported at least one of the symptoms of dependency. This percentage is quite serious, moreover considering that self-reporting questionnaire and interviews were used in the study, it could be expected that this rate in reality might be even more. In addition to the big percentage of participants who experienced at least one of the symptoms, 23 participants out of 100 were found to be addicted. This study also provides some support that AAS use might exhibit characteristics of dependence but the number of male users (94/100), in this study, should also be considered because some studies suggest that percentage of AAS use might be much higher in males than females (Williamson, 1993; Windsor and Dumitru, 1989; Yesalis et al., 1990). Hence, it might be suggested that 94 of the 100 male participants cannot represent the normal population. But, in some cases rates of AAS use might be similar for both males and females (Faigenbaum et al., 1998).

Brower et al. (1991) supported the fact that AAS use leads to dependence. Brower et al. stated that a very big percentage (94%) of the participants was having symptoms of dependence and 28 participants reported at least three of the dependence symptoms listed above. It means 28 participants met the criteria for dependence.

CONCLUSION

Besides various side effects of AAS which have been reported (Evans, 1997; Fred et al., 1975; Grace et al., 2001; Graham et al., 2007; Parkinson and Evans, 2006 and O'Sullivan et al., 2000), there is evidence that AAS use leads to dependence (e.g. Brower, 1989; Hays et al., 1990; Wood, 2006; Wood, 2008). Dependence can be psychological or physiological as well as being experienced together. In addition, because AAS users face various health problems (Larance et al., 2008), it is a growing public health concern (Kanayama et al., 2009). Knowing that AAS dependence seems to be biologicallly and neuropsychologically similar to classical substance dependence (Kanayama et al., 2009), it is obvious that the attention should be given to it. As stated before, AAS dependence should not be only considered as physiological, there are also psychological components of it (Yesalis et al., 1993). Seeing positive outcomes, being bigger and fitter, having big muscles, enhancing one's performance and also feeling good about oneself can have a positive effect on one's self-esteem and on other peoples' admiration towards AAS users (see Corrigan, 1996), therefore it seems that this is the reason why most people start using AAS. Once they start using them and experience the desired psychological effects, people get addicted to good feelings they have experienced, because people's needs and expectations have a very important effect on administration of any kind of drugs. Physiological dependence which is observed with tolerance and withdrawal (American Psychiatric Association, 2000) could also accompany to psychological dependence. It has been proved that when AAS are used, some physiological changes which may lead to dependence occur (Alexander et al., 1994; Ce´le´rier, 2003; Johansson et al., 1997; Wood, 2006). Further study should focus on physiological and psychological AAS dependence and possible treatments of them because these areas of substance dependence still remain unexplored.

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