Research Report

European Addiction Research

Eur Addict Res 2009;15:99–106
DOI: 10.1159/000199045

Published online: February 2, 2009

Multisubstance Use as a Feature of Addiction to Anabolic-Androgenic Steroids

Kurt Skarberg[a, b] Fred Nyberg[c] Ingemar Engstrom[a]

[a]School of Health and Medical Sciences, Psychiatric Research Centre, Orebro University, [b]Addiction Centre, Orebro County Council, Orebro, and [c]Department of Pharmaceutical Bioscience, Uppsala University, Uppsala, Sweden

Key Words

Anabolic-androgenic steroids · Drugs of abuse · Alcohol · Pharmaceuticals · Dietary supplements

Abstract

The aim of this study was to explore and describe total drug use among anabolic-androgenic steroid (AAS) users and the reasons given for the use of these drugs. The study was based on semi-structured interviews and questionnaires involving 32 patients who were attending an addiction centre in Orebro, Sweden, for AAS use. The results indicated that a history of polysubstance use among the patients was frequent. Over half were using drugs of abuse and also taking various other pharmaceuticals. Almost half of the patients took human growth hormones, and almost half of the interviewed persons were drinking alcohol to a hazardous or harmful extent. The most common reason given for taking AAS and other hormones was to increase muscle mass and strength, but some participants also used insulin as a means of losing fat. Cannabis was used to improve sleep, heroin to decrease pain and amphetamine to increase endurance and burn fat. Our data suggest that most of the current AAS users who have been admitted to a treatment programme are multiple drug users with polysubstance dependence. The study stresses the importance of carefully examining total drug use as part of the assessment regimen for this group.

Introduction

Anabolic-androgenic steroids (AAS), which are synthetic analogues of the male hormone testosterone [1], are known to exert strong effects on the human body. Users of AAS desire associated improvements in athletic performance and body appearance [2, 3]. One of the goals of the pharmaceutical industry during the 1960s had been to synthesize and modify the testosterone molecule to promote pure anabolic effects, without the associated androgenic effects. However, so far, attempts to minimize the androgenic effects have not been successful, and the available AAS retain the ability to promote masculine characteristics [4].

The use of AAS was historically confined to professional sports and bodybuilding [5], but recent data show that steroids are now also used by individuals not involved in sports [6]. Many young people are taking AAS for lifestyle purposes [7], and most current AAS users started taking the drug in their late teens [6, 8]. Use of AAS preparations that are not meant for human consumption (e.g., veterinary medication) also occurs [8].

Recently, AAS have received attention for their profound side effects. Studies have suggested that these steroids can induce aggression and addictive behaviour [8, 9] in addition to numerous physical side effects such as acne, sleep disturbance, gynaecomastia and testicular atrophy [6]. Cardiovascular changes (such as atherosclero-

KARGER

Fax +41 61 306 12 34
E-Mail karger@karger.ch
www.karger.com

1022–6877/09/0152–0099$26.00/0

Accessible online at:
www.karger.com/ear

Ingemar Engstrom, MD, PhD
Psychiatric Research Centre, PO Box 1613
SE–701 16 Orebro (Sweden)
Tel. +46 19 602 58 88, Fax +46 19 602 58 86
E-Mail ingemar.engstrom@orebroll.se

sis, hypertension, cardiac hypertrophy, impaired cardiac function and sudden death) and hepatic problems (e.g., cholestasis, hepatocellular hyperplasia and elevations of transaminases, conjugated bilirubin, alkaline phosphatase and lactate dehydrogenase) have been reported [10].

It has been suggested that chronic intake of AAS can result in opioid-type dependence [11]. However, although AAS are widely abused, the potential for dependence and addiction still remains unclear [8].

Use of AAS may be a gateway to the use of other drugs [12], such as opioids [13, 14], opioid agonists/antagonists (e.g., nalbuphine or butorphanol) [15], morphine [16] or alcohol [17]. AAS users have also been associated with polysubstance dependence [18], but information on total drug use patterns in AAS users is currently insufficient. The role of AAS in the development of polydrug use requires further clarification.

The effects of AAS can be enhanced by combination with other hormones such as human growth hormone (hGH), insulin, thyroid hormone and insulin-like growth factor 1 [6, 19], or sometimes, also including prohormones (e.g., androstadienone or dehydroepiandrosterone) [20, 21]. There is evidence that some dietary supplements can contain undeclared AAS – prohormones (e.g., nandrolone or testosterone prohormones) [22].

Various kinds of other drugs, such as ecstasy, marijuana, LSD [23], cocaine [7, 24, 25], amphetamine and γ-hydroxybutyric acid (GHB) [1, 6, 19], alcohol [26, 27] and dietary supplements (e.g., creatine, protein or ephedrine preparations) [9] have been used in combination with AAS.

Unfortunately, physicians are more likely to enquire about drugs such as heroin or cocaine than about AAS [8]. Some authors indicate that AAS users do not believe that their physician can provide reliable information about AAS. Therefore, it has been proposed that clinicians should learn more about and familiarize themselves with the lives of AAS users, so that they can supply beneficial counsel to their patients [2, 28].

The literature in this area is almost exclusively derived from the sporting community, and there is scarce information concerning people who attend addiction clinics. Therefore, we consider it scientifically relevant and of considerable clinical interest to further explore the patterns of total drug use in AAS users.

The aim of the study was to explore and describe the total lifetime and current use of drugs by AAS users recruited from an addiction clinic in Sweden, with the intention of providing beneficial input into the design of treatment programmes for AAS users.

Table 1. Reported lifetime and current use of drugs among 32 AAS users at an addiction clinic

Drugs/other preparations	Lifetime use	Current use
AAS	32 (100)[1]	32 (100)
hGH	15 (46.9)	2 (6.2)
Insulin	9 (28.1)	3 (9.4)
Insulin-like growth factor 1	5 (15.6)	0 (0.0)
Thyroid hormone (T3/T4)	4 (12.5)	1 (3.1)
Alcohol, hazardous or harmful use[2]	15 (46.9)	13 (40.6)
Drugs of abuse	29 (90.6)	18 (56.2)
Cannabis	26 (81.2)	4 (12.5)
Amphetamine	25 (78.1)	16 (50.0)
Ecstasy	18 (56.2)	4 (12.5)
GHB	15 (46.9)	5 (15.6)
Cocaine	13 (40.6)	2 (6.2)
LSD	9 (28.1)	0 (0.0)
Heroin	8 (25.0)	4 (12.5)
Pharmaceutical drugs	31 (96.9)	16 (50.0)
Other drugs	5 (15.6)	0 (0.0)
Dietary supplements	31 (96.9)	12 (37.5)

Figures in parentheses are percentages.
[1] Twelve of these also used AAS as veterinary agents.
[2] Defined by the AUDIT criteria.

Methods

Selection of Subjects

AAS users were consecutively included in the study over 3 years; subjects were recruited from a psychiatric addiction centre in Orebro county, central Sweden, a county of 275,000 inhabitants. The users were attending the addiction centre for complications related to their AAS use or because of a wish to stop using AAS.

For inclusion, the participants were: (1) to be >16 years of age, (2) to be fluent in Swedish, (3) to be using non-prescribed AAS, alone or in combination with other illicit agents, within the last 4 months, (4) to have been using AAS for at least 4 consecutive months, and (5) to be under the care of the addiction clinic, where a decision to commence treatment for their AAS use was agreed upon based on the initial clinical assessment.

Thirty-two subjects, 30 men and 2 women, were included in the study. None of those approached declined to participate in the study.

Instruments

Before the face-to-face interview, the participants were asked to write down a report of their lifetime and current drug use (including AAS) and hand it to the interviewer. The semi-structured interview format was derived from published studies [29, 30] and based upon our experience with clinical interviews of about 100 AAS users. It comprised questions concerning 6 areas of interest: childhood, adolescence, school experiences, gym training, use of alcohol and illicit drugs, and criminality. Participants were ques-

tioned about all drugs and substances of abuse, including hormones, pharmaceuticals (including prescription drugs), drugs of abuse, alcohol and other substances. The questions concerning alcohol consumption were taken from AUDIT (the Alcohol Use Disorders Identification Test), developed by the World Health Organization [31], which has been translated into Swedish [32]. All interviews regarding drugs were carried out by one of the authors (K.S.), and an independent psychiatrist made the psychiatric diagnoses.

Ethical Approval

The study protocol was approved by the research ethics committee of Orebro County Council (No. 538/99).

Results

The mean age at first use of AAS was 19.7 years (range 15–28 years) in males and 20.5 years in females. The mean duration of total AAS use was 5.1 (range 1–16) years in males and 3.0 (range 2–5) years in females. Twenty-six (81.3%) individuals came in contact with AAS within a training facility, 3 through a friend, 2 while traveling abroad and 1 through the internet.

The reasons for starting AAS included wanting to get better results from training (13 users), wanting to improve their competitive chances (7 users) and wanting to increase muscle mass and strength (5 users).

All 32 participants had taken AAS intended for human use and 12 had also taken preparations intended for veterinary use (e.g., boldenone undecylenate and trenbolone acetate). The figures for lifetime and current use of drugs are shown in table 1.

In addition to AAS, the most common hormone used was hGH. This hormone had been taken by almost half of the patients. Insulin had been used by almost a third of the patients and almost half drank alcohol to a hazardous or harmful degree (as defined in AUDIT), including 2 patients who had injected alcohol intravenously.

The interviewed patients frequently took other drugs of abuse. Most had used cannabis (81%) and amphetamine (78%) and a quarter had used heroin. They also frequently took pharmaceutical drugs and dietary supplements. Other drugs included petrol, solvents or thinners and mushrooms.

The most recent period of AAS use involved AAS alone for 7 participants, AAS in combination with other drugs of abuse for 13, AAS, other drugs of abuse and high consumption of alcohol for 7, AAS and alcohol for 4, and AAS with testosterone releasers for 1 subject.

All subjects underwent psychiatric assessment according to the DSM-IV system. Nine fulfilled the criteria for

Table 2. Lifetime use of oral and injected AAS (n = 32)

Chemical name	Patients	% of total population	Trade name and number of users
Lifetime use of oral AAS (n = 32)			
Methandrostenolone	30	93.8	Methandrostenolonum (Russian), 28 Dianabol, 9 Anabol tab (Thai-5), 7
Stanozolol	22	68.8	Winstrol, 19 Stanozolol, 7 Stromba, 4
Oxymetholone	12	37.5	Anadrol, 10 Anapolon 50, 4 Oxymetholone, 3
Methenolone acetate	10	31.3	Primobolan S
Testosterone undecanoate	10	31.3	Andriol, 8 Undestor, 5
Oxandrolone	9	28.1	Oxandrolone SPA, 8 Anavar, 2
Fluoxymesterone	7	21.9	Halotestin
Prohormone	5	15.6	Androstadienone, 3 DHEA (dehydroepiandrosterone), 2
Methyltestosterone	3	9.4	Methyltestosterone, 3 Teston, 1
Ethylestrenol	1	3.1	Maxibolin
Lifetime use of injected AAS (n = 32)			
Nandrolone esters	27	84.4	Deca Durabolin, 26 Dynabolon, 3 Extraboline, 2 Turinabol, 2
Testosterone blends (2 and 4)	26	81.3	Sustanon, 24 Omnadren, 18 Primoteston depot, 8 Testoviron, 5
Injectable testosterone: cypionate, enanthate, propionate, suspension	20	62.5	
Stanozolol	17	53.1	Winstrol depot, 17 Strombaject, 2
Trenbolone cyclohexylmethylcarbonate	10	31.3	Parabolan
Methenolone enanthate	9	28.1	Primobolan depot
Boldenone undecylenate (veterinarian drug)	7	21.9	Equipose, 3 Boldone, 2 Drive, 2 Ganabol, 1
Methyltestosterone	5	15.6	Testosterone
Trenbolone acetate (veterinarian drug)	5	15.6	Finaject, 5 Finaplix-H (pellets), 1
Drostanolone propionate	4	12.5	Masteron, 3 Masteril, 1
Other testosterone	3	9.4	Testoderm (patches), 2 Androgel (gel), 1
Methandrostenolone	3	9.4	Dianabol injection
Methandriol dipropionate (veterinarian drug)	2	6.3	Filybol, 1 Spectriol, 1

Table 3. Lifetime use of pharmaceutical drugs in combination with AAS (n = 31)

Reason for use	Patients	% of total population	Drug
Stimulants			
Sympathomimetics	29	93.5	ephedrine, 29
Sedatives			
Benzodiazepine derivatives	20	64.5	flunitrazepam[1], 16 diazepam, 13 oxazepam, 4
Phenothiazine derivatives	7	22.6	promethazine, 5 fentiazin, 2
Benzodiazepine related	3	9.7	zolpidem, 3
Azaspirone derivatives	2	6.4	buspirone, 2
Diphenylmethyl piperazine derivatives	2	6.4	hydroxyzine, 2
Adrenergic drugs	18	58.3	clenbuterol, 15 salbutamol, 5 bromhexin/ephedrine, 3 ethylmorphine/ephedrine, 2
Testosterone releasers	16	51.6	human chorionic gonadotropin, 15 menotrophin, 1
Analgesics	15	48.3	acetylsalicylic acid, 9 codeine, 6 dextropropoxiphene, 5 morphine, 4 chlorzoxazone, 2
Antidepressants	15	48.3	paroxetine, 10 citalopram, 3 venlafaxine, 4 sertraline, 1
Anti-oestrogens	12	38.7	proviron, 8 tamoxifen, 6 clomiphene, 5 arimidex, 1
Anti-inflammatories, NSAIDs	4	12.9	naproxen, 3 ketoprofen, 1
Diuretics	4	12.9	spironolactone, 2 furosemide, 2
Anti-acne preparations	3	9.7	roaccutane, 3
Antihypertensive drugs	2	6.4	clonidine hydrochloride, 2
Miscellaneous			
Muscle oil	3	9.7	synthol, 3
Dopamine and decarboxylase inhibitors	1	3.2	levodopa, 1

NSAIDs = Non-steroidal anti-inflammatory drugs.
[1] Rohypnol used by 16 patients and flunitrazepam used by 9 patients.

AAS abuse and 8 for AAS dependence. Many also fulfilled the criteria for abuse or dependence on drugs of abuse, including 9 for amphetamine dependence, 7 for amphetamine abuse, 3 for GHB dependence and 2 for cannabis dependence. All 4 participants who were using heroin were diagnosed as heroin abusers. Almost half of the AAS users were also heavy alcohol consumers; 7 fulfilled criteria for alcohol abuse and 5 for alcohol dependence. Seven patients who used pharmaceuticals fulfilled the criteria for abuse and 1 subject for dependence.

In response to a request to write down the kinds of AAS used, the patients named an average of 6 (range 2–28) different types. As shown in table 2, of the various oral AAS used, the most common were methandrostenolone (e.g., Methandrostenolonum) and stanozolol (e.g., Winstrol).

Of the injected steroid preparations, nandrolone esters (e.g., Deca Durabolin) and various testosterone blends were used most frequently (table 2). Most of the patients had used various types of testosterone (e.g., cypionate, enanthate) and stanozolol. Four patients had also used AAS formulated as pellets, patches and gel.

Table 3 shows a summary of all the pharmaceuticals ever used by the patients. Ninety-seven percent of the patients had taken pharmaceutical drugs. The drugs had been either prescribed by a physician or acquired on the street. The most common drug, ephedrine, had been used by over 93% of the patients. The most commonly taken sedative, flunitrazepam (e.g., Rohypnol), was used by more than 50% of the patients.

People training at gyms commonly use dietary supplements. Almost all patients in this study (97%) had used supplements, some of which are listed in table 4. Protein powder and creatine were the most common, but multivitamins, ephedrine preparations, hGH stimulators, fat-loss agents and stimulants were also taken.

Table 5 lists the reasons given for using the drugs. While many of these are well documented, some were surprising; for example, some patients stated that insulin not only increased muscle mass and strength, but also burned fat. The site enhancement oil Synthol was used by 2 patients before the summer holidays with the intention of increasing the strength and volume of some muscles.

Discussion

This study clearly indicates that the use of AAS is often combined with the use of other illicit drugs and high amounts of alcohol. This is in line with the findings of earlier studies investigating AAS use among athletes, adolescents and other users [6, 27, 29, 33], secondary and high school students [27, 34], as well as victims of suicide [12]. However, this study provides a much more detailed and comprehensive account of current and lifetime drug use patterns in AAS users than has been reported previously.

Table 4. Lifetime use of dietary supplements in combination with AAS (n = 31)

Dietary supplements	Patients	% of total population	Examples
Protein	30	96.8	weight gain protein and Super Mass Fuel
Creatine	27	87.1	
Multivitamins	18	58.1	
Ephedrine preparations	15	48.4	Ripped Fuel and Thermoprof
hGH stimulators	9	29.0	γ-aminobutyric acid, glutamine and fish oil
Fat-loss agents	8	25.8	conjugated linoleic acid and calcium pyruvate
Stimulants	6	19.3	caffeine tablets, ephedrine, caffeine, acetylsalicylic acid (ECA stack)
Plant steroid compounds	5	16.1	*Tribulus terrestris*
Anti-catabolics	5	16.1	β-hydroxy-β-methylbutyrate
Nutrition replacements	4	12.9	Meritene
Testosterone boosters	2	6.4	chrysin and testomin

Our study, which was based on interviews with patients seeking help at an addiction clinic for problems related to AAS, demonstrates that multisubstance use is widespread among these individuals. AAS use was commonly combined with the use of other hormones as well as with alcohol, drugs of abuse, pharmaceuticals and dietary supplements.

Many of the patients in this study combined their steroid intake with that of polypeptide hormones such as insulin and insulin-like growth factor 1. One of the reasons given for use of insulin, which to our knowledge has not been reported previously, was the belief that it could be used for both increasing muscle mass and burning fat, depending on the dose.

The use of a wide variety of pharmaceuticals was also very common. We found it particularly interesting that the patients frequently took central stimulants as well as sedatives. These drugs were often acquired on the street, but we also found several cases where the drugs were prescribed for physical reasons, probably by doctors who were unaware of the patients' drug situation.

Previous studies have suggested that alcohol abuse may appear as a consequence of or a combination with AAS use [35]. An animal study [17] demonstrated that use of AAS could lead to a progressively higher intake of alcohol. In our study, a substantial proportion of the patients currently took alcohol to a hazardous or harmful extent and almost half of them received a diagnosis of alcohol abuse or dependence according to the DSM-IV criteria.

As described in some recent studies, AAS use may be associated with severe social problems [36] and psychological and physical complications [26], while polysubstance use complicates the prognosis for recovery. It is well known that individuals using AAS are often susceptible to psychiatric complications such as depression, mania, psychosis, aggression and dependency on other drugs [37].

This study clearly indicated that the most frequently used drugs were cannabis, amphetamine and ecstasy; most patients admitted to taking these drugs. Central stimulants and sedatives also appear to be currently popular in this group. In contrast to lifetime use, the drugs most often used in combination with AAS at the time of the interview were amphetamine and alcohol. In addition, several users were currently dependent on amphetamine according to the DSM-IV criteria. In many cases, the patients initiated their use of amphetamine and/or heroin after attempting to withdraw from AAS, which raises the question of whether the use of AAS could lead to the use of addictive drugs such as amphetamine and/or heroin, as has previously been proposed [13, 14]. In fact, animal studies have indicated that AAS can sensitize rats to amphetamine [38].

The reasons given for taking pharmaceuticals in combination with AAS varied widely. Some of the reasons are well recognized, but some were new to us. Several individuals claimed that they were combining steroids with benzodiazepines, drugs of abuse (heroin, GHB and cannabis) or alcohol to improve their sleep. About two thirds of the patients combined AAS with benzodiazepines, mainly flunitrazepam. It has been reported that drugs such as flunitrazepam can induce aggressive behaviour and, in some individuals, lead to acts of violence [39]. High doses of AAS have also been associated with aggression; however, the behavioural effects of combining AAS with benzodiazepines have not yet been evaluated.

Table 5. Reasons given for taking accessory drugs

Group/drug	Reasons for use
Hormones	
hGH	increase muscle mass and strength
Insulin-like growth factor 1	increase muscle mass and strength
Insulin	increase muscle mass and strength, burn fat
Thyroid hormone	burn fat
Stimulants/fat loss	
Narcotics (amphetamine)	increase endurance, burn fat
Narcotics (cocaine)	increase endurance, burn fat
Alcohol	relaxing, improve sleep
Ephedrine	increase endurance, burn fat
Bronchodilators	increase endurance, burn fat
Ephedrine preparations	increase endurance, burn fat
Fat-loss agents	burn fat
Stimulants	increase endurance, burn fat
Plant steroid compounds	increase endurance
Sedatives	
Narcotics (cannabis)	improve sleep
Narcotics (GHB)	improve sleep, release GH
Narcotics (heroin)	improve sleep, decrease pain
Benzodiazepines	improve sleep, increase self control, sedation
Anti-depressants	relieve symptoms of depression, increase serotonin and noradrenaline levels
Opioids	
Analgesics	decrease pain from training
Drugs against side effects	
Testosterone stimulating	prevent testicular atrophy
Anti-oestrogens	prevent gynaecomastia
Testosterone stimulating drugs/anti-oestrogen (Clomid)	prevent gynaecomastia and prevent testicular atrophy
Anti-inflammatory, NSAIDs	treat inflammation, pain and fever
Anti-acne	reduce acne problems
Diuretics	reduce oedema
Anti-hypertensive drugs	lower high blood pressure
Miscellaneous	
Muscle oil (synthol)	cosmetic increase in size of some muscles
Levodopa	increase growth hormone
Protein	increase protein synthesis
Creatine	increase muscle mass
hGH stimulators	increase muscle mass
Anti-catabolics	improve hepatic protein synthesis and nitrogen economy
Nutritional replacements	over the counter food replacement
Testosterone boosters	increase blood serum levels of testosterone

NSAIDs = Non-steroidal anti-inflammatory drugs.

Analgesics such as morphine, codeine, dextropropoxyphene and acetylsalicylic acid were taken to decrease the pain associated with training. This can be risky behaviour, as previous studies have shown that AAS may facilitate addiction to opiates [14]. In a study of 88 heroin users, 25% had a previous history of using AAS [13]. Furthermore, animal studies have suggested that AAS could sensitize the brain to opiate dependence [16].

It is well known that sympathomimetic drugs are commonly used with AAS. In our study, more than 90% of the patients used ephedrine, and 58% used other adrenergic drugs (e.g., clenbuterol or salbutamol). The reason given for taking ephedrine was to increase endur-

ance and to burn fat. Similar reasons were given for taking bronchodilators (salbutamol) and central stimulants such as amphetamine and cocaine.

Testosterone stimulators, such as human chorionic gonadotropin, were used to prevent testicular atrophy, and anti-oestrogens (mesterolone, tamoxifen and clomiphene) were used to prevent gynaecomastia. Both these phenomena are known to result from the use of AAS.

The combination of AAS and dietary supplements was common among steroid users. In particular, creatine, vitamin preparations, ephedrine preparations and a variety of different proteins were used. Protein and creatine were taken by almost all of the patients, and the majority also used vitamins and ephedrine preparations. In addition to taking hGH (genotropin or somatotropin), some patients also took hGH stimulators. Anti-catabolics, nutrition replacement preparations and testosterone boosters were used to a lesser extent.

Overall, these findings suggest that often users of AAS not only take multiple steroids but commonly use other hormones, drugs of abuse, alcohol, pharmaceuticals and dietary supplements. The long-term consequences for the physiology and mental health of individuals combining AAS with all these agents are not easy to foresee. There are a number of reports available in the literature showing that polysubstance use combined with AAS at high doses can result in severe complications [3, 8, 12, 40, 41]. The adverse effects of the drugs taken, the interactions associated with polypharmacy, the effects of the large dosages and the increased risk of addiction to other drugs of abuse and alcohol are all major health care concerns that require further study. The use of illicit drugs and heavy drinking also raise the issue of appropriate treatment approaches. Polysubstance use is a challenge for the clinician; it is questionable whether we have effective pharmacological treatments for all these addictions. Comparison of treatments for AAS use and treatments for abuse of other substances could be useful in this respect [1], with emphasis on psychosocial and psychological approaches in particular [42].

Our present results are based on a relatively small group of patients seeking help at an addiction clinic, which limits generalization of the results to a broader group of AAS users. However, we suggest that the results are important enough to stress the necessity for physicians and other clinicians to carry out a comprehensive inquiry into AAS use by their patients, with particular attention paid to the possibility of polysubstance use.

References

1 Brower KJ: Anabolic steroid abuse and dependence. Curr Psychiatry Rep 2002;4:377–387.
2 Pope HG Jr, Kanayama G, Ionescu-Pioggia M, Hudson JI: Anabolic steroid users' attitudes towards physicians. Addiction 2004; 99:1189–1194.
3 Pagonis TA, Angelopoulos NV, Koukoulis GN, Hadjichristodoulou CS: Psychiatric side effects induced by supraphysiological doses of combinations of anabolic steroids correlate to the severity of abuse. Eur Psychiatry 2006;21:551–562.
4 Handelsman DJ: Testosterone: use, misuse and abuse. Med J Aust 2006;185:436–439.
5 Mottram DR, George AJ: Anabolic steroids. Baillieres Best Pract Res Clin Endocrinol Metab 2000;14:55–69.
6 Parkinson AB, Evans NA: Anabolic androgenic steroids: a survey of 500 users. Med Sci Sports Exerc 2006;38:644–651.
7 Simon P, Striegel H, Aust F, Dietz K, Ulrich R: Doping in fitness sports: estimated number of unreported cases and individual probability of doping. Addiction 2006;101:1640–1644.
8 Hall RC: Abuse of supraphysiologic doses of anabolic steroids. South Med J 2005;98:550–555.
9 Perry PJ, Lund BC, Deninger MJ, Kutscher EC, Schneider J: Anabolic steroid use in weightlifters and bodybuilders: an internet survey of drug utilization. Clin J Sport Med 2005;15:326–330.
10 Casavant MJ, Blake K, Griffith J, Yates A, Copley LM: Consequences of use of anabolic androgenic steroids. Pediatr Clin North Am 2007;54:677–690.
11 Le Greves P, Huang W, Johansson P, Thornwall M, Zhou Q, Nyberg F: Effects of an anabolic-androgenic steroid on the regulation of the NMDA receptor NR1, NR2A and NR2B subunit mRNAs in brain regions of the male rat. Neurosci Lett 1997;226:61–64.
12 Thiblin I, Lindquist O, Rajs J: Cause and manner of death among users of anabolic androgenic steroids. J Forensic Sci 2000;45:16–23.
13 Kanayama G, Cohane GH, Weiss RD, Pope HG: Past anabolic-androgenic steroid use among men admitted for substance abuse treatment: an underrecognized problem? J Clin Psychiatry 2003;64:156–160.
14 Arvary D, Pope HG Jr: Anabolic-androgenic steroids as a gateway to opioid dependence. N Engl J Med 2000;342:1532.
15 Wines JD Jr, Gruber AJ, Pope HG Jr, Lukas SE: Nalbuphine hydrochloride dependence in anabolic steroid users. Am J Addict 1999; 8:161–164.
16 Celerier E, Yazdi MT, Castane A, Ghozland S, Nyberg F, Maldonado R: Effects of nandrolone on acute morphine responses, tolerance and dependence in mice. Eur J Pharmacol 2003;465:69–81.
17 Johansson P, Lindqvist A, Nyberg F, Fahlke C: Anabolic androgenic steroids affects alcohol intake, defensive behaviors and brain opioid peptides in the rat. Pharmacol Biochem Behav 2000;67:271–279.
18 Gruber AJ, Pope HG Jr: Psychiatric and medical effects of anabolic-androgenic steroid use in women. Psychother Psychosom 2000; 69:19–26.
19 Evans NA: Current concepts in anabolic-androgenic steroids. Am J Sports Med 2004;32: 534–542.
20 Congeni J, Miller S: Supplements and drugs used to enhance athletic performance. Pediatr Clin North Am 2002;49:435–461.
21 Bahrke MS, Yesalis CE: Abuse of anabolic androgenic steroids and related substances in sport and exercise. Curr Opin Pharmacol 2004;4:614–620.

22 Geyer H, Parr MK, Mareck U, Reinhart U, Schrader Y, Schanzer W: Analysis of nonhormonal nutritional supplements for anabolic-androgenic steroids – results of an international study. Int J Sports Med 2004;25:124–129.
23 Nilsson S, Baigi A, Marklund B, Fridlund B: Trends in the misuse of androgenic anabolic steroids among boys 16–17 years old in a primary health care area in Sweden. Scand J Prim Health Care 2001;19:181–182.
24 Morrison CL: Cocaine misuse in anabolic steroid users. J Perform Enhancing Drugs 1996;1:10–15.
25 Blue JG, Lombardo JA: Steroids and steroid-like compounds. Clin Sports Med 1999;18:667–689.
26 Eklof AC, Thurelius AM, Garle M, Rane A, Sjoqvist F: The anti-doping hot-line, a means to capture the abuse of doping agents in the Swedish society and a new service function in clinical pharmacology. Eur J Clin Pharmacol 2003;59:571–577.
27 Nilsson S, Baigi A, Marklund B, Fridlund B: The prevalence of the use of androgenic anabolic steroids by adolescents in a county of Sweden. Eur J Public Health 2001;11:195–197.
28 Brown JT: Anabolic steroids: what should the emergency physician know? Emerg Med Clin North Am 2005;23:815–826.
29 Evans NA: Gym and tonic: a profile of 100 male steroid users. Br J Sports Med 1997;31:54–58.
30 Malone DA Jr, Dimeff RJ, Lombardo JA, Sample RH: Psychiatric effects and psychoactive substance use in anabolic-androgenic steroid users. Clin J Sport Med 1995;5:25–31.
31 Saunders JB, Aasland OG, Babor TF, de la Fuente JR, Grant M: Development of the Alcohol Use Disorders Identification Test (AUDIT): WHO Collaborative Project on Early Detection of Persons with Harmful Alcohol Consumption – II. Addiction 1993;88:791–804.
32 Bergman H, Kallmen H: Alcohol use among Swedes and a psychometric evaluation of the Alcohol Use Disorders Identification Test. Alcohol Alcohol 2002;37:245–251.
33 Kindlundh AM, Hagekull B, Isacson DG, Nyberg F: Adolescent use of anabolic-androgenic steroids and relations to self-reports of social, personality and health aspects. Eur J Public Health 2001;11:322–328.
34 Kindlundh AM, Isacson DG, Berglund L, Nyberg F: Factors associated with adolescent use of doping agents: anabolic-androgenic steroids. Addiction 1999;94:543–553.
35 Lukas SE: CNS effects and abuse liability of anabolic-androgenic steroids. Annu Rev Pharmacol Toxicol 1996;36:333–357.
36 Skarberg K, Engstrom I: Troubled social background of male anabolic-androgenic steroid abusers in treatment. Subst Abuse Treat Prev Policy 2007;2:20.
37 Talih F, Fattal O, Malone D Jr: Anabolic steroid abuse: psychiatric and physical costs. Cleve Clin J Med 2007;74:341–344, 346, 349–352.
38 Steensland P, Hallberg M, Kindlundh A, Fahlke C, Nyberg F: Amphetamine-induced aggression is enhanced in rats pre-treated with the anabolic androgenic steroid nandrolone decanoate. Steroids 2005;70:199–204.
39 Daderman AM, Fredriksson B, Kristiansson M, Nilsson LH, Lidberg L: Violent behavior, impulsive decision-making, and anterograde amnesia while intoxicated with flunitrazepam and alcohol or other drugs: a case study in forensic psychiatric patients. J Am Acad Psychiatry Law 2002;30:238–251.
40 Wilson-Fearon C, Parrott AC: Multiple drug use and dietary restraint in a Mr Universe competitor: psychobiological effects. Percept Mot Skills 1999;88:579–580.
41 Kanayama G, Pope HG, Cohane G, Hudson JI: Risk factors for anabolic-androgenic steroid use among weightlifters: a case-control study. Drug Alcohol Depend 2003;71:77–86.
42 Corcoran JP, Longo ED: Psychological treatment of anabolic-androgenic steroid-dependent individuals. J Subst Abuse Treat 1992;9:229–235.